Golden
Timber Supply Area
Analysis Report

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Preface

This analysis is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

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

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the Forest Practices Code 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 every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

When setting the allowable annual cut (AAC) the Chief Forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the Golden TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information to provide a focus for public discussions of possible timber harvest levels. The fifth will outline the Chief Forester's harvest level 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 Golden Timber Supply Area (TSA). Areas adjacent to the TSA (Federal and Provincial Park) that fall within the same biogeoclimatic zones as in the TSA were included in the analysis for their biodiversity seral stage contribution. The combined area is referred to as the Golden analysis area. The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short (next 20 years) and long (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. **As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Golden TSA covers about 893 000 hectares of area in the Rocky Mountain Trench area of British Columbia. A further 267 000 hectares is in either Provincial or Federal park and is included in the analysis. About 167 000 hectares of the Golden TSA area are considered available for timber production and harvesting under current management practices. Within the area available for timber harvesting, most of the forests are dominated by spruce, Douglas-fir and lodgepole pine species. Smaller areas are also dominated by cedar, hemlock and subalpine fir species. Spruce, Douglas-fir, and pine are the tree species most commonly used by the forest industry in the area.

Current forest management practices follow the standards and legislation set out by the Forest Practices Code and therefore the protection of wildlife and the environment will be managed through the Code. Further direction stems from the *Kootenay-Boundary Land Use Plan Implementation Strategy*.

The results of the base case forecast of this timber supply analysis suggest that the current allowable annual cut level in the Golden TSA of 535 000 cubic metres per year, (woodlots excluded) can be maintained for two decades without creating future timber shortages. This is followed by a reduction in the harvest level over the subsequent two decades to the long-term harvest level of 446 000 cubic metres per year. This period of reductions will be referred to as the "transition" period.

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

These sensitivity analyses showed that, within the range of uncertainty examined in this analysis, short-term timber supply (over the next 20 years) in the Golden TSA is very sensitive to some data and management changes. Changes in green-up ages and land base both caused changes in short-term harvest levels.

Uncertainty in the size of the timber harvesting land base affects both the timing of the decline to the long-term harvest level, and the long-term harvest level itself. A 10% increased land base could allow the initial harvest level to be maintained for four decades, two decades longer than in the base case, as well as a higher long-term harvest level than in the base case. A 10% decreased land base would require an immediate harvest level reduction of 2% followed by an immediate decline that eventually reaches a 10% lower long-term harvest level compared to the base case. At this time there is information regarding the low timber productivity reduction to suggest that the timber harvesting land base could be up to 5% smaller than defined in the analysis.

Executive Summary

Uncertainty about the age at which stands reach green-up conditions has a large effect on projected harvests. When green-up ages are decreased by 5 years there was essentially no change in the harvest forecast from that of the base case. A 5 year increase in green-up ages, however, necessitates a small yet immediate reduction in the initial harvest level. In addition, if the maximum allowable area below green-up age is decreased by 5% then the initial harvest level can only be maintained for one decade.

Several of the sensitivity analysis resulted in the initial harvest level being maintained for only one decade. This indicates that the timber supply can be quite sensitive to some management changes in the short term.

Biodiversity assumptions regarding both the emphasis option assignment and the low emphasis 'draw down' (i.e., low emphasis requirements phased in over 140 years) were also found to be quite sensitive. When biodiversity emphasis options (as outlined in the *Kootenay-Boundary Land Use Plan Implementation Strategy*) were applied in the analysis, only one decade at the base case initial harvest level was possible. The same is true when the low emphasis old—seral stage biodiversity requirement is fully applied at the start of the analysis planning horizon.

Uncertainty about existing volumes and minimum harvestable ages have a large effect on the mid-term projected harvests, as well as some short-term impacts. When minimum harvestable ages are decreased by 10 years, it is possible to sustain the base case initial harvest level for five decades (three decade increase) before falling to a long term that is about 10% lower than that of the base case. When minimum harvestable ages are increase by 10 years, however, a drop below the long-term harvest level in the transition period in inevitable. It is still possible to attain the base case initial harvest level for a decade but the harvest must then decline to 425 000 cubic metres before rising to a long-term level of 460 000 cubic metres. A non-declining flow possibility would have the initial harvest level at 437 000 cubic metres with the long-term level (460 000 cubic metres) being attained in decade 12.

If existing stand volume estimates are decreased by 10%, the initial harvest level projected in the base case can still be maintained for a decade but a substantial drop below the long-term harvest level in the transition period is required. When existing stand volumes are increased by 10% then the initial harvest level can be maintained for 5 decades. The long-term harvest level is virtually unaffected by changes in existing stand volume estimates. An inventory audit completed in 1997 indicated that, for the Golden TSA as a whole, current inventory information together with the timber volume estimation model used for this analysis produced accurate estimates of existing stand volumes.

The visually sensitive areas cover a relatively small portion of the timber harvesting land base, however, the forest cover requirements applied to these areas in the base case frequently limit timber supply throughout the planning horizon thus, increasing or decreasing those requirements affects timber availability. The initial timber supply can only be held for one decade if the maximum per cent area allowed in a disturbed state is decreased by 10%. If this maximum per cent disturbed area is increased by 10% the initial harvest level can be maintained for three decades.

Uncertainty about regenerated stand volume estimates has an impact on the long-term harvest level, where the long-term harvest level is affected proportionately to the size of the increase or decrease in volume estimates. When regenerated stand volume estimates are decreased by 10%, it is possible to achieve three decades at the base case initial harvest level before declining to the long-term level. There is concern that the site indices used for some regenerated stands is an underestimate of their growing potential, however, sensitivity analysis around the estimates of site index shows only a long-term timber supply impact.

In conclusion, this analysis indicates that using current inventory and growth and yield information, timber harvest in the Golden TSA can be maintained at the current allowable level for the next 20 years. However several factors related to the current forest inventory and management regime could have a significant affect on timber supply.

Executive Summary

The socio-economic analysis for the Golden TSA indicates that the current AAC of 535 000 cubic metres per year can support approximately 717 person-years of direct employment and 803 person-years of indirect and induced employment across the province. Approximately 55% of these jobs are held by residents of the Golden TSA.

In the third decade, or starting 21 years from now the base case forecast annual harvest level of 482 000 cubic metres would support 646 person-years of direct employment and 723 person-years of indirect and induced employment across the province. In the fourth decade, or 31 years from now the base case forecast annual harvest level of 446 000 cubic metres would support 598 person-years of direct employment and 669 person-years of indirect and induced employment across the province. Consequently, in 40 years the total employment associated with the Golden TSA's timber supply could decline by as much as 267 person-years of employment; 140 person-years of which could be within the Golden TSA.

If fully harvested, the current AAC would provide the provincial government with revenue of approximately $16.4 million per year. After the first two decades, the base case forecast reduction in the timber supply would reduce annual provincial government revenues by approximately $1.7 million in decade 3 and an additional $1 million in decade 4. A harvest of 446 000 cubic metres per year in the fourth decade would result in provincial government revenues of $13.7 million per year.

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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 — 250 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* requires that the timber supply for management units through out 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.

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.

**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 7 *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 8 *of the* Forest Act.

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.

Introduction

The following sections outline the timber supply analysis for the Golden TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by a summary and conclusions.

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

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis section of this report provides the Chief Forester with some of the information necessary for these considerations. The socio-economic analysis also provides information for the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Golden TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by undertaking a socio-economic analysis using the harvest forecast as projected in the base case.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands related activities, processing, and silviculture. Employment is measured in terms of person-years. A person-year is defined as a full-time job and part-time positions are converted to person-years. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment were calculated using the Golden TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for these indirect and induced imports.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as order of magnitude indicators.

Multiplier
An estimate of the total employment supported by each direct job. For example, a multiplier of 2.0 means that one direct job supports one indirect and induced job.

Employment coefficient
The number of person-years of employment supported by each 1000 cubic metres of timber harvested. For example, an employment coefficient of 1.0 indicates that each 1000 cubic metres of timber harvested supports one person-year of employment; or 500 000 cubic metres supports 500 person-years of employment.

1 Description of the Golden Timber Supply Area

The Golden analysis area lies in the mid-eastern part of British Columbia within the Nelson Forest Region (Figure 1), and is administered from the Columbia Forest District office in Revelstoke. It is located approximately 140 kilometres east of Revelstoke and is bounded by the Revelstoke Timber Supply Area to the west; the Invermere Timber Supply Area to the south; and the province of Alberta to the east. The Golden TSA is one of seven timber supply areas in the Nelson Forest Region and comprises a total area of about 893 000 hectares. This analysis, however, is based on the Golden analysis area. The Golden analysis area is made up of the Golden TSA (893 000 hectares) and a further 267 000 hectares of federal and provincial park for a total area of about 1 160 000 hectares. The Golden analysis area is defined by landscape units both within and adjacent to the Golden TSA. Approximately 46% of the Golden analysis area is alpine. About 39% of the Golden analysis area is considered productive forest in terms of timber growth. Spruce, Douglas-fir, and pine are the dominant tree species in the area.

The current allowable annual cut for the Golden TSA, effective in 1995, is 540 000 cubic metres per year. However, from 1992 to 1997, the average annual harvest has been less than 407 000 cubic metres per year.

The town of Golden is the only sizable community within the Golden TSA, while the town of Field is within the analysis area. Recreation, railway operations and tourism are also important sources of economic activity in the area.

The Golden analysis area is located within the traditional territory of the Ktunaxa / Kinbasket Tribal Council and that of the Shuswap Nation Tribal Council.

1.1 The environment

The Golden TSA, located in southeastern British Columbia, is bounded by the Selkirk and Purcell Mountains to the west and the Rocky Mountains to the east. Covering 893 000 hectares, this timber supply area includes valley bottom lands in the Rocky Mountain Trench and the Columbia River Valley as well as adjacent rugged mountainous areas. Extending from south of Golden, north to the Big Bend area near the Mica Dam, the Golden TSA borders five national parks and two provincial parks.

Most of this timber supply area lies in the interior wet belt. Lower elevations are occupied predominantly by stands of western redcedar, western hemlock, Douglas-fir and lodgepole pine, while higher elevation forests consist of spruce and subalpine fir. The southern portion of the area has a drier climate, resulting in a greater proportion of Douglas-fir and lodgepole pine. Mountain peaks are covered by expanses of alpine tundra, rock and ice. Table 1 summarizes the biogeoclimatic zones present, their location, the major tree species and other considerations such as climate and wildlife values.

1 Description of the Golden Timber Supply Area

Table 1. Biogeoclimatic zones of the Golden timber supply area

Zone	Location	Tree species		Other
		Dominant	Minor	
Interior Cedar-hemlock	Occupies valley bottoms and lower slopes (below 1500 metres).	Western hemlock Western redcedar Douglas-fir	Lodgepole pine Western white pine Engelmann spruce Hybrid white spruce Subalpine fir	Cool winters with heavy snow; warm, dry summers. This is the most productive forest zone in interior B.C. and has the highest diversity of tree species of any B.C. zone. Wildlife constrained by deep winter snows.
Interior Douglas-fir	Limited occurrences in valley bottoms south of Golden.	Douglas-fir Lodgepole pine	Hybrid white spruce	Warm, dry summers, cool winters. Provides wide range of wildlife habitats.
Montane spruce	Above interior Douglas-fir and below Engelmann spruce-subalpine fir (1100 to 1600 metres).	Hybrid white spruce Lodgepole pine Subalpine fir	Douglas-fir	Moderately short, warm summers and cold, snowy winters. Most ungulates (except caribou) migrate to these lower elevations in winter.
Engelmann spruce-subalpine fir	Above interior Cedar-hemlock and Montane spruce, and below Alpine tundra (1500 to 2250 metres).	Engelmann spruce Subalpine fir	Lodgepole pine Whitebark pine Limber pine	Short, cool growing season. Long, cold winters with heavy snow. Wildlife constrained by deep snows and steep slopes.
Alpine tundra	Above Engelmann spruce-subalpine fir.	Treeless except for stunted forms at lower elevations of zone.		Cold, windy and snowy. Low growing season temperatures. Wildlife species and diversity low.

As a result of its mountainous terrain and a climate modified by both coastal and continental influences, the Golden timber supply area has a diverse forested environment that provides habitat for a wide variety of wildlife species. According to a 1992 inventory, approximately 274 bird, 63 mammal, 9 amphibian and 8 reptile species inhabit the area. Large mammal species include black and grizzly bear, moose, elk, mule deer, bighorn sheep and mountain goat. The northern part of the Golden TSA also overlaps the range of one of only three viable populations of mountain caribou in western Canada.

Wildlife species that live at high elevations or rely on young forests for habitat are generally abundant. More than one-half of all species rely on low elevation habitats, including grasslands, wetlands and riparian forests. Animals that depend on the retention of mature forests include peregrine falcon, bald eagle, great blue heron, grizzly bear, caribou, fisher, cavity-nesting birds and small mammals.

1 Description of the Golden Timber Supply Area

The majority of species that occur or potentially may be found in the Golden timber supply area, and that are considered at risk or regionally significant, are presented in Table 2. In addition, 8 rare plant communities and 17 species of plants considered rare or endangered have been identified in the Golden TSA.

Table 2. Vulnerable, endangered, threatened and regionally significant species[1]

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	Regionally significant (yellow-listed)	
northern long-eared myotis	caribou	mountain goat	Vaux's swift
prairie falcon	fisher	marten	Barrow's goldeneye
western grebe	*luscus* wolverine	moose	common goldeneye
upland sandpiper	grizzly bear	elk	northern goshawk (*atricapillus*)
northern leopard frog	bighorn sheep (*canadensis)*	mule deer	long-eared owl
white sturgeon	southern red-back vole (*galei*)	white-tailed deer	sharp-shinned hawk
	great blue heron	Harlequin duck	wood duck
	short-eared owl	northern pygmy owl	northern saw-whet owl
	American bittern	bald eagle	blacked chinned hummingbird
	turkey vulture	Cooper's hawk	bufflehead
	American avocet	eared grebe	spotted frog
	sandhill crane	northern harrier	
	flammulated owl	pileated woodpecker	
	trumpeter swan		
	Lewis woodpecker		
	painted turtle		
	bull trout		

(1) B.C. Conservation Data Centre, June 1996.

Current forest management practices follow the standards and legislation set out by the Forest Practices Code (FPC) and guidebooks. As well, several strategies described in the *Kootenay-Boundary Land Use Plan Implementation Strategy* are being implemented. These standards and strategies serve to manage for a range of critical biodiversity values, throughout the Golden TSA. Many of these strategies are newly implemented and reflect improvements to past management of biological resources.

The resource management guidelines for ungulate winter habitat, riparian forests and wildlife trees are being implemented to manage for species that require these forest types. Implementation of these guidelines aids in the maintenance of critical forest habitats for many species.

1.2 First Nations

The Golden timber supply area is within the traditional territories of the Ktunaxa Nation and the Shuswap Nation. The Ktunaxa Kinbasket Tribal Council has submitted a comprehensive land claim covering the southeast corner of the province, including this timber supply area. The tribal council is currently conducting a traditional-use site inventory. There are no First Nations reserves or communities within the timber supply area.

1 Description of the Golden Timber Supply Area

Figure 1a. Map of the Golden analysis area in relation to the Nelson Forest Region and provincially.

1 Description of the Golden Timber Supply Area

Figure 1b. Map of the Golden analysis area landscape units.

2 Information Preparation for the Timber Supply Analysis

Much information is required for timber supply analysis. This information falls into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled by the B.C. Forest Service, Resources Inventory Branch in 1994. Additional land base information was added to this file by the Nelson Regional Land Information Management section and the Columbia Forest District office. These files contain a considerable amount of information on the forest land in the Golden analysis area including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other notable characteristics such as environmental sensitivity and physical accessibility (operability). Stand characteristics such as tree height, stocking* and age have been projected to 1996. Also, the file has been updated to account for timber harvesting up to January 1, 1994.

The inventory file represents the land base for the entire Golden analysis area as described above in, Section 1, "Description of the Golden Timber Supply Area." This includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, and areas in power lines, highways, or town sites. A description of these areas specific to the Golden TSA is provided below. These types of areas do not contribute to the timber supply of the Golden TSA but the forested areas do contribute to meeting seral-stage targets for biodiversity* objectives. Before assessing timber supply these non-contributing areas are identified and separated from the land base which represents the timber harvesting land base*. When deriving this data file, care is taken to make only a single separation for areas with more than one characteristic that would make it unavailable for harvesting (for example, where a park area is also suitable for wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is also removed from the Golden analysis area. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein 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 the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Biodiversity
The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

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 separating non-contributing areas from the total land base according to specified management assumptions.

2 Information Preparation for the Timber Supply Analysis

For the Golden TSA, the following types of areas were considered not to contribute to the timber harvesting land base.

- non-Crown area — areas not managed directly by the B.C. Forest Service.
- non-productive areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- streamside buffers/riparian areas — areas assumed to be unavailable for timber harvesting to account for protection for riparian* and stream ecosystems.
- environmentally sensitive areas* — portions of the areas having environmental sensitivity concerns are not available for timber harvesting.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (e.g., presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- low timber productivity areas — areas occupied by forest stands with low timber-growing potential.
- problem forest types — areas covered by timber stands that are physically operable and have adequate productivity, but are not yet currently utilized or have marginal merchantability.
- deciduous stands — areas covered by predominantly deciduous species are not currently utilized.
- existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- stand-level biodiversity — patches of standing timber larger than two hectares are maintained within harvested areas to provide for the maintenance of stand structure over time.
- future roads, trails, and landings - future losses of productive forest land to development. These areas are initially included in the timber harvesting land base, and are subsequently 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 for the Timber Supply Analysis." Table 3 summarizes the areas in each category, and shows the area of the timber harvesting land base.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
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 timber harvesting may cause avalanches.

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

2 Information Preparation for the Timber Supply Analysis

Table 3. Timber harvesting land base for the Golden TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total Golden analysis area	1 160 460.8	100.0	
Federal parks	– 219 813.0	18.9	
Provincial parks (> 100 hectares)	– 47 295.7	4.1	
Golden TSA total	**893 352.1**	**77.0**	
Non-Crown land	– 26 098.3	2.2	
Non-productive	– 571 456.6	49.2	
Total productive forest managed by the Forest Service (Crown forest)	**295 797.3**	**25.5**	**100**
Reductions to Crown forest:			
Non-commercial cover (brush)	2 089.9	0.2	0.7
Inoperable	82 458.7	7.1	27.9
Environmentally sensitive	9 981.7	0.9	3.4
Deciduous stands	10 629.4	0.9	3.6
Low timber productivity	2 114.3	0.2	0.7
Problem forest types	1 255.4	0.1	0.4
Existing roads	5 314.7	0.5	1.8
Riparian	7 166.8	0.6	2.4
Stand-level biodiversity	8 171.2	0.7	2.8
Total current reductions[a]	**– 129 182.1**	**11.1**	**43.7**
Current timber harvesting land base (includes 15 072.7 hectares not satisfactorily restocked (NSR)* land)[b]	**166 615.2**	**14.4**	**56.3**
Future reductions			
Future roads	8 522.0	0.7	2.9
Long-term timber harvesting land base	**158 093.2**	**13.6**	**53.4**

(a) Reductions were performed in the order listed in the table.
(b) NSR includes: current NSR and backlog NSR.

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

2 Information Preparation for the Timber Supply Analysis

In order to complete the timber supply analysis all forested land within the analysis area that contributes to the various requirements in the analysis must be included in the analysis land base. For example biodiversity requirements are met from all forested land thus for the Golden TSA the forested portion of the parks and the forested areas separated as not contributing to the timber harvesting land base must be included in the analysis model information. Table 4 shows the total forested land base that is included in the Golden analysis area.

Table 4. Golden analysis area, forested portion

Classification	Area (hectares)
Total productive forest managed by the Forest Service (Crown forest)	295 797.3
Forested portion of parks (for analysis of biodiversity contribution only)	+156 059.3
Forested portion of the Golden analysis area	**451 856.6**

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents both the Golden analysis area, and the forested area. As discussed above, the Golden analysis area includes parks (as does the forested area) that are outside of the Golden TSA. The Golden analysis area chart shows that about 61% of the area is classified as either non-forest, non-productive forest (i.e., having very few trees) or non—crown land. The forested area chart details the categories of forest land and shows that about 63% of the forest land in the Golden analysis area is not considered part of the timber harvesting land base. Of this, about 18% is considered to be physically or economically inoperable at this time. An additional 4% is identified as low timber productivity, problem forest types (PFT), deciduous stands and non-commercial cover. Approximately 1% of the productive forest is unavailable for harvesting due to existing roads, and 6% of the productive forest is excluded from timber harvesting due to stand-level biodiversity, riparian areas and environmental sensitivity (ESA). About 37% of the Golden analysis area forest is considered available for timber harvesting.

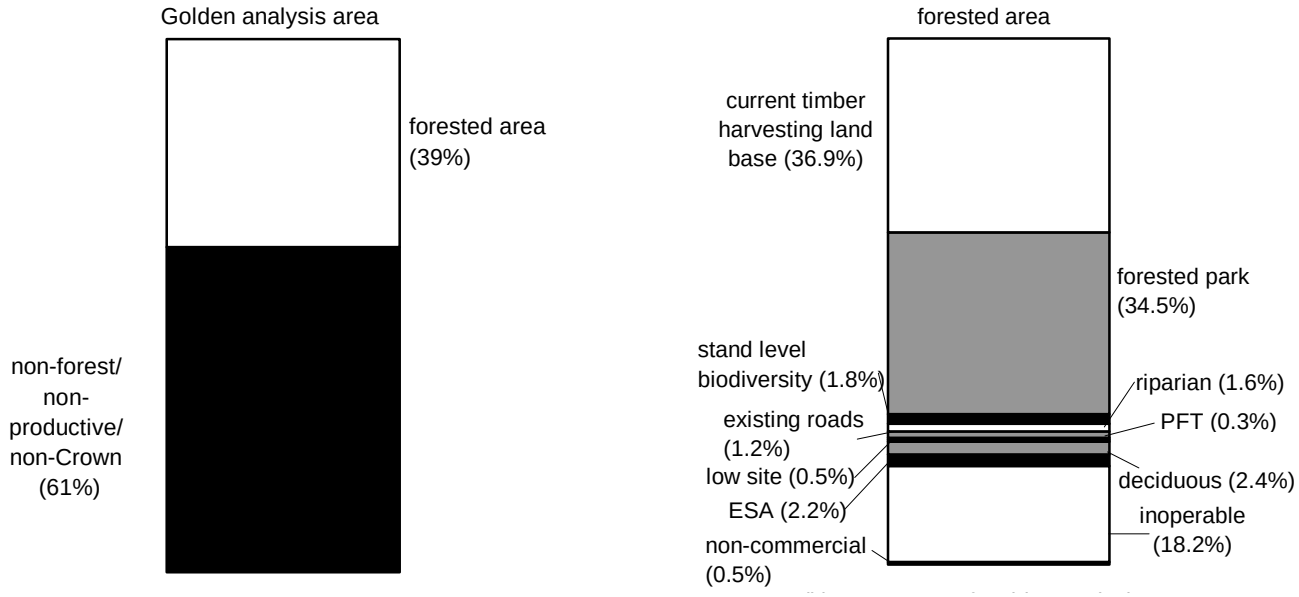


Figure 2. Composition of the total and productive forest land bases — Golden analysis area, 1998.

2 Information Preparation for the Timber Supply Analysis

Figure 3a shows the current composition of the Golden timber harvesting land base by dominant tree species and the area removed from the timber harvesting land base grouped into two additional categories. The 'operable excluded' refers to that portion of the Golden analysis area which is physically and economically operable but was removed from contributing to harvest due to other factors such as riparian management or environmental sensitivity, (see Table 1 for a complete list). The inoperable forest refers to forested area within the Golden analysis area which were deemed inoperable due to accessibility, economics, etc. These two categories make up 63% of the Golden analysis area. The timber harvesting land base is comprised of the other 37% of the area.

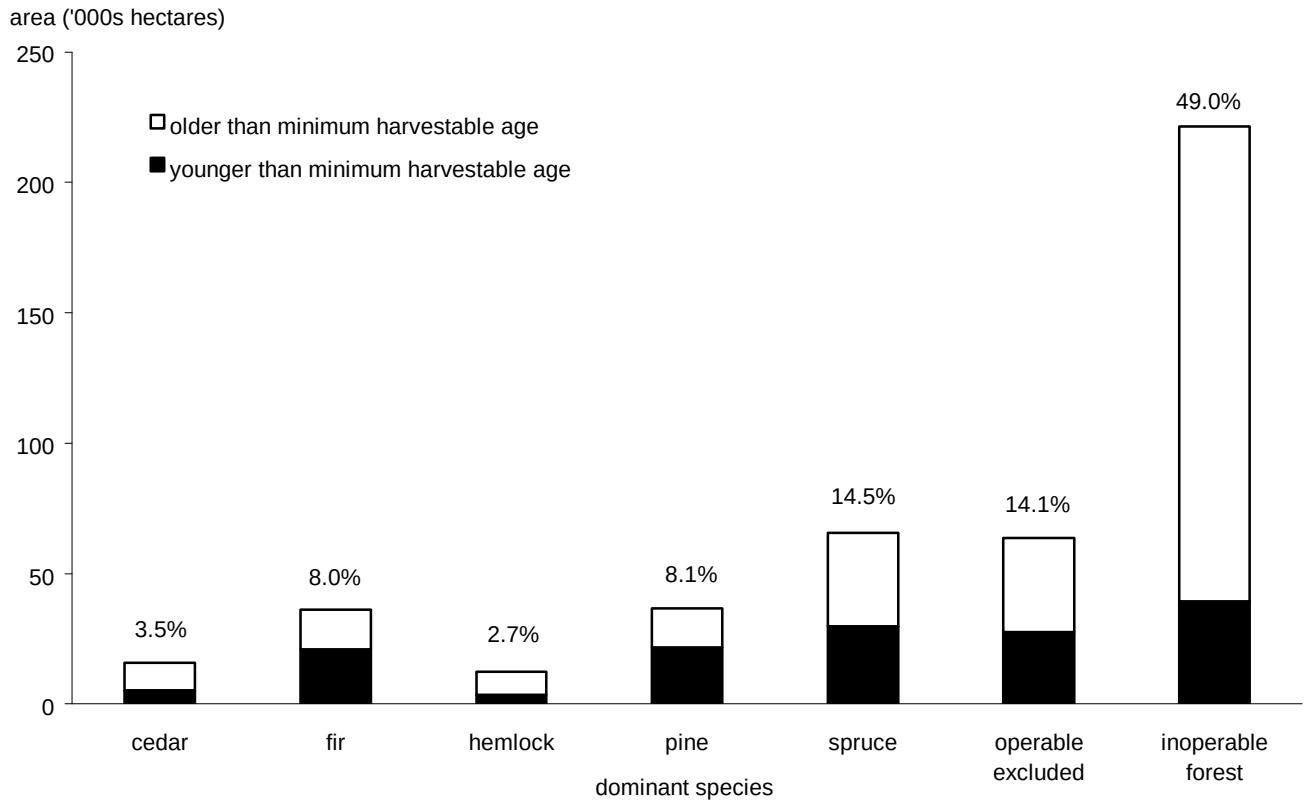


Figure 3a. Area by dominant tree species — Golden analysis area, 1998.

Figure 3b shows the current composition of the timber harvesting land base by dominant tree species. Spruce stands dominate about 39% of this area. Douglas-fir and lodgepole make up about 22% of the timber harvesting land base each.

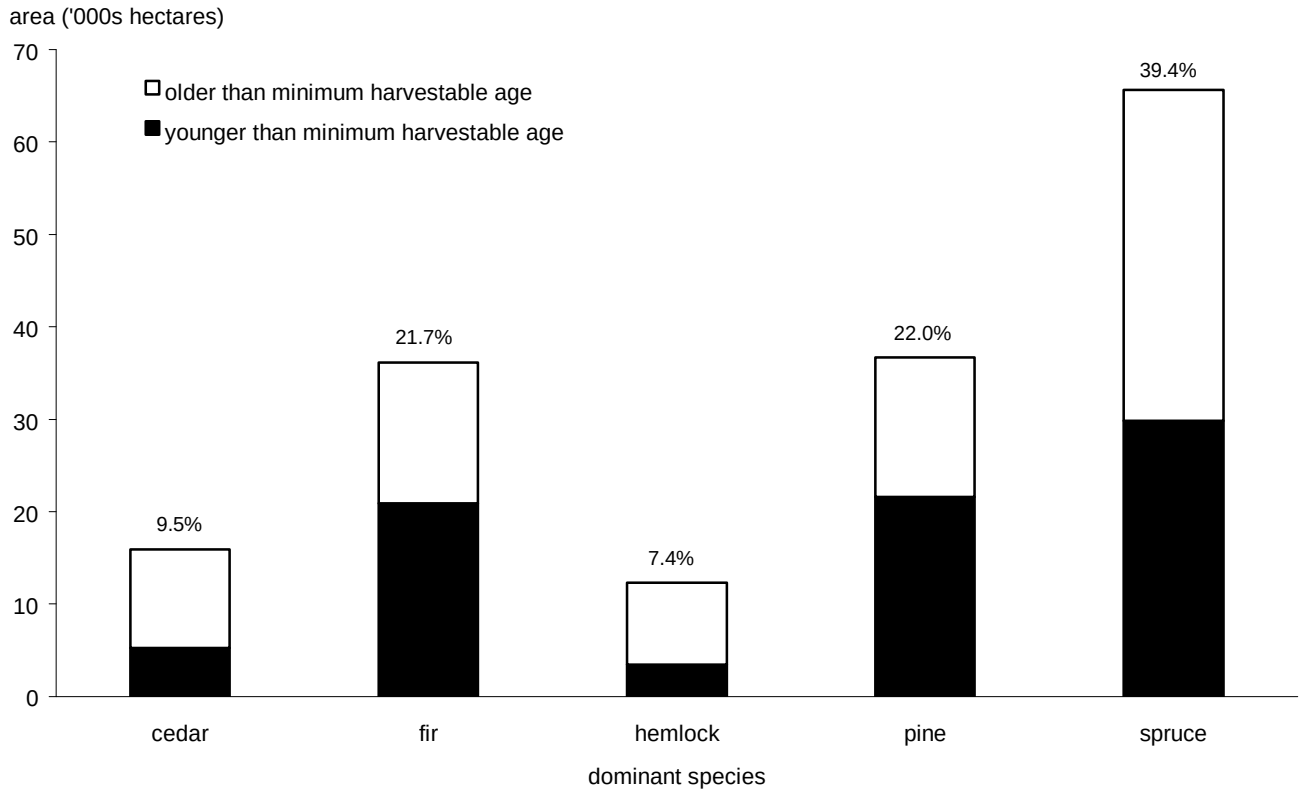


Figure 3b. Area by dominant tree species — Golden timber harvesting land base, 1998.

Figures 3a and 3b also show the proportion of area in each species that is either younger or older than the minimum harvestable age (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In the timber harvesting land base (Figure 3b), about 51% of stands are at or above the minimum harvestable age. There is significant variation around this proportion for each of the species groupings: 72% of hemlock stands, 67% of cedar stands, 54% of spruce stands, 42% of Douglas-fir stands and 41% of lodgepole pine stands are currently older than the minimum harvestable age.

In the Golden TSA, it appears that harvesting has been concentrated more in spruce, Douglas-fir and lodgepole pine stands. However, lodgepole pine–dominated ecosystems are susceptible to naturally-occurring fire and in this case the larger proportion of younger area of lodgepole pine forest is partly due to fire history. In addition, most harvested areas are planted with pine and/or spruce which increases the proportion of area occupied by younger pine and spruce stands.

2 Information Preparation for the Timber Supply Analysis

Figure 4 provides an overview of the distribution of site productivity within the timber harvesting land base, and the area in each class that is above and below the minimum harvestable age. More than one-half (56%) of the sites in the timber harvesting land base are classified as having good or medium 1 productivity, and 27% have poor productivity. The medium 1 and medium 2 classifications exist in the spruce and pine analysis units*. Sites were classified according to site index ranges which are further explained in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," Table A-2. — Definition of analysis units. Sites classified as having low productivity are excluded from the timber harvesting land base. Past disturbances appear to have been spread across all site productivity classes.

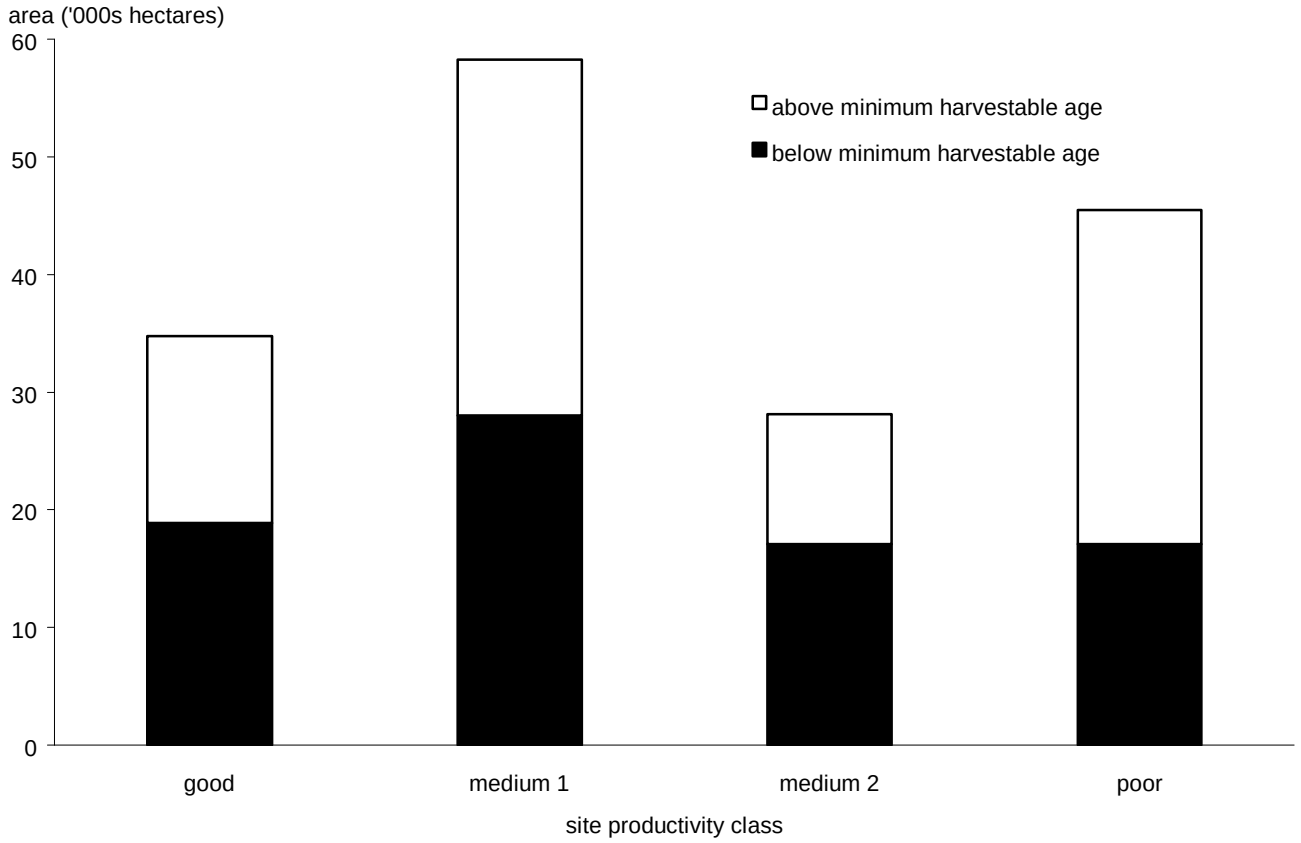


Figure 4. Area by site productivity class — Golden timber harvesting land base, 1998.

Analysis unit
The basic building blocks around which inventory data and other information are assembled for use in forest planning models. Analysis units represent the general level of aggregation, or detail, at which the growth and yield volume curves are created. They are normally defined by tree species and site qualities, but may also be defined to incorporate specific geographic areas or areas under a similar set of management practices.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age composition of forested stands in the Golden analysis area. Within the timber harvesting land base, a substantial portion (34%) of stands are older than 140 years — with about 13% being greater than 250 years. The timber harvesting land base also has about 31% of stands that are 30 years or younger, 29% are between 31 and 100 years old, and 6% are between 101 and 140 years of age. Almost 56% of the stands in the timber harvesting land base are at or above the minimum harvestable age applicable to the stand, and a large portion of the area presently occupied by stands between the ages of 60 and 100 years will reach minimum harvestable age in the short term.

