Revelstoke
Timber Supply Area
Analysis Report

B.C. Ministry of Forests
1450 Government Street
Victoria, B.C.
V8W 3E7

December 1998

Canadian Cataloguing in Publication Data

Main entry under title:
Revelstoke timber supply area analysis report

Includes bibliographical references: p.
ISBN 0-7726-3703-2

1. Timber - British Columbia - Revelstoke Region.
2. Forests and forestry - British Columbia - Revelstoke Region - Mensuration. 3. Forest management - British Columbia - Revelstoke Region.
4. Nelson Forest Region (B.C.). I. British Columbia. Ministry of Forests.

SD438.B7R48 1998 333.75'11'0971168 C98-960294-X

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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 Revelstoke 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. (The first two documents are the Information Report and the timber supply analysis Data Package). 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 Revelstoke Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short (next 20 years) and long (next 250 years) terms. 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 Revelstoke TSA covers about 500 000 hectares in the southeastern portion of British Columbia. About 68 000 hectares of the 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 western redcedar or western hemlock tree species at lower elevations, and Engelmann spruce and subalpine fir at higher elevations. Smaller areas are also dominated by Douglas-fir, western white pine, lodgepole pine, larch, cottonwood, birch and aspen. Western redcedar, western hemlock, Engelmann spruce, subalpine fir and Douglas-fir 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. Management practices are also influenced by the *Kootenay-Boundary Land Use Plan Implementation Strategy* and the Minister's Advisory Committee (MAC) recommendations to government on implementation of the *Kootenay-Boundary Land Use Plan* (KBLUP) in the Revelstoke TSA portion of the Columbia Forest District. This direction is reflected in the *Supplement to the Forest Development Plan Guidebook for the Nelson Forest Region* and the *Columbia Forest District, 1998-2002 Forest Development Plans,* and a Memorandum of Understanding between the Ministry of Forests and the Ministry of Environment, Lands and Parks Regarding Instructions for the Preparation of the 1998 Forest Development Plan which was released in October 1997. The information in the above documents defines much of current management.

The results of this timber supply analysis suggest that the current harvest level in the Revelstoke TSA of 230 000 cubic metres per year (woodlots excluded) can be maintained for up to four decades without creating future timber shortages. This is followed by a reduction in the harvest level over the subsequent four decades to the long-term harvest level of 159 000 cubic metres per year. This period of reductions is 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 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 Revelstoke TSA is stable. In only one case was short-term timber supply affected within the range of uncertainty examined. Uncertainty generally affected the timing of the transition to the long-term harvest level which began from 20 to 100 years from now depending on the variable examined, and in some cases affected the long-term harvest level.

Executive Summary

Uncertainty about timber volumes in existing stands had the largest effect on projected harvests over the next 250 years. If existing stand volumes were 10% lower than estimated in the base case, the initial harvest level projected in the base case could be maintained for only two decades; if existing stand volumes were 10% higher then the initial harvest level could be maintained for six decades. The long-term harvest level is affected only slightly by changes in existing stand volume estimates. Uncertainty about timber volumes in existing hemlock and cedar stands, where the greatest amount of uncertainty exists, affects projected harvests in a similar way. If existing hemlock and cedar stand volumes were 25% lower than in the base case, the initial harvest level of 230 000 cubic metres per year could be maintained for just one decade; if existing hemlock and cedar stand volumes were 25% higher then the initial harvest level could be maintained for eight decades. An inventory audit completed in 1997 indicated that, for the Revelstoke TSA as a whole, current inventory information together with the timber volume estimation model used for this analysis produced accurate estimates for existing stand volumes. Results from ongoing decay and waste surveys, particularly for hemlock and cedar-leading stands, were not available for this analysis.

Uncertainty about size of the timber harvesting land base, timber volumes in regenerated stands, minimum harvestable ages, the queuing or scheduling priority for mature stands for harvest, the size of area mapped as caribou habitat, requirements for mature forest for wildlife cover, and estimates of site productivity each has a moderate to large effect on projected timber supply. If the size of the timber harvesting land base is overestimated by 7%, the initial harvest level projected in the base case can be maintained for three decades before declining to a long-term level of 147 000 cubic metres per year (7.5% lower than in the base case). Conversely, if the size of the timber harvesting land base is underestimated by the same amount, the current harvest level could be maintained for five decades before declining to a long-term level of 170 000 cubic metres. Since the last AAC determination in 1994 a new forest inventory has been completed for the Revelstoke TSA. The new inventory, which was used in this analysis, classified approximately 19 000 hectares more land as productive forest than did the inventory used in the last analysis, resulting in a significant increase in the size of the timber harvesting land base.

Uncertainty about regenerated stand volume estimates has no impact on the length of time the initial harvest level can be maintained, but has an effect on long-term supply approximately proportionate to the change in volume estimates. Changes to minimum harvestable ages affect the timing of the transition to the long-term level; reductions in these ages allow the initial level to be maintained for longer, while increases in harvestable ages require an earlier decline. However, the long-term harvest is affected only slightly by either increases or decreases in minimum harvestable ages. Uncertainty in the queuing or harvest priority of mature eligible stands, as demonstrated by applying different harvest rules, affects both the timing of the decline to the long-term level, and the long-term level itself. Any harvest rule other than the relative oldest first rule used in the base case results in a decreased long-term level, and in some cases an earlier decline to the long-term level. Changes to the area managed as caribou habitat, or to the amount of mature forest required to be maintained for wildlife thermal cover affect both medium- and long-term timber supplies. Uncertainty regarding estimates of site productivity for regenerated stands could significantly change the long-term timber supply. If old-growth site index (OGSI) adjustments are made to all eligible stands, the long-term harvest level increases to 191 000 metres per year, 20.1% higher than in the base case; if OGSI adjustments are made just to eligible spruce stands, the long-term harvest level increases by 3.6%.