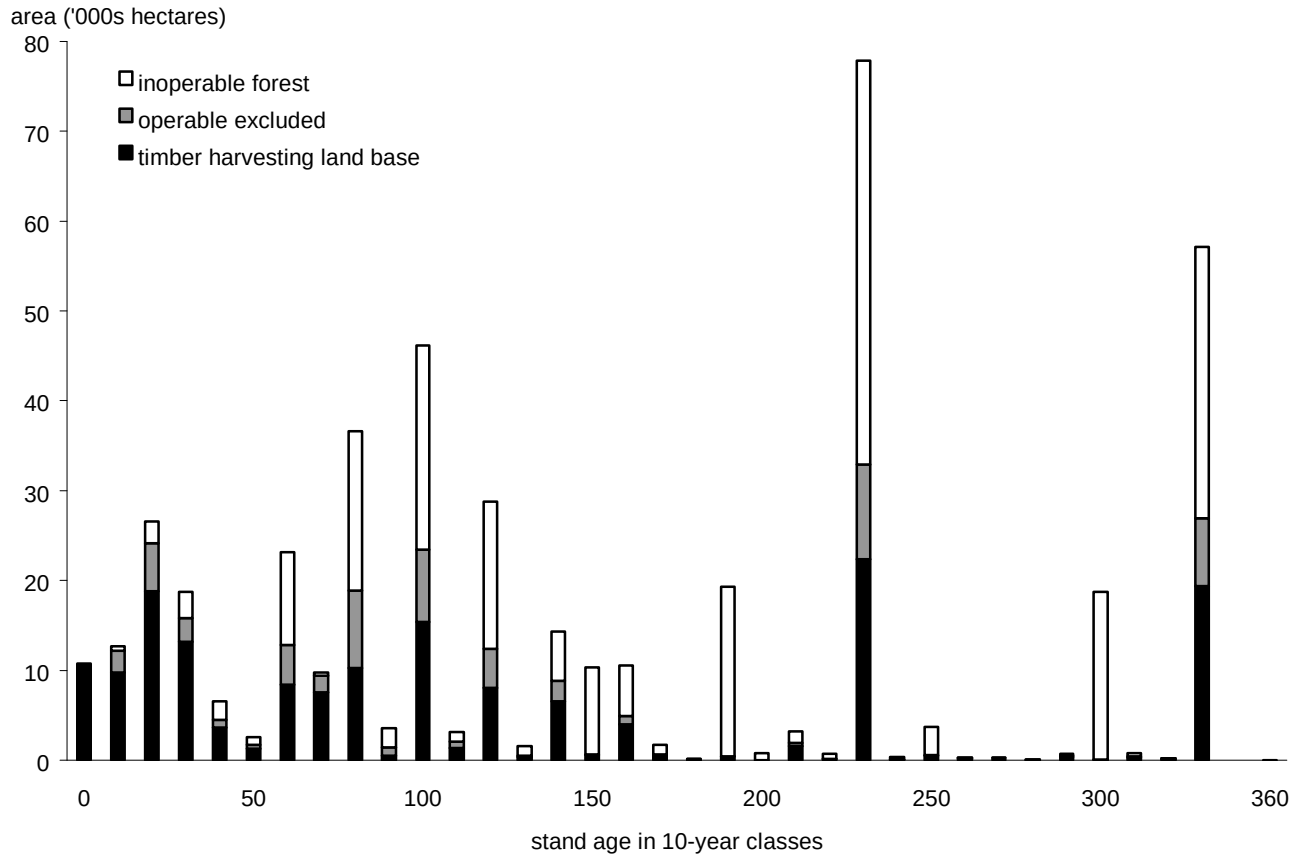


Figure 5. Current age class composition — Golden analysis area, 1998.

The age class distribution of forested stands excluded from the timber harvesting land base also affect timber supply. In the case of the Golden analysis area, a significant portion of the total land base is covered by these stands which, although they do not contribute timber volume to the harvest forecasts, do contribute to old and mature plus old seral targets for biodiversity and wildlife habitat. Thus, the area outside the timber harvesting land base which contributes to meeting non-timber management objectives can affect the pattern and extent of harvesting within the Golden TSA. In the inoperable forest, 24% of the area is greater than 250 years, and 64% is greater than 140 years. Only 3% of inoperable stands and 16% of operable non-contributing stands are 30 years or younger. In the analysis, most of the biodiversity– seral stage requirements (old and mature plus old) within the Golden analysis area are met by the area in the inoperable forest and operable excluded stands.

2 Information Preparation for the Timber Supply Analysis

As noted above the area of forested stands excluded from the timber harvesting land base also affects the timber supply. Figure 6 shows that all biogeoclimatic zones except the interior cedar hemlock (ICH) have at least 50% of their area in either the inoperable or non-contributing stands. Almost 75% of area in all Engleman spruce/subalpine fir (ESSF) zones are in the inoperable and non-contributing categories. In the ICHmw1, the largest biogeoclimatic variant, only 35% of the area is in the inoperable and non-contributing categories.

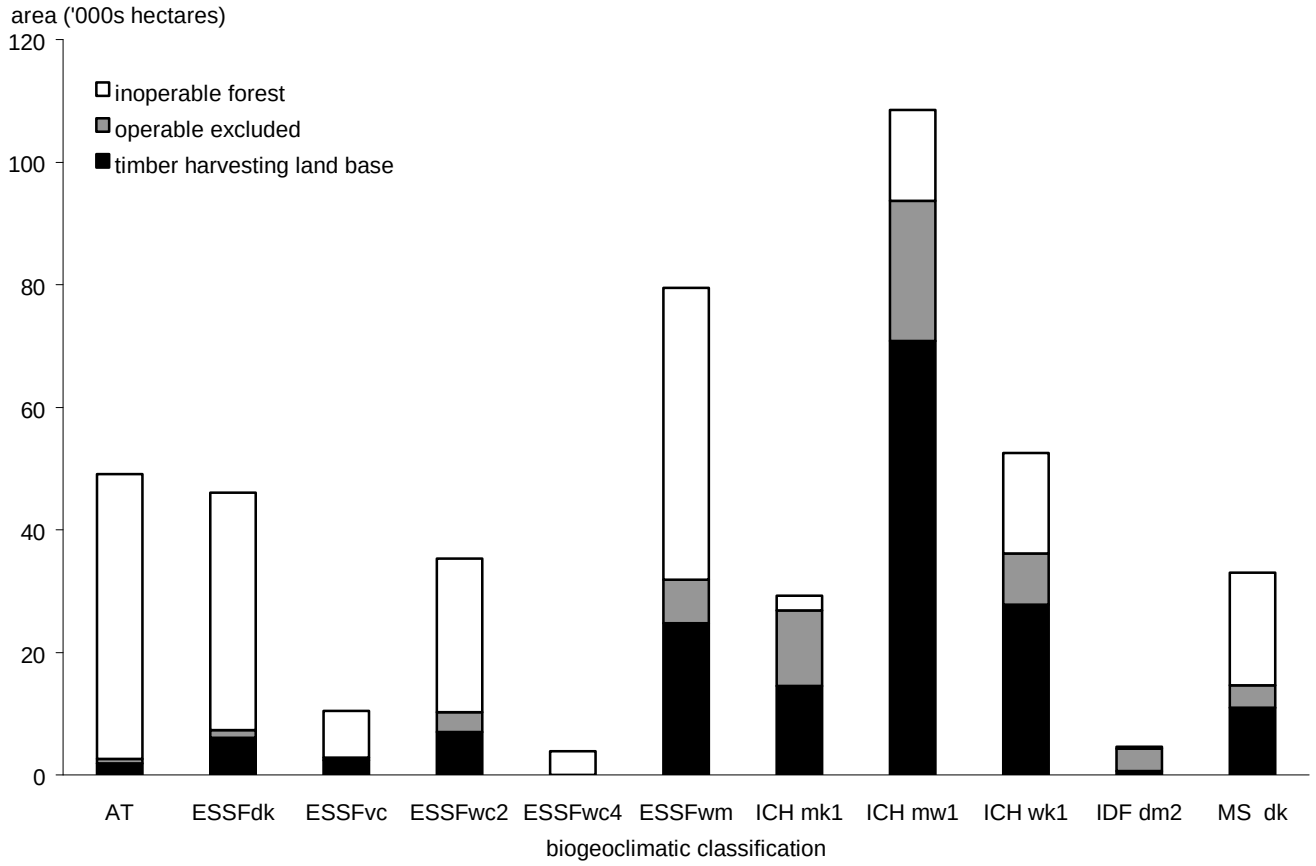


Figure 6. Distribution of area by biogeoclimatic units — Golden analysis area, 1998.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time (e.g., number of trees per area, tree diameter, tree height, species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (in B.C., cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of dimensions, that establish the minimum tree and log sizes that must be removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Golden analysis area. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing stands. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate volumes for the managed stands. All stands harvested or regenerated over the last 20 years, and those that will be harvested in the future are assumed to grow according to managed stand volume estimates from TIPSY.

Volume estimation and prediction is subject to a fair amount of uncertainty due to uncertainty in inventories which form the basis for estimating site productivity, and to limited experience with second growth in British Columbia. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates* the current timber inventory on the timber harvesting land base is approximately 32.4 million cubic metres. About 28.7 million cubic metres, or 88%, of the total, are currently merchantable; that is, older than the minimum harvestable age.

Volume estimate (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.

2 Information Preparation for the Timber Supply Analysis

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The focus of the timber supply review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Columbia Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species.
- Forest health and unsalvaged losses* — average annual unsalvaged losses to natural forces such as fire, insects and wind are expected to average 24 700 cubic metres per year. This amount has been subtracted from all harvest forecasts shown in this report.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set based on the age at which stands reach a minimum merchantable volume, a minimum diameter; the culmination age*; and professional judgment. The minimum harvestable age defines the youngest age at which a stand can be harvested in the analysis. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives* and overall timber harvest targets.
- Cutblock adjacency* and green-up* — in the Golden TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up height, before adjacent stands may be harvested. Furthermore, the area in the timber harvesting land base that does not meet green-up conditions cannot exceed 15% in the visual quality management zones, and 25% in the caribou, watersheds*, ungulate winter range, and integrated resource management zones. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. These guidelines are the analytical equivalent for between block adjacency and hydrologic recovery requirements.
- The integrated resources management (IRM) zone consists of areas not occupied by one of the other resource emphasis zones. The IRM zone consists of 83 542 hectares (50.1%) of the timber harvesting land base, and 111 397 hectares (48.3%) of the operable land base. IRM guidelines require that at most 25% (by landscape unit) of the IRM area can be less that 2 metres tall.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. This 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.
Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

- Management for caribou habitat — maintenance of specific caribou habitat types is required in the Golden analysis area. The caribou area is divided by biogeoclimatic zone to distribute harvest and provide habitat in both biogeoclimatic zones. Caribou habitat areas in the ESSF biogeoclimatic zone cover 6121 hectares of the operable land base, which includes 4313 hectares in the timber harvesting land base (forest cover requirements are placed on the operable land base which includes the timber harvesting land base and the operable excluded land base). Caribou habitat in the ICH biogeoclimatic zone covers 25 939 hectares (11.2%) of the operable land base, this includes 19 797 hectares (11.9%) of the timber harvesting land base. In all caribou habitat areas, at least 40% of the operable land base must be covered by stands older than 140 years, and at least 10% of the operable area must be covered by stands older than 250 years.
- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits in some areas of the Golden TSA. All visually sensitive areas in the Golden analysis area are assigned a visual quality objective*(VQO) of partial retention*. The VQO area, which occupies 21 343 hectares (12.8%) of the timber harvesting land base also occupies 29 194 hectares (12.7%) of the operable land base. In these areas, harvesting may be noticeable, but not dominant. At most 15% of the visually sensitive areas within a landscape unit may be covered by stands less than 6 metres tall (the visual green-up).
- Management of domestic watersheds — maintaining forest cover to maintain water quality and quantity, and to prevent erosion. In total, domestic watersheds cover 3899 hectares (2.3%) of the timber harvesting land base, and 8952 hectares (3.9%) of the operable land base. At most 25% of each domestic watershed area may be covered by stands less than 6 metres tall.
- Management of ungulate winter range — maintaining suitable cover for winter travel. Ungulate winter range comprises 44 895 hectares (26.9%) of the timber harvesting land base, and 23 314 hectares (36.6%) of the operable land base. At most 25% of the ungulate winter range (by landscape unit) area may be covered by stands less than 2 metres tall. Furthermore, 40% of the operable area is to remain in stands greater than 100 years.
- The caribou, ungulate winter range, VQO, and domestic watersheds resource emphasis areas overlap in many places. Thus there may be more than one forest cover requirements applied to an area within the TSA. In the cases where the area must meet several requirements the analysis was designed to ensure that all requirements are met.

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.

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**).*

- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit*, requirements are placed on the amount of area in the landscape unit that must be covered by stands with both old forest and 'mature plus old' forest characteristics. In the Golden analysis area, within each landscape unit – biogeoclimatic zone–subzone–variant combination, a proportion of the forested area must be covered by stands older than either 140 or 250 years for old-seral stage requirement and a portion greater than 100 or 120 years for the mature plus old requirement. See Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," for a more complete discussion of landscape-level biodiversity also refer back to Figure 6 for the land base associated with each biogeoclimatic zone–subzone–variant.

More detailed descriptions of all of these management practices and the assumptions used to assess their impacts on timber supply are included in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Landscape-level biodiversity
Maintenance of biodiversity can occur at a variety of levels. The Forest Practices Code Biodiversity Guidebook *applies to the landscape level and the stand level.*

Landscape unit
A landscape unit provides an appropriately sized (up to 100 000 hectares) planning unit for application of landscape-level biodiversity objectives.

2 Information Preparation for the Timber Supply Analysis

Figure 7 displays the composition of the timber harvesting land base according to management emphasis (or management zone). The percentages total to more than 100% due to the overlap between resource emphasis areas. Information on the overlap of management emphasis areas and details on the area associated with each can be found in Appendix A "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

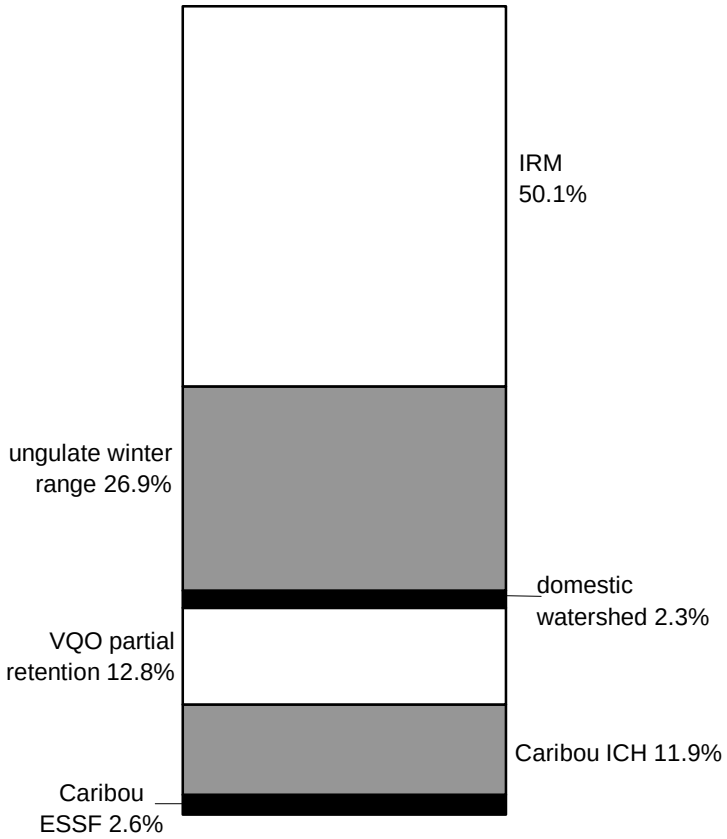


Figure 7. Forest management zones — Golden timber harvesting land base, 1998.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Golden analysis area, 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 projected harvest remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to assigned yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. The Forest Service model also 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 facilitates examination of 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 assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

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

4 Results

This section presents results of the timber supply analysis for the Golden analysis area. The analysis uses a recent assessment of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." 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 long-term venture, uncertainty surrounds much of the information important in determining timber supply. This uncertainty will be discussed in Section 5, "Timber Supply Sensitivity Analyses." However, it is important to keep in mind that the base case provides only a part of the timber supply picture for the Golden analysis area, and should not be viewed in isolation of the sensitivity analysis.

4.1 Base case harvest forecast

Figure 8 shows the base case harvest forecast* for the Golden analysis area. The current allowable annual harvest level of 535 000 cubic metres (540 000 minus 5000 cubic metres for woodlots) can be maintained for two decades, without causing timber supply shortages in the future. This is followed by a downward step of 10%, followed by a 7% reduction to the long-term harvest level* of 446 000 cubic metres per year, which is reached in decade 4.

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.

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

4 Results

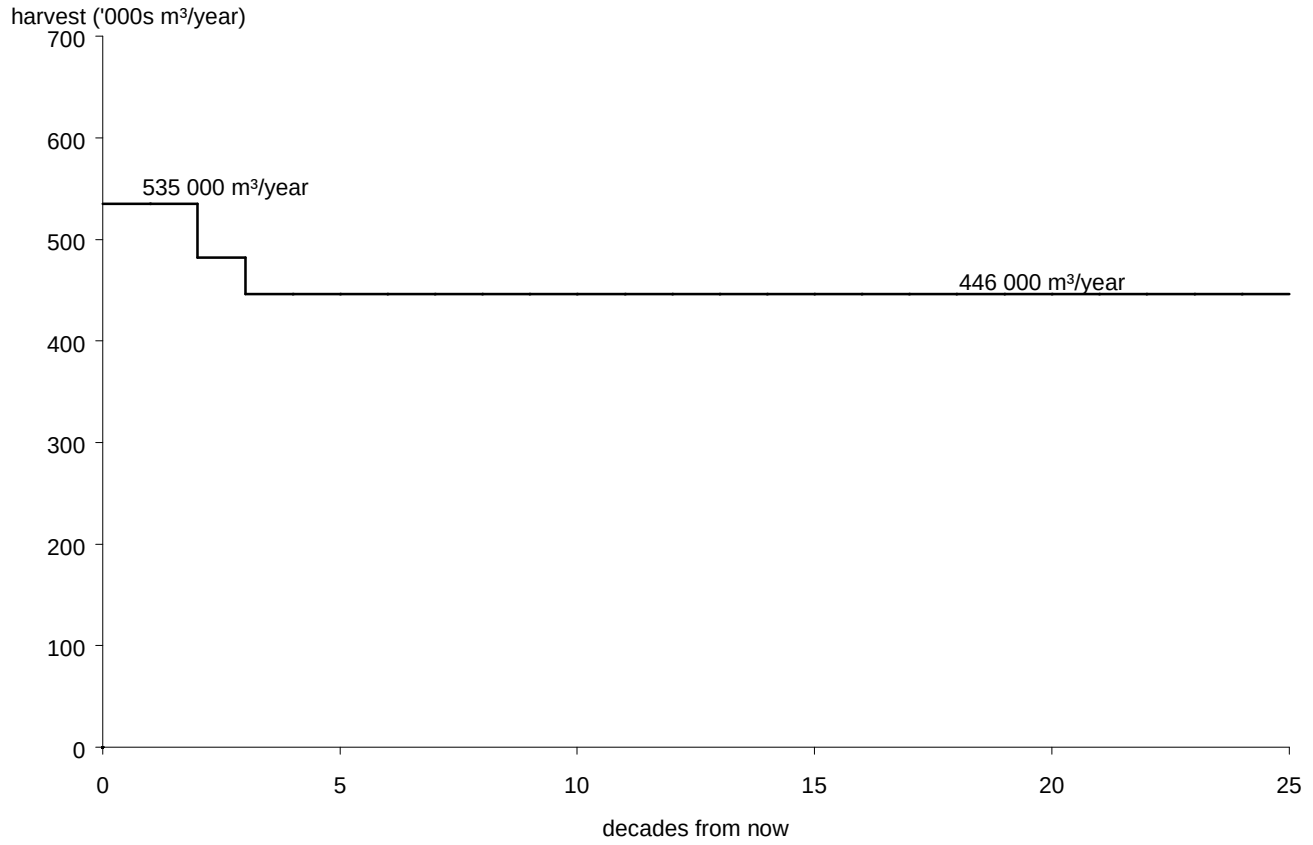


Figure 8. Base case harvest forecast for the Golden TSA, 1998.

Unsalvaged losses to natural forces such as insects, fire, small mammals, and disease are estimated to be 24 700 cubic metres per year for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report.

Several criteria are used to define the harvest flow used in the base case harvest forecast. The first was to maintain the current harvest level for the Golden TSA (535 000 cubic metres per year) for as long as possible without causing substantial timber supply shortages in the future. Harvest levels must decrease to the long-term harvest level in the base case because in the short term, harvesting takes place in older forests which have accumulated high timber volumes by growing for a long time. However, future harvesting on the same sites will take place in second-growth forests at younger ages, yielding lower volumes per hectare.

A second criterion was to manage the transition from the current harvest level to the long-term harvest level, at a reasonable rate of decline. This rated decline is mainly dependent on the transition from harvesting existing stands to harvesting regenerated, managed stands. As discussed, declines of 10% and 7% per decade were necessary to enable the current harvest level to be maintained for the maximum amount of time and to prevent harvest levels from declining below the long-term harvest level. As shown in Figure 9, the merchantable timber volume reaches a minimum of approximately 14 million cubic metres in decade 17. These basic criteria were applied when generating all harvest forecasts in this report.

4 Results

The long-term harvest level is defined as the harvest rate that will maintain the total timber growing stock* at a relatively even level in perpetuity (Figure 9). A constant growing stock serves as an indicator that a particular harvest level can be sustained over the long term. Conversely, a declining growing stock would signify that the long-term harvest level is above the productive capability of the land. The total growing stock on the timber harvesting land base declines rapidly over the next 7 decades as the existing mature stands are removed and replaced with younger stands. However, once harvesting occurs predominantly in younger managed stands, the growing stock stabilizes at approximately 24 million cubic metres.

For the most part, forest cover requirements* for landscape-level biodiversity do not limit the long-term harvest level, since forested stands outside the timber harvesting land base are projected to be in a condition to meet all of the requirements for old and mature plus old seral stages in the long term. Similarly, medium– term harvest levels and the timing of the decline to the long-term harvest level are not particularly limited by these forest cover requirements because older stands are abundant in the medium term. Rather, harvest levels are limited mainly by the amount of timber of a harvestable age and by the maximum amount of disturbance allowed in the partial retention VQO zone, the ungulate winter range, domestic watersheds, caribou habitat zones and the integrated resource management zones.

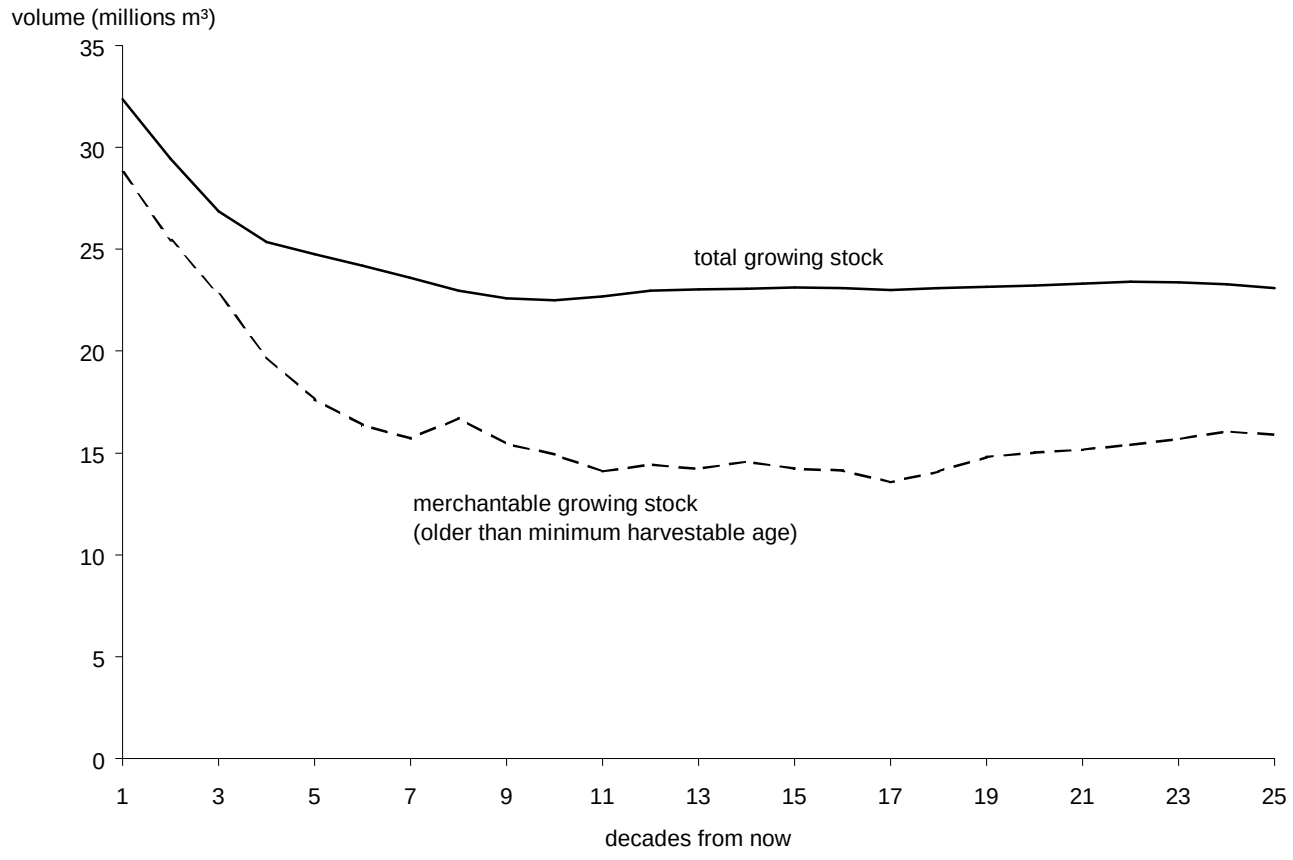


Figure 9. Changes in timber growing stock over time — Golden base case, 1998.

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

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency and Green-up period****).*

4 Results

It is important to note, that the current harvest profile (the types and ages of stands harvested) can only be maintained for a maximum of 20 years. The analysis indicates that if this profile is harvested for more than 20 years, there will be significant shortfalls in timber supply in the long term. In addition, continued harvesting of this specific profile could result in further reductions in short-term timber supply than is shown in several of the following sensitivity analyses.

Other harvest flow patterns are possible, for example, with different lengths of time at the current level, different rates of decline, and a different initial harvest level. Some alternatives are described in Section 5.1, "Alternative harvest flows over time."

The average growth rate projected from managed second-growth stands is about 2.56 cubic metres per hectare per year, about 26% more than the 2.0 cubic metres per hectare per year projected for existing stands. This volume increase is a result of stocking levels being controlled to ensure full site occupancy while avoiding over-stocking that would cause severe competition among trees. While the full benefit of improved management will not occur until most second-growth stands become available for harvesting, in 50 to 170 years from now, such management does allow maintenance of higher harvests in the medium term.

The long-term harvest level is below the theoretical maximum productive capacity of the timber harvesting land base of approximately 508 000 cubic metres. Theoretically, it is only possible to harvest at this level if all stands are harvested exactly at their age of maximum production. However because of forest cover requirements, the desire for a stable harvest flow over time and as it is almost impossible to schedule every stand for harvest at a particular age, it is not possible to meet the theoretical maximum harvest level.

4.2 Area, average volume, and average age harvested

Figure 10 shows how the annual area harvested would change over the next 250 years if the base case harvest forecast were followed. The amount of area harvested is projected to range from a minimum of 1296 hectares per year in decade 4, to a maximum of approximately 1645 hectares per year in decade 15. The area harvested is projected to fluctuate slightly because the harvest comes from stands of different quality and ages over time.

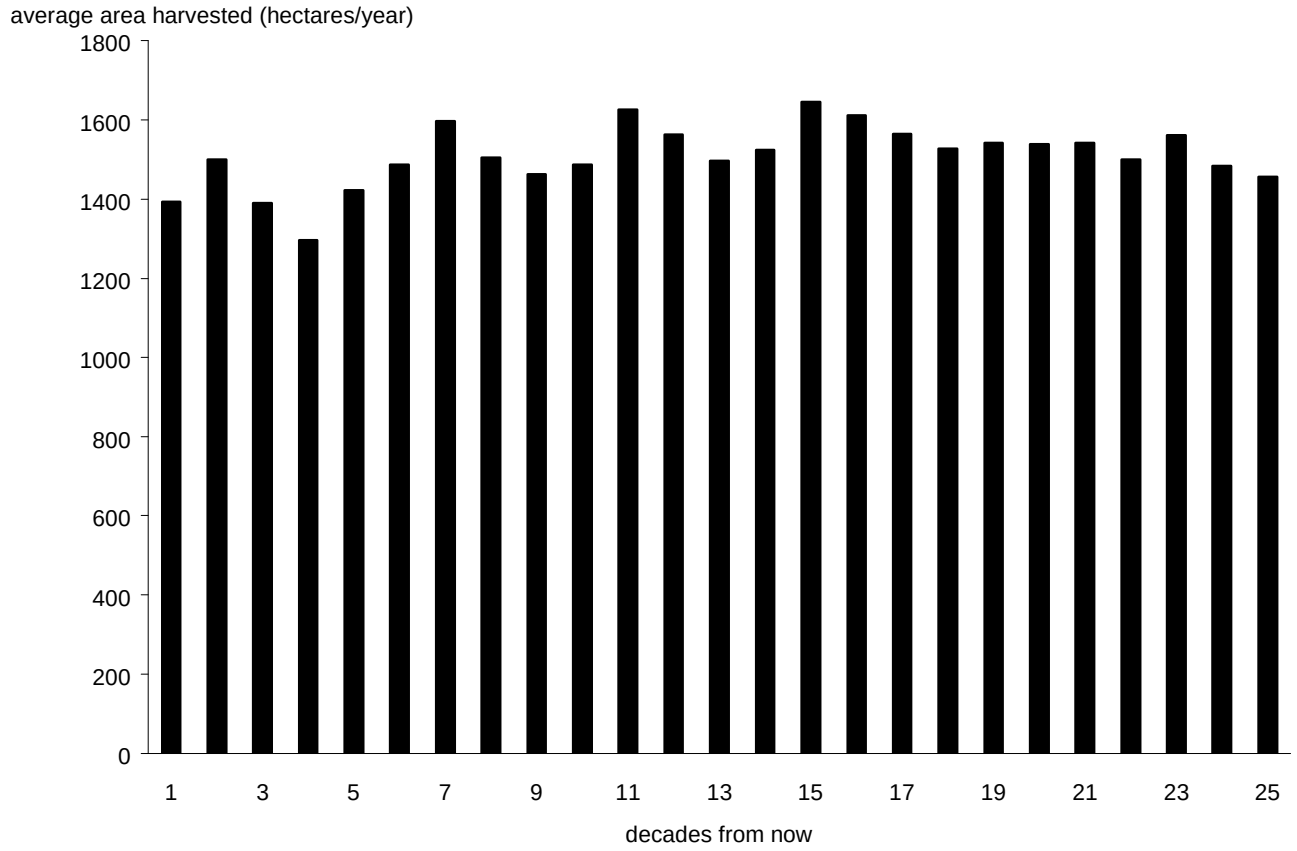


Figure 10. Area harvested over time — Golden TSA base case, 1998.

4 Results

Figure 11 shows the average timber volume per hectare harvested. The average harvested volume ranges from a maximum of 400 cubic metres per hectare in decade 1, to a minimum of 295 cubic metres per hectare in decade 10. A comparison of Figure 11 to the area harvested in Figure 10, shows that the average volume per hectare harvested is high when the amount of area harvested is low, and low when the amount of area harvested is high. This relationship is expected since the objective is to maintain a steady volume harvested per decade rather than a steady area harvested per decade.

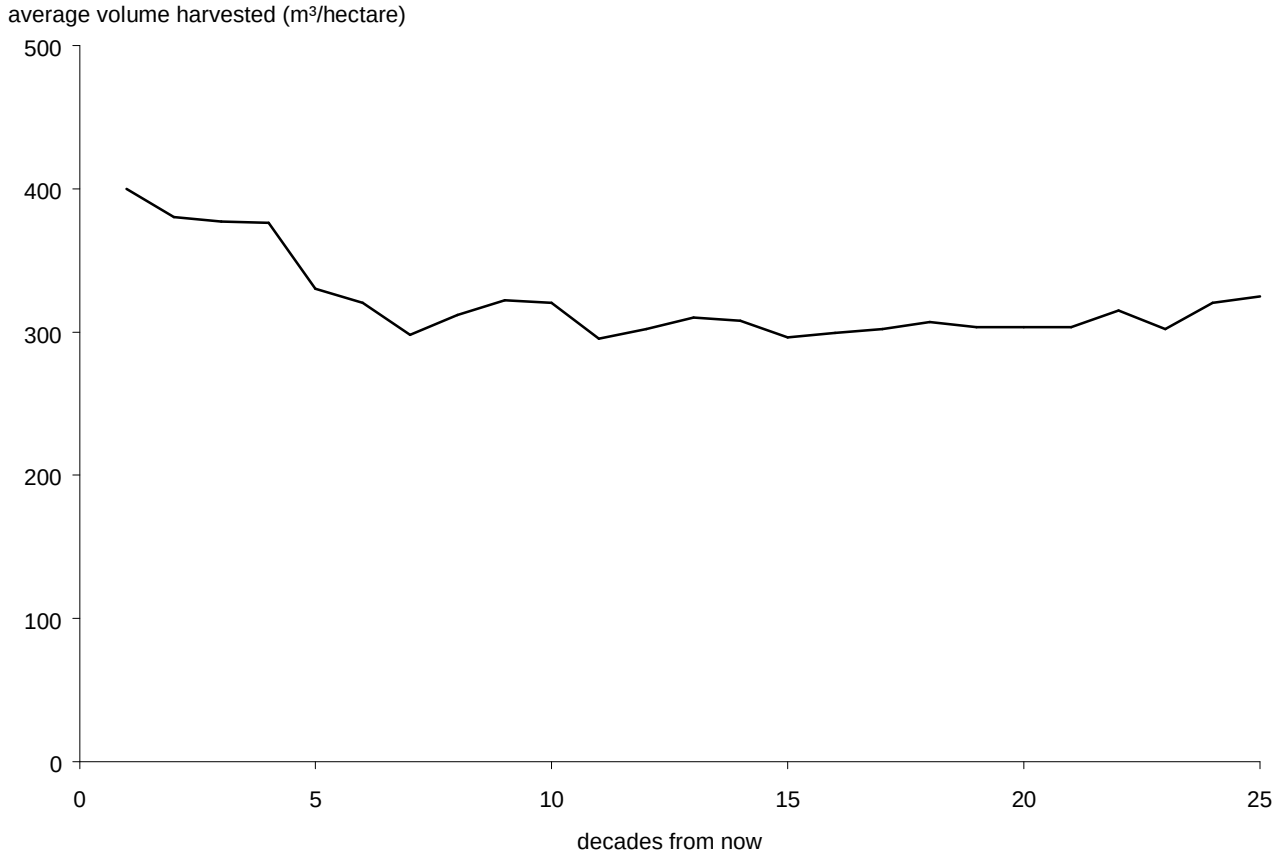


Figure 11. Average volume per hectare harvested over time — Golden TSA base case, 1998.

After 5 to 6 decades, the first regenerated managed stands become available for harvest, and the amount of area harvested is projected to increase because these young stands have a lower average volume per hectare at harvest. The average harvested volume per hectare is projected to reach its minimum, and the average harvested area close to its maximum, in decade 7 because almost no high volume older stands are available for harvest within the timber harvesting land base, and the harvest comes almost exclusively from lower volume, regenerated stands that have just reached their minimum harvestable ages. Furthermore, most of the regenerated stands harvested during this period occupy poor-quality sites. After decade 7, more regenerated stands on higher-quality sites are available for harvest resulting in an increase in the average volume per hectare harvested.

4 Results

Figure 12 tracks the change in the average age at which stands are harvested under the base case harvest forecast. Average harvested ages decline over the next 60 years from an initial average of 280 years to 102 years. During this period, few stands are harvested at the minimum harvestable age since there is an abundance of older stands available for harvest, and because older stands are given priority for harvest in the analysis. From decade 6 onward, most of the stands harvested are regenerated stands that have only recently reached minimum harvestable ages, which ranges from 60 to 170 years depending on species and site productivity. The average harvested age from decade 6 to decade 25 is about 107 years.

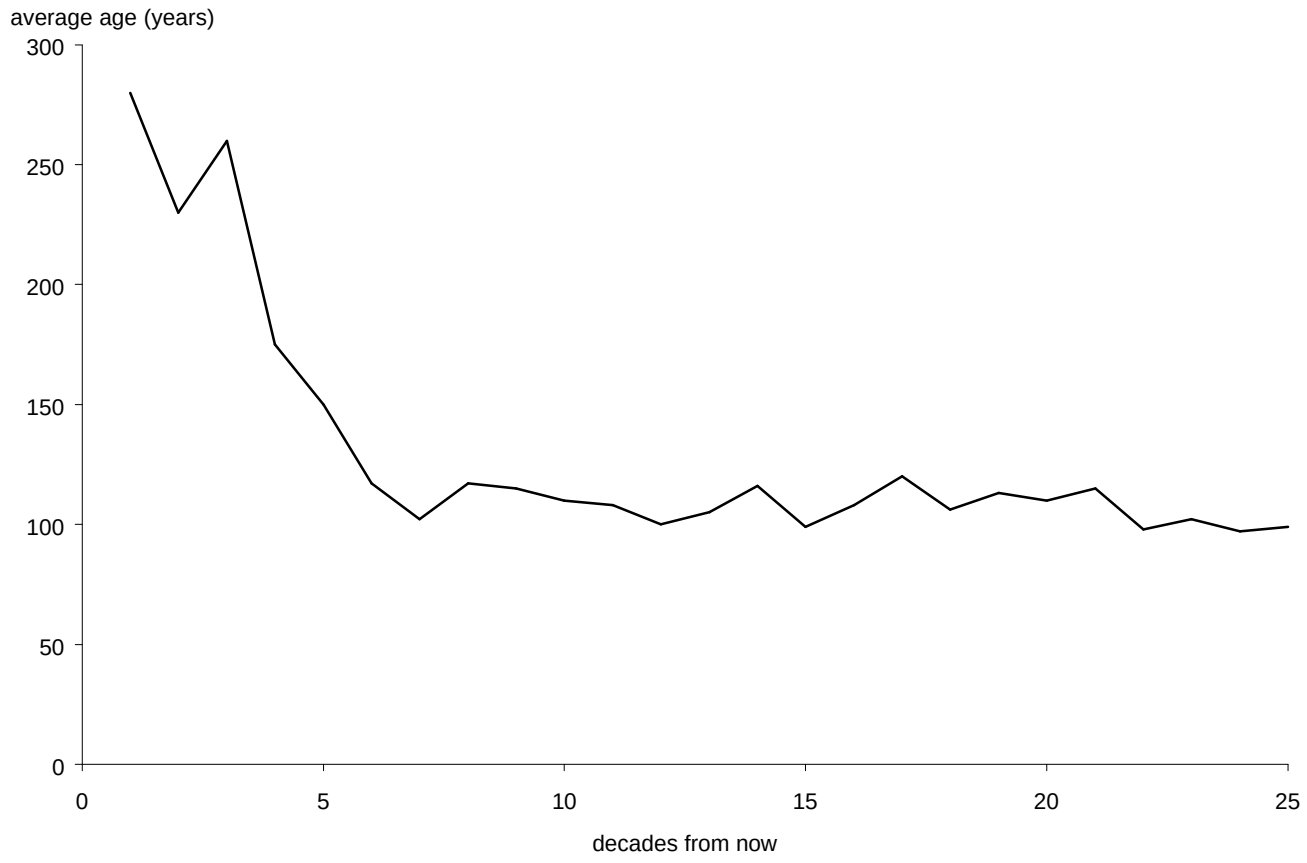


Figure 12. Average harvested age over time — Golden TSA base case, 1998.

4.3 Age class composition over time

The charts in Figure 13 show how the age composition of the productive forest within the Golden TSA land base would change over the next 200 years under the base case harvest forecast.

Currently, just over one-half of the timber harvesting land base (51%) consists of stands at or above minimum harvestable age. The productive forest land base also contains stands which are forested but have been excluded from the timber harvesting land base ("inoperable" and operable but non-contributing stands). While these operable excluded and inoperable stands range significantly in age, a large portion of these stands have older forest characteristics or can meet biodiversity and habitat criteria so that initially, very little of the timber harvesting land base must be retained to satisfy these values.

After 50 years, much less of the timber harvesting land base is covered by older forests, and after the first 4 decades the inoperable stands meet most wildlife habitat requirements and most landscape-level biodiversity requirements for the analysis area.

After 100 years the timber harvesting land base is almost evenly distributed between 10 and 120 years and very little older forest remains in the timber harvesting land base. At 200 years in the future, the projected age class distribution is somewhat less even because the harvesting of poor productivity stands varies from decade to decade, thus changing the amount of area that is harvested in order to achieve the base case harvest level. By the end of the 250-year planning horizon, all of the inoperable areas are older than 240 years, and the timber harvesting land base is once again characterized by a relatively even-age class distribution.

4 Results

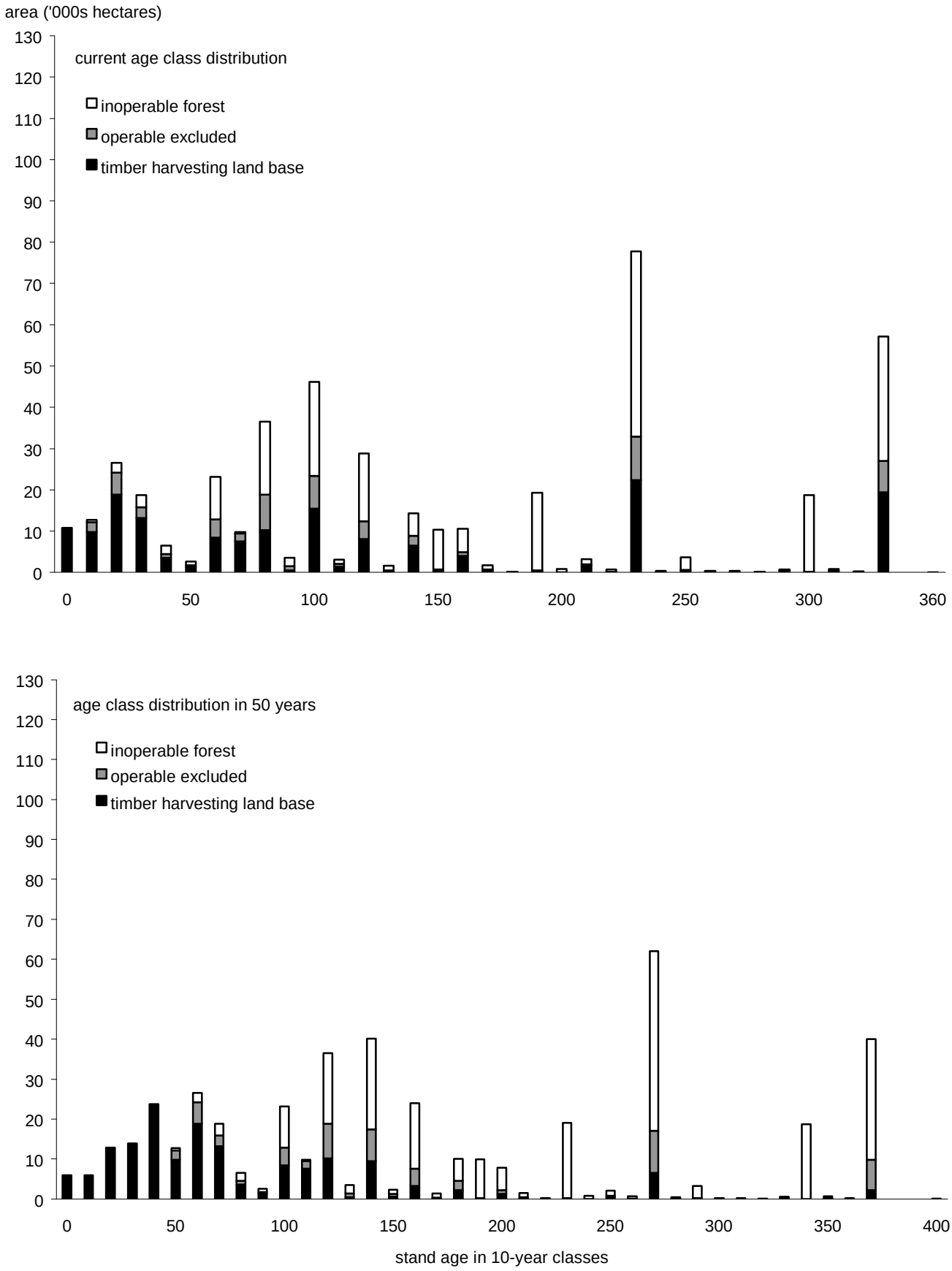


Figure 13. Changes in age composition on productive forest land base over time — Golden TSA base case, 1998.

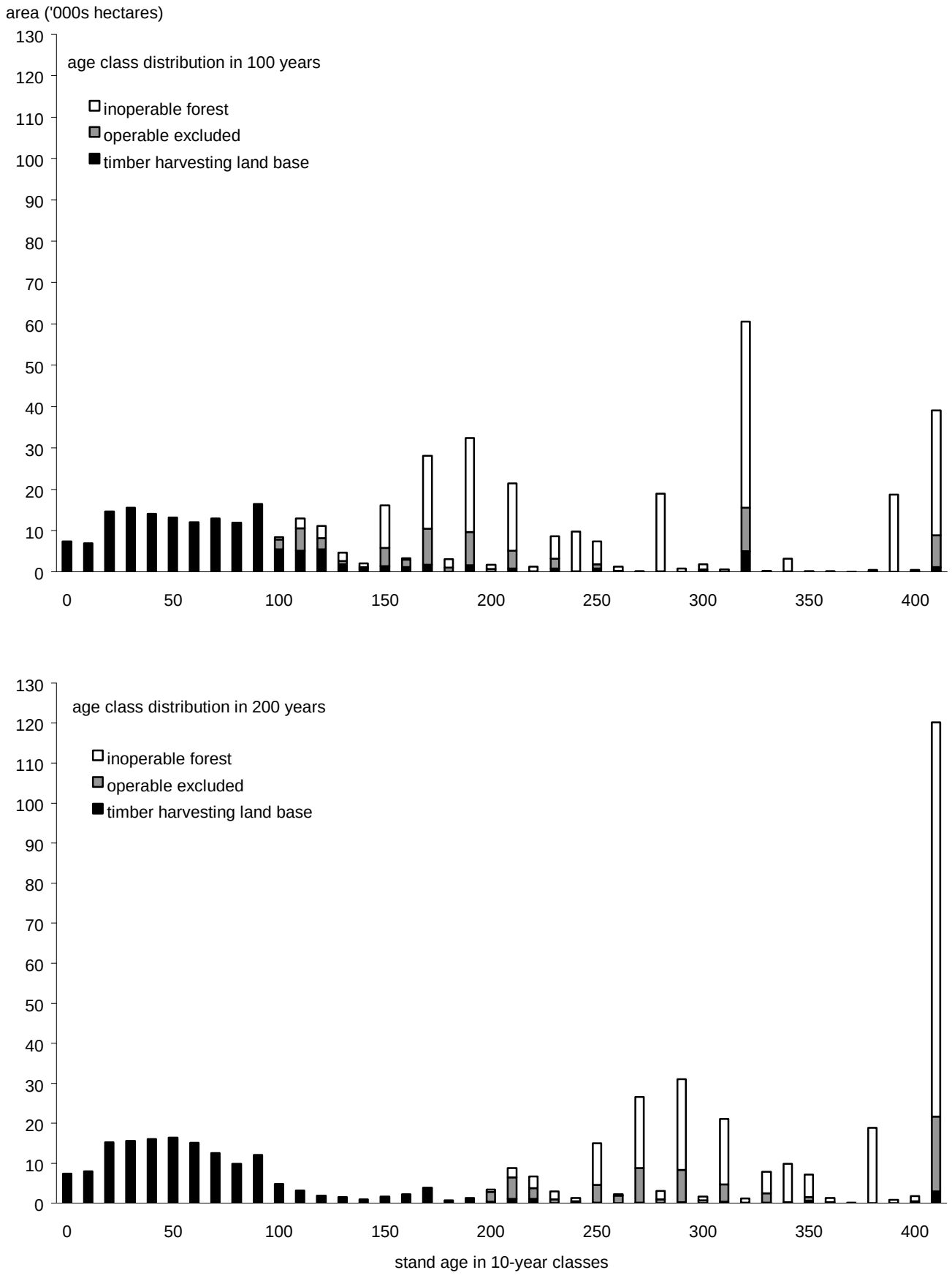


Figure 13. Changes in age composition on productive forest land base over time — Golden TSA base case, 1998 (concluded).

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. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

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

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

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

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

5 Timber Supply Sensitivity Analyses

5.1 Alternative harvest flows over time

The base case harvest forecast shown in Figure 8 was defined using criteria discussed in Section 4.1, "Base case harvest forecast," including managing the rate of decline in harvests from the current level, avoiding large and abrupt harvest shortfalls, and maintaining a fairly constant growing stock level over the long term. The last of these criteria is linked to maintaining the productivity of forest land, and is therefore an indicator of sustainability. The other criteria are attempts to avoid both excessive changes from decade-to-decade, and significant timber shortages in the future either of which might limit future options. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short- and long-term harvests.

Figures 14 to 16 compare harvest flow alternatives to the base case.

Figure 14 illustrates three alternative harvest flows including: the effects of maintaining the current AAC for as long as possible; the highest initial level; and a non-declining harvest. If the initial harvest level is held for as long as possible the current harvest level can be maintained for four decades. This is followed by a 21% drop to an interim harvest level, which is lower than the long-term harvest level. In decade 11 the harvest level rises to the base case long-term level. The harvest level cannot be maintained longer than four decades due to a lack of merchantable stands for harvest and forest cover requirements.

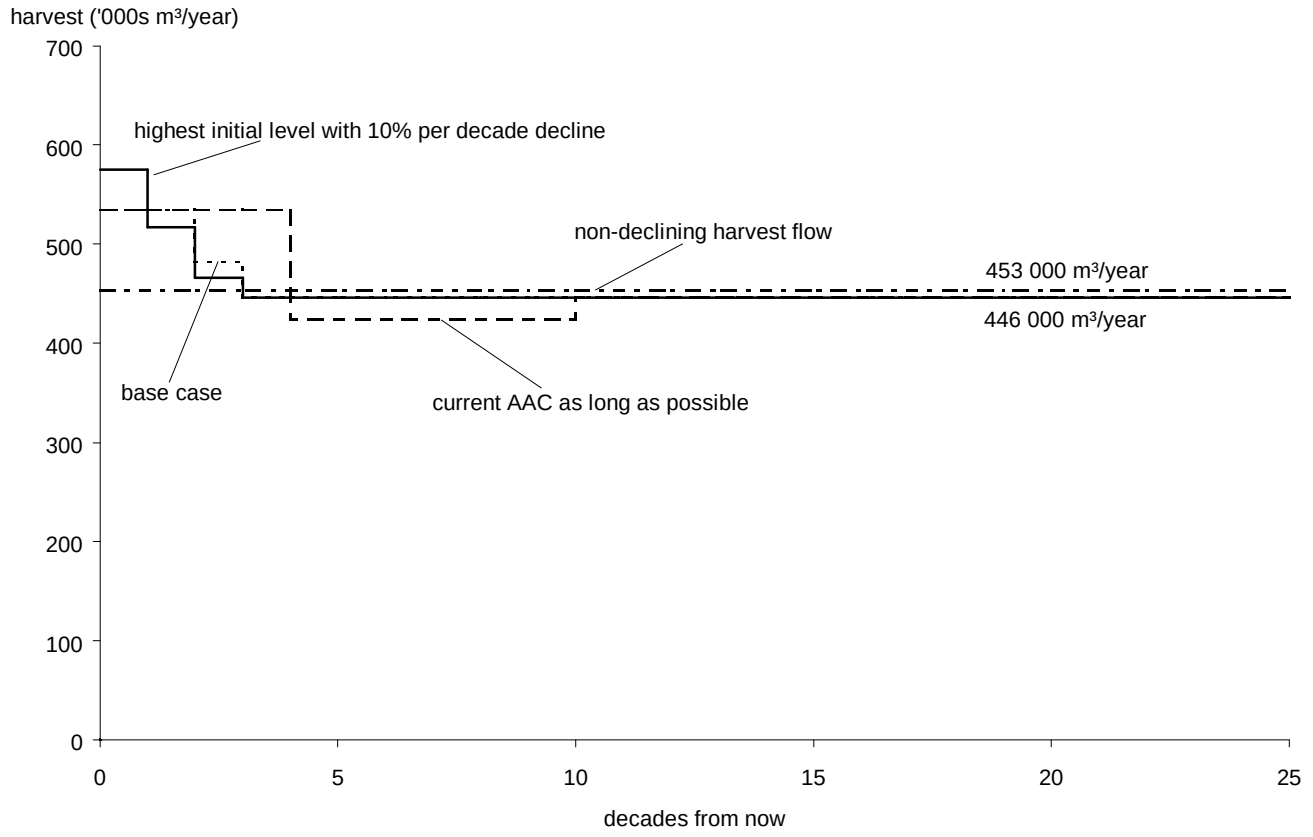


Figure 14. Alternative harvest flow patterns using base case data — Golden TSA, 1998.

Figure 14 also shows a harvest forecast with the short-term harvest level maximized while not allowing a drop below the long-term harvest level and maintaining a 10% per decade rate of decline. An initial harvest level of 575 000 cubic metres per year, 40 000 cubic metres higher than the current AAC, could be maintained for one decade before declining to the long term level. In addition, Figure 14 shows an alternative flow that starts at the highest rate of harvest that can be achieved if no decreases in the timber supply are allowed over the planning horizon; this is commonly referred to as a non-declining

forecast. When using this non-declining harvest flow, it is possible to increase the long-term level to 453 000 cubic metres. This is due to reserving harvest of some of the available short-term timber supply until later in the forecast however, eventually the harvest level will drop to the same long-term level as that in the base case. This will occur sometime after the 250 year planning horizon shown on the graph.

The above harvest flow alternatives all assume harvesting of both the short- and long-term timber supply at a maximum rate while causing no severe timber supply disruptions, and meeting current integrated management objectives. It would also be possible to reduce harvests to less than the levels shown here.

Figure 15 illustrates the results of runs where no flow controls are applied . These forecasts provide information on the maximum harvest available in each decade. With the relative oldest first harvest rule in place, in decade one it is possible to harvest over 840 000 cubic metres and not violate any of the forest cover requirements. This indicates a fair amount of flexibility when operationally selecting stands for harvest to fulfill the AAC. With a random harvest age rule in effect, about 750 000 cubic metres are available in decade one. The general 'eligibility' pattern is the same as that of the relative oldest first age rule. These forecasts also identify 'problem' decades such as the large dip in decades 4 through 7. This shows that the excess that appears to be available timber in decades 1 and 3 is required to fill in the harvest forecast during decades 4 through 7. This trend is also evident in several sensitivities later in this section.

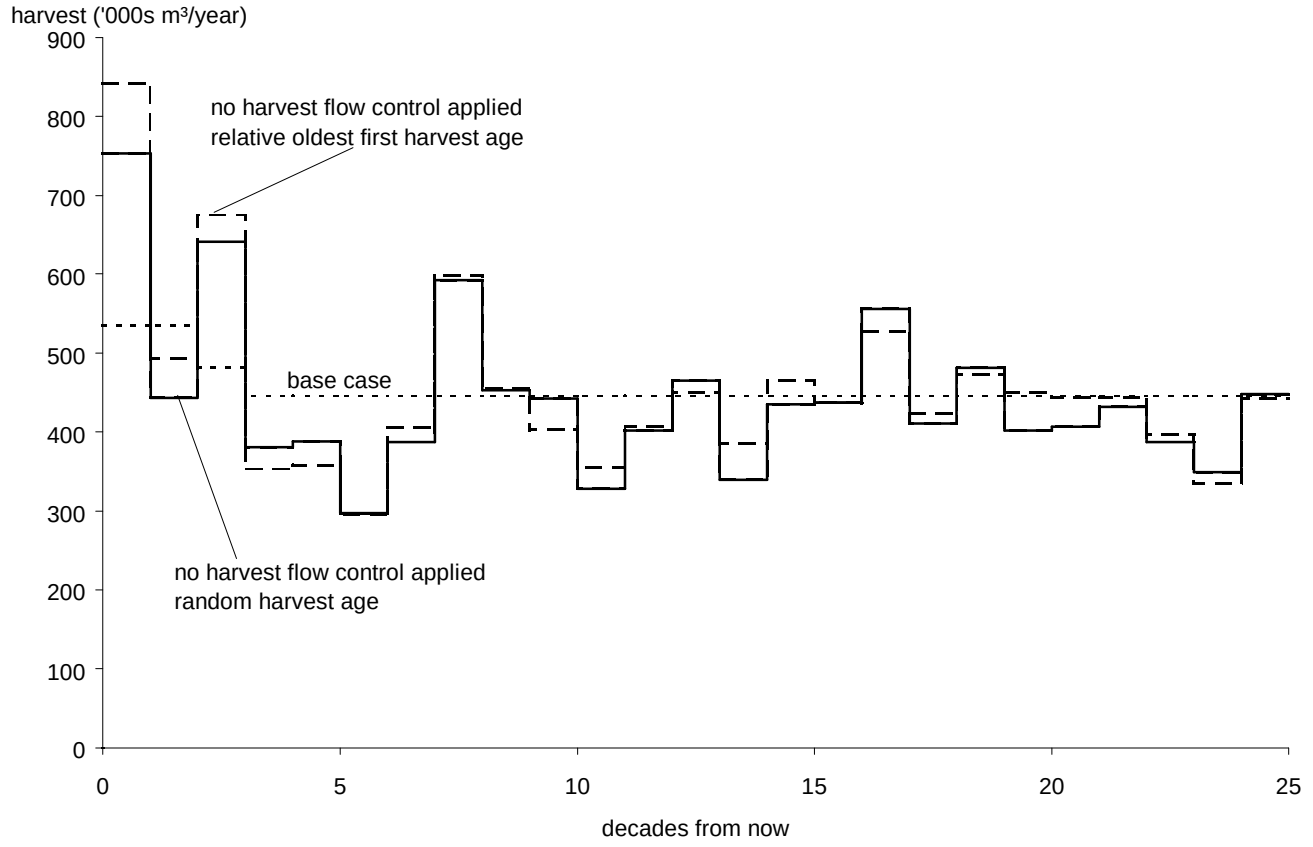


Figure 15. Alternative harvest flow patterns using base case data: no harvest flow control — Golden TSA, 1998.

5.2 Alternative harvest queue rules

It is possible to define different rules by which stands are ordered, or queued for harvest in FSSIM. These options allow us to change the profile of the ages of the stands harvested. Figure 16 demonstrates the use of the available harvest queue rules. In all cases, the harvest forecast maintains the base initial harvest level for two decades.

The base case uses the 'relative oldest first' rule. The relative oldest first rule prioritizes stands for harvest that have the greatest difference between the minimum harvest age and the stand age. Harvesting using the random harvest age rule queues stands between the minimum harvestable age and the oldest age in a random order. Using the random harvest rule results in a long-term harvest level that is about 9% less than the base case. The long-term level is lower because the average age of stands harvested is reduced, thus more area must be harvested to achieve the desired volume; this results in the green-up requirements impacting the long-term harvest level more than they do in the base case. In addition, the lower average harvest ages in the long term are further away from culmination of mean annual increment age than in the base case which also results in less volume being harvested overall.

The absolute oldest and the youngest first harvest rules both queue all stands above the minimum harvestable age simply by the stand age. The long-term level using the absolute oldest first harvest rule is 2% less than the base case. This is due to the fact that the relative oldest method maintains stands of some species to ages older than in the base case, thus when they are harvested these stands have built up higher volumes. The long-term level using the youngest first harvest rule is 6.5% less than that of the base case. This is due to the fact that in many decades the youngest first method on average harvests stands close to the minimum harvestable age. At these younger ages the stands have less volume per hectare. However, the long-term level using the youngest first harvest rule is higher than the random forecast because in some decades the majority of the harvest in the youngest first forecast must come from much older stands that have built up high volumes. Overall, the average harvest age in the long term is slightly higher for the youngest first harvest rule forecast than in the random harvest rule forecast.

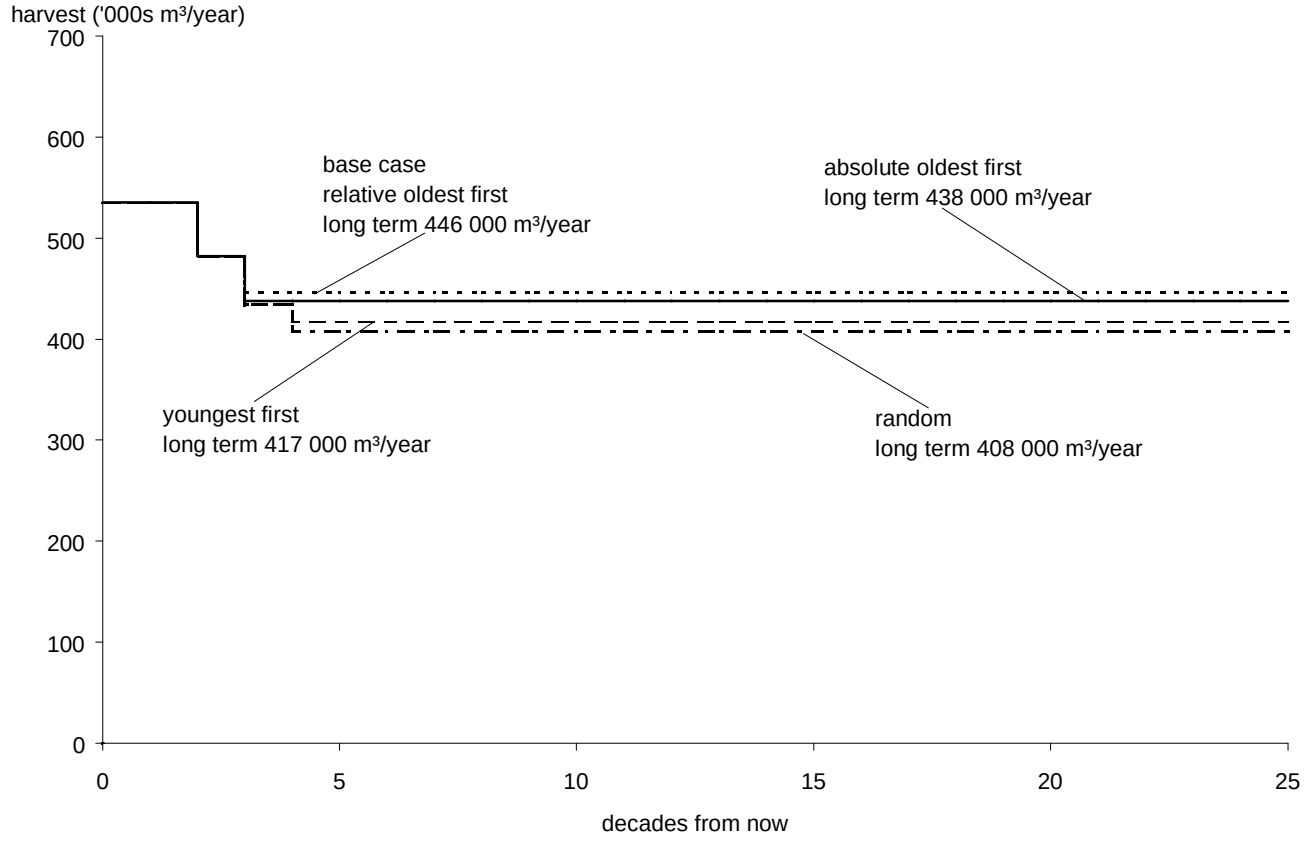


Figure 16. Alternative harvest queue rules: random, oldest first and youngest first — Golden TSA, 1998.

5 Timber Supply Sensitivity Analyses

5.3 Uncertainty in adjacency objectives

The Forest Practices Code (FPC) requires that trees in a harvested area reach a specified height (green-up height) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area, a maximum limit was set on the overall area that has not reached green-up condition. In this analysis, it was assumed that a maximum of 25% of the 'operable' land base of the caribou habitat, ungulate winter range, domestic watershed and integrated resource management zones could be covered by stands that have not met the green-up condition. Forest cover requirements are used in the analysis as a proxy for adjacency requirements. These requirements have some uncertainty as it is not possible to define the exact forest structure needed to meet the management objectives, in this case adjacency, for a particular area. Figure 17 illustrates three harvest forecasts that examine the uncertainty about how adjacency is represented in the analysis.

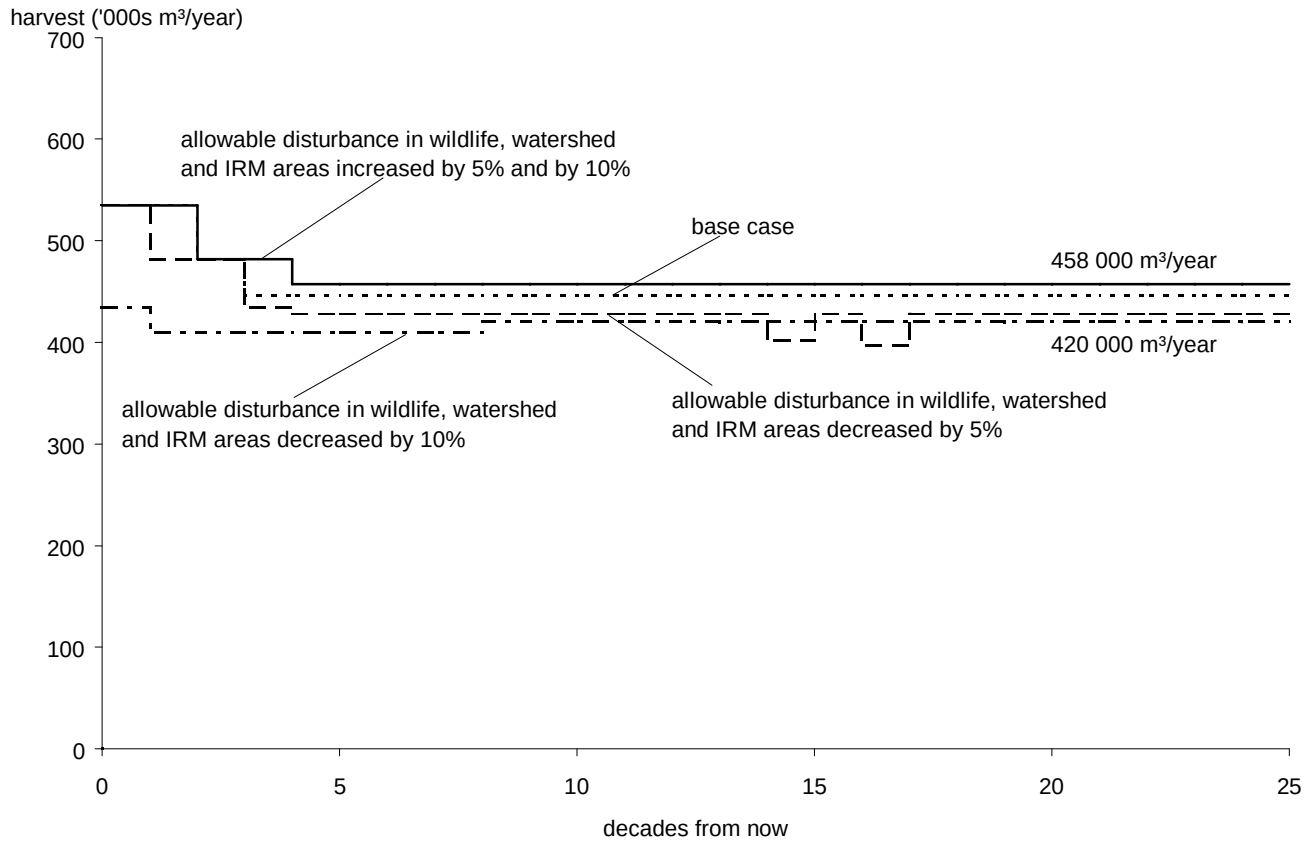


Figure 17. Harvest forecasts if forest cover requirements for disturbance in the wildlife (caribou and ungulate winter range), domestic watershed and integrated resource management (IRM) zones are changed by 5 and 10 percentage points — Golden TSA, 1998.

If adjacency requirements were more accurately represented by decreasing the maximum amount of allowable disturbance by five percentage points (i.e., going from 25% to 20% allowable disturbance) for the caribou, ungulate winter range, domestic watershed and integrated resource management zones, the initial harvest level can only be maintained for one decade. In addition the long-term harvest level is 428 000 cubic metres per year, 4% lower than that of the base case. In the current age class distribution about 20% of the operable area is less than 20 years old. Green-up ages for these management zones range from 11 to 22 years. Thus, while changing the allowable disturbance to 20% is very close to the present level, harvesting can occur in several zones and the timber supply is not severely

impacted. With a 10% decrease in adjacency, (15% allowable disturbance) a 19% immediate reduction in timber supply is necessary, as several management zones cannot be harvested in the short term.

No difference in the short-term timber supply exists if the maximum allowable disturbance is increased five or ten percentage points. An increase of 5% results in changes in the slope of the transition period and a slight increase in the long-term harvest level. Increasing the maximum allowable disturbance from 25% to 30% has only a small effect as the harvest level is not limited by these forest cover constraints.

5.4 Uncertainty in green-up ages

Forest cover requirements for visual quality, wildlife habitat, watersheds and adjacency applied in this analysis involve estimates of when stands will reach green-up conditions, expressed as the desired height of a stand. Green-up age, the age at which a stand exhibits the desired condition, is determined using a growth and yield model. The green-up period includes both the green-up age and the regeneration delay*, or time taken to establish a stand after harvesting. Uncertainty about green-up period arises because the desired green-up may either exceed or fall short of actual needs, the period of stand establishment may vary, and uncertainties about growth and yield may mean that stands will reach the desired condition sooner or later than estimated.

Figure 18 shows that harvest levels over both the short- and long-term are not sensitive to decreases in green-up ages. If green-up ages were actually 5 years less than in the base case, harvest levels in the short- and medium-term would be the same, and the long-term harvest level is 454 000 cubic metres per year, about 1.8% higher than in the base case harvest forecast. The slight increase in the long-term timber supply is due to a small increase in the availability of timber, particularly in the visual quality objective (VQO) and domestic watershed management zones. The forest cover requirements limiting disturbance in these zones limit timber supply in the base case; by making these requirements less restrictive in this sensitivity analysis, more timber is made available for harvest from the VQO and domestic watershed zones in the long term.

Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

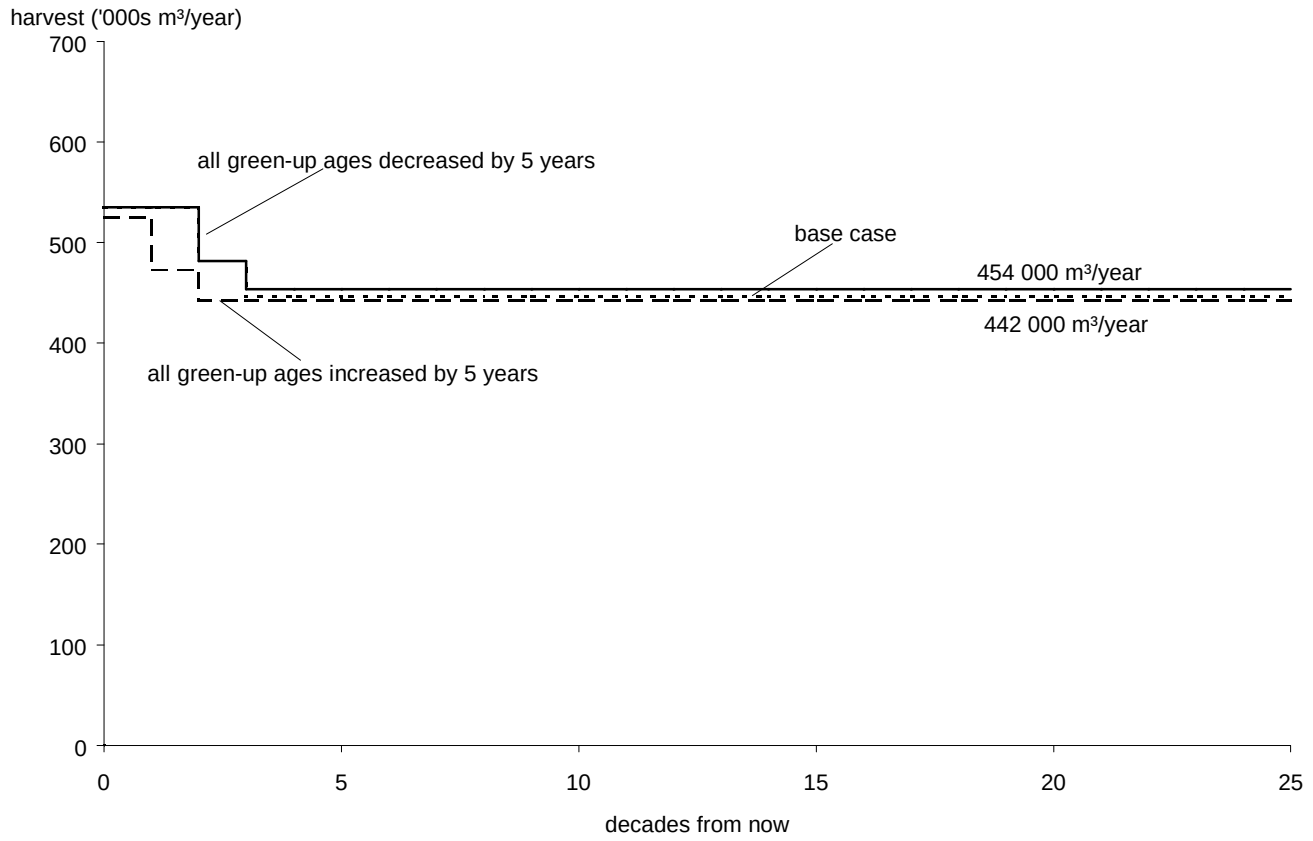


Figure 18. Harvest forecasts if green-up ages were either 5 years longer or shorter than the base case — Golden TSA, 1998.

If green-up ages were actually 5 years more than estimated for the base case, timber supply would be decreased in the short term relative to the base case. The initial harvest level decreases to 525 000 cubic metres (1% less than initial level in the base case) and can only be maintained for one decade. The long-term harvest level is also about 1% lower than that of the base case (442 000 cubic metres per year). Over the first 30 years of the planning horizon, however, the cumulative harvest would be about 7% lower than in the base case. Timber supply is affected by an increase in green-up ages because more stands are considered below green-up age, and therefore, less disturbance is allowed.

In summary, 5-year increases to green-up ages have a significant short-term timber supply impact, however there is little effect on available timber supply from a 5-year decrease in green-up ages.

5.5 Uncertainty in ungulate winter range guideline application

Current management as defined for this analysis includes an objective to maintain mature forests for the habitat of ungulate species in the Golden analysis area. There are about 150 ungulate winter range patches in the Golden analysis area that were designed and digitized by the Columbia Forest District. The ungulate winter range management zone totals about 45 000 hectares, or about 27% of the timber harvesting land base. Maintenance of ungulate habitat in this management zone is represented by a forest cover requirement that at least 40% of the area be in stands 100 years or older at all times, by landscape unit. In addition, a maximum of 25% of the ungulate winter range operable area (by landscape unit) may be less than two metres tall. Some uncertainty surrounds the application of these requirements as the actual

guidelines call for the maintenance of mature forest cover every 250 hectares. The requirement to maintain mature forest within 250 hectare patches stems from the ungulates need to have thermal cover for hiding, snow interception and warmth. The application of the forest cover guidelines by 250 hectare units brings a finer spatial resolution and prevents habitat at the north end of the landscape unit meeting the need for habitat in the south end of the landscape unit. The amount of allowable disturbance is also subject to a degree of uncertainty. This section examines the effects on timber supply of these uncertainties.

Figure 19 shows the implications to timber supply if the ungulate winter range (UWR) areas are divided into 250 hectare patches, on average, and changes are made to the maximum allowable disturbance per cent. In this sensitivity, the mature forest guidelines for winter range were applied to each of the 250 hectare patches. When these requirements are analysed in conjunction with an increase in allowable disturbance (allowing 35% by UWR area), it is still possible to achieve the base case initial harvest level for two decades; however, the long-term harvest level is reduced by 1.5%. The short-term level is unaffected for two reasons: first there is adequate timber available for harvest in other management zones to maintain the initial level; and second, the forest cover requirement in the ungulate areas is relaxed. Over the long term, however, these smaller winter range units require more of the timber harvesting land base to meet thermal cover requirements than does the base case, and thus extends harvest ages in each unit beyond that of the base case (where winter range units were aggregated).