Executive Summary

Factors with small effects on timber supply include the maximum amount of disturbance allowed in wildlife and integrated resource management zones, estimates of the age at which stands reach green-up conditions and uncertainty about how biodiversity requirements are implemented. For all these factors, the amount of time that the initial harvest level can be maintained is affected by one decade at most, and the long-term harvest level is affected slightly, if at all.

Visually sensitive areas and community watersheds cover a relatively small portion of the timber harvesting land base, so forest cover requirements applied to these areas do not significantly limit the Revelstoke TSA timber supply. On the other hand, moderate and high value caribou habitat covers a large portion of the timber harvesting land base; large changes in forest cover requirements applied to these areas significantly impact timber supply in the medium- and long-terms.

The socio-economic analysis for the Revelstoke TSA indicates that the current AAC of 230 000 cubic metres can support approximately 282 person-years of direct employment and an estimated 362 person-years of indirect and induced employment across the province.

The base case harvest forecast for the next four decades is 230 000 cubic metres per year — the same as the current AAC — suggesting there should be no significant changes in the current level of employment in the Revelstoke TSA.

If fully harvested and utilized, the current AAC and the base case harvest forecast would generate an estimated $7.4 million in provincial government revenues.

In conclusion, this analysis indicates that using current inventory and growth and yield information, timber harvests in the Revelstoke TSA can be maintained at the current allowable level for the next 40 years. Several factors related to the current forest inventory and management regime could affect timber supply; however, no conclusive evidence was available prior to completion of this analysis to suggest that significant inaccuracies exist in the information used.

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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 throughout British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

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

Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 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.

Introduction

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

The following sections outline the timber supply analysis for the Revelstoke 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 Revelstoke 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.

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.

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 activities, processing, and silviculture. Employment is measured in 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 direct employment averages for harvesting, processing and silviculture 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 Revelstoke 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 impacts.

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 indicators of general magnitude.

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 1.0 person-years of employment; or 500 000 cubic metres supports 500 person-years of employment.

1 Description of the Revelstoke Timber Supply Area

The Revelstoke timber supply area (TSA) lies in the southeastern part of British Columbia within the Nelson Forest Region (Figure 1), and is administered from the Columbia Forest District office in Revelstoke. It is bounded by the Monashee mountains to the west and the Selkirk mountains to the east, and straddles the Columbia River valley, which runs from the Mica Dam in the north to Monashee Provincial Park and Arrowhead in the south. The Trans–Canada highway passes through the southern part of the area providing easy access to an area of outstanding mountain scenery. Nearby are Mount Revelstoke National Park, a portion of Glacier National Park and several smaller provincial parks.

The Revelstoke TSA covers about 500 000 hectares. Approximately 39% of the total area of the Revelstoke TSA is alpine, 5% is sub-alpine forest not considered productive enough to support timber harvesting, and 12% is either brush, rock, lakes, rivers, swamps or private land. About 44% of the Revelstoke TSA is considered productive forest in terms of timber growth. Most of the productive forest is dominated by western hemlock, western redcedar, Engelmann spruce and subalpine fir tree species. Smaller areas are also dominated by Douglas-fir, western white pine, lodgepole pine, larch, cottonwood, birch and aspen.

The area's economy is well diversified with forestry, tourism and the public sector predominant. Information from the 1991 census indicates that the forest sector accounted for almost 20% of total employment in the Revelstoke TSA. The Revelstoke TSA's forest sector is composed of four sawmills, one cedar shake and shingle mill, a pole yard and logging related activities. Western redcedar, western hemlock, Engelmann spruce, subalpine fir and Douglas-fir are the tree species most commonly used by the forest industry in the area. The current allowable annual cut for the Revelstoke timber supply area, determined in 1994, is 230 000 cubic metres per year.

1.1 The environment

The Revelstoke TSA lies in the interior wet belt of the province. It is covered by three biogeoclimatic zones: interior cedar hemlock, Engelmann spruce-alpine and alpine tundra. The area's topography is characterized by rugged, mountainous terrain, and a cold, wet climate. The mountainous environment creates varied growing conditions resulting in diverse forests and high biodiversity* values. Valley bottoms are covered with western redcedar and western hemlock stands and stands of Engelmann spruce and subalpine fir occupy the higher elevation slopes. The mountain peaks are covered by vast expanses of alpine tundra, rock and ice. Because of the rugged landscape and cold, wet climate, only a small proportion (13.5%) of the Revelstoke TSA is available for timber harvesting.

The forests of the Revelstoke TSA are home to a wide variety of wildlife species that are able to survive or avoid the deep snows of winter. These include black and grizzly bear, caribou, moose, deer, elk and mountain goat, as well as smaller mammals such as marmots, martens and squirrels.

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

1 Description of the Revelstoke Timber Supply Area

Table 1 summarizes the biogeoclimatic zones and their locations, the tree species present, and other considerations such as wildlife values.

Over 60% of the Revelstoke TSA forest cover is old growth, which provides habitat for mountain caribou, cavity-nesting birds and small mammals. Cavity-nesting birds, including raptors, pileated woodpeckers and owls, depend on old-growth attributes such as large diameter snags and uneven-aged forests, particularly at lower elevations. Small, old-growth dependent mammals include the pine marten and certain species of bat.

The Revelstoke TSA area overlaps the range of one of the largest and most viable populations of mountain caribou in Canada. Due to heavy snowfall in the area, these caribou require sufficient canopy cover, which mature forests provide, to move between feeding areas. The caribou also depend on mature lichen-bearing forests for feeding.

Table 1. Biogeoclimatic zones of the Revelstoke timber supply area

Zone	Location	Tree species	Other
Interior cedar-hemlock (ICH)	Occupies valley bottoms and lower slopes (to 1500 metres).	**Dominant:** Western hemlock Western redcedar **Minor:** Engelmann spruce Hybrid white spruce Subalpine fir Lodgepole pine Western white pine Western larch Douglas-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 biogeoclimatic zone. Wildlife is constrained by deep winter snows.
Engelmann spruce-subalpine fir (ESSF)	Above interior cedar-hemlock and below alpine tundra (1500 to 2250 metres).	**Dominant:** Engelmann spruce Subalpine fir **Minor:** Lodgepole pine Whitebark pine Western white pine Douglas-fir Mountain hemlock Western hemlock Western redcedar	Short, cool growing season. Long, cold winters with heavy snow. Wildlife constrained by deep snows and steep slopes.
Alpine tundra (AT)	Above 2250 metres.	Treeless, except for stunted forms at lower elevations of zone.	Cold, windy and snowy. Low growing season temperatures. Wildlife species and diversity are low.

1 Description of the Revelstoke Timber Supply Area

The main fishing lake in the Revelstoke TSA is Lake Revelstoke with kokanee and rainbow trout being the primary species caught.

Table 2 summarizes the animal species considered at risk in the Revelstoke TSA. In addition, two vascular plants are red-listed (endangered or threatened), and two plant communities and eight vascular plants are blue-listed (vulnerable).

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

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	
northern long-eared myotis	*luscus* wolverine	Swainson's hawk
least chipmunk	fisher	gyrfalcon
western grebe	mountain caribou	sandhill crane
American white pelican	grizzly bear	lesser golden plover
ferruginous hawk	double-crested cormorant	long-billed curlew
peregrine falcon	great blue heron	short-billed dowitcher
prairie falcon	short-eared owl	red-necked phalarope
upland sandpiper	American bittern	California gull
Forster's tern	trumpeter swan	Lewis' woodpecker
sage thrasher	oldsquaw	painted turtle
bay-breasted warbler	surf scoter	bull trout
white sturgeon	turkey vulture	

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

Current forest management practices follow the standards and legislation set out by the Forest Practices Code. Consequently the protection of wildlife and the environment will primarily be managed though the Code. In addition, however, a Minister's Advisory Committee was established in 1995 to begin implementation of the *Kootenay-Boundary Land Use Plan* for the Revelstoke area. Draft recommendations on caribou habitat needs, the application of Code guidelines, alternative harvesting and silviculture techniques, and areas for enhanced forestry are being prepared for submission to the Minister of Forests by early 1999.

As timber harvesting proceeds in the Revelstoke TSA, the conversion of mature and old-growth forests to younger, managed stands may have an impact on species which depend on the characteristics of older forests. Mountain caribou rely on mature forest cover at a range of elevations to meet their needs for food (understory vegetation and lichen) and for ease of travel throughout the year. Low elevation mature forests are believed to be particularly critical for early winter feeding range. Cavity-nesting birds (eagles, ospreys, owls) depend on lower elevation mature forests to provide the small mammals they hunt for food.

Moose and deer do not rely on older forests and gain some benefit from increased forage following timber harvesting. However, the road building associated with harvesting allows for increased human access, for logging or recreation. Risks are being minimized through access management.

1.2 First Nations

The Revelstoke TSA is within the traditional lands of the Shuswap Nation, the Ktunaxa/Kinbasket Nation and the Okanagan Nation. Currently, there are no First Nations reserves or communities within the Revelstoke timber supply area. The Ktunaxa/Kinbasket Tribal Council, of which the Shuswap Indian Band is a member, has submitted a comprehensive land claim which covers the southeast corner of the province including the Revelstoke timber supply area. Negotiations on this claim are currently in the framework agreement stage. A traditional-use site inventory is currently underway by the Ktunaxa/Kinbasket Tribal Council.