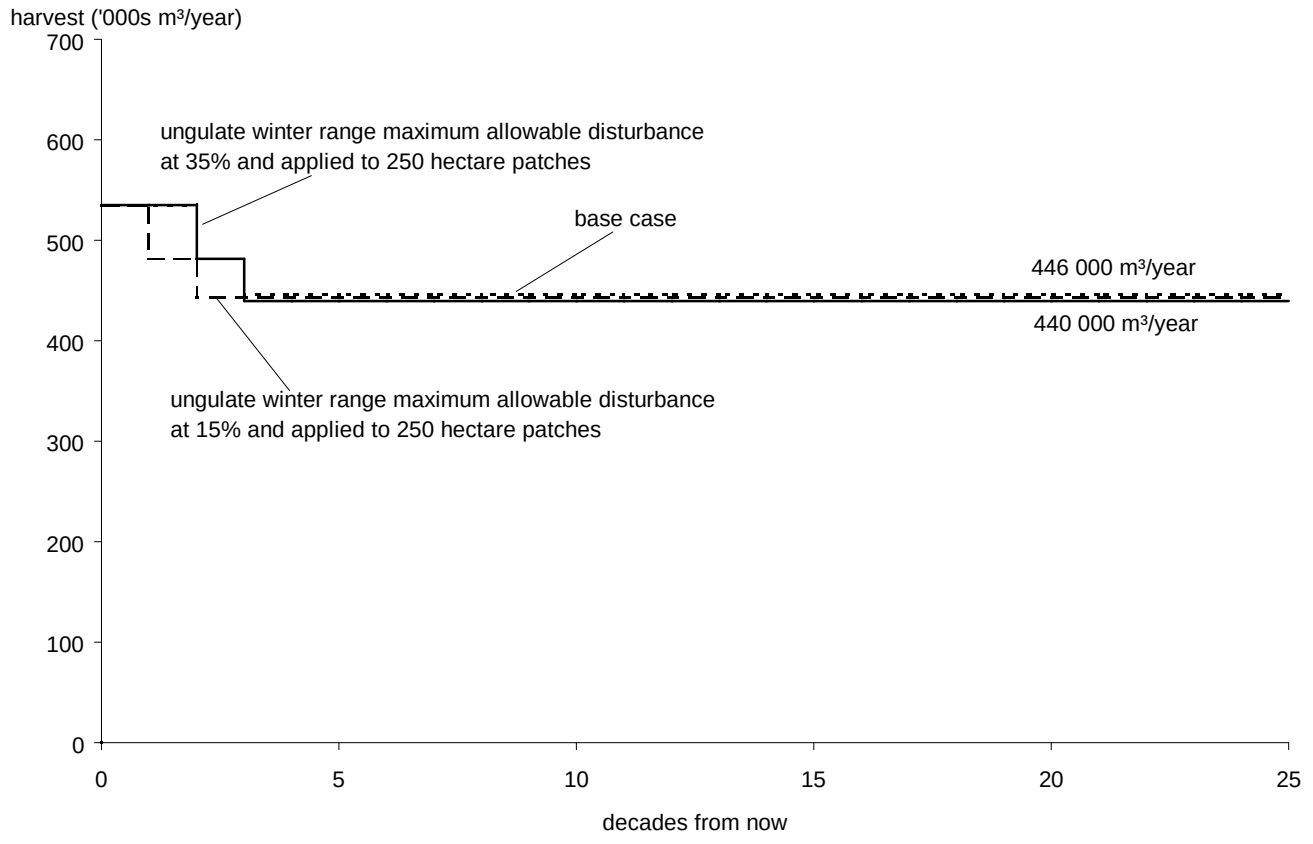


Figure 19. Harvest forecasts if forest cover objectives for ungulate winter range zones were applied to 250 hectare patches with changes in the maximum allowable disturbance per cent — Golden TSA, 1998.

Figure 19 also shows the implications to timber supply if 250 hectare patches, on average, are imposed on the ungulate winter range area as well as reducing the allowable disturbance by 10 percentage points. When these requirements are analysed, it is possible to maintain the base initial level for just one decade before declining to a long-term harvest level which, is also about 1.5% less than that of the base. The short-term level is affected as there is not enough timber available for harvest in the other management zones to compensate for the reduction in harvest within the ungulate winter range areas.

5.6 Uncertainty in the application of the old—seral landscape level biodiversity requirements

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biological diversity as an essential component of sustainable use of forests. The *FPC Biodiversity Guidebook* provides recommendations for maintaining biodiversity at both the stand level and the landscape level. Stand-level biodiversity has been addressed in this analysis by removing portions of each stand from the timber harvesting land base. Uncertainty about stand-level biodiversity can be assessed through sensitivity analysis that examine the timber supply impacts of land base reductions. Landscape-level biodiversity, however, has been modelled in this analysis through the use of forest cover requirements applied to biogeoclimatic zone/sub-zone/variant types within each draft landscape units. There is uncertainty about how the recommendations in the biodiversity guidebook should be interpreted and applied in a modelling environment, as well as how the emphasis options should be applied within landscape units. The following sensitivity analyses provide an indication of the risk associated with uncertainty about landscape–level biodiversity.

Figure 20 illustrates the effects on timber supply if the low-emphasis (LEB) portion of old-seral requirements outlined in the biodiversity guidebook were applied in full at the beginning of the planning horizon, rather than increased over 140 years to the full amount, as in the base case. When such a change is made, it is still possible to achieve the base initial harvest level for one decade before declining to the long-term level. The old–seral requirements for each landscape unit in the base case, initially range from 6.7% to 14.2% (depending on biogeoclimatic zone / sub–zone / variant). Immediate application of the full old—seral requirement changes this range to 9.4% to 19.9%. This requires more old seral to be maintained over the first 140 years than in the base case. Forest requirements for old seral must be met initially in part from stands within the timber harvesting land base and increasing this requirement causing a decrease in the amount of mature timber available for harvest. After four decades or so, most old-seral requirements can be met by stands outside the timber harvesting land base. As a result, the long-term level is the same as that of the base harvest forecast.

5 Timber Supply Sensitivity Analyses

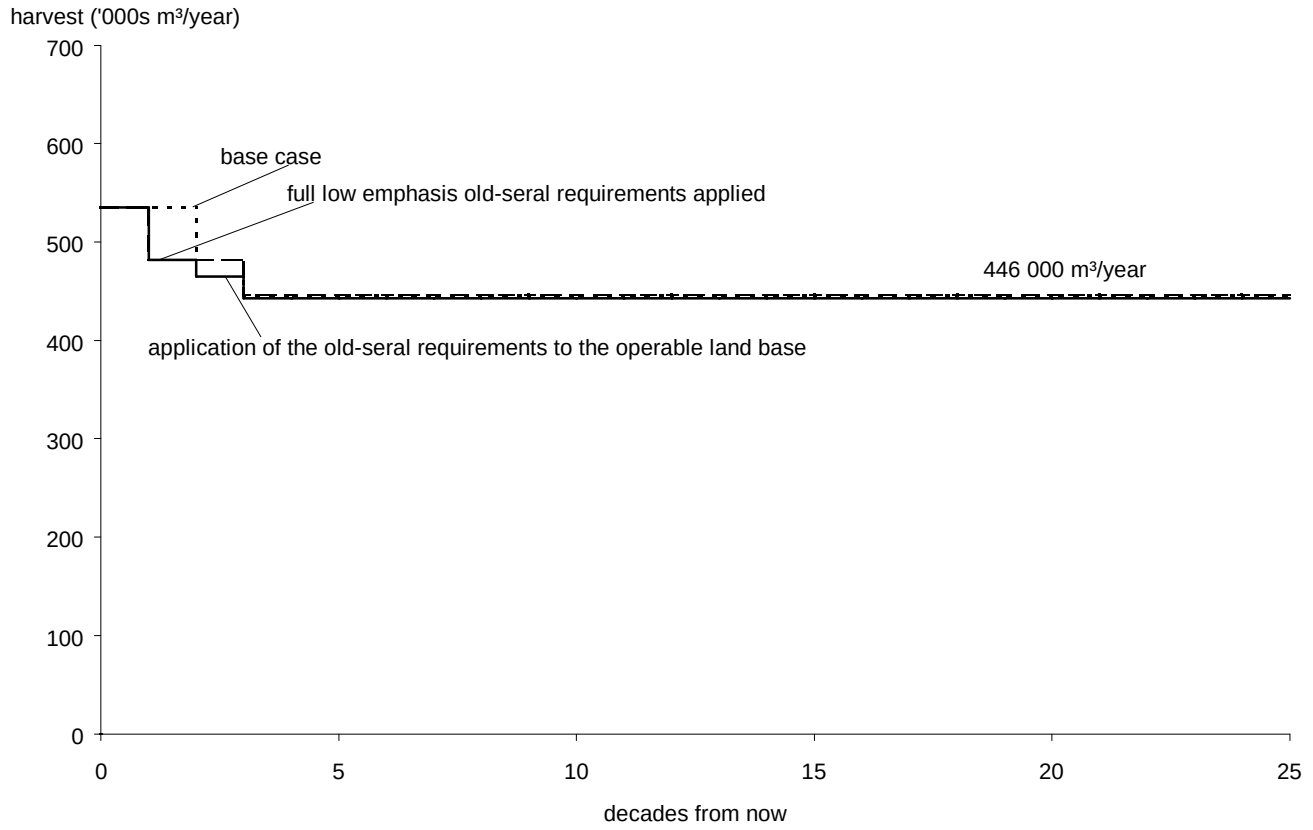


Figure 20. Harvest forecasts if landscape-level biodiversity assumptions are changed — Golden TSA, 1998.

There is also a concern that attempting to meet the landscape level old—seral requirements in the areas outside of the timber harvesting land base may not result in full representation of all biogeoclimatic variants. As noted above the old-seral requirement must be partially met from the timber harvesting land base for the first 40 years however, after that the areas outside of the timber harvesting land base can meet all old—seral requirements. Figure 20 illustrates the effect of forcing some of the old—seral requirement to always be met from the operable land base. At this time it is unknown how much of the requirement needs to be met on the operable land base. In order to test the sensitivity of this uncertainty the old-seral forest cover requirements were applied to both the total forested land base (as in the base case) as well as the operable land base. This insures that there is old-seral stands in the operable area at all times. With this dual application, it is still possible to attain the base initial harvest level for one decade. The short-term available timber supply is affected because applying the old-seral stage forest cover requirements to the timber harvesting land base reduces the amount of mature timber that is available for harvest in the medium term.

In summary, the timber supply of the Golden analysis area is sensitive in the short term to the immediate full application of the old—seral requirements. The timber supply is also sensitive to application of the old—seral requirement to the operable land base in addition to the total forested land base.

5.7 Uncertainty in biodiversity emphasis options

The guidelines for maintaining biodiversity specify a minimum percentage of the forest within each biogeoclimatic variant within each landscape unit that should be retained in old forest. The percentage that should be maintained depends on the biodiversity emphasis assigned to the landscape unit. Areas with a low-biodiversity emphasis require less old forest and allow a longer time period before the guideline must be met than in areas with a high biodiversity emphasis. A general target is to have the following proportions of the timber harvesting land base under each biodiversity emphasis: low biodiversity — 45%; intermediate biodiversity — 45%; high biodiversity — 10%. In the Golden TSA, the *Kootenay-Boundary Land Use Plan Implementation Strategy* provides some direction on application of draft biodiversity–emphasis options for each landscape unit. Since the emphasis options are only draft at this time, the modelling approach used in the base case harvest forecast was to calculate the average, area weighted proportion of old growth that would be retained and apply this average requirement to each landscape unit. However, it is possible that applying old-growth retention requirements individually to each landscape unit, based on the biodiversity emphasis for each landscape unit, may have a different effect on the harvest forecast. The sensitivity of the harvest forecast to this issue was tested by applying the old-growth requirements from the biodiversity guidebook to each landscape unit individually, based on the draft–biodiversity emphasis assigned to each landscape unit in the *Kootenay-Boundary Land Use Plan Implementation Strategy* (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." for details).

Figure 21 illustrates the effect of applying the draft *Kootenay-Boundary Land Use Plan* biodiversity–emphasis options. When the emphasis options are applied, the base case initial harvest level can only be maintained for one decade before declining to the long-term level. The proportion of the timber harvesting land base under each draft-biodiversity emphasis falls fairly close to the target of 45% low, 45% medium and 10% high biodiversity. Thus, this sensitivity shows the actual placement of the emphasis options by landscape unit is having an effect on the timber supply differently than is seen when using an average requirement.

5 Timber Supply Sensitivity Analyses

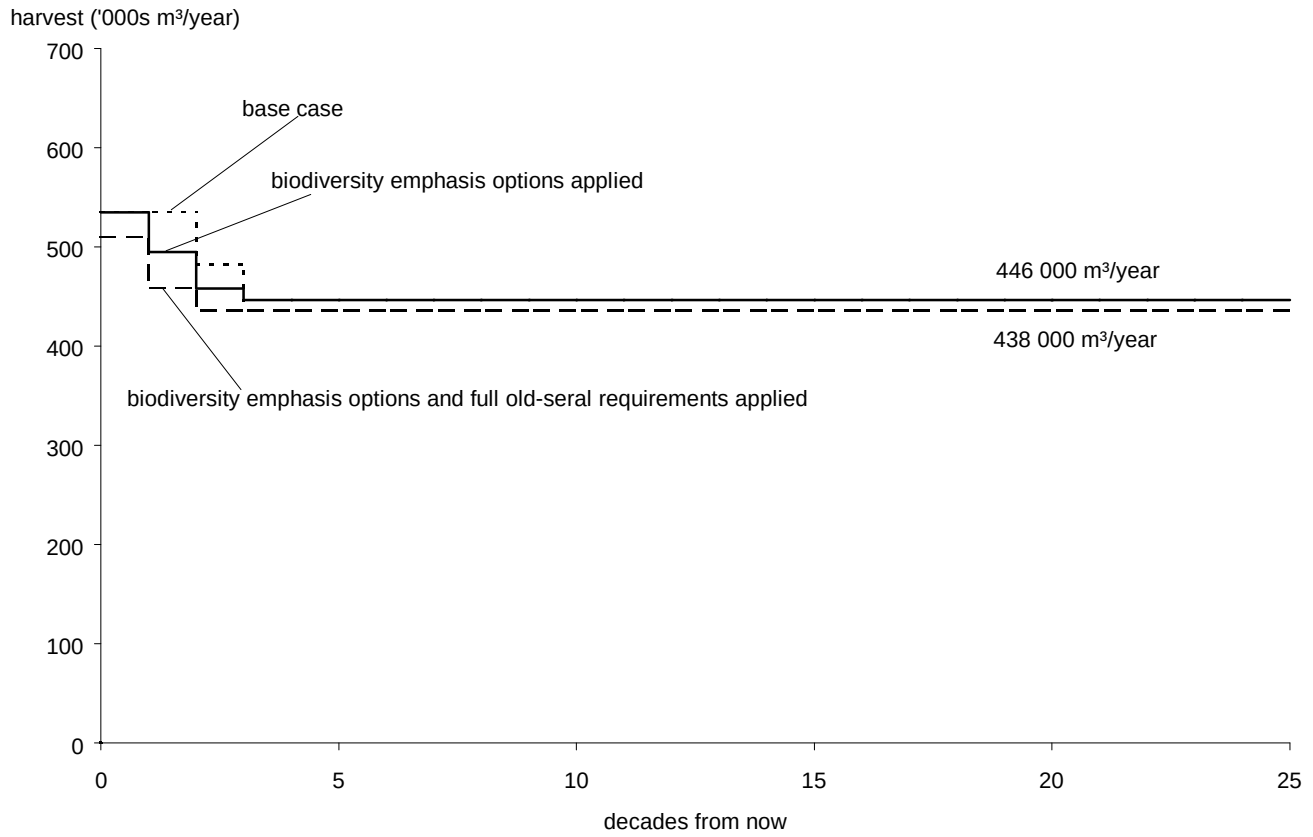


Figure 21. Harvest forecasts with changes to biodiversity-emphasis options, proportionate and full low-emphasis biodiversity (LEB) now — Golden TSA, 1998.

Figure 21 also shows a sensitivity analysis in which the low-emphasis (LEB) portion of old-seral requirements outlined in the biodiversity guidebook are applied in full immediately and the draft biodiversity-emphasis options were applied. The combination of these two changes results in an immediate 5% reduction in initial harvest level. This is followed by a decline to a slightly lower long-term harvest level than in the base case. This changes the old-seral requirement percentages in low-emphasis areas from about 4% to about 13%. Forest requirements for old—seral must be met initially in part from stands within the timber harvesting land base, causing a shortfall in available mature timber for harvest. After four decades or so, the need for the timber harvesting land base to contribute to the old—seral requirements decreases as most of the requirements can be met by stands outside the timber harvesting land base. As a result, the long-term level is only 2% lower than that of the base harvest forecast.

In summary, application of the draft biodiversity–emphasis options to the landscape units in the Golden TSA results in an impact on timber supply in the second and third decades. Application of both the draft biodiversity-emphasis options and full application of the old—seral requirements in the low emphasis landscape units results in a significant impact on the short-term timber supply.

5.8 Uncertainty in biodiversity contribution from areas outside the timber harvesting land base

The *Forest Practices Code Act of British Columbia, (FPC) Biodiversity Guidebook* provides recommendations for maintaining biodiversity at the landscape level. The guidebook allows for parks areas to contribute to meeting the seral-stage requirements.

The base case assumed that the forested areas in parks could contribute to the seral-stage requirements for those landscape units that included park area. There are seven landscape units where more than 30% of the forested area is comprised of park land. In these landscape units, forest cover requirements for mature plus old and old-seral requirements were predominantly met within the park area. An alternate interpretation is to remove parks from the land base altogether which assumes park areas are already accounted for in the make-up of the biodiversity guidebook seral-stage targets. The analysis of this latter interpretation is shown in Figure 22. When parks are excluded from the land base, the base case initial harvest level can be maintained for one decade. The long-term harvest level is about 1% lower as removal of the forested park area causes more of the requirements to be met from the timber harvesting land base in landscape units that contained a portion of forested park area.

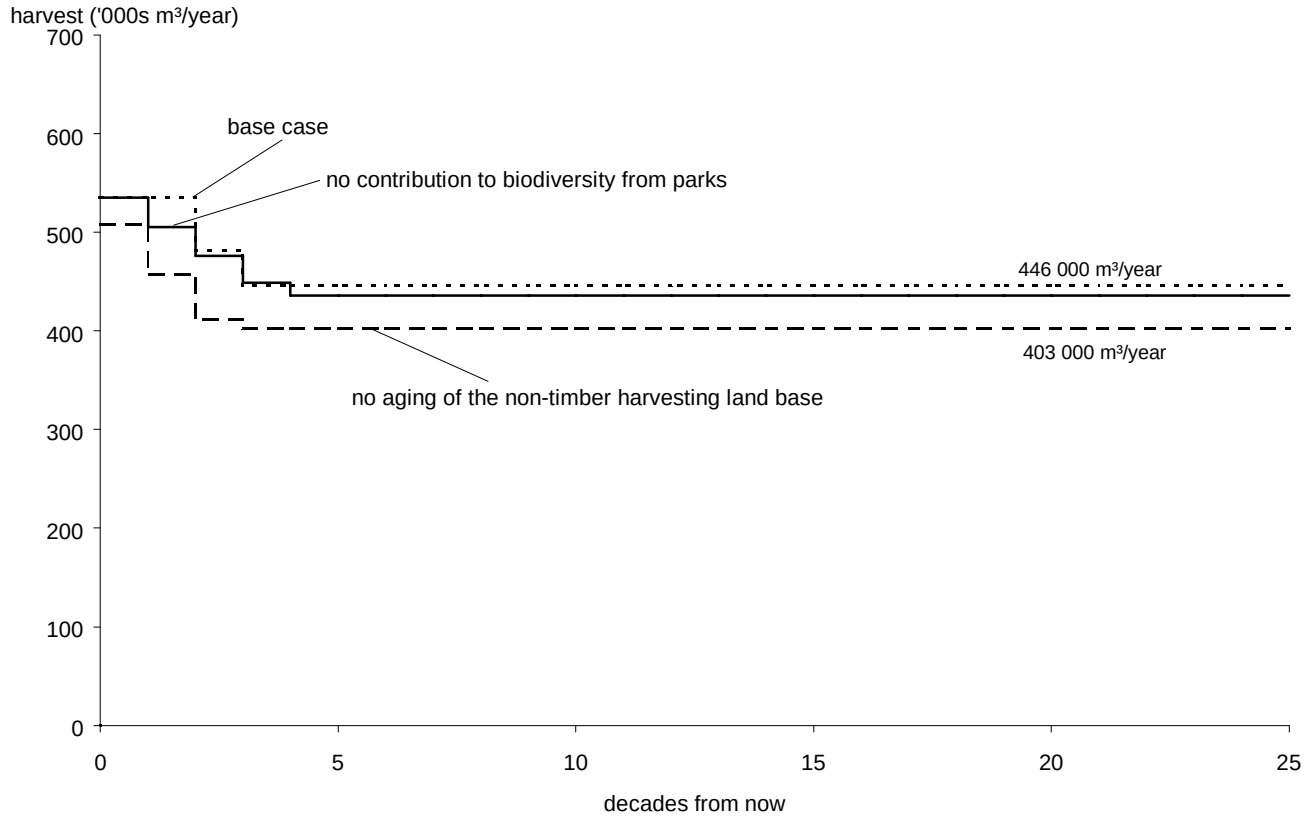


Figure 22. Harvest forecasts in which the aging assumptions or park contribution assumptions are changed — Golden TSA, 1998.

Due to a lack of information regarding the dynamic changes that may take place in the forested areas outside of the timber harvesting land base, the base case assumes that the non-timber harvesting land base forests age during the planning horizon. A sensitivity that 'froze' the current age distribution of the non-timber harvesting land base stands was conducted and the results are presented in Figure 22. When the non-timber harvesting land base current age class distribution is held 'static', the initial harvest level drops to 508 000 cubic metres per year (a 5% reduction from the base initial harvest level). The long-term harvest level is about 10% lower than that of the base case due to the increased need to use the

timber harvesting land base to meet seral-stage requirements. Holding the ages static does not likely represent the future distribution of the non-timber harvesting land base, and in particular may constraint the short-term timber supply unnecessarily. The base case assumption that there will be no creation of young stands in the non-timber harvesting land base in the future also does not likely represent the future distribution of the land base and will likely overestimate the long-term timber supply. Thus, while there may be some small risk to the short-term timber supply in the base case from this uncertainty, the long-term level is at a higher risk.

5.9 Uncertainty in forest cover requirements for visual quality

Visual quality objectives (VQOs) may be stated as the proportion of an area on which forestry activities may be visibly obvious. The B.C. Forest Service, Forest Practices Branch, has provided a range of allowable visible disturbance for each VQO category (stated as a maximum per cent area younger than green-up height). Different disturbance limits will meet a particular VQO (for instance, partial retention) depending on the specific terrain and forest in the area. Determining forest cover objectives for the partial retention VQO areas involved a series of calculations to incorporate information on visual sensitivity, and the degree to which forest outside the harvesting land base can contribute to visual objectives (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis").

Partial retention and retention areas were all treated as partial retention VQO areas because less than 20 hectares of the Golden analysis area are considered to have a retention VQO*.

Uncertainty about forest cover objectives may arise from inventory and classification of land into VQO and sensitivity categories, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality.

Figure 23 illustrates that the timber supply is sensitive to uncertainty about current forest cover requirements for VQOs in the Golden analysis area. If the maximum allowable disturbance forest cover requirements applied to the partial retention VQO zones are changed from the current 15% to 25%, (the same percentage used in the integrated resource management zone) the current harvest level can be maintained an additional decade over the base case followed by the same decline rate as in the base case. A long-term harvest level of 449 000 cubic metres per year, or approximately 0.7% above that of the base case, could be achieved. In total, over the next 50 years, 4% more timber supply would be available for harvest than in the base case, while between 60 and 250 years from now, 0.7% per year more would be available.

Retention VQO
*Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).*

5 Timber Supply Sensitivity Analyses

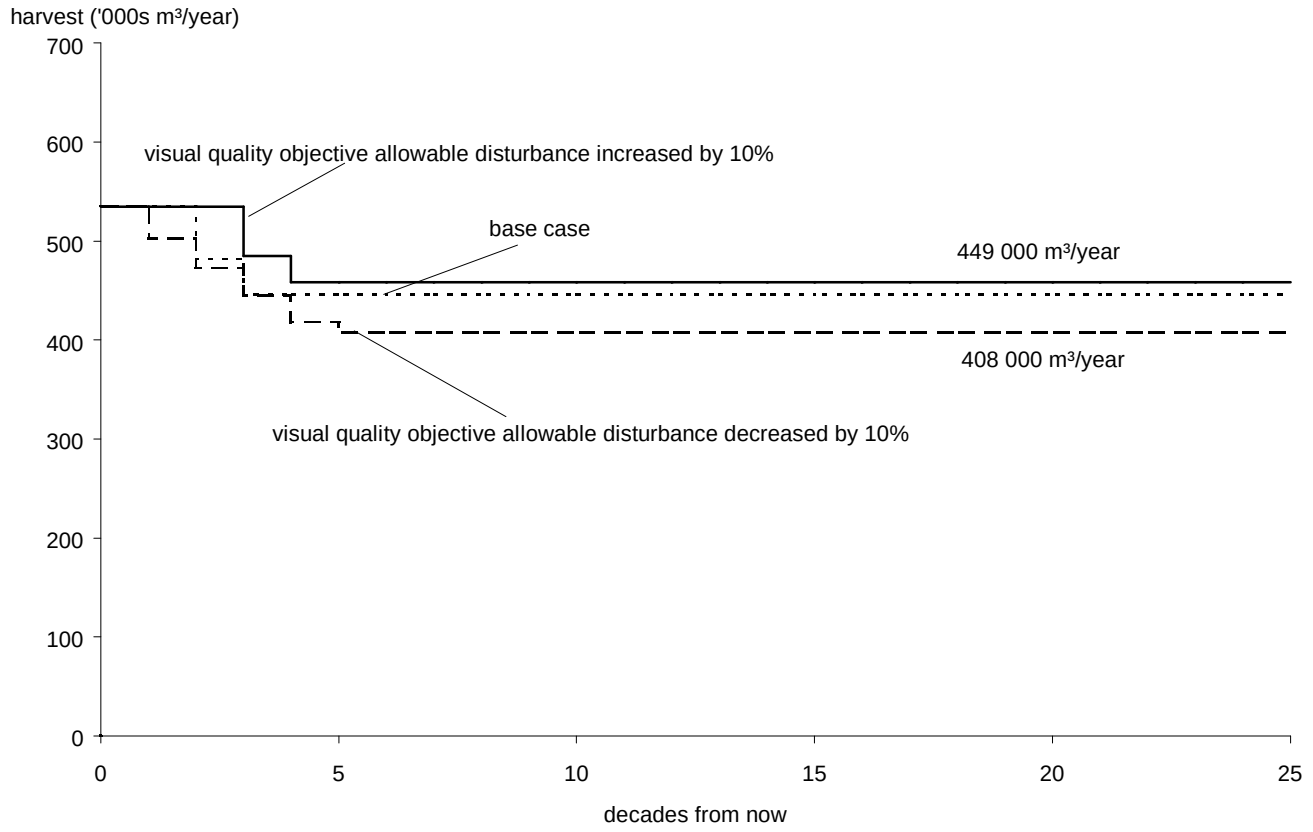


Figure 23. Harvest forecasts if forest cover objectives for partial retention VQO management areas changed to retention levels or changed to integrated resource management zone levels — Golden TSA, 1998.

Decreasing the maximum area which is allowed to be in a visually disturbed state, such that the forest cover requirements applied represent more restrictive retention VQO levels (i.e., changing from 15% to 5%), also has a impact on timber supply. The current harvest level could only be maintained for one decade before declining to the long-term harvest level at the same rate as in the base case. The long-term harvest level, reached after decade 5, would be 9% below the base case level. The total timber supply over the next 50 years would be decreased by 3%.

In summary, these results show that uncertainty about forest cover requirements needed to meet currently defined VQOs has an effect on timber supply over short- and long-terms. This is primarily because the partial retention VQO zone is the only management zone in the Golden analysis area in which harvesting is consistently limited by the forest cover requirements in the base case. Therefore, either relaxing or restricting these requirements directly impacts the availability of timber. However, partial retention VQO areas represent a relatively small portion of the timber harvesting land base of the Golden analysis area (12.8%) which moderates the overall impact on timber supply.

5.10 Uncertainty in minimum harvestable ages

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Minimum harvestable ages determine when second growth will be available for harvest, therefore affecting how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain. This is partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, minimum harvestable ages were estimated as the combination of the following factors: age at which stands reached a minimum volume, age to a minimum diameter, culmination of mean annual increment age, and professional judgment. These minimum stand volume criteria are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," and apply to both managed and unmanaged stands. This method was chosen to ensure that only stands with sufficient merchantable volume and size would be considered available for harvest. The minimum harvestable ages are minimums; stands may be harvested at older, but not younger, ages. In fact, many stands are harvested at ages beyond the minimum in order to meet management objectives and forest cover requirements. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Figure 24a shows how timber supply would change if stands become merchantable either 10 years sooner or later than assumed for the base case. Figure 24b represents the effects of 20 year changes.

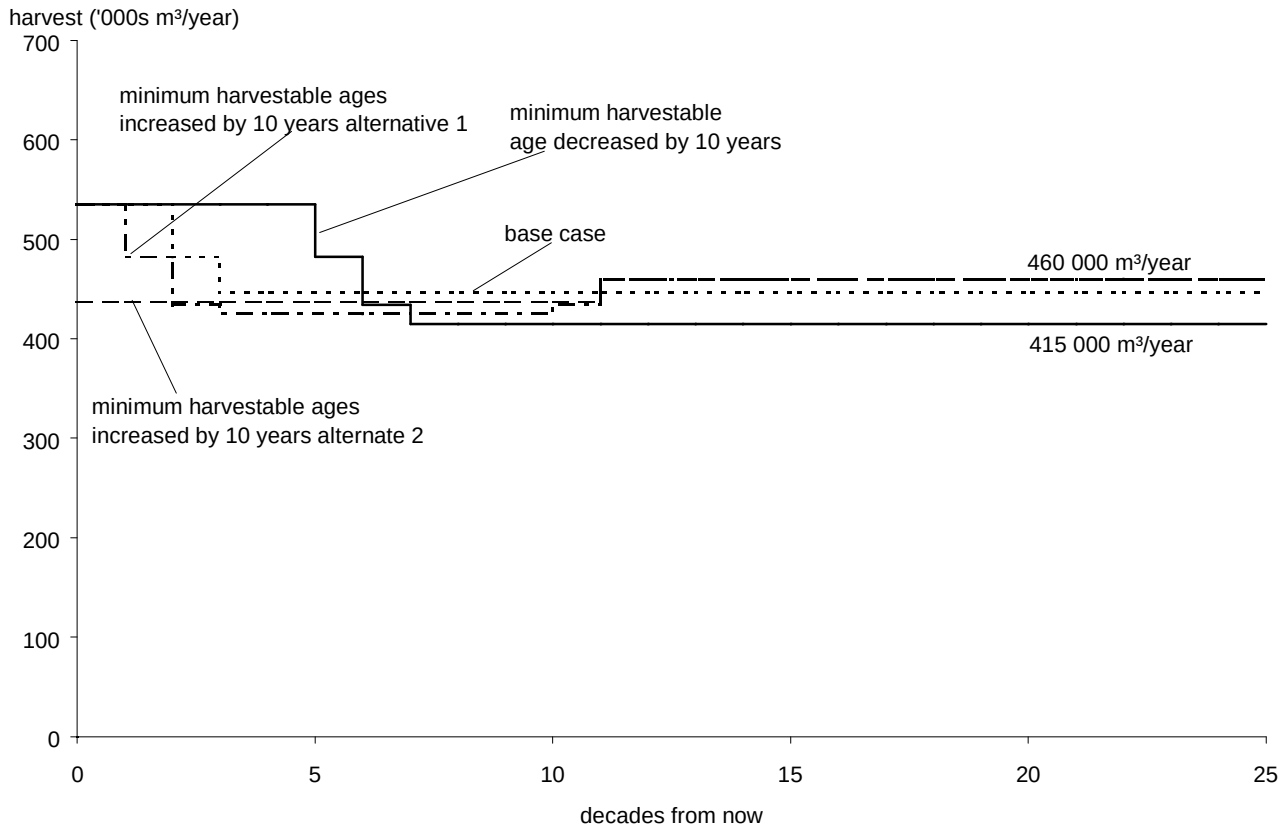


Figure 24a. Harvest forecasts if minimum harvestable ages are 10 years younger or older than the base case — Golden TSA, 1998.

If minimum harvestable ages were 10 years older than in the base case, results indicate that the available timber supply in the transition period (mid term), would be substantially decreased. In fact, it is necessary to drop below the long-term harvest level for a period of time, as there is not enough merchantable timber available over the mid term to avoid this drop below the long-term harvest level which is based on managed stand volume estimates. The first alternative harvest forecast shows that the current AAC of 535 000 cubic metres per year can be maintained for one decade if followed by a 10% rate of decline to a low level of 425 000 cubic metres per year. The harvest then increases to the long-term harvest level in decade 12. A second alternative commences at 437 000 cubic metres and rises to the long-term level (460 000 cubic metres) in decade 12. Regenerating stands, which are critical to timber supply during the transition of harvesting from old growth to second growth, must age an additional decade before they are considered merchantable. As a result, during the transition period, there are not as many regenerated stands old enough to be harvested as there are in the base case. Thus, the harvesting of existing timber must occur at a slower rate to avoid serious timber supply disruptions in the future. The overall harvest over the first 110 years of the planning horizon is about 5% lower than in the base case. The long-term harvest level is about 3% higher than that of the base case. When minimum harvestable ages are increased by 20 years (Figure 24b), an immediate 5% reduction is necessary and the mid-term harvest level drops to 395 000 cubic metres per year.

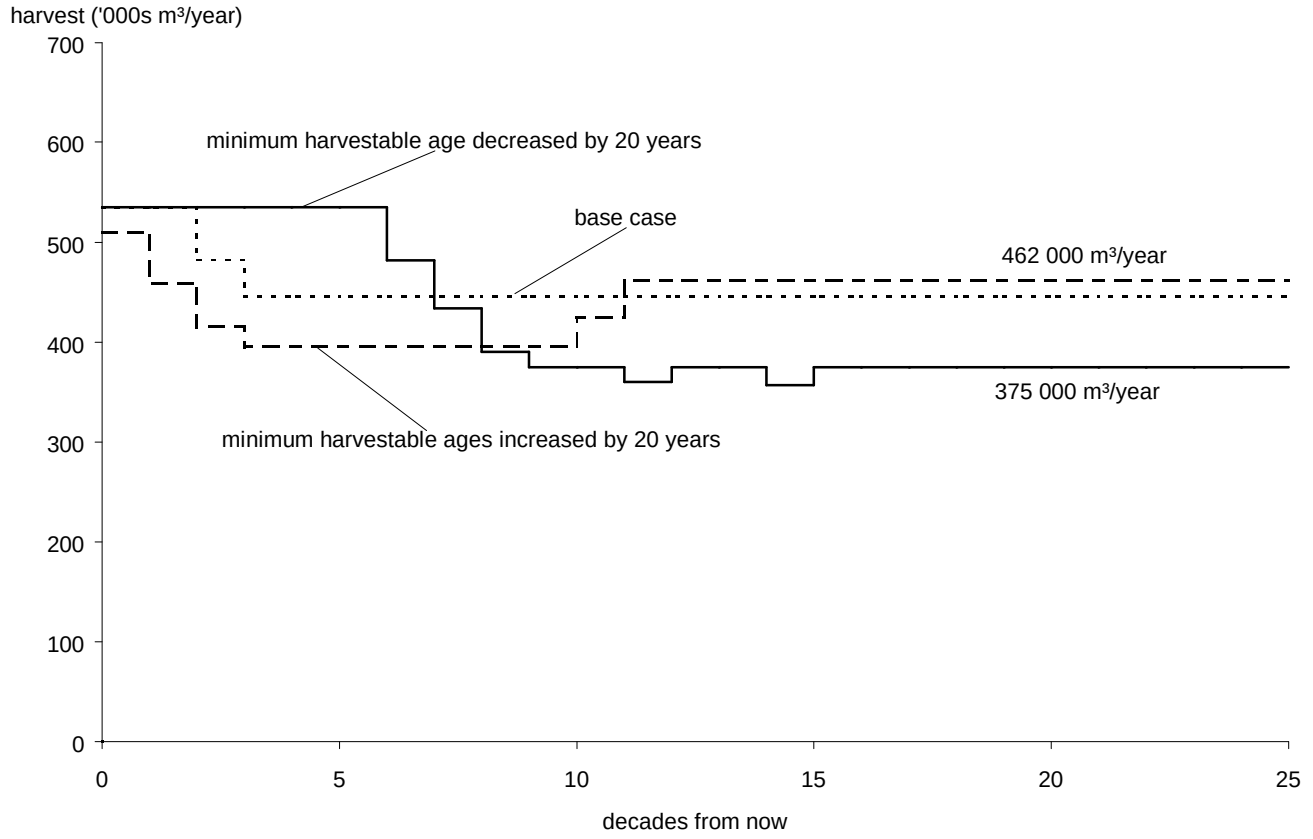


Figure 24b. Harvest forecasts if minimum harvestable ages are 20 years younger or older than the base case — Golden TSA, 1998.

If minimum harvestable ages were decreased by 10 years (Figure 24a), three additional decades at the base initial harvest level are possible before declining to a long term that is about 7.5% lower than that of the base harvest forecast. If the minimum harvestable ages were reduced by 20 years (Figure 24b), four additional decades at the base initial harvest level are possible. Reducing minimum harvestable ages allows stands to be harvested earlier, thereby increasing the available stands in the short term.

In this analysis, minimum harvestable ages are not viewed as decisions made to meet forest management objectives, but rather as approximations of the timing of merchantability. This analysis highlights that timber supply is sensitive to uncertainty about this timing. Whether minimum harvestable ages used in the base case are appropriate, optimistic, or pessimistic is largely a matter of opinion. The factors used for minimum harvestable age establishment were based primarily upon a timber quantity regime, while a timber quality regime would likely result in higher minimum harvestable ages for many stands. These issues are discussed here because of all variables important to timber supply, minimum harvestable ages are perhaps the most uncertain, at least in areas where most second growth will not be harvested for many years. Many other variables are based on sampling data and experience, or management decisions. Minimum harvestable age, however, will depend on technology and markets well into the future.

5.11 Uncertainty in estimates of timber volumes in existing stands

Estimates of standing timber volumes in existing forest stands are subject to some uncertainty because they are based on extrapolation of measurements from some stands to all stands in an area, and on inventory classifications which contain some uncertainty. The standing volumes are more accurate when averaged over large areas, but may not reflect actual volumes in a specific stand. Uncertainty may also stem from estimates of the volume lost to decay in standing trees, and to waste and breakage during timber harvesting, as well as estimates of utilization levels practiced during harvesting.