1 Description of the Revelstoke Timber Supply Area

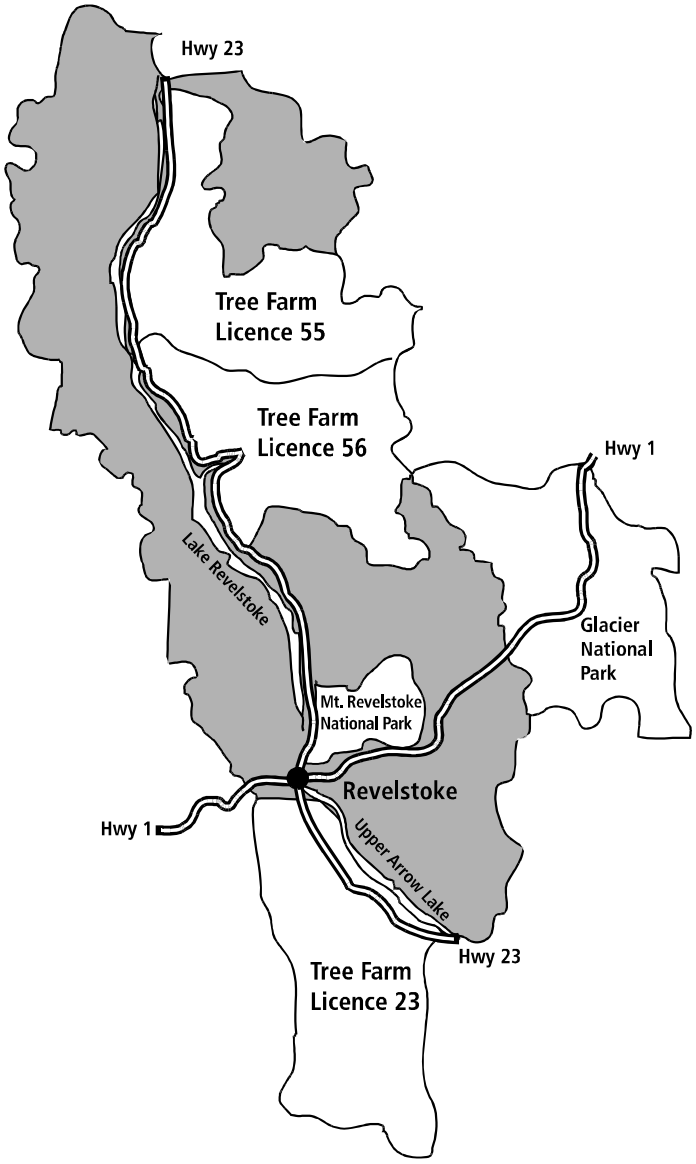

Figure 1. Map of the Revelstoke timber supply area.

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 1997. This file contains a considerable amount of information on the forest land in the Revelstoke TSA 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 1997. Also, the file has been updated to account for timber harvesting up to January 1, 1992.

The inventory file represents the land base for the entire Revelstoke analysis area as described above, Section 1, "Description of the Revelstoke Timber Supply Area." It 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 Revelstoke TSA is provided below. These types of areas do not contribute to the timber supply of the Revelstoke TSA. Before assessing timber supply these non-contributing areas are identified separately from the land base which represents the timber harvesting land base*. In this classification process, each specific area (e.g., stand of trees) is assigned either to the timber harvesting, or to the non-contributing land base (in some cases a stand may be divided, with part assigned to the harvesting land base and part to the non-contributing area). There is no double accounting of area; for example, the area of a forest stand that falls within a park, and is also on hazardous terrain, is assigned only once to the non-contributing land base.

Identifying areas not contributing to timber supply does not mean the area is also removed from the Revelstoke TSA. 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.

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 Revelstoke 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-forest and non-productive forest 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.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons.
- specific area exclusions — the Greeley Creek watershed was considered inoperable because of low value, high cost timber combined with high sensitivity to site degradation and concern for water quality.
- existing unclassified roads — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- environmentally sensitive areas* — portions of the areas considered sensitive.
- streamside, wetland and lakeside buffers — area otherwise available for timber production that was assumed to be unavailable for harvesting to provide protection for riparian* and stream ecosystems.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- deciduous types — areas occupied by predominately deciduous forest stands which are not currently utilized.
- problem forest types (low quality timber)— areas covered by coniferous forest stands that are physically operable and have adequate productivity, but are not currently utilized or have marginal merchantability.
- future roads — 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 classification 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.

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

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

2 Information Preparation for the Timber Supply Analysis

Table 3. Timber harvesting land base for the Revelstoke TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	501 471.1	100.0	
Not managed directly by the B.C. Forest Service	- 7 172.7	- 1.4	
Non-forest and non-productive forest land	- 272 821.1	- 54.4	
Total productive forest managed by the Forest Service (Crown forest)	**221 477.3**	**44.2**	**100.0**
Reductions to Crown forest:			
Non-commercial cover (brush)	69.3	0.0	0.0
Inoperable	120 376.2	24.0	54.4
Greeley Creek	8 592.4	1.7	3.9
Existing unclassified roads	2 262.2	0.5	1.0
Environmentally sensitive areas	12 821.6	2.6	5.8
Riparian management areas	2 048.1	0.4	0.9
Low timber productivity	1 175.8	0.2	0.5
Deciduous types	1 596.5	0.3	0.7
Problem forest types	4 867.9	1.0	2.2
Total current reductions[a]	**153 810.0**	**30.7**	**69.4**
Current timber harvesting land base (includes 4 917.9 hectares not satisfactorily restocked (NSR)* land)[b] and 1 417.9 hectares of Timber Licences 467 and 451[c]	**67 667.3**	**13.5**	**30.6**
Future reductions			
Future roads	4 381.2	0.9	2.0
Long-term timber harvesting land base	**63 286.1**	**12.6**	**28.6**

(a) Reductions were performed in the order listed in the table.
(b) NSR includes: current NSR and backlog NSR.
(c) These Timber Licences are currently being harvested, and will revert to BCFS jurisdiction.

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

Figure 2 represents both the total Revelstoke TSA area, and the productive forest land base. The total area chart shows that about 56% is classified as either non-forest or non-productive forest (i.e., having very few trees). The productive forest chart details the categories of forest land and shows that about 64% of the forest land in the Revelstoke TSA is considered to be unavailable for harvesting at this time due to environmental sensitivity, geographic isolation or physical or economical inoperability. An additional 3% is identified as low timber productivity, problem forest types, and non-commercial cover. Approximately 1% of the productive forest is unavailable for harvesting due to existing roads, and 1% of the productive forest is excluded from timber harvesting due to streamside, lakeside or wetland buffers. About 31% of the productive forest is considered available for timber harvesting (including NSR).