Figure 25 illustrates that timber supply in the Golden TSA is very sensitive to uncertainty in existing stand volume estimates. If existing volumes are actually 10% greater than those used for the base case, the current AAC could be maintained for 5 decades — 3 decades longer than in the base case. The harvest level then drops 10% and is held for another 3 decades. The long-term harvest level, reached in decade 8 is the same as that of the base case.

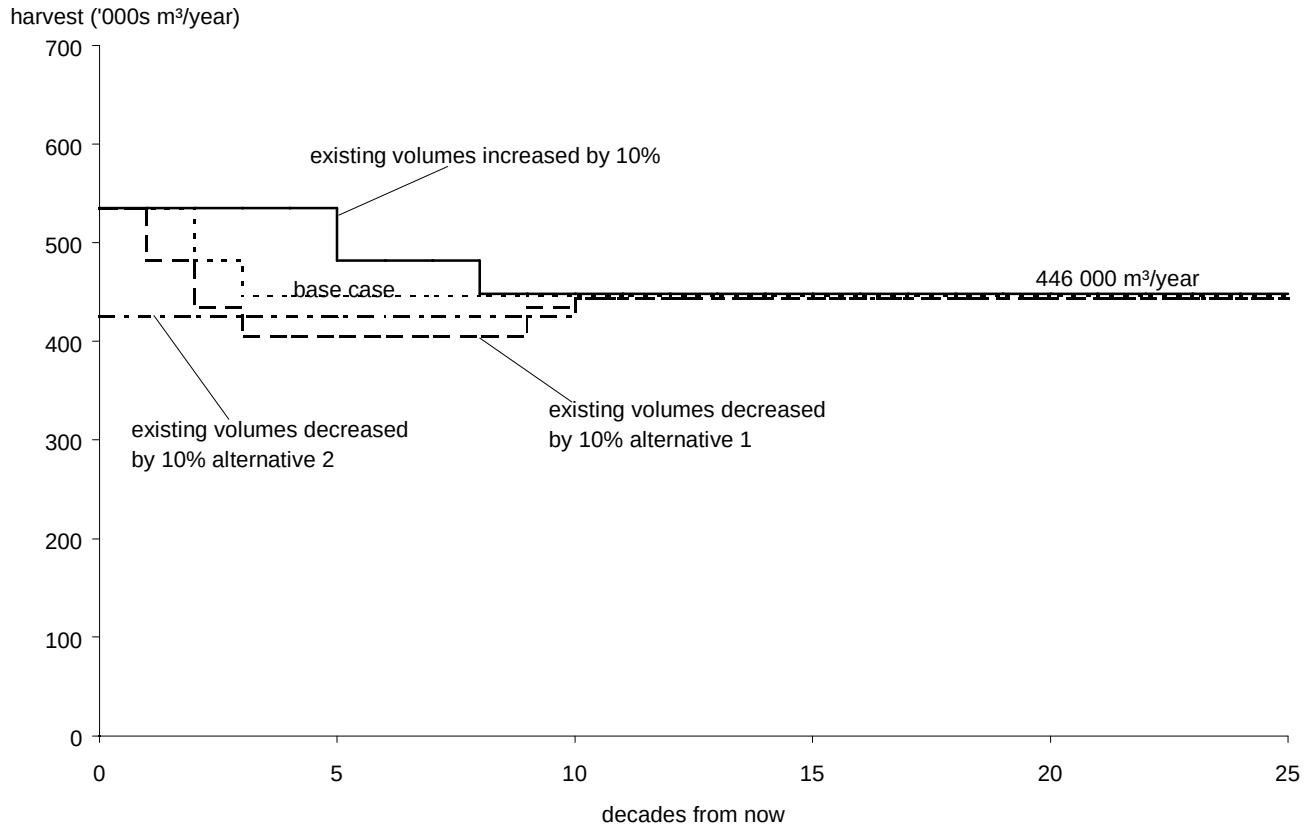


Figure 25. Harvest forecasts if existing stand volume estimates are 10% higher or lower than the base case — Golden TSA, 1998.

If existing volumes are reduced by 10% in the base case, the current harvest level could still be achieved, but harvests would need to decline to 10% below the long-term level during the mid term, before rising back up in decade 10 (alternative 1). If existing volumes are 10% lower than estimated for the base case, the total harvest over the next 110 years would have to be about 6.5% less than in the base case to avoid creating severe timber supply disruptions further in the future. The long-term harvest level would not be affected.

The alternate flow 2, demonstrates that the harvest level must drop below the long-term harvest level at some point if volumes were indeed 10% less than used in the base case. The timber supply is highly sensitive to overestimation of existing stand volumes because as the volume of timber that is obtained from each stand harvested decreases, harvesting must occur on more area to obtain the same total harvest volume. Thus, as the area covered by existing unmanaged stands will be harvested at a faster rate than in the base case, the harvest level must be decreased earlier to ensure a gradual transition to harvesting in the second-growth forest.

This sensitivity analysis shows that timber supply is very sensitive to uncertainty about standing volumes in existing mature forests. However, a recently completed inventory audit indicates that the volume estimates used are reasonably accurate.

5.12 Uncertainty in regenerated stand volume estimates

Estimates of timber volumes in regenerated managed stands are uncertain for similar reasons as existing stand volumes; however, there is additional uncertainty around the estimates of site productivity (discussed further in Section 5.13, "Uncertainty in site productivity estimates"). In this section, the effects on timber supply of using managed stand tables and their associated uncertainty are shown.

Figure 26 shows that if managed stand volumes were to exceed the base case managed stand volume estimates by 10%, the higher volume contributions of managed stands to timber supply cause the long-term harvest level to be approximately 10% higher than in the base case. The current AAC could be maintained for two decades before declining at the same rate as in the base case. After decade 7 the harvest level increases to the long-term harvest level of 490 000 cubic metres per year (10% higher than in the base harvest forecast).

5 Timber Supply Sensitivity Analyses

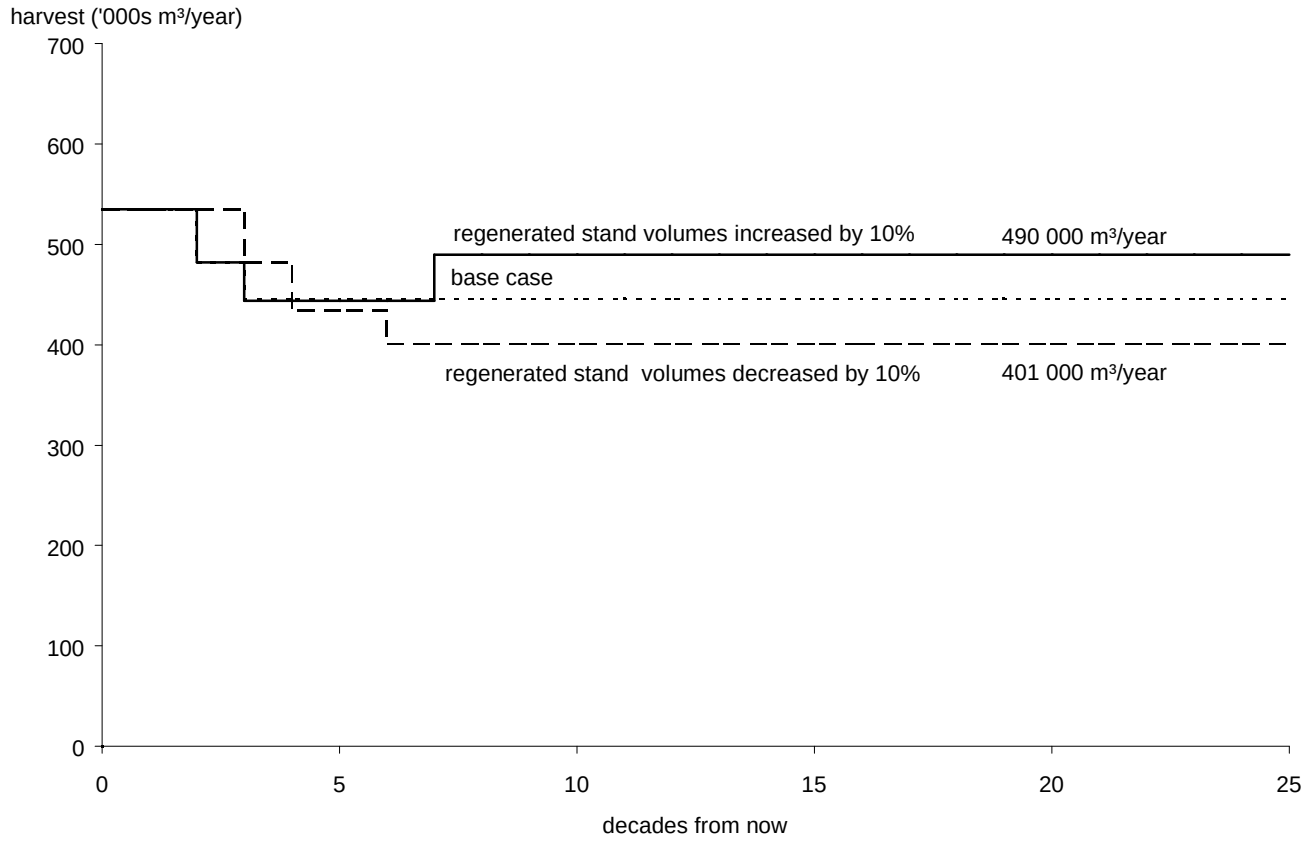


Figure 26. Harvest forecasts if regenerated stand volume estimates are 10% higher or lower than the base case — Golden TSA, 1998.

If regenerated stand volume estimates are in fact 10% lower than expected, the long-term harvest level is projected to be 401 000 cubic metres per year, which is approximately 10% lower than the base case long-term harvest level. In this harvest forecast, the current AAC can be maintained for three decades (one decade more than in the base case) before declining at a rate of 10% per decade to the long-term harvest level, which is reached after 60 years. Maintaining the harvest for an additional decade is a function of harvest flow, and a lower long-term level. As the long-term harvest level is lower than in the base case, not as much mature timber must be retained during the transition period, in particular decades 5 through 7 and thus more harvesting can take place in the short term.

Figure 27 illustrates two harvest flows that would result if the volume estimates for existing, unmanaged stands (VDYP volume estimates) were substituted for managed stand volume estimates. This substitution shows the potential impact on timber supply if managed stand volume estimates were not available. Alternative 1 shows that the base case initial harvest level can be maintained for three decades and still decline at 10% per decade thereafter. However, the long-term harvest level is 35% below the base case level. A second alternative flow has an initial level just over 650 000 cubic metres followed by a 10% per decade decline for the next 6 decades to the same lower long-term level.

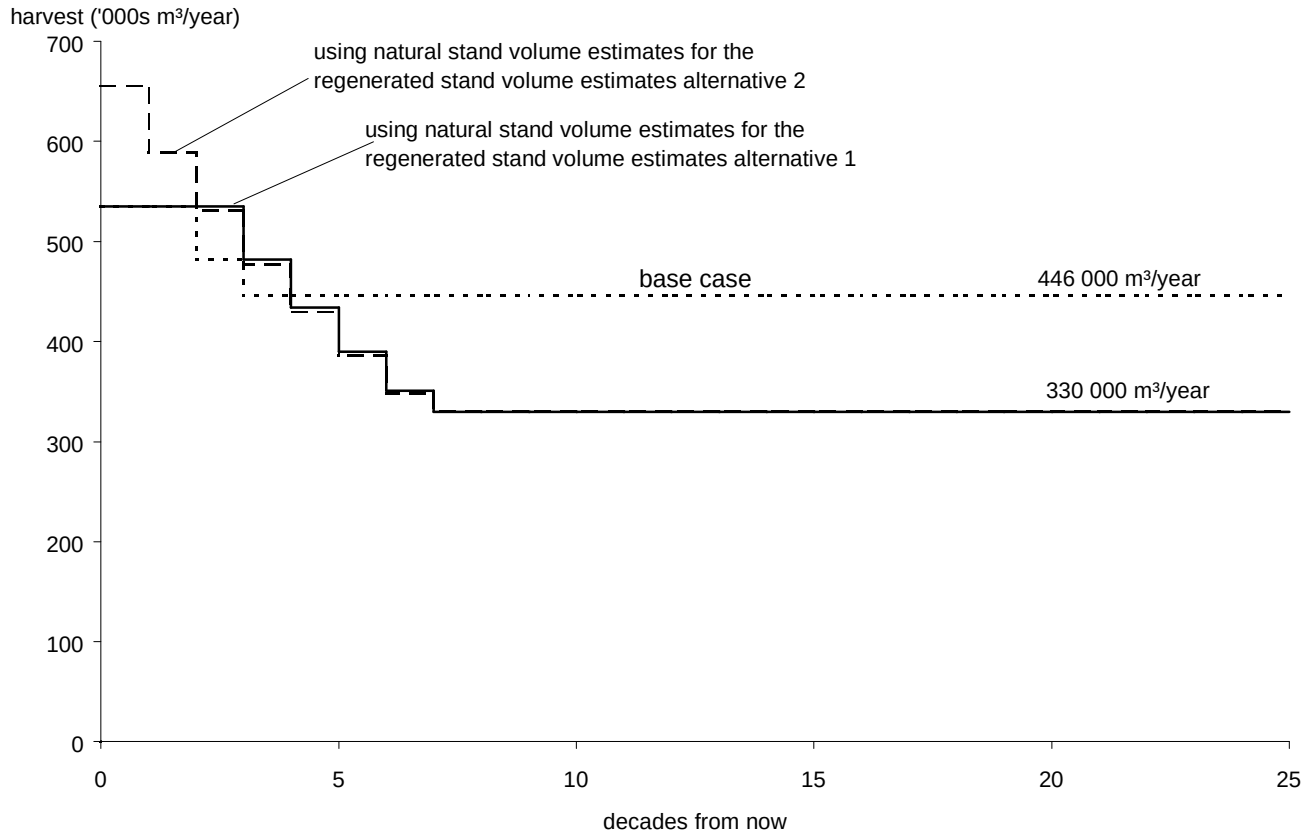


Figure 27. Harvest forecasts using natural stand volume estimates for the estimate of regenerated stand volumes — Golden TSA, 1998.

In summary, uncertainty about regenerated stand volume estimates has a proportional impact on the long-term harvest level projected in the base case.

5.13 Uncertainty in site productivity estimates

Estimating the future productivity of the existing mature forest is difficult in that it is not possible to know with certainty how the productivity of a regenerated stand will compare to the productivity of the existing stand it replaces. The productivity of a site largely determines how quickly trees will grow. It therefore affects expectations of timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate assessments of site productivity come from stands between 30 and 150 years old; estimating site productivity in both younger- and older-stands is difficult. Currently, about 38% of the Golden TSA timber harvesting land base comprises stands between 30 and 150 years old. Thus, a substantial area lies outside the age range that provides accurate estimates. This section examines how timber supply is affected by uncertainty in site productivity estimates which affect regenerated stand volumes, green-up ages, and minimum harvestable ages. Each of these have been examined individually in previous sections.

Site productivity is often expressed in terms of the site index* at a breast height age of 50 years. If site indices were underestimated, regenerated stands would grow faster than estimated in the base case. As a result, they would reach the required green-up height sooner, and would achieve minimum merchantable volumes, and thus, minimum harvestable ages, sooner than estimated in the base case. Figure 28 displays how timber supply would change if current data underestimate actual site productivity by 2.5 metres. The underestimated site productivity forecast is based on increasing site productivity on regenerated stands by 2.5 metres, thus increasing the regenerated stand volume estimate and reducing minimum harvestable ages by 10 years. The overestimate forecast uses a 2.5 metre reduced productivity estimate and adds 10 years to the minimum harvestable ages.

Site index
A measure of site productivity. Site indices in British Columbia are based on heights of free-growing dominant trees of a given species at a reference age of 50 years above breast height. Site index curves have been developed for British Columbia's major commercial tree species.

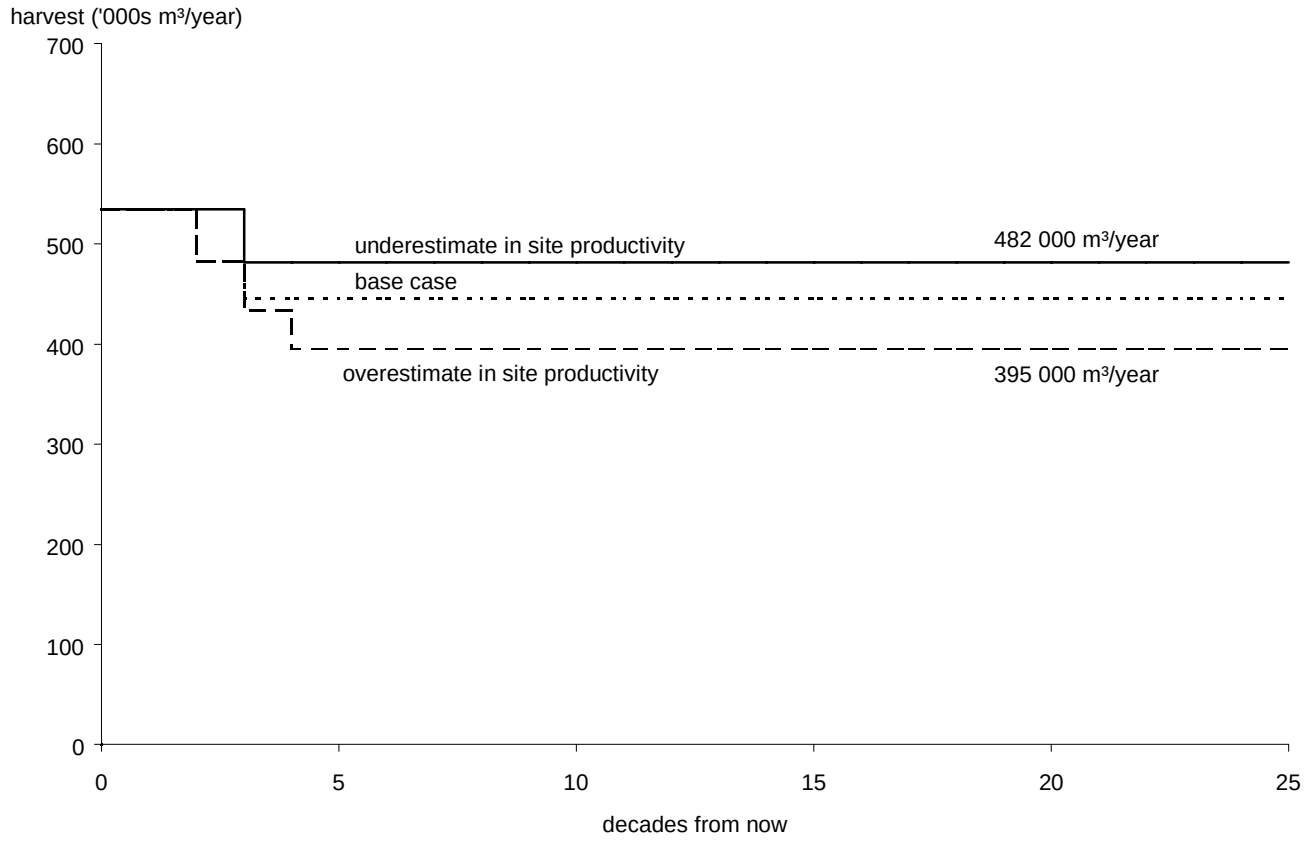


Figure 28. Harvest forecasts if site index is increased or decreased by 2.5 metres — Golden TSA, 1998.

The harvest forecast for the underestimate in site productivity shows that it would be possible to prolong the initial harvest level for an additional decade prior to one 10% step down to the long-term harvest level. The long-term level, reached in the fourth decade, is about 8% higher than that of the base case. The long term is higher mainly due to the increase in regenerated stand volume estimates which has a greater impact than a reduction to the minimum harvestable ages (when only minimum harvestable ages were reduced, the long-term level was reduced).

The increases in timber supply over the next 100 years shown Figure 28 stem from increases in regenerated stand timber volumes in stands available for harvest several decades from now. The volume of timber in the existing stands available for harvest over the next few decades would not change if volumes in managed regenerated stands were different than predicted for the base case.

If site indices were overestimated, the volumes of regenerated stands would be smaller than estimated in the base case, and these stands would not grow as quickly, increasing the number of years required to reach green-up conditions and minimum harvestable age. Figure 28 also shows the affect on timber supply if site indices are actually 2.5 metres less than estimated in the base case, including a 10 year increase to the minimum harvestable ages. The current AAC could still be maintained for two decades before declining to the long-term harvest level at a rate of 10% per decade. However, the long-term harvest level of 395 000 cubic metres per year is 12% lower than the long-term harvest level projected in the base case. Over the next 130 years, the cumulative timber supply would be 8% less than in the base case.

In summary, uncertainty about site productivity quite dramatically affects long-term timber supply. If site productivity has been overestimated in the base case, immediate harvest level reductions relative to the base case would not be required. However, in the case of site productivity underestimation, an additional decade at the initial harvest level is possible due to the higher volumes from regenerated stands, and lower minimum harvestable ages.

5.14 Uncertainty in land base available for harvesting

Defining the timber harvesting land base for this analysis involved several assumptions about the types of forest land that are available for harvesting. Inventory classifications together with terrain inventory resource mapping (used for riparian area estimates) and geographical information systems (GIS) analysis were used to approximate areas to be excluded from timber harvesting. Since approximations were used to define the land base, and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the timber harvesting land base under current management.

Stand-level biodiversity assumptions, operability, problem forest types, environmentally sensitive areas, low site, etc. all add an element of uncertainty about the size of the timber harvesting land base. To address these concerns, the area in all stand types and ages within the timber harvesting land base in the base case was both increased and decreased by 10%. In the case of timber harvesting land base increases, the additional area was assumed to come from inoperable areas — which were reduced by an equivalent area. In the case of timber harvesting land base decreases, the area removed from the timber harvesting land base was assumed to be inoperable, so while it no longer contributed to timber supply, it continued to contribute to forest cover requirements for wildlife and old growth.

If the timber harvesting land base were in fact 10% larger than defined for the base case, the current harvest level could be maintained for four decades before declining to a long-term harvest level 9% (487 000 cubic metres per year) higher than in the base case (Figure 29). Over the first 150 years, the total timber supply in this forecast would be 8.5% higher than in the base case, while over the remainder of the planning horizon, timber supply would be 9% greater.

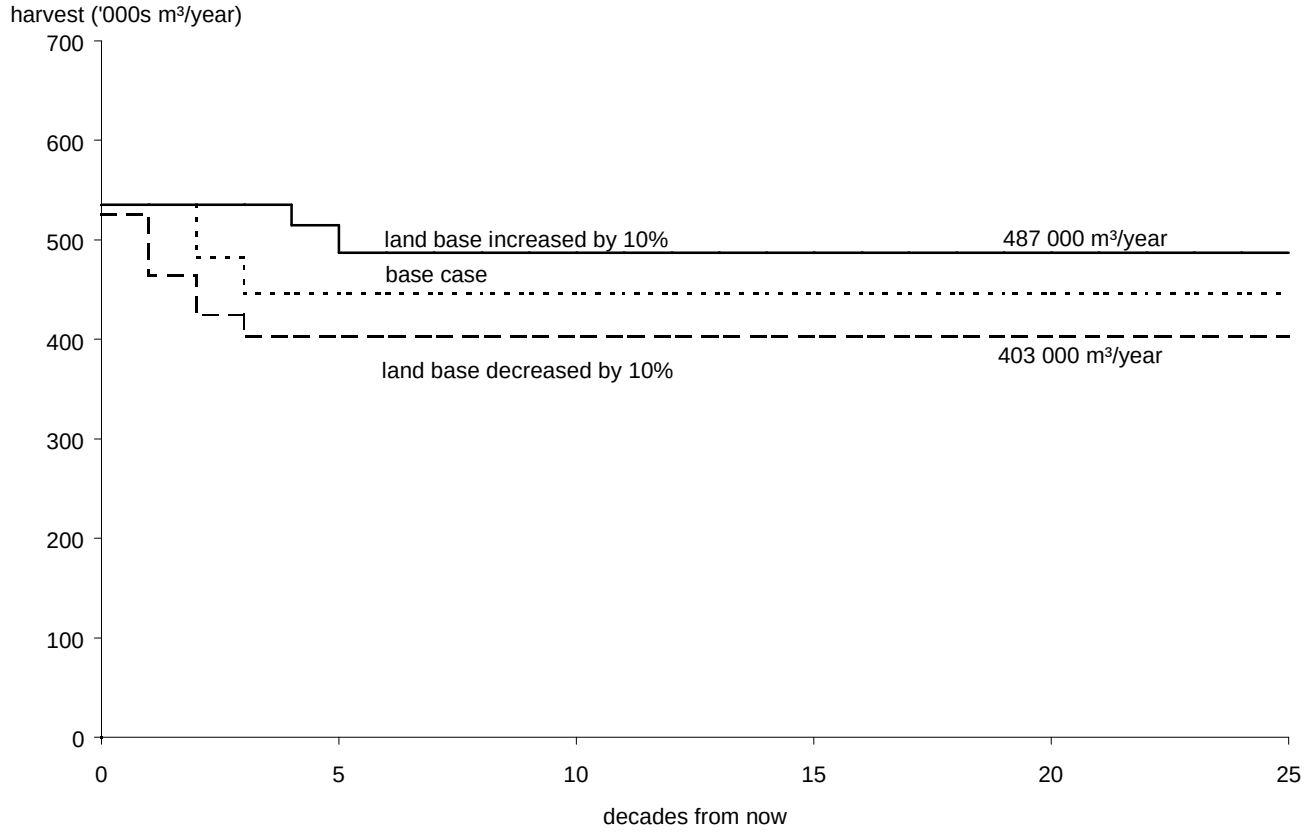


Figure 29. Harvest forecasts if the timber harvesting land base is increased or decreased by 10% — Golden TSA, 1998.

5 Timber Supply Sensitivity Analyses

Results displayed in Figure 29 also indicate that if the timber harvesting land base were 10% smaller than in the base case, the current harvest level could not be maintained. The initial harvest level would be reduced to 525 000 cubic metres, (a 2% reduction) followed by a decline of 10% per decade to the long-term level. The long-term level is about 10% less than that of the base harvest forecast. Timber supply over the next 150 years would be 9% lower than in the base case.

In summary, timber supply is sensitive to uncertainty about the size of the timber harvesting land base. Short-term timber supply is affected when land base is decreased. An increased land base can extend the time over which harvesting could continue at the initial harvest level projected in the base case; a decreased land base would require earlier harvest level reductions, or larger declines further into the future.

6 Summary and Conclusions of the Timber Supply Analysis

The results of the base case harvest forecast suggest that the current allowable harvest level in the Golden TSA of 535 000 cubic metres per year can be maintained for up to 20 years without requiring substantial future harvest level reductions, or creating severe future timber supply disruptions. Using current inventory and timber growth information, and assuming continuation of current forest management practices, harvests could be maintained at the current level for 20 years if followed by a 10% reduction in the third decade and a fourth decade reduction of 7.5% to the long-term harvest level of 446 000 cubic metres per year, (17% below the current level).

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

These sensitivity analyses showed that, within the range of uncertainty examined in this analysis, short-term timber supply (over the next 20 years) in the Golden TSA is very sensitive to some data and management changes. Changes in green-up ages and decrease to the size of the timber harvesting land base caused an immediate reduction in short-term harvest levels.

Several of the sensitivity analysis resulted in the initial harvest level being maintained for only one decade. This indicates that the timber supply can be quite sensitive to some management changes in the short term. The initial harvest level can only be maintained for one decade; if the *Kootenay-Boundary Land Use Plan Implementation Strategy* biodiversity emphasis options are applied; if the full low old—seral biodiversity requirement is applied immediately; if the maximum allowable area below green-up is decreased; if the minimum harvestable ages are decreased and if the estimates of existing stand volumes are decreased 10%.

If the timber harvesting land base was increased 10% or the existing stand volume estimates were increased 10% then the initial harvest level can be maintained for four and five decades, respectively.

The forest inventory and management factors discussed above could affect timber supply over the next 120 years, and uncertainties about several of these factors required maintaining the initial harvest level for only 1 decade. In addition, a few of the uncertainties examined in this analysis would require short-term harvest reductions.

Over the long term, that is during the period from 100 to 250 years from now, site productivity, regenerated stand volume estimates, minimum harvestable ages, and the size of the timber harvesting land base have large effects on timber supply. Uncertainty about the forest cover requirements for visual quality, landscape-level biodiversity, ungulate winter range units, and contribution from parks to biodiversity all have moderate effects on long-term harvest levels. Green-up ages, maximum disturbance objectives for integrated resources management areas and wildlife management zones, and estimates of timber volumes in existing stands have low to no effect on long-term timber supply.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, and the current management regime, timber harvests in the Golden TSA can be maintained at the current allowable level for the next 20 years. Several factors related to the current forest inventory and management regime could affect the short-term timber supply. No conclusive evidence was available prior to completion of this analysis to suggest that significant inaccuracies exist in the information used.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis examines the socio-economic implications of alternative harvest levels in the Golden TSA. It compares the level of forestry activity currently supported by timber harvested from the Golden TSA to the level of activity that could be supported as the Golden timber supply moves towards its long-term harvest level. The analysis uses the base case harvest forecast as an indication of future timber supply levels.

The socio-economic analysis includes:

- a profile of the current socio-economic setting;
- a description of the forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Socio-economic setting

7.1.1 Current population and demographic trends

The Golden TSA is sparsely populated. In 1996, the estimated population of the Golden TSA was slightly less than 6,000 people (see Table 5). The town of Golden is the largest population centre within the Golden TSA. Other communities include Nicholson, south of Golden and a rural population corridor from the southern boundary of the Rocky Mountain Trench to Donald in the north.

Population forecasts for the Columbia-Shuswap Regional District, which includes the Golden TSA, indicate a modest net inflow of population over time. By the year 2001, the population of the region is expected to increase by about 6% - 7%.[1] The stability of the forest industry and new investments in tourism and real estate will be important to the realization of this growth.

Table 5. Population statistics, Golden TSA

Communities	Population 1991 census	Population 1996 census	% change 1991 – 1996
Golden	3,721	3,968	6
Other communities[a]	1,964	1,888	– 4
Total — Golden TSA	5,685	5,856	3

Source: BCSTATS, with 1996 Census data

(a) Estimated by BCSTATS to be about 60% of Columbia-Shuswap subdivision A.

(1) B.C. Stats, Population Section.

7.1.2. Economic profile

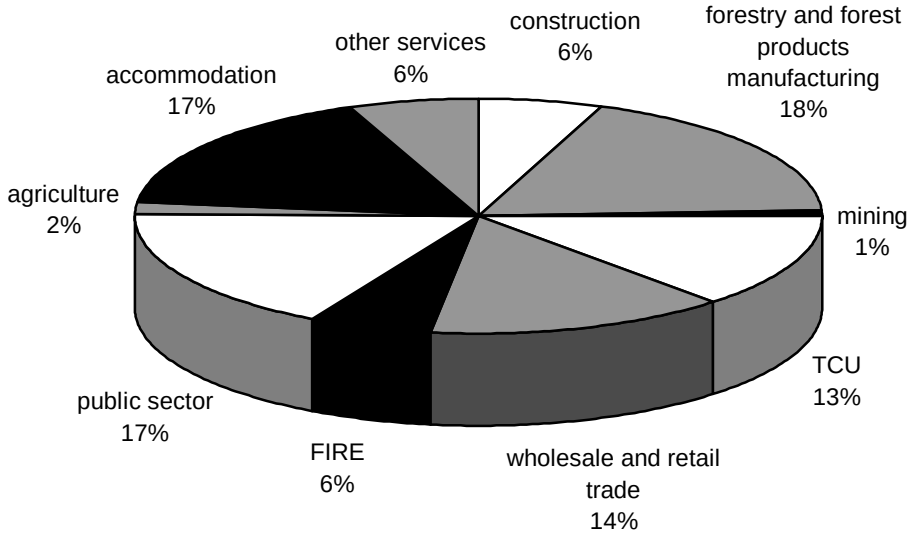
The total experienced labour force in the Golden TSA increased by 4.5% to 3,260 in 1996 from 3,120 in 1991. In comparison, the provincial experienced labour force increased by 14% over the same period. The unemployment rate in the Golden TSA was 14.4% in 1996 compared to 13.7% in 1991.

As Figure 30 illustrates, the major employment sectors in the Golden TSA are forestry, accommodation and the public sector (which includes education, health, and other federal, provincial and local public services). In 1996, the forestry sector, including harvesting and processing related activities, accounted for approximately 18% of the labour force; in contrast, in 1991, the forestry sector accounted for 29% of the labour force.

Tourism is also important in the Golden TSA economy. Tourism related employment is included as part of the accommodation, retail trade, transportation, communications and utilities (TCU) and other services sectors as shown in Figure 30. It is estimated that more than 400 people are employed in the tourism industry in the Golden TSA. Almost 100 businesses in the Golden TSA provide services for tourism, including adventure and guiding operations, retail and service businesses, food and beverage facilities, and accommodations. Between 1994 and 1997, the number of accommodation rooms in the Golden TSA increased by almost 75%. Recently, Golden Peaks Resorts Inc. announced plans to develop a four-season, five-star resort in the Golden area, which will increase the tourism sector's importance to the area's economy.

Transportation services is a stable component of the area's economic base due to Golden's location on national east-west transportation routes. The mining sector consists of two mines which produce silica and magnetite. Opportunities for the development of silica-based products have been identified and local community groups such as the Golden Economic Development Office are pursuing development possibilities.

Growth in the labour force between 1991 and 1996 was concentrated in the public sector and wholesale and retail trade, which increased by 35% and 20% respectively. The finance, insurance, real estate and other business services (FIRE) and other personal services sectors also increased from 1991 to 1996.



Source: 1996 Census of Canada.

Note: Other services includes services not elsewhere allocated. TCU consists of transportation, communications and utilities. FIRE consists of finance, insurance and real estate and other business services.

Figure 30. Employment by sector, 1996 — Golden TSA, 1998.

7 Socio-Economic Analysis

Employment income is another indicator of a sector's contribution to the economy. Basic sectors* with high income levels tend to support more non-basic* activities than those with lower income levels.[2] Using basic employment and income, Table 6 indicates which sectors will have a greater impact on the local economy. For example, in 1991 the forestry sector supported 39% of basic employment and 45% of basic income in the Golden TSA. In comparison, tourism accounted for 18% of basic employment but only 8% of basic income, reflecting the lower wages and part-time nature of employment in the tourism industry. (Non-basic employment and non-basic income are not included in these figures.) This illustrates the greater flow of revenue and incomes associated with the forestry sector.

Data from Statistics Canada, comparing average weekly earnings in different sectors of the economy, indicate that the forestry sector is one of the highest paying sectors and, therefore, a major contributor to the local and provincial economies. Mining is the only sector that has consistently paid higher average wages than forestry. In 1997, the average weekly earnings in the forestry sector were approximately $903, compared to $1,050 for the mining sector. In comparison, average weekly earnings were approximately $709 for the construction industry; $791 for other goods producing industries; $266 for the accommodation, food and beverage service industries; and $785 for public administration.

Employment multipliers* provide another perspective of the forest industry's role in the economy. Estimates by the Ministry of Finance and Corporate Relations indicate that for every 100 full-time direct forestry jobs in the Golden TSA, another 45 to 55 indirect and induced jobs* are supported, depending on the forestry activity (harvesting or processing). In comparison, for every 100 full-time direct jobs in the tourism sector, an estimated additional 12 indirect and induced jobs are supported. The differences are a result of larger spending patterns by both forestry sector businesses and their employees. Table 6 compares basic employment, basic income, and employment multipliers for the basic sectors of the Golden TSA's economy.

(2) Basic sectors differ slightly than the employment sectors used in Figure 30. A basic sector includes both direct employment and the employment generated by basic sector companies purchasing inputs and other goods and services, such as those captured in the accommodation, FIRE and TCU categories for example. Note that 1996 updates to the data used in Table 6 is not yet available, as such the table serves only as an illustration of the different income impacts among sectors. For a more in-depth discussion of basic sector employment see Horne and Powell, 1995, *British Columbia Local Area Economic Dependencies and Impact Ratios*. Ministry of Finance and Corporate Relations, Government of British Columbia.

Basic sector
Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Basic employment and income are indicators used to describe the size of basic sectors.
Non-basic sectors
Non-basic sectors, such as retail outlets, are supported by basic sectors.

Multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by workers spending their incomes on goods and services; for example, at retail outlets.

Table 6. Comparison of employment, income and employment multipliers, (from 1991 census data), Golden TSA

Basic sector	% of basic employment[a]	% of basic income[b]	Employment multiplier[c]
Forestry and related	39	45	1.45 – 1.55
Mining and related	2	3	1.48
Agriculture and food	1	1	1.19
Tourism	18	8	1.12
Public sector	21	22	1.24
Other basic employment	19	21	
Total	100	100	

Source: Ministry of Finance and Corporate Relations, *The Revised Forest District Tables*. March, 1996.

(a) The employment percentages in Table 6 are for basic employment, as such employment is aggregated differently than in Figure 30.

(b) After tax income, based on total employment income but excludes transfer payments and other non-employment income.

(c) Includes direct, indirect and induced jobs.

7.2 Golden TSA forest industry

7.2.1 Current allowable annual cut

The allowable annual cut (AAC) for the Golden TSA is 540 000 cubic metres which came into effect January 1995. From 1981 to 1995, the AAC was 650 000 cubic metres. The current AAC is apportioned to various licences, as outlined in Table 7. Two forest licences account for more than 80% of the apportionment and the Ministry of Forests' small business forest enterprise program accounts for another 15%. The Golden TSA timber supply review does not include the timber supply and AAC for issued woodlots in its analysis, therefore the projected base case is 535 000 cubic metres (540 000 cubic metres less the 5,000 cubic metres for currently issued woodlots).