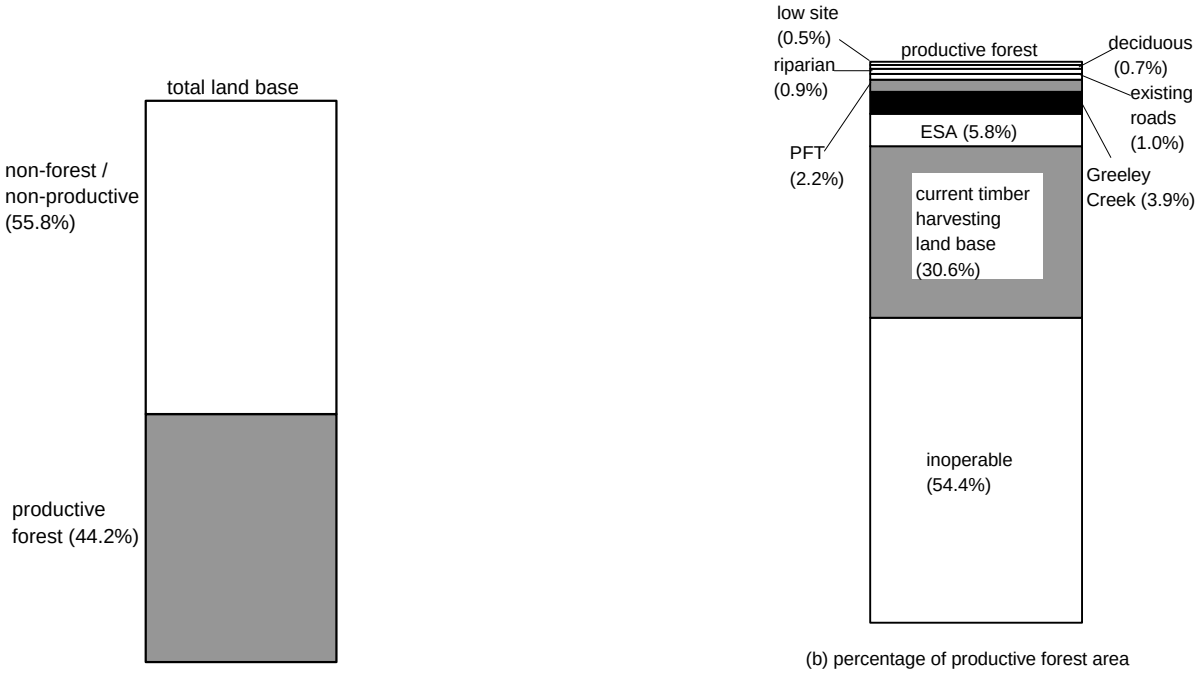

Figure 2. Composition of the total and productive forest land bases — Revelstoke TSA, 1998.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Stands dominated by hemlock species cover about 33% of the timber harvesting land base, with spruce and sub-alpine fir (balsam) dominating on 30%, cedar on 21%, and Douglas-fir, larch and lodgepole pine on 16%. After harvest, most stands are expected to be planted to similar species, depending on site conditions.

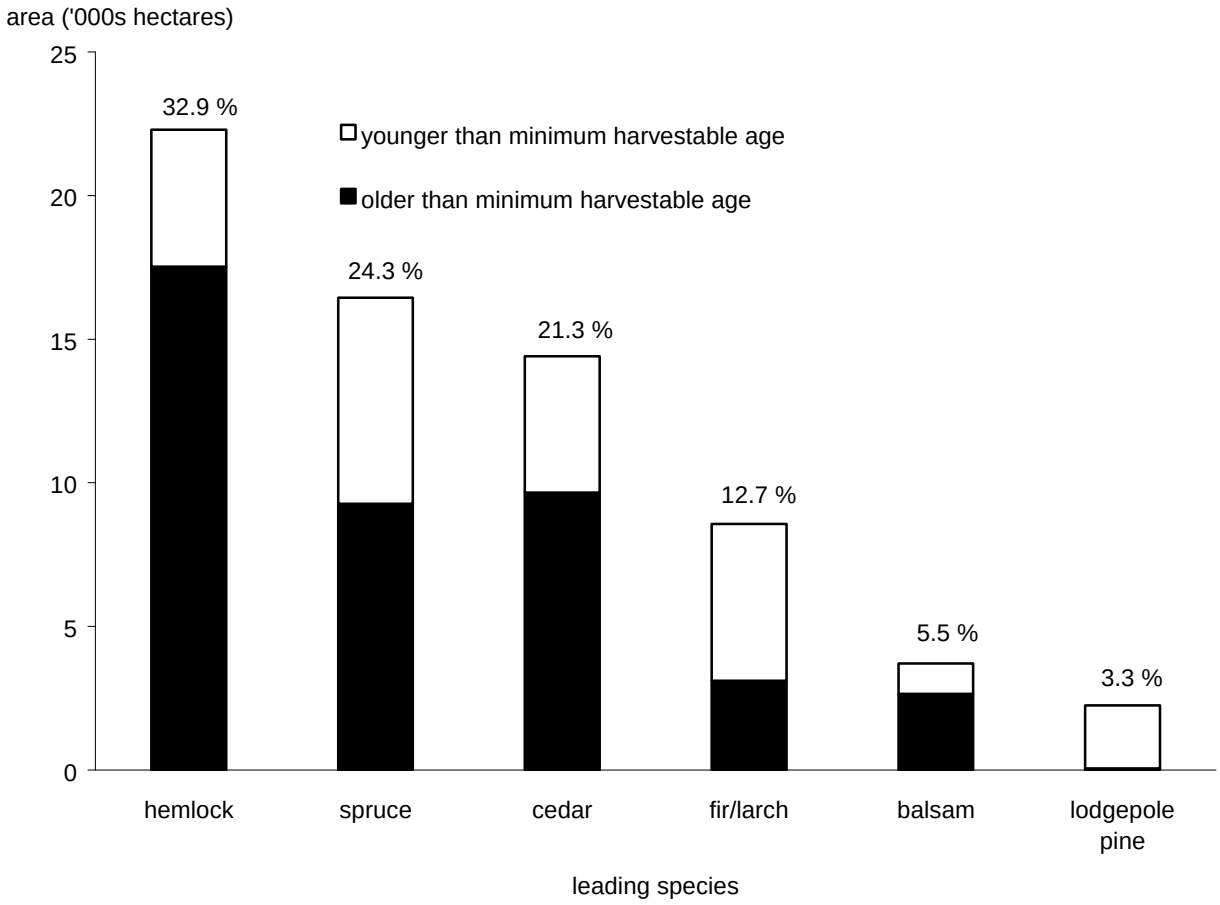

Figure 3. Area by dominant species — Revelstoke TSA timber harvesting land base, 1998.