Table 7. Allowable annual cut apportionment, 1995 — Golden TSA

Type of licence	Volume (cubic metres)	Per cent (%)
Forest licences, replaceable	426 543	83
Timber sale licence (TSL) > 10 000 cubic metres, replaceable	0	0
TSL < 10 000 cubic metres, replaceable	72	< 1
Small business forest enterprise program (SBFEP)	81 839	15
Forest Service reserve	29 887	2
Woodlot licences	1 659	< 1
Forest licences, non-replaceable	0	0
Total	540 000	100

7.2.2 Golden TSA harvest history

Table 8 summarizes the volume of timber harvested in the Golden TSA from 1993 – 1997. It indicates that recent actual annual harvests have been significantly lower than the AAC, due in part to weak markets for B.C. wood products and to the restructuring of operations by the TSA's major licensee (see Section 7.2.3, "Major licensees and processing facilities"). The small business forest enterprise program has also seen a significant decrease in volumes harvested in recent years. However, the Ministry of Forests' records indicate that the volume sold, but not yet harvested, in the program remains close to the 1993 – 1997 annual average of about 60 000 cubic metres.

Table 8. Volume billed, by type of licence, 1993 – 1997 (cubic metres), Golden TSA

Type of licence[a]	1993	1994	1995	1996	1997	1993 – 1997 average
Forest licence	475 505	316 698	293 019	156 488	212 175	290 777
Small business forest enterprise program (SBFEP)	64 722	110 391	56 744	35 173	30 639	59 534
Woodlots	4586	8218	6178	1703	3938	4925
Other [b]	16 758	23 163	23 997	17 767	39 903	24 318
Total	561 571	458 470	379 938	211 131	286 655	379 553
Allowable annual cut	650 000	650 000	540 000	540 000	540 000	

Source: Ministry of Forests, Harvest database.

(a) Timber harvested from private lands are not included.
(b) Other consists of cutting permits such as rights-of-way, road permits and other small temporary permits.

The actual annual harvest level is an important indicator of forestry activity in the Golden TSA. While the AAC sets the maximum permissible harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Cut control regulations provide the flexibility for licensees to vary the harvest level each year[3]. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential. This difference between the AAC and the actual annual harvest level could influence the potential short-term impacts of changes in the AAC.

7.2.3 Golden TSA major licensees and processing facilities

Evans Forest Products Ltd. (Evans) currently has a replaceable forest licence to harvest 375 227 cubic metres per year. The current level reflects two recent reductions: in 1995, following the last timber supply review the AAC for the licence was reduced to 394 976 from 473 622 cubic metres; in 1996, the AAC for the licence was further reduced by 5% to its current level of 375 227 cubic metres, as a result of the licence transfer to its present owner.[4] An estimated 80% – 85% of Evans' harvest is processed within the Golden TSA, with the remaining volume sold or traded to other processors outside the Golden TSA. Evans also relies on timber supplies from outside the region. As shown in Table 9, based on 1994 – 1996 data, Evans' forestry activities generated an estimated 487 – 535 person-years* of harvesting, silviculture and timber processing employment in the province. More than 90% of the workers who are employed by Evans live within the Golden TSA.

Table 9. Evans harvest and employment statistics

Allowable annual cut	375 227 cubic metres
1992–1996 average annual harvest	299 857 cubic metres
1997 harvest	197 312 cubic metres
Employment[a] (1994 – 1996 person-years):	
Harvesting and administration	130 – 131
Log transport and road construction and maintenance	111 – 137
Silviculture	16 – 32
Timber processing	230 – 235
Total	487 – 535

(a) Based on 1994 – 1996 annual average harvest of 228 747 cubic metres. Harvest figures include waste and reject, and road and cutting permits.

Person-year(s)
A full-time full-year job of at least 200 days per year. A part-time job lasting 100 days per year equals 0.5 of a person-years.

(3) Cut control regulations provide that over a five-year cut control period the actual harvest must range within 10% of the AAC, and may be with 50% and 150% in any year. The range gives licensees flexibility to adapt to changing conditions, including changing market conditions.

(4) Upon transfer of a replaceable licence, the allowable annual cut specified in the licence is reduced by 5%. The volume reduction is made available for other Ministry programs, such as the Small Business Forest Enterprise Program and Woodlot Licence Program.

In recent years, Evans has encountered financial difficulties. In the latter part of 1996, these difficulties culminated in the permanent closure of the company's lumber mill in Donald and the temporary curtailment of the company's plywood mill operation in Golden and harvesting operations in the Golden TSA. Evans has since restructured and resumed operating its remaining plant, and in 1998 established a new laminated veneer lumber (LVL) operation at its Golden plant. The LVL operation will not require additional timber supply because it utilizes peeled veneer from Evans' existing plywood operations. The plywood mill is capable of processing an estimated 300 000 cubic metres of timber annually.

Wood River Forest Inc. (Wood River) currently has a replaceable forest licence to harvest 51 315 cubic metres per year, reduced in 1995 from 61 533 cubic metres per year. The timber is processed in the company's lumber plant in Revelstoke, which is outside the Golden TSA. All Wood River employees live outside the Golden TSA. Table 10 summarizes Wood River's 1992—1996 harvest activity in the Golden TSA and associated employment.

Table 10. Wood River harvest and employment statistics

Allowable annual cut	51 315 cubic metres
1992 – 1996 cut control period average annual harvest	57 432 cubic metres
1997 harvest	51 198 cubic metres
Employment[a] (1994 – 1996 person-years):	
Harvesting and administration	17
Log transport and road construction and maintenance	10
Silviculture	2 – 7
Timber processing	18
Total	47 – 52

(a) Based on 1994 – 1996 annual average harvest of 33 528 cubic metres. Harvest figures include waste and reject, and road and cutting permits.

Small Business Forest Enterprise Program (SBFEP)

The current volume apportioned to the SBFEP in the Golden TSA is approximately 81 800 cubic metres per year. The SBFEP's harvests between 1993 and 1997 averaged approximately 60 000 cubic metres, or about 16% of the total harvest in the Golden TSA. An estimated 70% of the SBFEP's harvest is processed within the Golden TSA, while the remaining 30% is processed outside the Golden TSA. Table 11 shows that based on 1994 – 1996 data, forestry activities in the SBFEP generated an estimated 135 – 151 person-years of harvesting, silviculture and timber processing employment in the province. An estimated 65% of workers associated with the SBFEP's harvesting and silviculture activities live within the Golden TSA.

Table 11. Small business forest enterprise program harvest and employment statistics

Allowable annual cut	81 839 cubic metres
1993 – 1997 average annual harvest	59 534 cubic metres
1997 harvest	30 639 cubic metres
Employment[a] (1994 – 1996 person-years):	
Harvesting and administration	32 – 35
Log transport and road construction and maintenance	32 – 39
Silviculture	5 – 10
Timber processing	66 – 67
Total	135 – 151

(a) Based on 1994 – 1996 annual average harvest of 67 436 cubic metres.

Other primary processing plants

After Evans, the next largest primary processing plant in the Golden TSA is the Golden Specialty Wood Products and Veneer Ltd. which began limited operations in 1997, producing lumber and sliced veneer. Its estimated annual timber requirement is 10 000 cubic metres. In addition, there are a number of small-scale lumber mills in the Golden TSA that collectively process less than 6 000 cubic metres of timber annually.

Golden TSA timber supply and processing capacity

Approximately 70% of the timber harvested in the Golden TSA is processed within the TSA, while most of the remaining volume is processed in the Revelstoke TSA. Since the closure of the lumber mill at Donald reduced primary processing capacity in the Golden TSA, the annual timber requirement of the remaining processing plants is estimated to be 320 000 cubic metres. This requirement can be supplied by the Golden TSA if all of the current AAC of 535 000 cubic metres is fully harvested and processed.

7.2.4 Forestry sector employment and employment coefficients*

The preceding harvesting and employment information is used in the development of employment coeffecients, which will be used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

1) harvesting and other woodlands-related employment such as log salvage, log scaling, and harvest planning and administration (activities in log hauling and road building and maintenance are accounted for as indirect employment);
2) silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning; and
3) primary timber processing employment, such as manufacturing activities at lumber mills, veneer and plywood mills, shake and shingle mills and pulp and paper mills.

> ***Employment coefficient***
> *The number of person-years supported by each 1000 cubic metres of timber harvested, for example, a coefficient of 1.0 indicates that each 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.*

Harvesting employment

The harvesting component includes employees who work in the harvesting operations of a forest company as well as those who work as contract loggers. Generally, harvesting activity in the Golden TSA occurs between late May and mid-March, with about 120 – 150 days of active logging per year. In the past, cable and ground–based harvesting systems were used most frequently in the Golden TSA. In recent years, there has been an increase in the volume of timber harvested by innovative means such as helicopter logging, especially in environmentally sensitive areas. Harvesting employment will be the first component of the forest industry to adjust to harvest level changes.

Silviculture employment

Basic silviculture consists of surveys, site preparation, planting, brushing, cone collection and spacing. Enhanced or intensive silviculture includes spacing, fertilization and pruning. In the Golden TSA, major licensees are responsible for basic silviculture on areas harvested under major licences; the provincial government is responsible for enhanced silviculture and the remaining basic silviculture on Crown land. The silviculture employment component will not be affected as quickly as the harvesting component to harvest level changes because an amount of time can elapse between when harvesting takes place and replanting begins, and because enhanced activities are concentrated on areas previously harvested.

Primary timber processing employment

The timber harvested from the Golden TSA is processed into a variety of products such as lumber, veneer, log homes, poles and posts, shakes and shingles, and pulp and paper at mills within the Golden TSA and in neighbouring TSAs, such as the Revelstoke TSA. There is often a high degree of interdependence between the forest districts which complicates the timing and magnitude of potential harvest related impacts.

Employment coefficients

Employment coefficients, expressed as person-years of employment per 1000 cubic metres of harvest, have been calculated using the harvest volume and employment information. Table 12 summarizes employment supported by the 1994 – 1996 harvests in the Golden TSA and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

1) Golden TSA employment and employment coefficients, which comprise residents of the Golden TSA who are employed in the forestry sector; and

2) provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Golden timber supply, including both residents of the Golden TSA and those who live elsewhere in the province.

Employment coefficients have been calculated for both groups to identify the importance of the forestry sector within the Golden TSA and to highlight the contribution that the Golden TSA's forestry sector makes to the provincial economy. Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs per 1000 cubic metres of timber harvest or processed. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

More detailed information regarding employment coefficients is presented in Appendix B, "Socio–Economic Analysis Background Information".

Table 12. Direct employment and employment coefficients, average 1994—1996, Golden TSA

	TSA employment (person-years)	TSA employment coefficients (person-years/'000s cubic metres)	Provincial employment (person-years)	Provincial employment coefficients (person-years/'000s cubic metres)
Harvesting	169	0.48	198	0.57
Silviculture	4	0.01	43	0.12
Processing	194	0.55	228	0.65
Total direct	367	1.05	469	1.34
Indirect + induced	182	0.52	525	1.50
Total employment	549	1.57	994	2.84

Note: Employment estimates are reported in person-years and are based on 1994 – 1996 average employment and average 1994—1996 harvest of 349 846 cubic metres in the Golden TSA. Coefficients may not add due to rounding. Employment supported by non-Golden TSA harvests have been netted out.

During the previous timber supply review, the 1994 *Socio-Economic Assessment of Timber Supply Scenarios for the Golden TSA* indicated that the previous AAC of 650 000 cubic metres supported an estimated 692 person-years of direct employment in the province. The provincial employment coefficient was 1.06 person-years of direct employment per 1000 cubic metres. The current timber supply review indicates that harvesting, silviculture and processing activities associated with Golden TSA's average 1994 – 1996 harvest of 349 846 cubic metres supported an estimated 469 person-years of direct employment in the province, as indicated in Table 12. The provincial employment coefficient is 1.34 person-years of direct employment per 1000 cubic metres.[5]

The Golden TSA was administered by the Golden Forest District Office until January 1997 after which the forest district was combined with the Revelstoke Forest District to form the Columbia Forest District. Approximately 27 people currently work in what is now known as the Golden Field Office. They oversee the management of forestry–related activities on Crown land in the Golden TSA. Employees in the Ministry of Forests are not included as part of direct employment in the forestry sector because their activities are more related to government policy rather than to the volume of timber harvested.

7.2.5 Golden TSA Forestry employment income

In 1996, the average annual income for direct forestry employees was approximately $46,950 (see Table 13) and indirect and induced average annual incomes were $32,500. Based on 1994 – 1996 annual averages, the Golden TSA's timber harvest generated approximately $22.0 million in direct employment income and an additional $17.1 million of indirect and induced employment income. Altogether, the harvest generated an estimated total of $39.1 million in employment income, or about $111,710 per 1000 cubic metres harvested.

(5) Differences in employment coefficient rations can be due to several reasons: 1) different sources of information; 2) different methods of calculations; 3) reference to employment at different harvest levels; 4) different definitions of full-time employment; and, 5) different definitions of forestry sub-sectors. Whichever definitions are used, however, the resulting estimates of impacts of harvest level changes should illustrate similar effects.

Table 13. Estimate of forestry sector provincial employment income, 1994—1996 Golden TSA[a]

	Estimated person-years of employment	Average annual income per worker	Total employment income ($ million)	Employment income ($ per '000s cubic metres)
Direct employment	469	$46,950[b]	$22.0	$62,940
Indirect/induced employment	525	$32,500	$17.1	$48,770
Total	994		$39.1	$111,710

(a) Based on 1994 – 1996 annual average of 349 846 cubic metres
(b) Price Waterhouse, The Forest Industry in British Columbia, 1996.

7.2.6 Provincial government revenues

The provincial government receives taxes and revenues from the forest industry. The forest industry pays stumpage, royalties and rent to the provincial government for the right to harvest and use timber. The forest industry also pays operating taxes such as logging tax, corporate income tax, property and sales taxes. As well, the provincial and federal governments receive revenues from forestry employees through income taxes.

Between 1994 and 1996, the timber harvest in the Golden TSA contributed approximately $4.3 million in stumpage and rent payments annually to the provincial government. Other taxes paid by the forest industry, such as logging tax, corporate income, property and sales taxes, contributed approximately $3.0 million annually. In addition, the provincial government received approximately one-third of the $10.1 million in income taxes paid by forestry sector employees. Table 14 presents the various average provincial government revenues.

Table 14. Estimate of provincial revenues, Golden TSA

	Average volume harvested (1994 – 1996)	Estimated of total amount paid ($ million)	Provincial revenue ($ per '000s cubic metres)
Stumpage and related revenues[a]	349 846	$4.31	$12,329
Forest industry taxes[b]	349 846	$3.03	$8,664
Employment income taxes[c]	349 846	$3.36	$9,604
Total		$10.60	$30,597

Sources:

(a) Ministry of Forests, Revenue Branch.

(b) Based on estimates by Price Waterhouse, includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Based on income tax rates from Revenue Canada and includes only the provincial share of income taxes paid.

7.3. Socio-economic implications of the base case harvest forecast

The base case harvest forecast suggests the current AAC can be maintained for two decades at 535 000 cubic metres. At the beginning of the third decade, the base case forecasts a reduction of 10% to 482 000 cubic metres and at the beginning of the fourth decade, or 30 years from now, a further reduction of 7% to 446 000 cubic metres.

The socio-economic analysis focuses on harvest level changes in the short- to medium-term of 10 to 30 years from now and considers:

- the short- and long-term implications of alternative harvest levels for both the Golden TSA and the province;
- possible impacts on the communities within the Golden TSA;
- timber requirements of processing facilities within the Golden TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forestry activity that the base case harvest forecast could support, assuming that the current role of the forestry sector in the provincial economy continues and that labour productivity does not change. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment remain constant and that the types and portions of wood products manufactured remain the same.

Employment impacts associated with future harvest levels are calculated using employment coefficients (person-years of employment per 1000 cubic metres). This method of calculating employment coefficients assumes that employment levels in the future can be predicted using current conditions of employment and the volume of timber harvested and processed. While this method can be reasonably accurate for short-term forecasts (within the next 3 to 5 years), employment coefficients 20 years from now may be very different due to changes in market conditions, timber processing technologies, etc. The analysis provides an indication of the magnitude of impacts to employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

7.3.1 Short- and long-term implications of alternative harvest levels

Golden TSA employment and income impacts

For the first two decades of the base case forecast, the timber supply would support an estimated 561 person–years of direct employment in the forestry sector and an estimated 279 person-years of indirect and induced employment; totalling 840 person-years of employment in the Golden TSA. However, these figures are based on full utilization of the Golden TSA AAC. Recent harvest levels have been below the AAC, subsequently employment would have to increase to the levels indicated. Total employment income for the first two decades would average approximately $35.4 million per year.

In decade 3, the base case forecast annual harvest level of 482 000 cubic metres would support an estimated 506 person-years of direct employment in the forestry sector and an estimated 251 person-years of indirect and induced employment, totalling 757 person-years of employment in the Golden TSA. This amounts to a decrease from current levels of 55 person-years of direct employment and between 16 and 28 person-years of indirect and induced employment.[6] Annual employment income would decline from current levels by between $3.1 and $3.5 million.

(6) The ranges for employment and income changes take into consideration employment insurance and other social assistance programs that provide temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced will leave the Golden TSA to seek opportunities elsewhere and will no longer spend their income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments to unemployed or displaced workers will temporarily encourage them not leave the community, thus reducing the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. More details are given in Appendix B, "Socio-Economic Analysis Background Information."

In decade 4, the base case forecast annual harvest level of 446 000 cubic metres would support an estimated 468 person-years of direct employment in the forestry sector and an estimated 232 person-years of indirect and induced employment, totalling 700 person-years of employment in the Golden TSA. This amounts to a decrease from current levels of 93 person-years of direct employment and between 27 and 47 person–years of indirect and induced employment. Annual employment income would decline from current levels by between $5.3 and $5.9 million.

Provincial employment and income impacts

Provincial employment includes all forestry sector employment supported by the timber harvested from the Golden TSA, including employment within the TSA.

If the current timber supply of 535 000 cubic metres is fully harvested and processed, it could support an estimated 717 person-years of direct employment and 803 person-years of indirect and induced employment; totalling 1,520 person-years of employment in the province. Total employment income for the first two decades would average approximately $59.8 million per year.

In decade 3, the base case forecast annual harvest level of 482 000 cubic metres would support an estimated 646 person-years of direct employment and 723 person-years of indirect and induced employment; totalling 1,369 person-years of employment in the province. This amounts to a decrease from current levels of 71 person-years of direct employment and between 68 and 80 person–years of indirect and induced employment. Annual provincial employment income would decline from current levels by between $5.1 to $6.0 million.

In decade 4, the base case forecast annual harvest level of 446 000 cubic metres would support an estimated 598 person-years of direct employment and 669 person-years of indirect and induced employment; totalling 1,267 person-years of employment in the province. This amounts to a decrease from current levels of 119 person-years of direct employment and between 106 and 148 person-years of indirect and induced employment. Annual employment income would decline from current levels by between $8.6 to $10.0 million.

Provincial government revenues

Provincial government revenues from the forest industry come from three major sources:

1) stumpage, royalties and rent payments;
2) forest industry taxes, including logging tax, corporate income tax, sales tax, property tax, electricity tax; and
3) income taxes paid by those who are employed in the industry.

Provincial revenues from the Golden TSA's current AAC of 535 000 cubic metres would be approximately $16.4 million (in 1996 dollars), provided the entire AAC was harvested and processed. However, actual annual harvests from the Golden TSA during 1994 – 1996 averaged approximately 350 000 cubic metres, resulting in annual provincial revenues of about $10.6 million.

Assuming there will be no change to the rates of tax or to stumpage-related charges, the base case forecast harvest level for the third decade would lower potential annual provincial revenues by an estimated $1.7 million. By decade 4, annual provincial revenues would decline from current levels by $2.7 million.

7 Socio-Economic Analysis

Table 15. Socio-economic impacts: base case harvest forecast, Golden TSA

		Base case harvest forecast		
	Current[a] AAC	**Decades 1-2 (0-19 years)**	**Decade 3 (20-29 years)**	**Decade 4 (30+ years)**
Timber supply ('000s cubic metres)	535	535	482	446
Harvest level (1993-1997 average)	380	—	—	—
Difference from current AAC	– 155	0	– 53	– 89
Golden timber supply area				
Employment	**(person-years)**			
Direct	561	561	506	468
Indirect/induced	279	279	251	232
Total	840	840	757	700
Range[b] of employment gain (loss)		(0)	(71 –- 83)	(120 – 140)
Employment income	**($1996 million)**			
Direct	26.4	26.4	23.7	22.0
Indirect/Induced	9.0	9.0	8.2	7.5
Total	35.4	35.4	31.9	29.5
Range of income gain (loss)		(0)	(3.1 – 3.5)	(5.3 – 5.9)
Province[c]				
Employment	**(person-years)**			
Direct	717	717	646	598
Indirect/Induced	803	803	723	669
Total	1,520	1,520	1,369	1,267
Range of employment gain (loss)		(0)	(139 – 151)	(225 – 267)
Employment Income	**($1996 million)**			
Direct	33.7	33.7	30.3	28.1
Indirect/Induced	26.1	26.1	23.5	21.7
Total	59.8	59.8	53.8	49.8
Range of income gain (loss)		(0)	(5.1 – 6.0)	(8.6 – 10.0)
Provincial government revenues	**($1996 million)**			
Stumpage and related payments	6.6	6.6	5.9	5.5
Forest industry taxes	4.6	4.6	4.2	3.9
Employee income taxes	5.2	5.2	4.6	4.3
Total	16.4	16.4	14.7	13.7
Gain (reduction) in revenues		(0)	(1.7)	(2.7)

(a) Estimates for current employment differ from those in Table 12. Employment figures in this table are based on the current AAC of 535 000 cubic metres, while the figures in Table 12 are based on the 1994 – 1996 annual average harvest volume of 349 846 cubic metres. Due to rounding, some totals may not be the sum of their components.

(b). The ranges for employment and income changes take into consideration employment insurance and other social assistance programs that provide temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced will leave the Golden TSA to seek opportunities elsewhere and will no longer spend their income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments to unemployed or displaced workers will temporarily encourage them not to leave the community, thus reducing the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. More details are provided in Appendix B, Socio-Economic Analysis Background Information.

(c) The Golden TSA employment and income estimates are included as part of the provincial employment and income estimates.

7.3.2 Community impacts

The impacts of short- and long-term changes in the timber supply will be much greater on an economy which is dependent on a single industry than on one which is more diversified. The Golden TSA relies on the forest industry for a substantial portion of its economic activity. Recently, the Economic Development Department of the Town of Golden reported[7] that the community is still adjusting to the closure of a lumber mill in 1996. The report estimated that about 180 forest workers lost their jobs, with secondary effects on other segments of the community. The potential for two decades of stability in forestry employment as indicated in the preceding employment impact analysis should be considered within the context of earlier downturns in the Golden economy.

Recent harvest levels indicate some potential for increased employment in the forest industry, depending on the ability of industry to economically utilize the current AAC available. This potential, combined with the projected population growth in the Golden area would contribute to a more stable economy in the Golden TSA.

The economic analysis of the base case harvest forecast suggests that the forestry sector will remain a key industry sector in the Golden TSA, and the projected stability in harvest levels for the next two decades will provide an opportunity for the forestry sector and its workers to adjust to lower harvest levels in subsequent decades. Even in decades 3 and 4, the forecast harvest levels are greater than the volume of timber currently being harvested in the Golden TSA, indicating that the forestry sector should be able to at least maintain its current contribution to the TSA's economy. This may also allow time for other sectors, such as transportation services and tourism, to increase their importance and provide additional stability and diversification to the economy in the Golden TSA.

7.3.3 Nature, production capabilities and timber requirements of processing facilities in the Golden TSA

Approximately 70% of the timber harvested in the Golden TSA is processed within the TSA, with most of the remaining volume processed in the Revelstoke TSA. The processing plants in the Golden TSA have an estimated annual timber requirement of approximately 320 000 cubic metres. The timber supply indicated in the base case should be sufficient for these mills, although the suitability of the current timber profile requires that some of the timber is traded for more suitable veneer quality timber.

In terms of expanding production capacity, the forecast reduction to the timber supply after 20 years would not encourage the development of a new medium to large processing facility, if it required a stable long-term supply of timber from the Golden TSA. The average milling requirement, for example, of a medium to large lumber mill in the Kootenays is 200 000 to over 500 000 cubic metres of timber per year. The Golden TSA timber supply would be insufficient for a facility within this production range, given the capacity of the mills already operating in the TSA. The current over−capacity of processing facilities and demand for timber in the Nelson Forest Region further highlights this constraint. However, this does not preclude the possibility of existing processors expanding their current operations.

7.3.4 Regional timber supply issues

In the past, approximately 30% of the Golden TSA's harvest has been processed outside the TSA. Mills located outside the TSA which rely on the Golden timber supply could eventually be affected by the reduction forecast to occur in two decades.

(7) Town of Golden, Economic Development Department, *Golden TSR — Status of Community, Impacts and Changes in 1998*. March, 1998.

The harvest from Wood River Inc.'s forest licence is processed in the company's lumber plant in Revelstoke. Their average annual timber requirement is approximately 320 000 cubic metres. Timber harvested from the Golden TSA supplies about 10% to 15% of this requirement, which is not expected to change during the first two decades of the base case for the Golden TSA. However, Wood River harvested near its full allotment during the last five year period, indicating that any future reduction could affect its supply.

The movement of timber across forest district boundaries means that communities in the Golden TSA are also vulnerable to timber supply changes in other forest districts. The high quality logs required for veneer and veneer products accentuates the Golden TSA's dependence on non-TSA sources of timber. Evans routinely trades or exchanges timber from its licence in the Golden TSA for other log species and the quality required for its veneer/plywood plant. Estimates from 1996 indicate that the Evans plant received more than 60% of its log supply from within the Nelson Forest Region. The remaining log supply was from areas outside the Nelson Forest Region and from private sources within the province.

Information from the previous timber supply review indicates that the timber supply in the east Kootenay region could decline by 10% or approximately 200 000 cubic metres within 10 to 15 years.[8] However, this outlook may change as each successive timber supply review re-examines the timber supply in the region. In addition, the *Kootenay-Boundary Land Use Plan* may have further implications for communities as the timber supply adjusts to meet the objectives of the land use plan. How these planning processes may eventually impact the Golden TSA will depend on how the timber supply is affected, the production and timber requirements of processing facilities, timber flows at the time, and international markets supply and demand.

7.4 Summary

The forest industry is the largest industrial sector of the Golden TSA economy. Evans is a major licence holder and operates the largest timber processing plant in the Golden TSA. The other major licence holder is Wood River, which operates a lumber mill in Revelstoke.

In recent years, harvests in the Golden TSA have been below the AAC. If the current timber volume of 535 000 cubic metres (the current AAC of 540 000 cubic metres less woodlots) was fully harvested and processed, there would likely be increases in employment, employment income and provincial government revenues. Within the Golden TSA, the current AAC would support an estimated 840 person-years of total employment (includes direct, indirect and induced jobs) and $35.4 million in employment income. Provincially, if the current AAC was fully harvested and processed, it would support an estimated 1,520 person-years of total employment, $59.8 million in employment income, and an estimated $16.4 million in provincial government revenues.

The base case harvest forecast for the Golden TSA indicates a stable timber supply for the first two decades. Maintaining the timber supply at its current level not only provides for a stable forest industry, it also could lead to more employment if the AAC were fully harvested.

(8) These figures are from an examination of the Cranbrook, Invermere, and Revelstoke timber supply review 1 (TSR1) documents, and this current timber supply analysis of the Golden TSA.

7 Socio-Economic Analysis

After two decades, or 20 years from now the base case forecasts a timber supply of 482 000 cubic metres per year, which is a reduction of approximately 10% from the current AAC. Within the Golden TSA, this amounts to a reduction of up to 83 person-years of total employment from the potential of the current AAC. Annual employment income in the Golden TSA would be reduced by up to $3.5 million. Provincially, the forecast timber supply would result in an estimated reduction of 151 person-years of total employment, including the 83 person-years in the Golden TSA. Annual provincial employment income would decline by up to $6.0 million, and annual provincial government revenues would decline by approximately $1.7 million.

After three decades, or thirty years from now the base case forecasts a timber supply of 446 000 cubic metres per year, which is a reduction of just under 17% from the current AAC. Within the Golden TSA, this amounts to a reduction of up to 140 person-years of total employment from the potential of the current AAC. Annual employment income in the Golden TSA would be reduced by up to $5.9 million. Provincially, the forecast timber supply would result in a decrease of up to 267 person-years of total employment, including the 140 person-years in the Golden TSA. Annual provincial employment income would decline by up to $10.0 million, and annual provincial government revenues would decline by approximately $2.7 million from current levels.

The base case harvest forecast suggests that the forestry sector will remain a key sector in the Golden TSA. The projected changes in harvest levels for the third and fourth decades are gradual enough to provide time and opportunities for the forestry sector and communities to adjust to the changes in timber supply. However, the regional timber supply and demand will be an important determinant of the industry structure throughout the Kootenays. For the Golden TSA, it is possible that other sectors, such as transportation services and tourism, will be able to increase their importance in the local economy, providing greater stability and diversification to the local economy.

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9 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 8 of the Forest Act*.
Analysis unit	The basic building blocks around which inventory data and other information are assembled for use in forest planning models. Analysis units represent the general level of aggregation, or detail, at which the growth and yield volume curves are created. They are normally defined by tree species and site qualities, but may also be defined to incorporate specific geographic areas or areas under a similar set of management practices.
Basic income and employment	Indicators used to describe the size of a basic sector.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors. Basic employment and income are indicators used to describe the size of basic sectors.
Biodiversity	The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Culmination age	The age at which a timber stand reaches its highest mean annual increment (MAI). MAI is calculated as stand volume divided by stand age. Culmination age is the optimal biological rotation age to maximize volume production from a growing site.
Cutblock adjacency	The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. This can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Employment coefficient	The number of person-years of employment supported by each 1000 cubic metres of timber harvested. For example, an employment coefficient of 1.0 indicates that each 1000 cubic metres of timber harvested supports one person-year of employment; or 500 000 cubic metres supports 500 person-years of employment.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.
Forest cover requirements	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency guidelines and Green-up**).

9 Glossary

Forest inventory	Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized, over time, for a specified land base and set of management assumptions. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by workers spending their incomes on goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Landscape-level biodiversity	Maintenance of biodiversity can occur at a variety of levels. The *Forest Practices Code Biodiversity Guidebook* applies to the landscape level and the stand level.
Landscape unit	A landscape unit provides an appropriately sized (up to 100 000 hectares) planning unit for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base and includes objectives and guidelines for non-timber values) and estimates of timber growth and yield.

9 Glossary

Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Multiplier	An estimate of the total employment supported by each direct job. For example, a multiplier of 2.0 means that one direct job supports one indirect and induced job.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
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.
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**).
Person-year of employment	A full-time job of at least 200 days per year. A part-time job lasting 100 days per year equals 0.5 of a person-year.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see **Visual quality objective**).
Riparian area	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 in British Columbia are based on heights of free-growing dominant trees of a given species at a reference age of 50 years above breast height. Site index curves have been developed for British Columbia's major commercial tree species.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
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 separating non-contributing areas from the total land base according to specified management assumptions.

9 Glossary

Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7 of the Forest Act*.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimate (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

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

A.1 Inventory Information

The 1993 Ministry of Forests forest cover inventory for the Golden TSA is the primary inventory used to determine the timber harvesting land base and the associated management themes to be used in defining forest management activities. This 1:20 000-scale inventory was first produced in 1967 and has been updated to 1993 for disturbance. The date projected ranges by mapsheet from 1995 to 1997. A number of non-standard inventories were also used in the analysis as follows:

Table A-1. Inventory information used in the analysis

Data	Source	Vintage	Update	Source scale
Golden TSA forest cover FC1 files	MoF (Ministry of Forests) standard inventory files	1967	1993	1:20,000
Hamber Provincial Park forest cover	MoF standard inventory files	1967	10/94	1:20,000
Federal (National) Park forest cover	Nelson Forest Region files	1956		1:32,000
Road systems	MoF ATLAS Project and MoF standard inventory files	1996		1:20,000
Caribou habitat	MoF District non-standard inventory files	06/95	05/97	1:50,000
Ungulate winter habitat (non-caribou)	MoF District non-standard inventory files	1980's	01/97	1:20,000
Watershed atlas (community and domestic watersheds)	MoF Nelson Forest Region files	1997	N/A	1:20,000
New (1995-1997) protected areas	MoF Nelson Forest Region files	1995-1997	N/A	1:20,000
Draft landscape unit boundaries	MoF District non-standard inventory files	1996	04/97	1:40,000
Visual landscape inventory	MoF District non-standard inventory files	1993	1996	1:20,000
Natural disturbance types	Biodiversity guidebook	09/95	1995	1:250,000
Draft biodiversity emphasis	FDP, MOU and KBLUP	10/96	1997	1:40,000
Land ownership	MoF standard inventory files	1967	10/94	1:20,000

The inventory file required a number of corrections due to typo's and an oversight in GIS processing. The typo corrections are shown in Table A-2. The oversight in GIS processing stemmed from the inclusion of the non-standard park inventory data. This data was processed in a manner that doubled the park area. To correct the problem, areas that were in the parks database were halved. In one instance (mapsheet 82N037) the park area had been quadrupled — necessitating a 0.25 area adjustment factor.

A.2 Zone and Analysis Unit Definition

Table A-2. Inventory corrections

Original condition in process file	Revised for use in analysis
Landscape unit OG2 (O - Oscar)	Landscape unit G02 (zero)
Biogeo ESSFcp-	Biogeo ESSFwc4
Biogeo ESSFww1	Biogeo ESSFwc2
Biogeo ESSGap-	Biogeo AT
Biogeo AT-----	Biogeo AT
Biogeo ESSFdk-	Biogeo ESSFdk
Biogeo ESSFvc-	Biogeo ESSFvc
Biogeo ESSFwm-	Biogeo ESSFwm
Biogeo ICH-mk1	Biogeo ICH mk1
Biogeo ICH-mw1	Biogeo ICH mw1
Biogeo ICH-wk1	Biogeo CH wk1
Biogeo MS-dk-	Biogeo MS dk
Biogeo ZZZZ---	Biogeo ZZZZ
Biogeo ICH b	Biogeo ICH wk1

A.2.1 Management zones and tracking of multiple objectives (grouping)

The Golden analysis area was divided into 355 separate zones for analysis purposes. Zone delineation is based on common forest management objectives such as forest cover requirements or geographic location. In this analysis, zones are the finest result of any change in landscape unit, NDT, biogeoclimatic classification (variant level), biodiversity-emphasis option (not applicable for the base case), domestic watershed, ungulate winter range, caribou habitat, visual quality or integrated resource management. For the delineation of landscape unit, ungulate winter range, caribou habitat, domestic watershed and visual quality area, specific GIS overlays were used; a detailed listing and maps of the zones are available from the Columbia Forest District office.

As shown in Table A-3., the above zones were grouped into 232 'groups' in order to apply forest cover requirements. Forest cover requirements for each group are discussed in Sections A.4.4, "Forest cover requirements" and A.4.5, "Landscape-level biodiversity." Grouping enables the analyst to apply constraints to different parts of the land base or zones as well as to enhance reporting structures. Groups may be thought of as layers of different objectives which must be tracked over time.

In the Golden analysis, the following groups were identified for the purpose of modelling current forest management:

1. Biodiversity group — areas within the Golden analysis area defined by combination of landscape unit, biogeoclimatic classification (to the variant level), and biodiversity-emphasis option (sensitivity analysis only) as such there were 135 groups to which cover requirements were applied.

2. Caribou — areas within the Golden analysis area defined by *Kootenay-Boundary Land Use Plan* (KBLUP) as primary and secondary caribou habitat and a 134 hectare wildlife management area designated in the KBLUP. Caribou areas were divided by biogeoclimatic lines (ESSF versus ICH) for management purposes making the total number of groups equal to 19. Caribou habitat was derived from a non-standard GIS overlay while the wildlife management area was delineated as follows:

Mapsheet 82N045, polygons	1042, 365, 381, 336, 349, 212, 334, 345, 346, 353 358, 366, 367, 368, 370, 382, 386, 392, 393 396, 400, 731, 111, 1320
Mapsheet 82N035, polygons	366, 348, 334, 335
Mapsheet 82N036, polygons	36, 38, 34
Mapsheet 82N026, polygon	684
Mapsheet 82N016, polygons	181, 194

3. Visual quality group — areas identified as visually sensitive from the forest district sources. All VQO areas were assigned to the 'partial retention' category. VQO areas are predominately along the trans-Canada highway, therefore only 11 groups were necessary to apply cover requirements. A non-standard GIS overlay defined VQO areas.

4. Domestic watershed group — the Ministry of Environment, Lands and Parks staff identified important domestic watershed areas. Eight separate areas were identified as having domestic watershed qualities. These eight areas fell over several landscape units therefore eleven groups were necessary to apply cover requirements. The domestic watershed overlay used for this analysis is a recent product and therefore was not available digitally at the time of this analysis. Domestic watersheds were therefore defined using the following attributes:

<u>Domestic Watershed 1</u>

Mapsheet 82N045

Polygons 652, 641, 645, 657, 658, 642, 561, 624, 729, 621, 620, 622, 551, 550, 555, 552, 25, 544, 24, 54, 596, 571, 572, 570, 84, 76, 208, 207, 204, 205, 206, 579, 580, 391, 742, 397, 56, 594, 573, 741, 598, 602, 605, 606, 604, 610, 516, 182, 183, 599

Mapsheet 82N055

Polygons 239, 256, 262, 304, 816, 308, 307, 818, 306, 303, 305, 302, 804, 782, 266, 830, 831, 833, 835, 840, 839, 838, 844, 845, 843, 841, 840, 842, 846, 241, 792, 296, 267, 812, 296, 297, 771, 272, 274, 273

A.2 Zone and Analysis Unit Definition

Domestic Watershed_2

Mapsheet 82N035
Polygons 413, 411, 421, 414, 387, 416

Mapsheet 82N036

Polygons 181, 345, 160, 180, 343, 183, 150, 179, 171, 169, 187, 189, 185, 184, 193, 195, 192, 191, 177, 176, 198, 693, 212, 211, 213

Mapsheet 82N046

Polygons 452, 481, 475, 477, 491, 474, 473, 471, 499, 470, 472, 486

Domestic Watershed_3

Mapsheet 82N026

Polygons 35, 62, 175, 725, 652, 69, 649, 651, 689, 96, 624, 627, 628, 629, 630, 625, 621, 39

Mapsheet 82N025

Polygons 414, 268, 387, 309, 411, 2850, 267, 353, 423, 321, 410, 409, 336, 407, 408, 335, 402, 347, 352, 368, 362, 333, 406, 427, 406, 405, 404, 426

Mapsheet 82N035

Polygons 532, 547, 527, 545.

Domestic Watershed_4

Mapsheet 82N026

Polygons 209, 210, 53, 339, 341, 343, 337, 305, 311, 312, 326, 325, 338, 306, 334, 333, 343, 345, 211, 212, 346, 213, 318, 319, 320, 321, 322, 323, 316, 293, 292, 291, 299, 271, 272, 273, 274, 275, 264, 267, 163

Domestic Watershed_5

Mapsheet 82N016

Polygons 275, 277, 286, 292, 296, 302.

Domestic Watershed_6

Derived using Sheds_ID 188

A.2 Zone and Analysis Unit Definition

Domestic Watershed 7

Derived using Sheds_ID 224

Domestic Watershed 8

Derived using Sheds_ID 236

The Sheds_ID variable is from the watershed atlas overlay (MELP product).

5. Ungulate winter range group — the Ministry of Environment, Lands and Parks and the forest district staff identified ungulate winter range areas which are currently being managed. Winter range exists in 23 landscape units — therefore 23 groups were necessary for application of cover requirements. The source of the ungulate winter range was a non-standard overlay. The base case modelled winter range by landscape unit. A sensitivity analysis used a combination of landscape units and the winter range polygons (about 250 hectare average).
6. Integrated resource management (IRM) group — all areas not assigned to one of the other resource management groups (not including the biodiversity group). Remnants from all 29 landscape units are represented in the IRM group.

The following table summarizes the area in each group — notwithstanding overlapping group areas. The area is sub-divided into inoperable forest, operable but excluded from timber harvesting forest, and timber harvesting land base. These land base definitions are important for applying forest cover requirements. In the biodiversity group, the forest cover requirements are applied to the total forest. In the IRM group the requirements were imposed on the timber harvesting land base. In the remaining groups the requirements were applied to the operable forest (operable non-contributing plus the timber harvesting land base).

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting land base by management group

Group	Group definition		Area (hectares)		
	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
1	G01	AT	1 649	4	41
2	G01	ESSFdk	2 402		
3	G01	ESSFwc2	4 999	349	676
4	G01	ICH wk1	1 043	454	1 335
5	G02	AT	766	0	5
6	G02	ESSFvc	3		
7	G02	ESSFwc2	3 830	85	483
8	G02	ESSFwm	1		
9	G02	ICH mw1	11	76	86
10	G02	ICH vk1		0	
11	G02	ICH wk1	826	816	3 671
12	G03	AT	757	4	9
13	G03	ESSFwc2	1 720	207	556
14	G03	ESSFwm	145	2	0
15	G03	ICH mw1	579	268	370
16	G03	ICH wk1	389	616	4 599
17	G04	AT	2 147	18	44
18	G04	ESSFwc2	3 652	1 047	344
19	G04	ESSFwm	460	44	34
20	G04	ICH mw1	478	1 223	1 913
21	G04	ICH vk1		0	6
22	G04	ICH wk1	796	2 930	2 926
23	G06	AT	748	0	0
24	G06	ESSFwc2	1 934	93	335
25	G06	ESSFwm	22		
26	G06	ICH mw1	42	74	304
27	G06	ICH wk1	430	403	1 051
28	G07	AT	2 280	72	44
29	G07	ESSFwc2	3 520	611	1 755
30	G07	ESSFwm	238	31	92
31	G07	ICH mw1	148	143	1 107
32	G07	ICH wk1	1 187	1 085	3 943
33	G08	AT	1 426	30	20
34	G08	ESSFwc2	3	3	0
35	G08	ESSFwm	2 581	437	1 302
36	G08	ICH mw1	743	1 607	5 557
37	G08	ICH wk1		7	27
38	G09	AT	558		
39	G09	ESSFwm	2 216	231	861
40	G09	ICH mw1	1 085	1 087	2 933

continued

Table A-3. Timber harvesting land base by management group (continued)

Group	Group definition		Area (hectares)		
	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
41	G10	AT	636	2	0
42	G10	ESSFwm	3 756	702	1 597
43	G10	ICH mw1	1 497	1 531	3 630
44	G11	AT	479		
45	G11	ESSFvc	1 187	141	658
46	G11	ESSFwc2	690	19	180
47	G11	ICH mw1		1	6
48	G11	ICH wk1	467	193	1 577
49	G12	AT	1 114	48	45
50	G12	ESSFvc	1 132	76	150
51	G12	ESSFwc2	450	188	525
52	G12	ICH vk1	4	3	4
53	G12	ICH wk1	454	319	844
54	G13	AT	4 410	15	48
55	G13	ESSFvc	1 474	259	1 565
56	G13	ESSFwc2	2 481	170	850
57	G13	ESSFwm	148	5	36
58	G13	ICH mw1	96	132	430
59	G13	ICH wk1	694	432	2 163
60	G14	AT	2 906	0	1
61	G14	ESSFvc	3 463		
62	G14	ESSFwc4	20		
63	G14	ESSFwm	2 995	113	620
64	G14	ICH mw1	500	182	535
65	G14	ICH wk1	8 023	282	1 351
66	G15	AT	1 505	4	32
67	G15	ESSFvc	0		
68	G15	ESSFwm	1 362	164	1 135
69	G15	ICH mw1	70	1 050	4 311
70	G16	AT	239	2	4
71	G16	ESSFwm	805	470	1 117
72	G16	ICH mw1	269	4 495	17 969
73	G17	AT	579	26	49
74	G17	ESSFwm	2 249	503	1 696
75	G17	ICH mw1	512	1 002	2 754
76	G18	AT	392	1	11
77	G18	ESSFwm	2 225	309	616
78	G18	ICH mw1	1 231	743	1 427
79	G19	AT	855		
80	G19	ESSFwm	4 440	511	424
81	G19	ICH mw1	1 224	1 082	2 153
82	G20	AT	1 395	73	181
83	G20	ESSFwm	3 205	487	1 904
84	G20	ICH mk1	491	6 226	1 255

continued

Table A-3. Timber harvesting land base by management group (continued)

Group	Group definition		Area (hectares)		
	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
85	G20	ICH mw1	363	2 621	6 819
86	G20	IDF dm2	178	697	80
87	G20	MS dk	69		
88	G21	AT	2 902	160	250
89	G21	ESSFwm	6 395	1 179	4 061
90	G21	ICH mk1	1 134	3 032	4 743
91	G21	ICH mw1	169	371	874
92	G22	AT	2 897	31	118
93	G22	ESSFwm	6 389	273	1 773
94	G22	ICH mw1	4 038	1 152	5 794
95	G22	ICH wk1	21	5	70
96	G23	AT	1 731	52	147
97	G23	ESSFwm	3 025	522	1 447
98	G23	ICH mk1	58	2 285	4 865
99	G23	ICH mw1	530	3 335	9 133
100	G23	IDF dm2		233	92
101	G24	AT	1 767	33	119
102	G24	ESSFwm	1 560	262	857
103	G24	ICH mw1	304	57	130
104	G25	AT	66	39	60
105	G25	ESSFdk	2 097	262	264
106	G25	ESSFwm	11	28	227
107	G25	ICH mk1	118	35	173
108	G25	IDF dm2	143	2 721	456
109	G25	MS dk	325	590	541
110	G26	AT	7 993	78	365
111	G26	ESSFdk	24 484	1	35
112	G26	ESSFwm	2 805	611	3 328
113	G26	ICH mk1	536	539	1 739
114	G26	ICH mw1	670	570	2 313
115	G26	IDF dm2	38		
116	G26	MS dk	15 395	1 169	1 809
117	G27	AT	282	1	5
118	G27	ESSFdk	2 884	233	1 348
119	G27	MS dk	124	516	2 344
120	G28	AT	2 065	48	250
121	G28	ESSFdk	6 819	749	4 427
122	G28	ESSFwm	157	213	1 594
123	G28	ICH mk1		311	1 670
124	G28	ICH mw1		5	12
125	G28	MS dk	2 455	1 342	6 302
126	G29	AT	1 163	29	7
127	G29	ESSFwc2	1 844	429	1 278
128	G29	ICH mw1	13	81	168
129	G29	ICH wk1	301	746	4 243

continued

Table A-3. Timber harvesting land base by management group (continued)

	Group definition		Area (hectares)		
Group	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
130	G38	AT	730		
131	G38	ESSFvc	257		
132	G38	ESSFwc4	3 869		
133	G38	ESSFwm	443		
134	G38	ICH mw1	288		
135	G38	ICH wk1	1 744		
Total biodiversity			221 587	63 664	166 612
1	G01	Car - ESSF	2 097	269	515
2	G01	Car - ICH	1 413	334	1 004
3	G02	Car - ESSF	3 569	85	483
4	G02	Car - ICH	1 549	804	3 545
5	G03	Car - ESSF	1 865	209	556
6	G03	Car - ICH	1 722	884	4 972
7	G04	Car - ESSF	2 180	550	378
8	G04	Car - ICH	1 709	2 816	3 732
9	G08	Car - ICH		5	19
10	G11	Car - ESSF	1 876	161	839
11	G11	Car - ICH	946	191	1 562
12	G12	Car - ESSF	1 109	112	294
13	G12	Car - ICH	764	292	772
14	G14	Car - ICH	33		
15	G20	Wildlife mgt		24	39
16	G23	Wildlife mgt		62	193
17	G25	Wildlife mgt		0	0
18	G29	Car - ESSF	1 528	422	1 248
19	G29	Car - ICH	1 147	730	3 959
Total Caribou/wildlife			23 507	7 950	24 110
1	G14	VQO - PR	880	252	1 211
2	G15	VQO - PR	128	13	128
3	G16	VQO - PR		487	3 154
4	G19	VQO - PR		0	3
5	G20	VQO - PR	1 844	1 984	2 493
6	G21	VQO - PR	769	32	75
7	G22	VQO - PR	570	230	1 797
8	G23	VQO - PR	3 214	2 899	9 280
9	G24	VQO - PR	318	1	5
10	G25	VQO - PR	902	1 106	1 046
11	G26	VQO - PR	1 587	847	2 151
Total VQO — PR			10 212	7 851	21 343

continued

Table A-3. Timber harvesting land base by management group (continued)

Group	Group definition		Area (hectares)		
	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
1	G20	1 watershed	53	1 482	1 110
2	G20	2 watershed	133	442	161
3	G20	6 watershed	1 618	1 371	1 225
4	G21	1 watershed	0	1	
5	G21	2 watershed	2	44	0
6	G21	6 watershed	0		
7	G23	3 watershed	80	499	865
8	G25	4 watershed	50	438	239
9	G25	5 watershed	2	272	63
10	G25	7 watershed	951	105	84
11	G25	8 watershed	496	397	146
12	G26	2 watershed		2	6
13	G26	3 watershed	1		
14	G26	7 watershed	1		
15	G28	5 watershed	8		
Total community watersheds			3 395	5 053	3 899
1	G03	UWR		34	429
2	G04	UWR	39	1 264	2 005
3	G06	UWR		0	1
4	G07	UWR		35	429
5	G08	UWR	198	376	1 366
6	G09	UWR	225	359	1 203
7	G10	UWR		75	19
8	G11	UWR		0	4
9	G12	UWR	95	101	398
10	G13	UWR	46	38	427
11	G15	UWR	6	223	948
12	G16	UWR		3 971	16 762
13	G17	UWR	14	307	1 113
14	G18	UWR	71	70	104
15	G20	UWR	527	7 869	4 181
16	G21	UWR	38	699	518
17	G22	UWR	44	412	2 298
18	G23	UWR	5	1 508	1 933
19	G25	UWR	277	2 912	528
20	G26	UWR	319	1 355	2 844
21	G27	UWR		178	565
22	G28	UWR	13	1 440	6 632
23	G29	UWR	40	88	188
Total UWR			1 957	23 314	44 895

continued

Table A-3. Timber harvesting land base by management group (concluded)

	Group definition		Area (hectares)		
Group	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
1	G01	IRM	6 583	203	534
2	G02	IRM	319	88	216
3	G03	IRM	3	4	0
4	G04	IRM	3 639	1 568	939
5	G06	IRM	3 176	569	1 689
6	G07	IRM	7 371	1 907	6 511
7	G08	IRM	4 555	1 702	5 521
8	G09	IRM	3 632	959	2 591
9	G10	IRM	5 888	2 160	5 209
10	G11	IRM	0	2	18
11	G12	IRM	1 282	228	498
12	G13	IRM	9 258	975	4 665
13	G14	IRM	16 994	326	1 296
14	G15	IRM	2 803	981	4 401
15	G16	IRM	1 314	995	2 328
16	G17	IRM	3 326	1 225	3 386
17	G18	IRM	3 777	982	1 951
18	G19	IRM	6 519	1 593	2 575
19	G20	IRM	2 112	1 133	3 517
20	G21	IRM	9 813	4 015	9 360
21	G22	IRM	1 2731	830	3 820
22	G23	IRM	2 130	2 071	5 090
23	G24	IRM	3 313	351	1 102
24	G25	IRM	330	72	158
25	G26	IRM	50 028	1 063	5 104
26	G27	IRM	3 291	572	3 133
27	G28	IRM	11 475	1 228	7 621
28	G29	IRM	605	53	309
29	G38	IRM	7 331		
Total IRM			183 598	27 855	83 542

A.2.2 Analysis unit characteristics

To simplify the analysis, individual forest stands were aggregated according to dominant tree species (inventory type group) and timber growing capability (site index). An analysis unit represents a combination of stands dominated by specific tree species or silvicultural regime within a set range of timber growing capability — as indicated by the inventory type group and site index in the forest inventory file.

A.2 Zone and Analysis Unit Definition

Table A-4. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-23. for existing natural stands and Table A-24. for existing and future managed stands). The analysis units are not management-zone specific; that is, an analysis unit can be in one or more management zones described in Section A.2.1, "Management zone and tracking of multiple objectives (grouping)."

Table A-4. Definition of analysis units

Analysis unit	Species	Inventory type groups	Site index range (metres)	Age	Timber harvesting land base area (hectares)
Existing					
11	F, FPl FL	1, 5, 7, 8, 33, 34	22+	> 20	4 128
12	F, FPl FL	1, 5, 7, 8, 33, 34	17–21.9	> 20	8 234
13	F, FPl FL	1, 5, 7, 8, 33, 34	10–16.9	> 20	4 371
14	FC, FH, FS	2-4,	21+	> 20	2 875
15	FC, FH, FS	2-4,	17–20.9	> 20	5 710
16	FC, FH, FS	2-4,	9–16.9	> 20	5 699
21	H	13–17	14+	> 20	2 799
22	H	13–17	11–13.9	> 20	5 694
23	H	13–17	9–10.9	> 20	2 572
24	C	9–11	19+	> 20	1 731
25	C	9–11	14–18.9	> 20	6 061
26	C	9–11	10–13.9	> 20	4 526
31	S, B	21, 24	18+	> 20	3 992
32	S, B	21, 24	15–18.9	> 20	7 220
33	S, B	21, 24	10–14.9	> 20	8 562
34	S, B	21, 24	5–9	> 20	11 734
41	SF, SH, SPl, BS	20, 22, 23, 25, 26	21+	> 20	3 954
42	SF, SH, SPl, BS	20, 22, 23, 25, 26	17–20.9	> 20	4 600
43	SF, SH, SPl, BS	20, 22, 23, 25, 26	13–16.9	> 20	5 131
44	SF, SH, SPl, BS	20, 22, 23, 25, 26	4–12.9	> 20	4 814
51	Pw, Pa, Pl	27–31	21+	> 20	5 500
52	Pw, Pa, Pl	27–31	19–20.9	> 20	7 200
53	Pw, Pa, Pl	27–31	16–18.9	> 20	4 321
54	Pw, Pa, Pl	27–31	9–15.9	> 20	5 841

continued

A.2 Zone and Analysis Unit Definition

Table A-4. Definition of analysis units (concluded)

Analysis unit	Species	Inventory type groups	Site index range (metres)	Age	Timber harvesting land base area (hectares)
Initial second growth					
111	F, FPl FL	1, 5, 7, 8, 33, 34	22+	< 20	427
112	F, FPl FL	1, 5, 7, 8, 33, 34	17–21.9	< 20	1 792
113	F, FPl FL	1, 5, 7, 8, 33, 34	10–16.9	< 20	637
114	FC, FH, FS	2–4,	21+	< 20	389
115	FC, FH, FS	2–4,	17–20.9	< 20	1 316
116	FC, FH, FS	2–4,	9–16.9	< 20	562
121	H	13–17	14+	< 20	920
122	H	13–17	11–13.9	< 20	300
123	H	13–17	9–10.9	< 20	0
124	C	9–11	19+	< 20	2 408
125	C	9–11	14–18.9	< 20	387
126	C	9–11	10–13.9	< 20	750
131	S, B	21, 24	18+	< 20	3 872
132	S, B	21, 24	15–18.9	< 20	4 273
133	S, B	21, 24	10–14.9	< 20	1 334
134	S, B	21, 24	5–9	< 20	61
141	SF, SH, SPl, BS	20, 22, 23, 25, 26	21+	< 20	1 010
142	SF, SH, SPl, BS	20, 22, 23, 25, 26	17–20.9	< 20	1 299
143	SF, SH, SPl, BS	20, 22, 23, 25, 26	13–16.9	< 20	2 460
144	SF, SH, SPl, BS	20, 22, 23, 25, 26	4–12.9	< 20	1 302
151	Pw, Pa, Pl	27–31	21+	< 20	750
152	Pw, Pa, Pl	27–31	19–20.9	< 20	4 172
153	Pw, Pa, Pl	27–31	16–18.9	< 20	6 303
154	Pw, Pa, Pl	27–31	9–15.9	< 20	2 618

NSR is included in the above area figures.

All forested non-timber harvesting land base area was coded as analysis unit 95 (285 241 hectares).

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Golden analysis area. The Golden analysis area includes five large parks which are not part of the Golden TSA. One of the first steps in this timber supply analysis was to define the timber harvesting land base. This land base was derived by identifying certain types of land and forest where timber harvesting is not likely to occur under current management. The characteristics of each of these types are discussed below. The order in which these reductions were performed can be found in Section 2.1, "Land base inventory, Table 3. Timber harvesting land base for the Golden TSA."

A.3.1 Land not managed by the B.C. Forest Service

The ownership (OWNER and OWNR_CH) codes on the inventory file were used to determine which areas are not managed by the B.C. Forest Service. This category may include areas such as parks, ecological reserves, private land and various special use permit areas. Forest in ownership's 62 C (forest management unit); 69 C (forest reserves); and portions of 61-C (UREP) and 70-N (timber licence in a TSA) contribute to timber harvesting.

Ownership code 70-N Timber Licences are allowed to contribute to the land base over the next five years as each licence expires.

Table A-5. Land not managed by the B.C. Forest Service for timber supply

Land not managed for timber supply within the Golden analysis area	Area removed (hectares)
Glacier National Park	87 289
Kootenay National Park	8 952
Yoho National Park	123 572
Hamber Provincial Park	22 884
Cummins Provincial Park	24 411
01–N miss-classified	3 033
40–N private	14 110
60–N Eco-reserve	2 707
61–N UREP	1 978
63–N Provincial Park (< 100 hectares)	523
69–N Miscellaneous reserve	946
76–N TFL unreported	143
77–N Woodlot licence	2 544
99–N Miscellaneous lease	115

A.3 Definition of the Timber Harvesting Land Base

Note: Cummins Provincial Park was defined as all of landscape unit 5 plus the following polygons:

Mapsheet 83D010, polygons 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116, 117, 118, 119, 122, 124, 234 , 236, 238

Mapsheet 83D090, polygons 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72

A.3.2 Non-forest land

Non-forest (TYPID_PR = 6 – 569 379 hectares) and non-typed (TYPID_PR = 8 – 2078 hectares) areas do not contribute to timber harvesting. These categories include areas covered by such things as sparse alpine forest, ice, swamps, water, and rock.

A.3.3 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5 – 2090 hectares), were not included in the timber harvesting land base.

A.3.4 Calculated area in riparian reserves and riparian management zones

To account for protection of riparian and stream values within the Golden analysis area, 7167 hectares were excluded from the timber harvesting land base. Table A-6. describes the information used to derive this reduction.

Table A-6. Riparian management areas

Riparian stream class	Stream length (km)	Reserve zone width (metres)	Management zone width (metres)	Retention in management zone (%)	Total riparian area reserve (metres)	Total area reduction (hectares)
S1	1	50	20	50	60	9.4
S2	385	30	20	50	40	3 079.2
S3	287	20	20	50	30	1 723.0
S5	1 064	0	30	25	8	1 703.0
Wetland	215	10/10/0	40/20/30	25/25/25	12	394.5
Lakes	282	10/10	0/20	0/25	14	257.6

The riparian analysis was conducted using the Ministry of Environment, Lands and Parks watershed atlas. In the watershed atlas, aquatic features were mapped on 1:50000 scale NTS maps. TRIM water coverage (1:20,000) is the preferred map base for inventory and analysis, however, it does not have the 'intelligence' of the watershed atlas, nor does TRIM have ancillary information about stream gradient. The process of classifying streams using watershed atlas information is outlined in a May 1997 report, *Riparian Management Area Classifications for the Arrow, Golden, and Revelstoke Forest Districts.* Most S4 and S6 streams are too small to form part of the watershed atlas and are therefore not accounted for. Due to classification issues, lakes and wetland areas were accounted for by averaging management and reserve zone.

A.3 Definition of the Timber Harvesting Land Base

The total riparian area reserve is made up of the reserve zone plus the management zone multiplied by the retention. For example:

Reserve zone	50 metres
Management zone	20 metres
Retention in management zone	50%
Implied reserve in management zone	(20 * 0.5) = 10 metres
Total riparian area reserve =	60 metres (reserve zone 50 metres plus implied management zone 10 metres)

The forested portion of the riparian area reserve was treated in the analysis as part of the operable non-contributing or the inoperable forest (as dictated by the operability line).

A.3.5 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as wildlife habitat, sensitive soils and regeneration. A portion of areas classified as environmentally sensitive were excluded from the timber harvesting land base according to Table A-7.

Table A-7. Per cent of area considered unavailable for timber harvesting due to environmental sensitivity

ESA code (1 – high sensitivity) (2 – moderate sensitivity)	Per cent (%) of area unavailable for timber harvesting	Area reduction (hectares)
Es1 (soils)	90	7703.2
Er1 (recreation)	30	7.9
Ep1 (regeneration difficulty)	90	1936.0
Eh1 (watershed)	100	157.9
Ew1 (wildlife)	100	141.2
Ea1 (avalanche)	100	35.5

Environmentally sensitive area reductions were established by the Ministry of Forests (MoF) staff in collaboration with specialists from the Ministry of Environment, Lands and Parks (MELP). The percentage unavailable reflects site sensitivity to forest management, value for other resources, and current management practices. The Ew1 reduction was not supposed to take place as the wildlife areas are put into management zones and forest cover requirements are applied. However as several other reductions took place after the ESA reduction there is a small upward pressure on the timber harvesting land base of less than 141 hectares. Recreation areas were addressed through review of all UREPs as well as management of visual quality. The ESA exclusion factors shown in Table A-7. were applied in all management zones.

A.3 Definition of the Timber Harvesting Land Base

The ESA definitions are:

- Es — areas with unstable soils that may deteriorate unacceptably after forest harvesting.
- Ep — areas where regeneration will likely be difficult.
- Ew — areas of critical importance to wildlife for food, shelter or reproduction.
- Er — areas of importance for recreation (UREP areas in 61-C reduced by 30%).
- Ea — areas of avalanche instability.
- Eh — areas important for maintenance of water quality.

A.3.6 Inoperable areas

The inventory file contains an operability classification for the Golden TSA. All areas that were inoperable (OPERABLE = I) were excluded from the timber harvesting land base — 82 004.4 hectares . In addition to the areas classed as inoperable on the inventory file the Bluewater north drainage was deemed inoperable due to access problems — a further 454.3 hectares . The Bluewater north was defined as follows:

Mapsheet 82N065 — polygons 152, 333, 334, 335, 465, 470, 473, 474, 475, 476, 477, 478, 479

Mapsheet 82N064 — polygons 416, 417, 418, 419, 421, 424

Mapsheet 82N075 — polygons 4, 17, 18, 19, 21, 22, 23, 25, 34

A.3.7 Sites with low timber growing potential

Sites may have low timber growing potential either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. Typically, these stands are intermixed with other stands within the forested land base. Any of these stands not considered to be harvestable were identified through an examination of the distribution of sites in the forested land base and removed from consideration for the timber harvesting land base. The stands excluded from the timber harvesting land base due to low timber growing potential are described in Table A-8.

A.3 Definition of the Timber Harvesting Land Base

Table A-8. Description of sites with low timber growing potential

Inventory type group	Species	Characteristics				
		Maximum age to achieve minimum volume (years)	Minimum volume (m^3)	Reduction (%)	Site index S 50	Area reduction (hectares)
1 5 7 8 33 34	Fir and larch	250	150	100	10	160.5
2-6	Fir leading	150	150	100	9	50.2
12-17	Hemlock	200	150	100	9	232.4
9 10 11	Cedar	200	200	100	10	289.7
18 20 21 24	Spruce balsam	200	200	100	5	1192.3
19 22 23 25 26	Spruce	250	150	100	4	2.3
27-31	Pine	150	150	100	9	187.0

Information obtained after the analysis was complete indicated that perhaps more area should have been deducted for low site. The requested volumes are not achieved when some stands (that meet the site index criteria) are projected to the ages in the above table. A static approach was used to derive figures in Table A-8. Only those stands currently above the 'maximum age to achieve the minimum volume' were used to define the low site cutoff. It was assumed that younger stands with site index values greater than those listed would achieve the volume at the age in the table. Subsequent analysis indicates that many younger stands (when projected) do not achieve the required minimum volume by the age indicated. Volume is determined on more than site index and leading species, other factors such as secondary species, crown closure and stocking class are also important. The additional area has been calculated at 7583 hectares (i.e., in addition to the 2114 hectares in Table A-8).

A.3.8 Problem forest types

Non-merchantable forest types are stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability. These types were identified based on current forest management practices and recent harvesting performance, and were excluded from the timber harvesting land base. Table A-9. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

Table A-9. Problem forest types criteria

Inventory type group	Leading species	Age (years)	Reduction per cent (%)	Area reduction (hectares)
12, 15, 17, 19	H, HB, HDec, BH	> 140	100	1255.4
35-42	Deciduous	All	100	10629.4

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Recreation areas

Recreation areas such as campgrounds, trails and lookout sites are identified in the Forest Service review of UREPs. In UREP areas, 30% of the area was excluded from the timber harvesting land base. This area, does, however, contribute to forest cover requirements.

A.3.10 Existing unclassified roads, trails, and landings

Almost all existing road systems in the Golden TSA were located via photo transfer, using 1991 and 1993 air photos. These road systems were incorporated digitally into the most recent (October 1994) forest cover maps. Although the roads are on the digital maps, they are not recorded as an "area-based" feature from which to determine hectares occupied by roads. Therefore, a geographic information system (GIS) was used to determine the road lengths through the timber harvesting land base — to determine which age classes are covered by roads. These lengths are then multiplied by the road widths shown in Table A—10.

Reductions for roads, landings and skid trails were determined using the following assumptions:

1) Past harvest/salvaged wildfire areas occupy 38% (64 000 hectares) of the timber harvesting land base since the 1960s (from district forest inventory file).
2) Sixty-five per cent of past harvest has been conventional and 35% has been cable.
3) Fifty per cent of past conventional harvest has been winter and 50% has been summer.
4) Fifty per cent of all past conventional harvest has occurred on slopes less than 30%, and 50% has occurred on slopes greater than 30%.
5) Past site disturbance levels from secondary roads, landings and summer skid trails, and the per cent area of logged areas occupied by landings are taken or interpolated from the 1988 report, *Quantification of Soil Disturbance following Logging in the Golden TSA*.
    - 100% growth loss occurs on main and secondary roads and landings.
    - 40% growth loss occurs on summer skid roads.
    - Summer ground skidding with > 25 cm sidecut occupies 7% on < 30% slopes and 24% on steeper slopes.
    - Past harvested areas have an average 3.3% of their timber harvesting land base occupied by landings.
6) Winter conventional harvest areas incur no loss in soil productivity due to detrimental disturbance.
7) Existing roads was done as part of a spatial analysis project for the Golden area. The area in existing road was derived using this data set (based on above criteria).

Table A-10. Estimates for existing unclassified roads and landings

	Road length (kilometres)	Road width (metres)	Reduction area (hectares)
Existing RTLs			
Secondary roads	133	16	212.5
Logging roads	3 189	16	5 102.2
Trails			
Landings			
Total			5 314.7

No explicit reduction for skid trails and landings incorporated in the analysis.

A.3.11 Stand-level biodiversity reductions

Wildlife tree patches are retained on cutblocks within the Golden analysis area to provide for the maintenance of stand structure over time. The *Biodiversity Guidebook* describes two methods for providing the maintenance of stand structure over time. One method is wildlife trees while the other is wildlife tree patches. Different silvicultural systems may provide the intended structural diversity through modifying the timing timber is available.

Table A-11. Reductions to reflect volume retention in cutblocks

Management zone	Reason for residual volume	Persistence	Residual area on the timber harvesting land base (%)	Area removed from the timber harvesting land base (ha)
All	Wildlife tree patch	Permanent	4.7	8 171.2

A.3 Definition of the Timber Harvesting Land Base

Data source and comments:

Wildlife tree patches greater than two hectares are common in the Golden TSA. Within the model, wildlife tree patches are considered as an area loss from the timber harvesting land base. These areas do, however, contribute to the seral-stage targets.

The wildlife tree patch percentage was derived by calculating a weighted average of the wildlife tree requirements as directed in the *Biodiversity Guidebook* (Table 20a), assuming that 25% of the wildlife tree requirement is coming from the non-contributing land base.

A.3.12 Estimated area of future roads, trails and landings

To account for the loss of productive forest land during future timber harvesting and development, a portion of the timber harvesting land base is not considered to contribute to further timber production after it is harvested for the first time. The amount of area lost to production from future harvesting activities was calculated as:

1) Future soil disturbance (mainly skid roads) and permanent access structures (main and secondary roads and landings) will be within the limits recommended in the *Soil Conservation Guidebook*.

   Future harvested areas will have an average of 7.0% of their timber harvesting land base occupied by main and secondary roads and landings.

   Future conventional summer harvested areas will have an average of 7.5% of their timber harvesting land base occupied by dispersed soil disturbance (including skid trails). This compares to an average of 10% for past harvesting (from above assumptions). Future cable harvested areas will have no dispersed soil disturbance. After 1998, it is assumed that the excavated dispersed soil disturbance from summer conventional harvesting will be rehabilitated, with a net growth loss of 20% on the rehabilitated skid trails. It is assumed that winter conventional harvested areas will not have excavated dispersed soil disturbance, and compaction will result in a 10% net growth loss on skid trails.

2) Fifty per cent of future conventional harvest will be winter and 50% will be summer. Seventy per cent of future harvest will be cable and 30% will be conventional.

3) Main/secondary road widths from past and future denudation average 16 metres, and 18 metres respectively, horizontal distance.

   Calculation for future roads, skid trails and landings:

   Main and secondary roads = 4% of timber harvesting land base hectares harvested.

   Landings = 3% of timber harvesting land base hectares harvested.

   Skid roads = 30% conventional harvest * 7.5% disturbance * 15% degraded = 0.4% of timber harvesting land base hectares harvested.

   Total = 7.34% of timber harvesting land base hectares harvested.

Stands greater than 30 years of age have 7.34% reduction upon harvest to account for future roads. This reduction is to be made to all areas yet to be harvested. After the model harvests all areas, then this reduction will no longer apply.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (1.3 metres) by species and is used in the analysis to calculate merchantable volume.

In the Golden analysis area, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-12.

Table A-12. Utilization levels

Analysis unit	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Pine	12.5	30	10
Cedar > 140 years old	17.5	30	15[a]
Cedar < 140 years old	17.5	30	10
All other species	17.5	30	10

(a) Although listed as 15 cm — it will be modelled as 10 cm.

A.4.2 Minimum harvestable age by analysis unit

Minimum harvestable ages are simply minimum criteria. While harvesting may occur in stands at the minimum age in order to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time or avoiding large inter-decadal changes in harvest levels), most stands will not be harvested until well past the minimum timber harvestable ages because other resource values take precedence (e.g., requirements for the retention of older forest).

The criteria used to define minimum harvestable ages for this analysis include: 90% of culmination age; a 25 cm minimum diameter; minimum volume per hectare; and professional judgment.

Minimum harvestable age defines the earliest age at which a stand may be harvested, not the age at which harvesting must occur. For this analysis, minimum harvestable ages were defined by the criteria outlined in Table A-13. These criteria apply to both existing and regenerated stands.

A.4 Forest Management Assumptions

Table A-13a. Minimum harvestable age criteria — existing stands

Analysis unit	Age to achieve minimum diameter (25 cm)	Age to achieve minimum volume m^3/hectare 150 m^3/ha for F, S, Pl 200 m^3/ha for C, H	Culmination age	Minimum harvestable age natural stands
11 Fir dry	60	60	100	90
12 Fir dry	70	80	120	100
13 Fir dry	80	110	140	120
14 Fir wet	60	50	90	80
15 Fir wet	70	70	110	90
16 Fir wet	80	90	120	100
24 Cedar	60	70	80	90
25 Cedar	70	80	90	100
26 Cedar	80	130	100	130
21 Hemlock	70	80	90	80
22 Hemlock	90	120	110	120
23 Hemlock	110	160	160	160
31 Spruce wet	60	60	80	70
32 Spruce wet	80	80	110	90
33 Spruce wet	90	110	140	120
34 Spruce wet	120	160	200	170
41 Spruce dry	60	60	90	80
42 Spruce dry	70	70	120	100
43 Spruce dry	80	80	130	110
44 Spruce dry	110	120	170	150
51 Pine	90	50	70	70
52 Pine	100	60	80	80
53 Pine	110	70	100	100
54 Pine	140	90	120	120

A.4 Forest Management Assumptions

Table A-13b. Minimum harvestable age criteria — regenerated stands

Analysis unit	Age to achieve minimum diameter (25 cm)	Age to achieve minimum volume m^3/hectare 150 m^3/ha for F, S, Pl 200 m^3/ha for C, H	Culmination age	Minimum harvestable age regenerated stands
111 Fir dry	40	40	70	60
112 Fir dry	60	60	90	80
113 Fir dry	80	90	100	90
114 Fir wet	40	50	80	70
115 Fir wet	60	60	100	90
116 Fir wet	100	100	150	100
124 Cedar	60	70	110	90
125 Cedar	90	110	140	100
126 Cedar	100	140	170	130
121 Hemlock	50	60	90	80
122 Hemlock	60	80	110	90
123 Hemlock	80	110	140	120
131 Spruce wet	40	50	70	60
132 Spruce wet	60	70	100	90
133 Spruce wet	80	90	140	120
134 Spruce wet	120	140	200	170
141 Spruce dry	40	50	70	60
142 Spruce dry	50	60	90	80
143 Spruce dry	70	70	110	90
144 Spruce dry	110	120	180	150
151 Pine	40	50	70	60
152 Pine	50	60	80	70
153 Pine	60	60	80	70
154 Pine	70	80	110	90

A.4 Forest Management Assumptions

A.4.3 Harvest profile

The data package indicated that the random harvest age rule was to be in effect for analysis purposes. The relative oldest harvest age rule was imposed, however, due to the complexity in the interpretation of results from runs conducted with the random harvest age rule. Analyses using the random harvest age rule are included in the report for comparative purposes. The impetus for identifying the random harvest age rule for use in the base case was the current operational harvest profile.

An analysis of harvesting over the last 5 years and recently submitted forest development plans (1998 - 2003) shows that the planned harvest has a profile as shown in Table A-14. The harvesting of younger age classes is occurring predominately in the pine types, due to mountain pine beetle problems, and plywood quality fir types. A analysis of the feasibility of continuing with this profile was completed. This analysis shows that this profile can be maintained for a maximum of 20 years. However, the longer this profile is maintained the higher the likelihood that there will be further downward pressure on the long-term timber supply.

Table A-14. Analysis of past 5-year harvest ages

Description	Per cent (%) of past timber harvest (by equivalent clearcut area)	Per cent (%) of annual timber harvest (FDP volume)
Age classes 8 + 9	69	67
Age classes 6-7	17	15
Age classes < 6	14	18

A.4.4 Forest cover requirements

This analysis involved an aspatial evaluation of timber supply. However, the timber supply model used (FSSIM Version 2.2) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition, or the minimum required area of old-age forest. Since site specific adjacency guidelines and forest level cover requirements are linked, use of forest cover guidelines can approximate the effect of adjacency guidelines as well as broader forest level goals. The forest cover requirements applied in this analysis approximate current forest management practices. All groups were modelled separately within each landscape unit.

Landscape unit boundaries extend into provincial and national park lands where they are the same biogeoclimatic subzone as the adjacent TSA lands. In such instances, the park lands were assumed to be part of the non-contributing land base within the landscape unit for the model. The integrated resource management zone (IRM) encompasses that portion of the timber harvesting land base not occupied by any other zone or group, aside from biodiversity emphasis.

Table A-15. specifies the forest cover requirements for the Golden analysis area.

A.4 Forest Management Assumptions

Table A-15. Management emphasis zone forest cover requirements

Resource emphasis	Forest cover objective				
	Green-up height (metres)	Green-up age (years)	Maximum area less than green-up age (%)	Minimum older age (years)	Minimum area greater than older age (%)
Caribou ESSF	2	19 to 26	25	140	40
				250	10
Caribou ICH	2	15 to 21	25	140	40
				250	10
Visual quality	6	22 to 42	15	N/A	N/A
Watersheds	6	21 to 31	25	N/A	N/A
Ungulate winter range	2	11 to 17	25	100	40
Integrated resource management	2	13 to 22	25	N/A	N/A

Range in green-up age is due to differences in analysis unit representation within landscape units and resource emphasis areas.

Green-up per cent and minimum older per cent are based on the 'operable' land base (i.e., the operable non-contributing plus the timber harvesting land base) for all resource emphases except the IRM. In IRM areas only the timber harvesting land base contributes towards achieving green-up and minimum older objectives.

Data package had inadvertently indicated 30% for caribou ESSF — should be 40%. Also a typographical error in the ungulate winter range was corrected - the data package should have stated that the requirement for old seral is 40% in ungulate winter range areas.