Figure 3 also shows the proportion of area of 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 total, about 62% of stands in the timber harvesting land base are at or above the minimum harvestable age. There is significant variation around this proportion for each of the species groupings: 79% of hemlock, 59% of spruce and balsam, 67% of cedar, 36% of fir and larch, and 2% of lodgepole pine stands are older than the minimum harvestable age.

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 relative amount of area in each class that is older than the minimum harvestable age. About one-quarter of the sites in the timber harvesting land base are classified as having good productivity, 52% as medium, and 23% as poor or low. The small proportion of low productivity site (0.8%) included in the timber harvesting land base is occupied by backlog not satisfactorily restocked stands. The majority of sites classified as having low productivity are excluded from the timber harvesting land base. The proportion of area older than minimum harvestable age in each site class indicates that harvesting has concentrated more on good and medium productivity sites than on poor sites. However, a large proportion of stands in each site class is currently old enough to harvest, and the composition by site class and age does not appear to present a significant issue for timber supply in the short term.

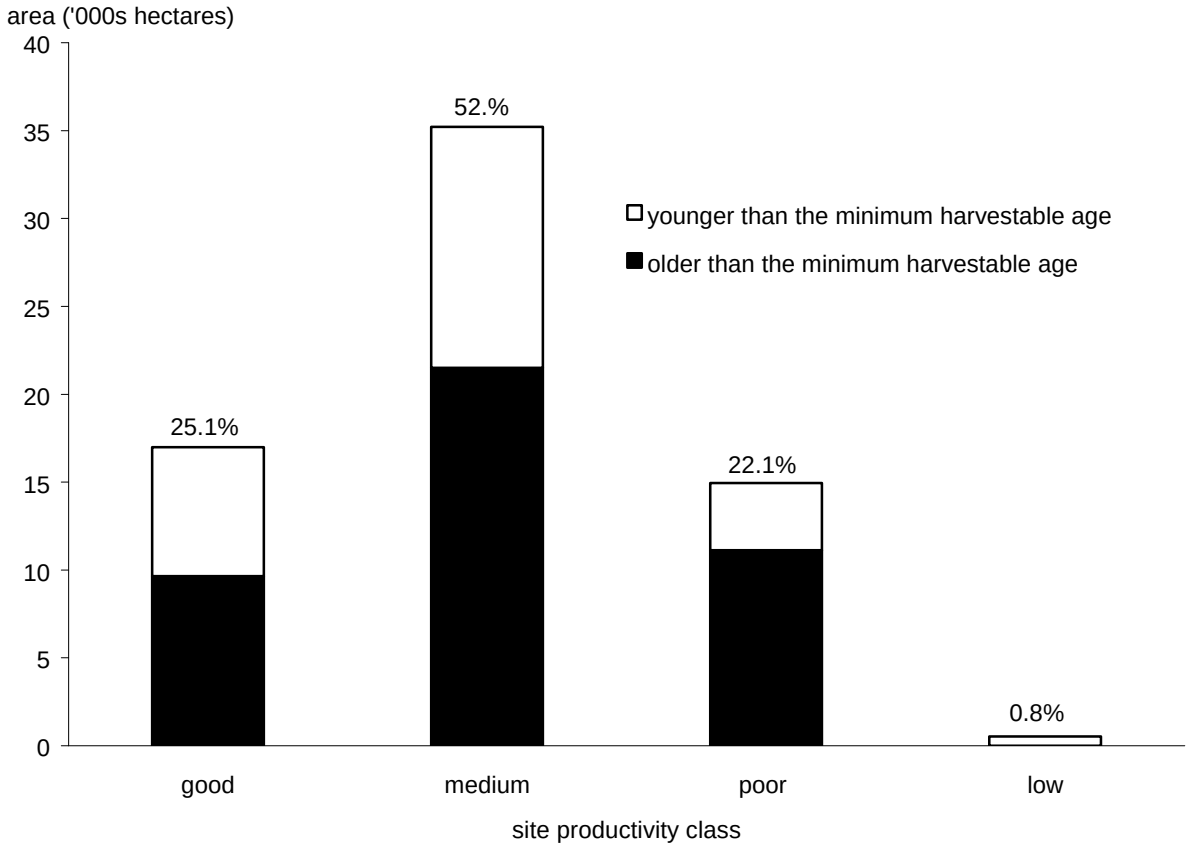

Figure 4. Area by site productivity class — Revelstoke TSA timber harvesting land base, 1998.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age composition of productive forested stands in the Revelstoke TSA. Within the timber harvesting land base, a substantial portion (56%) of stands are older than 140 years. About 23% of stands are 20 years or younger, 15% are between 21 and 100 years old, and 34% are between 101 and 250 years of age. Just over 28% of stands are older than 250 years. Almost 62% of the stands in the timber harvesting land base are at or above the minimum harvestable age applicable to the stand.