A.4.5 Landscape-level biodiversity

Biodiversity guidelines were modelled using information from the *Forest Practices Code Biodiversity Guidebook*. Operationally, the *Kootenay-Boundary Land Use Plan Implementation Strategy* draft biodiversity emphasis options are applied. However, because the implementation strategy has draft emphasis assignments, and it is expected that biodiversity emphasis assignment will be completed within 1 to 2 years; the timber supply analysis will use constraints that do not prejudge what may be expected when the emphasis levels have been assigned. As it is unknown at this time which landscape units will be officially assigned low–, intermediate– or high–emphasis, a single weighted constraint for each of the mature plus old-seral stage requirements and the old-seral stage requirements was developed based on the anticipated distribution of 45% low–, 45% intermediate– and 10% high-emphasis. The values shown in Table A-16. reflect the weighted biodiversity guidebook values.

A.4 Forest Management Assumptions

Table A-16. Landscape-level biodiversity: biodiversity guidebook distribution objectives for each seral stage for the NDTs in the Golden analysis area

Biogeoclimatic unit	Time frame (years)	NDT	Mature and old-seral stage		Old-seral stage	
			Minimum retention area (%)	Minimum age (years)	Minimum retention area (%)	Minimum age (years)
ESSFwc2	now – 70	1	30.2	120	14.2	250
ESSFwc4	now – 70	1	30.2	120	14.2	250
ESSFwm	now – 70	1	30.2	120	14.2	250
ESSFvc	now – 70	1	30.2	120	14.2	250
ICHwk1	now – 70	1	28.1	100	9.7	250
ICHvk1	now – 70	1	28.1	100	9.7	250
ESSFmw	now – 70	2	25.4	120	6.7	250
ICHmw1	now – 70	2	25.3	100	6.7	250
ESSFdk	now – 70	3	20.1	120	10.5	140
ICHmk1	now – 70	3	20.1	100	10.5	140
MSdk	now – 70	3	21.9	100	10.5	140
IDFdm2	now – 70	4	28.1	100	9.7	250
Parkland[a]	Now – 70	5	30.2	120	14.2	250
ESSFwc2	71 – 140	1	30.2	120	17.0	250
ESSFwc4	71 – 140	1	30.2	120	17.0	250
ESSFwm	71 – 140	1	30.2	120	17.0	250
ESSFvc	71 – 140	1	30.2	120	17.0	250
ICHwk1	71 – 140	1	28.1	100	11.6	250
ICHvk1	71 – 140	1	28.1	100	11.6	250
ESSFmw	71 – 140	2	25.4	120	8.0	250
ICHmw1	71 – 140	2	25.3	100	8.0	250
ESSFdk	71 – 140	3	20.1	120	12.6	140
ICHmk1	71 – 140	3	20.1	100	12.6	140
MSdk	71 – 140	3	21.9	100	12.6	140
IDFdm2	71 – 140	4	28.1	100	11.6	250
Parkland[a]	71 – 140	5	30.2	120	17.0	250
ESSFwc2	141+	1	30.2	120	19.9	250
ESSFwc4	141+	1	30.2	120	19.9	250
ESSFwm	141+	1	30.2	120	19.9	250
ESSFvc	141+	1	30.2	120	19.9	250
ICHwk1	141+	1	28.1	100	13.6	250
ICHvk1	141+	1	28.1	100	13.6	250
ESSFmw	141+	2	25.4	120	9.4	250
ICHmw1	141+	2	25.3	100	9.4	250
ESSFdk	141+	3	20.1	120	14.7	140
ICHmk1	141+	3	20.1	100	14.7	140
MSdk	141+	3	21.9	100	14.7	140
IDFdm2	141+	4	28.1	100	13.6	250
Parkland[a]	141+	5	30.2	120	19.9	250

(a) Some timber harvesting land base is typed as park land due to scale of biogeoclimatic classification mapping. In these instances — values for NDT1 ESSF will be used.

The Golden TSA Timber Supply Review Data Package inadvertently had draw down values listed for mature plus old. This has been corrected in the above table.

A.4 Forest Management Assumptions

The forest cover requirements used in the analysis were determined in accordance with the letter from John Allan and Cassie Doyle to field operations staff of the Ministry of Forests and the Ministry of Environment, Lands and Parks regarding *Achieving Acceptable Biodiversity Timber Impacts*, dated August 25, 1997. As specified in the Doyle-Allen letter (April 1997), early-seral requirements were not applied. Furthermore, old-forest requirements for low-emphasis landscape-level biodiversity were designed to be met within three rotations of 70 years each, with one-third of the percentage met over the first 70 years, two-thirds of the requirements met from 71-140 years from the present, and the full requirement applied from 141 years onward, as follows.

Table A-17. Calculation of low-emphasis biodiversity option older forest cover requirements

Time	Old-seral cover requirement, low emphasis
0 - 70	Guidebook % * 0.33
70 - 140	Guidebook % * 0.66
140 +	Guidebook % * 1.0

For example, to calculate the older forest cover requirements applied over time to the low-biodiversity emphasis ESSF portions of the Golden TSA, the following calculation was used:

Time 0 - 70: old forest % = 9% * 0.33 = 2.97

Time 70 - 140: old forest % = 9% * 0.66 = 5.94

Time 140+: old forest % = 9% * 1.00 = 9.00

Thus, in the analysis, the old-forest requirements increased over time. However, it is important to note that this increase in older forest cover requirements only applies to low-emphasis biodiversity areas. In the absence of designated landscape units, the Golden TSA was modelled as if 45% of the area has a low-biodiversity emphasis, 45% a medium-biodiversity emphasis, and 10% a high-biodiversity emphasis. Thus, the low-emphasis biodiversity requirements for each NDT determined according to the above calculation were weighted according to the 45%- 45%- 10% distribution by emphasis as follows:

Older forest requirement = (0.45* low emphasis older forest requirement)

+ (0.45 * medium emphasis requirement) + (0.10* high emphasis requirement)

For example, over time, the old-forest cover requirements for CWH would be calculated as follows:

Time 0 - 70: old forest % = (9% * 0.45) * 0.33
+ 9% * 0.45
+ 13% * 0.10
= 6.7%

Time 70 - 140 : old forest % = (9% * 0.45) * 0.66
+ 9% * 0.45
+ 13% * 0.10
= 8.0%

Time 140+: old forest % = (9% * 0.45) * 1.00
+ 9% * 0.45
+ 13% * 0.10
= 9.4%

A.4 Forest Management Assumptions

The following Table A-18. outlines the resulting forest cover requirements applied in the analysis to account for landscape-level biodiversity.

Table A-18. Landscape-level biodiversity forest cover requirements percentages applied in the analysis

		Mature + old					Old				
	NDT	**ESSF**	**ICH**	**MS**	**IDF**	**PP**	**ESSF**	**ICH**	**MS**	**IDF**	**PP**
Low	1	19	17				19	13			
	2	19	15				9	9			
	3	14	14	14			14	14	14		
	4		17		17	17		13		13	13
Intermediate	1	36	34				19	13			
	2	28	31				9	9			
	3	23	23	26			14	14	14		
	4		34		34	34		13		13	13
High	1	54	51				28				
	2	42	46				13				
	3	34	34	39			21	21	21		
	4		51		51	51	19			19	19
Wtd Ave	1						14.2	9.7			
(45/45/10)	2						6.7	6.7			
Time 0 (i.e. 2/3)	3						10.5	10.5	10.5		
	4							9.7		9.7	9.7
Wtd Ave	1						17.0	11.6			
(45/45/10)	2						8.0	8.0			
Time 70 (i.e. 2/3)	3						12.6	12.6	12.6		
	4							11.6		11.6	11.6
Wtd Ave	1	30.2	28.1				19.9	13.6			
(45/45/10)	2	25.4	25.3				9.4	9.4			
Time 140	3	20.1	20.1	21.9			14.7	14.7	14.7		
Full low biodiversity	4		28.1		28.1	28.1		13.6		13.6	13.6

A.4 Forest Management Assumptions

A.4.6 Unsalvaged losses

This section outlines the methods used to estimate the average annual unsalvaged volume losses due to insect epidemics, fires, and wind. Timber volume losses to insects and diseases that normally occupy stands (endemic losses) are accounted for in inventory sampling for timber yield estimation. The purpose of the unsalvaged losses estimate is to account for catastrophic events and other factors not recognized in yield estimates. Table A-19. summarizes the estimate for unsalvaged losses in the Golden analysis area used in this analysis.

Table A-19. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (hectares)	Average volume per hectare	Annual unsalvaged loss (m^3/year)
Wildfire	36.8	350	12 880
Broadcast/fringe burn	35.2	300	10 560
Total fire	72.0	350	23 440
Spruce bark beetle	0		0
Douglas-fir bark beetle	0		0
Mountain pine bark beetle	2	350	700
Total insects	2	350	700
Windthrow/blowdown	1.5	350	525
Avalanche	0		0
Total loss	75.5		24 700

All unsalvaged losses indicated are from the timber harvesting land base.

Information regarding unsalvaged losses was collected from the Golden Forest District staff, licensee annual reports, the protection fire reporting system, MLSIS/ISIS (silviculture databases), and Forest Insect Disease Survey (FIDS) reports. The best data available was used for the analysis which often consisted of 'professional judgment' as data sources. Data was pooled from different sources, often in different units and brought together to form a unified product.

A.4.7 Basic silviculture and regeneration assumptions

Basic silviculture consists of any activities required to establish free-growing stands of commercially-valued tree species after harvesting an area. Basic silviculture is a legislated requirement under the *Forest Act*, and is assumed to occur in the Golden analysis area. Table A-20. outlines the regeneration regime for each analysis unit, and specifies the expected regeneration delay following harvesting, based on immature plantation history (ISIS), Nelson Forest Region free-growing stocking standards, and local knowledge.

A.4 Forest Management Assumptions

Recent plantations and future stands will be grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. A MSYT may be built from a number of tables if more than one regeneration method is used within an analysis unit. When this is the case, tables are produced for the different regeneration methods (each method x species combination) are then aggregated into one table.

Table A-20. Regeneration assumptions

Natural stand analysis unit	Composition	Natural stand site index	Regen delay	OAFs 1	OAFs 2	Regen method	Regen species	%	Density initial
11	F, FPl, FL, FDecid, LF, L	24.0	2	15	5	Plant	F Pl S	40 40 20	1200
12	F, FPl, FL, FDecid, LF, L	19.1	2	15	5	Plant	F Pl S	40 40 20	1200
13	F, FPl, FL, FDecid, LF, L	14.5	2	15	5	Plant	Pl F	80 20	1200
14	FC, FH, FS	24.6	2	15	5	Plant	F S	50 50	1200
15	FC, FH, FS	18.9	2	15	5	Plant	F S	50 50	1200
16	FC, FH, FS	14.3	2	15	5	Plant	F Pl	80 20	1200
24	C, CF, CH	16.6	2	15	5	Plant	C S H	20 60 20	1200
25	C, CF, CH	12.3	2	15	5	Plant	C S H	20 60 20	1200
26	C, CF, CH	10.0	2	15	5	Plant	S F Pl	70 20 10	1200
21	HC, HF, HS, H, HB, HDec, B, BH	20.5	2	15	5	Plant	C S H	20 60 20	1200
22	HC, HF, HS, H, HB, HDec, B, BH	16.4	2	15	5	Plant	C S H	20 60 20	1200
23	HC, HF, HS, H, HB, HDec, B, BH	12.7	2	15	5	Plant	S F Pl	70 20 10	1200

continued

A.4 Forest Management Assumptions

Table A-20. Regeneration assumptions (concluded)

Natural stand analysis unit	Composition	Natural stand site index	Regen delay	OAFs 1	OAFs 2	Regen method	Regen species	%	Density initial
31	S, B	22.8	2	15	5	Plant	Pl	20	1200
							S	70	
							B	10	
32	S, B	16.6	2	15	5	Plant	Pl	20	1200
							S	70	
							B	10	
33	S, B	12.4	2	15	5	Plant	Pl	20	1200
							S	80	
34	S, B	8.3	2	15	5	Plant	Pl	20	1200
							S	70	
							B	10	
41	S, SB SF, SH, SPl, Sdec	23.5	2	15	5	Plant	S	70	1200
							F	20	
							Pl	10	
42	S, SB SF, SH, SPl, Sdec	18.6	2	15	5	Plant	S	20	1200
							F	20	
							Pl	60	
43	S, SB SF, SH, SPl, Sdec	15.4	2	15	5	Plant	S	20	1200
							F	20	
							Pl	60	
44	S, SB SF, SH, SPl, Sdec	9.6	2	15	5	Plant	S	70	1200
							F	20	
							Pl	10	
51	PwPa, Pl PlF, PlS, PlDec	23.3	2	15	5	Plant	S	20	1200
							F	20	
							Pl	60	
52	PwPa, Pl PlF, PlS, PlDec	19.6	2	15	5	Plant	S	20	1200
							F	20	
							Pl	60	
53	PwPa, Pl PlF, PlS, PlDec	17.1	2	15	5	Plant	Pl	100	1200
54	PwPa, Pl PlF, PlS, PlDec	13.9	2	15	5	Plant	S	20	1200
							F	20	
							Pl	60	

All values in the above table are based on current performance as estimated by the Golden Forest District staff.

A.4 Forest Management Assumptions

Provincial average operational adjustment factors (OAFs) values are applied to the managed stand yield curves as recommended by the Ministry of Forests, Research Branch — as no local values are available. It should be noted that there is concern that these OAFs underestimate the losses expected on some stands due to root rot disease. The impact of this under estimate will be examined through sensitivity analysis.

Regeneration delay is the time between the completion of harvesting and the germination of the new seedlings. The regeneration delay was reduced from 4 years (as reported in the data package) to 2 years based on work done by the Nelson Region AAC mitigation strategy team.

A.4.8 Immature plantations

Table A-21. identifies stands of existing immature forest where the density (stems per hectare) was controlled. These stands will be immediately assigned to a managed stand yield curves (TIPSY).

Table A-21. Immature plantation history

	Area managed (%)	
Analysis unit	**Age 1 – 10**	**Age 11 – 20**
All	100	100

A.4.9 Not satisfactorily restocked (NSR) areas

The inventory file shows a total of 15 073 hectares of NSR within the timber harvesting land base. The area of NSR by analysis unit is shown in Table A-22. The inventory file has information on species and ages for the NSR areas, therefore, it was used to assign analysis unit.

After the analysis was completed, it was determined that the NSR information was suspect partially due to forest inventory transformation. The values portrayed in the inventory file were mid-pointed averages for pine species. Furthermore a significant portion of the NSR area had an age greater than 20 (as indicated in Table A-22). These older NSR areas acted as other stands their age in the analysis — thereby not affecting green-up. The Golden Forest District staff have indicated that perhaps the analysis should have set all NSR ages back to 0 for analysis purposes.

A.4 Forest Management Assumptions

Table A-22. Distribution of not satisfactorily restocked (NSR) areas

	Analysis unit	Age	Area (hectares)
11	F, FPl, FL, FDecid, LF, L	> 20	69.9
12	F, FPl, FL, FDecid, LF, L	> 20	47.2
13	F, FPl, FL, FDecid, LF, L	> 20	4.2
14	FC, FH, FS	> 20	19
15	FC, FH, FS	> 20	16.9
16	FC, FH, FS	> 20	32.9
21	C, CF, CH	> 20	194.3
22	C, CF, CH	> 20	192.2
23	C, CF, CH	> 20	87.9
24	HC, HF, HS, H, HB, HDec, B, BH	> 20	51.5
25	HC, HF, HS, H, HB, HDec, B, BH	> 20	15.3
26	HC, HF, HS, H, HB, HDec, B, BH	> 20	175
31	S, B	> 20	17.3
32	S, B	> 20	122.4
33	S, B	> 20	187.18
41	S, SB SF, SH, SPl, Sdec	> 20	42.9
42	S, SB SF, SH, SPl, Sdec	> 20	9.6
43	S, SB SF, SH, SPl, Sdec	> 20	49.3
44	S, SB SF, SH, SPl, Sdec	> 20	50.2
53	PwPa, Pl PlF, PlS, PlDec	> 20	41.5
111	F, FPl, FL, FDecid, LF, L	< 20	156.9
112	F, FPl, FL, FDecid, LF, L	< 20	283.7
113	F, FPl, FL, FDecid, LF, L	< 20	23.2
114	FC, FH, FS	< 20	236.8
115	FC, FH, FS	< 20	239.1
116	FC, FH, FS	< 20	197.1
121	C, CF, CH	< 20	380.5
122	C, CF, CH	< 20	86.8
124	C, CF, CH	< 20	380.15
125	HC, HF, HS, H, HB, Hdec, B, BH	< 20	121.64
126	HC, HF, HS, H, HB, Hdec, B, BH	< 20	172.72
131	S, B	< 20	1 218.6
132	S, B	< 20	592.27
133	S, B	< 20	158.5
134	S, B	< 20	64.3
141	S, SB SF, SH, SPl, Sdec	< 20	277.4
142	S, SB SF, SH, SPl, Sdec	< 20	139.2
143	S, SB SF, SH, SPl, Sdec	< 20	224.96
144	S, SB SF, SH, SPl, Sdec	< 20	256.7
151	PwPa, Pl PlF, PlS, PlDec	< 20	313
152	PwPa, Pl PlF, PlS, PlDec	< 20	2 412.31
153	PwPa, Pl PlF, PlS, PlDec	< 20	3 616.99
154	PwPa, Pl PlF, PlS, PlDec	< 20	2 093.21
Total			15 072.73

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-23. shows the volume estimates by analysis unit for existing natural stands. The deciduous species in a predominantly coniferous stand were excluded from volume compilation procedures.

Table A-23. Timber volume tables for existing natural stands (cubic metres)

Age	Analysis unit 11	Analysis unit 12	Analysis unit 13	Analysis unit 14	Analysis unit 15	Analysis unit 16	Analysis unit 21	Analysis unit 22	Analysis unit 23
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
30	20.5	1.5	0.1	25.7	1.7	0.1	2.5	0.0	0.0
40	68.6	32.2	2.4	84.0	39.3	3.9	33.2	1.2	0.1
50	117.0	69.1	20.3	141.6	84.2	25.4	88.7	17.8	2.0
60	164.1	105.5	42.8	195.5	126.6	53.9	138.8	55.0	15.9
70	209.0	140.6	66.0	245.5	166.1	82.9	183.8	90.3	42.7
80	251.5	174.2	88.5	291.7	202.6	110.6	224.4	122.7	70.3
90	291.4	206.2	110.2	333.9	236.0	136.3	254.3	148.5	93.1
100	327.1	236.7	131.1	372.1	266.8	159.9	278.4	170.3	112.4
110	357.6	265.1	151.2	404.4	295.2	181.9	298.0	188.6	128.8
120	384.0	289.8	169.2	431.6	319.6	201.1	313.1	203.6	142.5
130	408.3	311.8	186.0	457.2	342.6	219.7	336.1	223.2	159.3
140	429.0	330.0	200.3	480.1	362.5	236.4	357.4	241.3	174.9
150	447.5	346.0	212.9	500.9	380.2	251.4	377.1	258.2	189.4
160	464.1	359.9	223.6	519.7	396.0	264.8	395.1	273.8	202.8
170	478.9	372.3	232.6	536.9	410.2	276.6	411.4	288.0	215.2
180	492.2	383.3	241.4	552.7	423.5	288.3	426.4	301.3	226.6
190	503.9	392.9	249.2	567.2	435.6	299.3	440.3	313.6	237.2
200	515.7	402.7	257.4	581.0	447.1	310.0	454.1	326.0	247.9
210	526.8	411.9	265.2	594.1	458.0	320.2	467.2	338.1	258.3
220	537.3	420.8	272.5	606.4	468.3	329.9	479.8	349.7	268.4
230	547.3	429.1	279.4	618.1	478.0	339.0	491.4	361.0	278.2
240	556.7	437.1	285.8	629.2	487.2	347.7	502.1	372.0	287.7
250	565.7	444.6	291.9	639.7	496.0	355.9	512.2	382.6	296.9
260	565.4	444.8	292.2	640.8	497.5	357.9	516.6	388.3	302.4
270	565.1	444.9	292.5	641.8	498.8	359.7	520.7	393.5	307.6
280	564.7	445.0	292.8	642.7	500.0	361.4	524.6	398.5	312.7
290	564.3	445.0	292.9	643.6	501.2	363.0	528.1	403.0	317.5
300	563.8	445.0	293.0	644.3	502.2	364.5	531.5	407.1	322.0
310	563.3	444.9	293.0	644.9	503.1	365.9	534.6	410.9	326.2
320	562.7	444.7	293.0	645.5	503.9	367.2	537.6	414.3	330.1
330	562.0	444.5	292.9	646.0	504.7	368.4	540.3	417.6	333.7
340	561.2	444.1	292.7	646.4	505.4	369.5	542.9	420.7	337.1
350	560.2	443.5	292.5	646.7	506.0	370.6	545.3	423.7	340.3

continued

A.5 Volume Estimates for Existing Stands

Table A-23. Timber volume tables for existing natural stands (cubic metres)

Age	Analysis unit 24	Analysis unit 25	Analysis unit 26	Analysis unit 31	Analysis unit 32	Analysis unit 33	Analysis unit 34
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	9.9	0.2	0.1	4.6	0.7	0.0	0.0
40	73.9	33.7	1.2	47.7	9.7	1.0	0.0
50	131.3	82.4	27.6	113.1	41.8	7.4	0.1
60	183.4	126.8	58.4	170.4	86.6	23.3	1.5
70	229.5	166.0	86.0	219.5	127.6	54.9	5.8
80	271.5	201.7	111.2	260.9	163.3	86.1	15.8
90	301.3	227.7	130.7	294.7	193.8	114.1	34.3
100	325.0	248.3	146.8	322.9	220.3	139.0	53.0
110	344.0	264.8	160.1	346.4	243.3	161.3	72.2
120	358.2	277.4	170.6	365.9	263.2	181.1	91.2
130	382.5	298.2	185.8	385.0	282.8	200.6	109.8
140	406.2	318.5	200.5	401.8	300.5	218.5	127.4
150	428.3	337.5	214.2	416.7	316.4	234.8	143.8
160	448.8	355.2	227.1	429.7	330.4	249.7	159.3
170	468.0	371.7	239.0	441.2	343.1	263.3	173.7
180	486.2	387.4	250.6	451.6	354.7	275.8	187.3
190	503.4	402.2	261.4	460.7	365.2	287.4	199.9
200	520.3	416.9	272.2	469.1	375.0	298.1	211.8
210	536.6	431.0	282.5	476.6	384.0	308.1	223.0
220	555.4	447.4	294.4	483.4	392.4	317.3	233.5
230	573.5	463.6	306.2	489.5	400.1	326.0	243.3
240	591.0	479.4	317.9	495.2	407.3	334.1	252.6
250	607.5	494.8	329.3	500.3	414.0	341.6	261.3
260	608.9	496.8	331.2	502.3	416.7	345.5	266.3
270	610.1	498.7	333.0	504.0	419.2	349.0	271.0
280	611.3	500.3	334.7	505.5	421.3	352.2	275.3
290	612.4	501.7	336.4	506.7	423.3	355.1	279.4
300	613.3	503.1	337.8	507.8	424.9	357.8	283.1
310	614.3	504.4	339.1	508.7	426.4	360.2	286.7
320	615.1	505.6	340.3	509.4	427.7	362.3	289.9
330	615.8	506.7	341.3	510.0	428.9	364.3	293.0
340	616.5	507.7	342.4	510.4	429.9	366.1	295.8
350	617.2	508.7	343.3	510.8	430.8	367.7	298.3

continued

A.5 Volume Estimates for Existing Stands

Table A-23. Timber volume tables for existing natural stands (cubic metres) (concluded)

Age	Analysis unit 41	Analysis unit 42	Analysis unit 43	Analysis unit 44	Analysis unit 51	Analysis unit 52	Analysis unit 53	Analysis unit 54
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
30	0.5	0.2	0.0	0.0	58.7	23.9	5.0	0.2
40	45.6	4.4	1.2	0.0	124.1	77.4	46.7	15.5
50	119.1	54.3	20.1	0.6	181.5	124.8	87.9	47.4
60	183.7	111.6	65.2	5.8	230.9	166.4	124.9	80.0
70	239.3	164.1	112.0	20.9	273.7	203.0	158.0	109.8
80	286.4	211.3	154.4	45.0	311.2	235.3	187.8	136.8
90	324.9	253.1	191.4	74.9	344.5	264.3	214.7	161.6
100	357.0	290.1	223.9	102.7	374.5	290.4	239.2	184.4
110	383.8	323.0	252.5	128.6	401.7	314.2	261.7	205.4
120	405.3	351.7	277.2	152.5	426.6	336.1	282.4	224.9
130	425.7	378.5	301.4	176.6	449.8	356.6	301.9	243.3
140	442.8	399.7	322.5	199.5	465.1	370.5	315.3	256.5
150	457.6	417.6	340.9	220.6	477.0	381.4	325.9	267.2
160	470.0	432.6	356.8	240.1	485.5	389.3	333.6	275.2
170	480.6	445.2	370.7	258.0	490.6	394.2	338.6	280.9
180	489.7	455.9	383.2	274.6	492.4	396.3	340.9	284.1
190	497.5	464.5	394.3	289.8	490.9	395.6	340.6	285.0
200	505.0	473.3	404.8	304.3	493.6	398.3	343.3	288.2
210	511.8	481.4	414.5	318.1	496.7	401.2	346.3	291.6
220	518.1	488.7	423.4	331.0	499.9	404.2	349.3	294.8
230	523.8	495.4	431.6	343.2	503.2	407.2	352.2	297.9
240	529.1	501.5	439.2	354.7	506.4	410.1	354.9	300.9
250	533.9	507.1	446.2	365.5	509.5	412.9	357.6	303.6
260	536.0	510.6	449.9	371.9	511.8	414.9	359.5	305.8
270	537.8	513.8	453.2	377.9	514.1	416.9	361.3	307.7
280	539.3	516.6	456.2	383.4	516.1	418.6	362.9	309.5
290	540.6	519.1	458.9	388.6	518.1	420.3	364.5	311.1
300	541.7	521.4	461.3	393.3	520.0	421.8	365.8	312.6
310	542.7	523.4	463.4	397.6	521.7	423.2	367.1	313.8
320	543.5	525.2	465.3	401.6	523.3	424.4	368.2	315.0
330	544.1	526.8	467.0	405.2	524.7	425.6	369.2	316.0
340	544.7	528.2	468.5	408.5	526.0	426.6	370.0	316.8
350	545.1	529.4	469.9	411.5	527.2	427.4	370.7	317.5

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index for each analysis unit was used, along with regeneration assumptions, as input to TIPSY. Table A—20 and Table A-21. document which stands were assumed to be managed in the analysis.

Operational adjustment factors (OAFs) used in managed stand yield table generation were:

OAF 1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand), and OAF 2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age).

Table A-24. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age.

A.6 Volume Estimates for Regenerated Stands

Table A-24. Timber volume tables for regenerated stands (cubic metres)

Age	Analysis unit 111	Analysis unit 112	Analysis unit 113	Analysis unit 114	Analysis unit 115	Analysis unit 116	Analysis unit 121	Analysis unit 122	Analysis unit 123
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	25.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	57.0	28.0	3.0	57.0	7.0	0.0	0.0	0.0	0.0
40	156.0	53.0	25.0	142.0	21.0	7.0	63.0	0.0	0.0
50	251.0	114.0	44.0	256.0	84.0	14.0	162.0	56.0	0.0
60	330.0	182.0	80.0	346.0	155.0	36.0	255.0	126.0	25.0
70	395.0	237.0	113.0	415.0	219.0	65.0	342.0	194.0	68.0
80	449.0	287.0	143.0	476.0	280.0	95.0	417.0	256.0	113.0
90	480.0	329.0	177.0	515.0	329.0	128.0	477.0	315.0	157.0
100	502.0	363.0	205.0	545.0	368.0	157.0	528.0	366.0	196.0
110	522.0	393.0	226.0	568.0	402.0	180.0	572.0	409.0	232.0
120	537.0	420.0	244.0	585.0	432.0	201.0	608.0	445.0	269.0
130	549.0	442.0	260.0	601.0	457.0	220.0	643.0	476.0	300.0
140	560.0	460.0	276.0	615.0	478.0	238.0	666.0	503.0	326.0
150	569.0	474.0	289.0	628.0	493.0	256.0	686.0	528.0	346.0
160	578.0	486.0	300.0	639.0	504.0	271.0	701.0	550.0	363.0
170	587.0	494.0	309.0	650.0	514.0	284.0	715.0	568.0	377.0
180	594.0	501.0	318.0	659.0	523.0	296.0	729.0	583.0	390.0
190	600.0	507.0	325.0	664.0	530.0	307.0	740.0	596.0	401.0
200	604.0	511.0	332.0	668.0	535.0	317.0	750.0	605.0	410.0
210	607.0	516.0	338.0	671.0	540.0	327.0	759.0	612.0	418.0
220	610.0	518.0	344.0	674.0	543.0	336.0	769.0	619.0	426.0
230	612.0	521.0	348.0	677.0	545.0	344.0	778.0	627.0	432.0
240	613.0	523.0	352.0	677.0	547.0	351.0	785.0	633.0	437.0
250	615.0	525.0	355.0	677.0	549.0	357.0	793.0	639.0	442.0
260	616.0	527.0	357.0	677.0	550.0	363.0	800.0	645.0	446.0
270	616.0	528.0	360.0	677.0	551.0	368.0	806.0	651.0	449.0
280	616.0	530.0	362.0	677.0	552.0	372.0	812.0	655.0	449.0
290	616.0	531.0	363.0	677.0	552.0	377.0	818.0	659.0	448.0
300	616.0	531.0	363.0	677.0	552.0	377.0	818.0	659.0	448.0

continued

A.6 Volume Estimates for Regenerated Stands

Table A-24. Timber volume tables for regenerated stands (cubic metres)

Age	Analysis unit 124	Analysis unit 125	Analysis unit 126	Analysis unit 131	Analysis unit 132	Analysis unit 133	Analysis unit 134
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	80.0	0.0	0.0	0.0
40	7.0	0.0	0.0	107.0	15.0	0.0	0.0
50	60.0	3.0	1.0	212.0	62.0	0.0	0.0
60	132.0	20.0	3.0	305.0	127.0	29.0	0.0
70	201.0	61.0	16.0	383.0	193.0	68.0	0.0
80	263.0	106.0	40.0	434.0	249.0	114.0	12.0
90	323.0	153.0	71.0	472.0	305.0	160.0	30.0
100	374.0	192.0	104.0	500.0	350.0	199.0	55.0
110	417.0	230.0	139.0	519.0	383.0	237.0	83.0
120	453.0	267.0	168.0	523.0	409.0	274.0	112.0
130	484.0	302.0	196.0	524.0	430.0	308.0	142.0
140	511.0	330.0	222.0	523.0	447.0	334.0	167.0
150	536.0	354.0	249.0	523.0	461.0	356.0	191.0
160	558.0	374.0	274.0	520.0	473.0	373.0	214.0
170	576.0	392.0	294.0	517.0	482.0	388.0	236.0
180	591.0	407.0	312.0	515.0	491.0	400.0	260.0
190	603.0	421.0	325.0	515.0	494.0	411.0	282.0
200	611.0	433.0	338.0	515.0	494.0	420.0	299.0
210	618.0	444.0	349.0	515.0	494.0	427.0	315.0
220	627.0	455.0	357.0	515.0	493.0	434.0	328.0
230	634.0	465.0	365.0	515.0	493.0	440.0	339.0
240	641.0	473.0	373.0	515.0	491.0	444.0	348.0
250	647.0	481.0	379.0	515.0	489.0	448.0	357.0
260	653.0	488.0	385.0	515.0	488.0	452.0	364.0
270	658.0	495.0	389.0	515.0	487.0	455.0	370.0
280	663.0	501.0	394.0	515.0	486.0	456.0	376.0
290	667.0	504.0	398.0	515.0	486.0	455.0	381.0
300	667.0	504.0	398.0	515.0	486.0	455.0	381.0

continued

A.6 Volume Estimates for Regenerated Stands

Table A-24. Timber volume tables for regenerated stands (cubic metres) (concluded)

Age	Analysis unit 141	Analysis unit 142	Analysis unit 143	Analysis unit 144	Analysis unit 151	Analysis unit 152	Analysis unit 153	Analysis unit 154
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	88.0	0.0	0.0	0.0	66.0	66.0	0.0	0.0
40	107.0	62.0	0.0	0.0	139.0	81.0	80.0	60.0
50	210.0	120.0	70.0	0.0	230.0	140.0	126.0	90.0
60	307.0	186.0	106.0	0.0	305.0	206.0	167.0	104.0
70	379.0	239.0	152.0	11.0	365.0	260.0	213.0	131.0
80	430.0	286.0	197.0	31.0	413.0	306.0	250.0	157.0
90	472.0	325.0	233.0	59.0	451.0	344.0	279.0	183.0
100	502.0	356.0	265.0	90.0	482.0	374.0	304.0	210.0
110	520.0	382.0	293.0	124.0	494.0	401.0	325.0	232.0
120	529.0	405.0	316.0	154.0	503.0	423.0	342.0	248.0
130	536.0	424.0	335.0	181.0	510.0	442.0	356.0	263.0
140	541.0	441.0	351.0	207.0	515.0	457.0	369.0	276.0
150	544.0	453.0	365.0	232.0	520.0	468.0	379.0	287.0
160	545.0	463.0	378.0	257.0	523.0	477.0	388.0	297.0
170	547.0	471.0	389.0	279.0	526.0	481.0	396.0	305.0
180	550.0	478.0	398.0	297.0	529.0	485.0	404.0	313.0
190	553.0	481.0	406.0	313.0	532.0	487.0	410.0	319.0
200	555.0	210.0	413.0	325.0	535.0	489.0	413.0	324.0
210	558.0	485.0	419.0	337.0	537.0	491.0	416.0	328.0
220	560.0	487.0	423.0	346.0	540.0	492.0	418.0	332.0
230	562.0	488.0	427.0	355.0	542.0	493.0	420.0	336.0
240	563.0	489.0	430.0	362.0	543.0	494.0	422.0	339.0
250	565.0	489.0	431.0	369.0	544.0	495.0	424.0	342.0
260	566.0	490.0	432.0	375.0	544.0	495.0	426.0	345.0
270	566.0	490.0	433.0	380.0	545.0	495.0	427.0	346.0
280	567.0	491.0	433.0	385.0	545.0	496.0	429.0	346.0
290	567.0	491.0	434.0	389.0	546.0	497.0	430.0	345.0
300	567.0	491.0	434.0	389.0	546.0	497.0	430.0	345.0

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- Employment multiplier — employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- Employment coefficient — employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future as a result of changes in market conditions, product mix or production technologies.
- Timing of impacts — employment impacts are shown to occur simultaneously with a change in the harvest level. While this is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period of time, as levels of business and consumer spending adjust to changes in harvest levels.
- Operating thresholds of mills — it is unlikely that impacts on processing employment due to changes in harvest levels will be in direct proportion to the harvest changes; i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment. Impacts on timber processing employment are more likely to occur in a step-wise manner related to operating thresholds of the mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay-off a shift of workers or to close the mill, either temporarily or permanently. Conversely , if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in processing employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurate predictions of an individual mill's operating threshold is not possible. As a result, impact figures pertaining to employment in timber processing are best interpreted as orders of magnitude of change rather than as precise changes in employment levels.
- Government expenditures — provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if there are significant changes to a community's population. This would amplify the community impacts of losses or gains in forestry sector jobs.
- Proportional harvest reductions — harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from B.C. STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Income data pertaining to direct employment in the forest industry are from Price Waterhouse.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 200 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and
3) timber processing.

The procedure for estimating employment and income impacts involved several steps. The first step was to assess current activity in each of the three sub-sectors. This was followed by an estimate of indirect and induced employment and employment income impacts, using data from the Ministry of Finance and Corporate Relations (1996) and by Price Waterhouse Inc. (1996). Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using the Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands related jobs including harvesting, log salvage, planning and administration functions. The employment multipliers used in this analysis define activities such as log transport and hauling, road building and maintenance work as indirect employment rather than direct employment, as a result they are not included in the direct impact estimates.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the Golden TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident versus non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting — consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2) Provincial direct employment in harvesting — consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients on a per 1000 cubic metres basis. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

B.2 Economic Impact Analysis Methodology

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilizing, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to provide estimates of the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers; i.e., those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated in a similar fashion.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector are those who work to provide goods and services to firms directly engaged in the basic forestry sector; for example, those who provide log transport services. Induced employment are those who work to provide the goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets. Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that a displaced worker will leave the region, reducing total income in the region by his/her full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Golden TSA analysis are as follows:

Table B-1. Employment multipliers

Forest sub-sector	Golden TSA migration multiplier	Golden TSA no-migration multiplier	Provincial (Interior) migration multiplier	Provincial (Interior) no-migration multiplier
Harvesting	1.55	1.33	2.14	1.80
Solid wood processing	1.45	1.26	2.29	1.93
Plywood	1.45	1.26	1.93	1.64
Pulp	N/A	N/A	3.02	2.48

Source: Ministry of Finance and Corporate Relations. *The Revised Forest District Tables*, March, 1996.
A Provincial Impact Estimation Procedure for the British Columbia Forest Sector. Ministry of Finance and Corporate Relations. 1996.

Employment income estimates

Employment income was calculated using average income estimates for workers in the forest industry. The average pre-tax income (less benefits) for forestry sector workers in 1996 was approximately $46,950; and approximately $32,500 for those in indirect and induced occupations. Income taxes were calculated based on marginal tax rates of 23% to 28% with one-third of the total income tax accruing to the province.

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecasted harvest level is multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of orders of magnitude of change rather than as precise estimates of changes in employment levels.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. See Table B2.

Table B-2. Golden TSA estimates of provincial government revenues

	Average revenue 1994-1996[a] ($1996 millions)	Revenue per '000s m^3 ($ per '000s m^3)
Stumpage and related payments	$4.31	$12,329
Forest industry taxes	$3.03	$8,664
Employee income Tax	$3.36	$9,604
Total	$10.60	$30,597

(a) Based on 1994-1996 annual average of 349 846 cubic metres in the Golden TSA.
Source: Ministry of Forests.