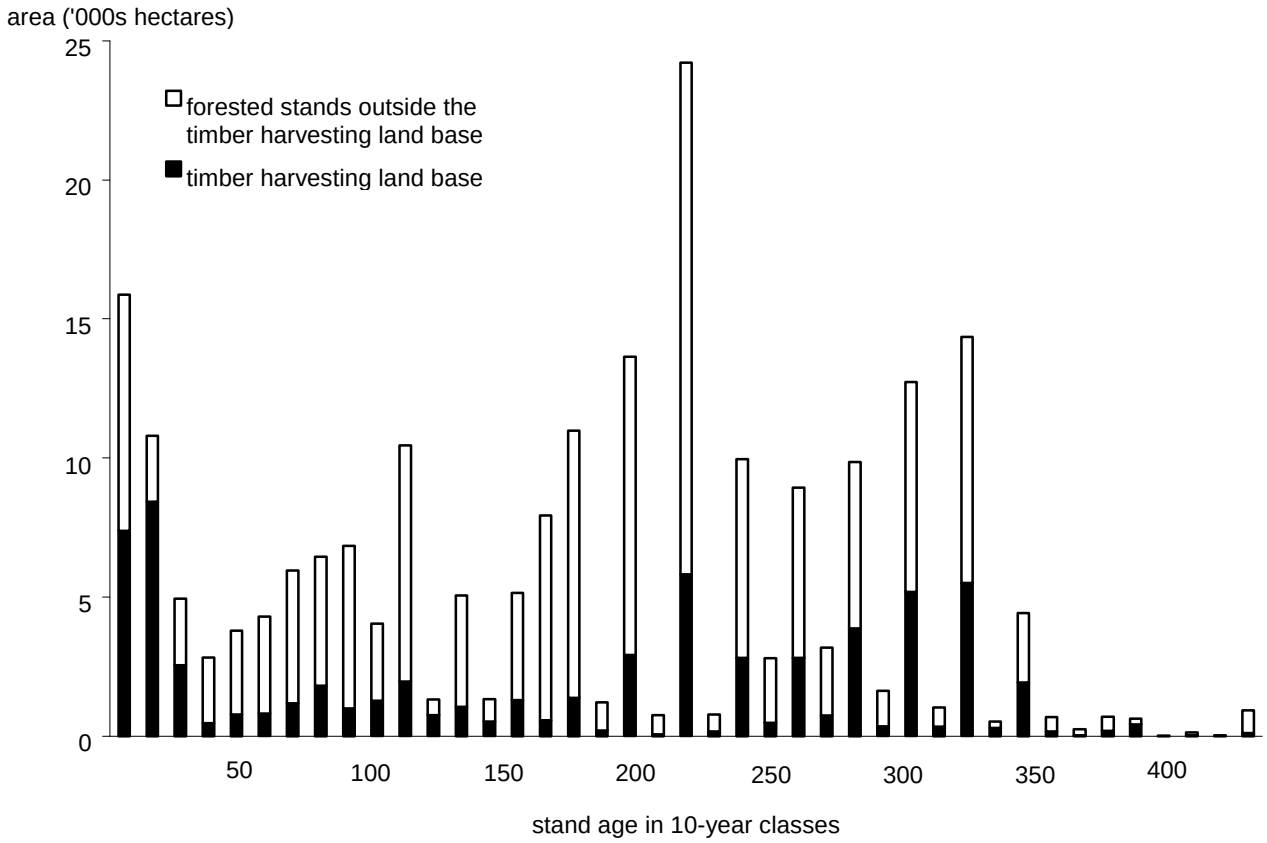

Figure 5. Current age class composition — Revelstoke TSA productive forest land base, 1998.

2 Information Preparation for the Timber Supply Analysis

The age class distribution of forested stands outside the timber harvesting land base can affect timber supply. In the case of the Revelstoke TSA, a significant portion of the total land base is covered by these stands which, although they do not contribute to the timber supply, can affect how much harvesting can be conducted and the pattern of the harvesting within the Revelstoke TSA by providing desired stand conditions such as old-forest attributes. About 25% of these non-contributing stands are older than 250 years. Only 6% of non-contributing stands are 20 years or younger, 19% are between 21 and 100 years old, and 50% are between 101 and 250 years of age. Nearly all the requirements for old-forest attributes within the Revelstoke TSA are met by the area covered by non-contributing stands older than 250 years. In addition, since a very large portion of these stands are between the ages of 101 and 250 years of age, all older forest requirements for most management areas within the Revelstoke TSA can be provided for by non-contributing stands aging over the next 100 years, provided no large catastrophic timber losses due to fire, insects or disease occur in them in the interim.

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 that could be the subject of growth and yield (for example, 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 British Columbia, 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 are 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 Revelstoke TSA analysis. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing natural stands. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for managed stands. This is different from the last analysis conducted in 1993 where the VDYP model was used to estimate yields for regenerated stands because the TIPSY model was not available. All stands harvested over the last 20 years, and those harvested in the future, are assumed to grow according to managed stand yield 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* for existing stands, the current timber inventory on the timber harvesting land base is approximately 18.6 million cubic metres. About 18.0 million cubic metres, or 96.8%, 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.

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* — timber losses to fire and other natural agents are expected to average 8586 cubic metres per year.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Revelstoke TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (two metres in height), before adjacent stands may be harvested. Furthermore, in the integrated resource management zones, the area in the timber harvesting land base that does not meet green-up conditions cannot exceed 25%. In wildlife management zones, area in the physically operable forested area (which includes forest outside the timber harvesting land base) that does not meet green-up conditions cannot exceed 25%. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.
- Maintenance of caribou, mule deer and moose habitat is a management objective in the Revelstoke TSA. Each of these species requires specific habitat types. For caribou areas, which comprise 32 979 hectares (48.7%) of the timber harvesting land base, at least 10% of the physically operable forest area must be maintained in stands that are 250 years or older, and 40% of the physically operable forest must be maintained in stands that are 140 years or older. Forest cover requirements for caribou habitat are applied in each landscape unit, by ESSF (11 084 hectares) and ICH (21 896 hectares) biogeoclimatic zones. For mule deer and moose areas, which comprise 10 035 hectares (14.8%) of the timber harvesting land base, at least 40% of the physically operable forest area must be maintained in stands that are 100 years or older.
- The integrated resources management (IRM) zone consists of areas outside of the other resource emphasis zones. Integrated resource management areas cover 26 647 hectares (39.4%) of the timber harvesting land base. Green-up conditions are met in an integrated resources management area when trees reach two metres in height, or approximately 15 years of age.

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., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits. Areas with a visual quality objective (VQO)* of retention VQO* occupy 1430 hectares (2.1%) of the timber harvesting land base. In these areas alterations should not be easy to see. At most 5% of the physically operable forest within the visually sensitive areas may be covered by stands less than six metres tall (the visual green-up). Areas with a visual quality objective of partial retention VQO* occupy 2964 hectares (4.4%) of the timber harvesting land base. In these areas, harvesting may be noticeable, but not dominant. At most 15% of the physically operable forest may be covered by stands less than six metres tall.
- Management of community watersheds — maintaining forest cover to protect water quality and quantity, and to prevent erosion. Community watersheds cover 378 hectares (0.6%) of the timber harvesting land base. At most 25% of the physically operable forest land may be covered by stands less than nine metres tall. Domestic watersheds also exist, but almost entirely fall outside of the timber harvesting land base. Because of this, the management of domestic watersheds has little or no affect on timber supply.
- 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 several criteria: 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 specific type of stand is expected to become harvestable. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets.

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.
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).***

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****).*
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.

- Stand-level biodiversity — to maintain biological diversity in forest stands, wildlife trees and wildlife tree patches are retained after harvesting cutblocks. In the Revelstoke TSA, retention of wildlife trees and patches is estimated to reduce stand-level timber yields by 3%, after accounting for contributions from forest outside the timber harvesting land base.
- 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 old-forest characteristics. In the Revelstoke TSA, within each ecosystem type and biogeoclimatic variant, a proportion of the forested area must be covered by stands older than 250 years. The proportion depends on the level of emphasis placed on biodiversity for a landscape unit, as well as the level of stand disturbance naturally occurring in each ecosystem. Also, for two landscape units having area in the Revelstoke TSA, Mount Revelstoke National Park and a portion of Glacier National Park, forest in the park is counted as contributing to old-forest requirements.

More detailed descriptions 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."

The above discussion outlines the following forest management emphases within the Revelstoke TSA:

- General integrated resource management where cutblock adjacency objectives apply.
- Wildlife habitat management where the objective is to ensure that the proportion of the area that does not meet green-up conditions does not rise above a maximum limit.
- Wildlife habitat management where the objective is to maintain a minimum proportion of the area in older forests that are important for habitat.
- Stand-level biodiversity.
- Landscape-level biodiversity.
- Visual quality management.
- Protection of water quality and quantity in community watersheds.

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. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution, landscape connectivity, stand structure and species composition.*

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

To facilitate analysis of the different management regimes associated with these emphases, the Revelstoke TSA was divided into management zones.

Figure 6 displays the composition of the timber harvesting land base according to management emphasis (or management zone type). Percentages total more than 100% in Figure 6 because management emphases overlap approximately on approximately 10% of the area.

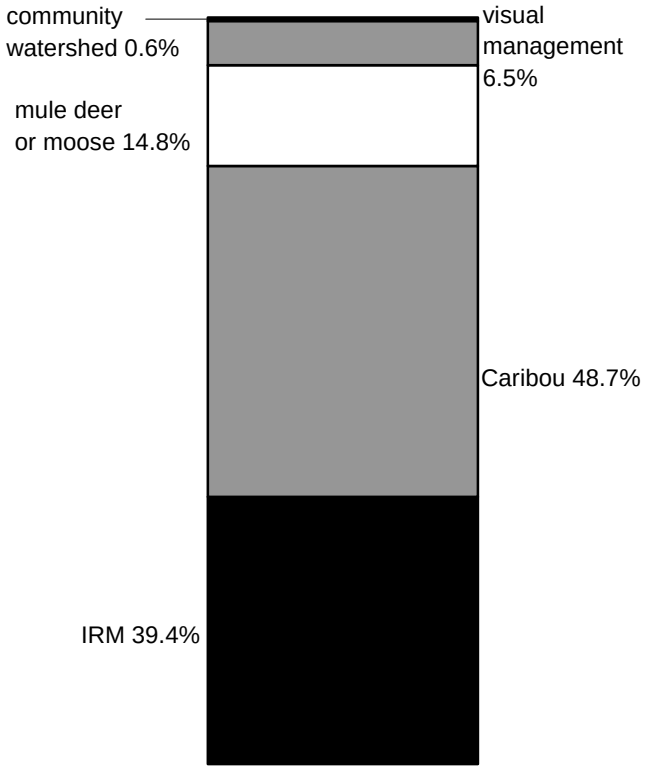

Figure 6. Forest management emphasis — Revelstoke TSA timber harvesting land base, 1998.

3 Timber Supply Analysis Methods

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

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. 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 Revelstoke TSA. The analysis uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation 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 Revelstoke TSA, and should not be viewed in isolation of the sensitivity analysis.

4.1 Base case harvest forecast

Figure 7 shows the base case harvest forecast* for the Revelstoke TSA. The current allowable annual harvest level of 230 000 cubic metres can be maintained for four decades, without causing timber supply shortages in the future, if followed by three downward steps of approximately 10% each to a sustainable long-term harvest level* of 159 000 cubic metres per year, which is reached in decade 8. This long-term harvest level is maintained for the remainder of the analysis horizon.

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

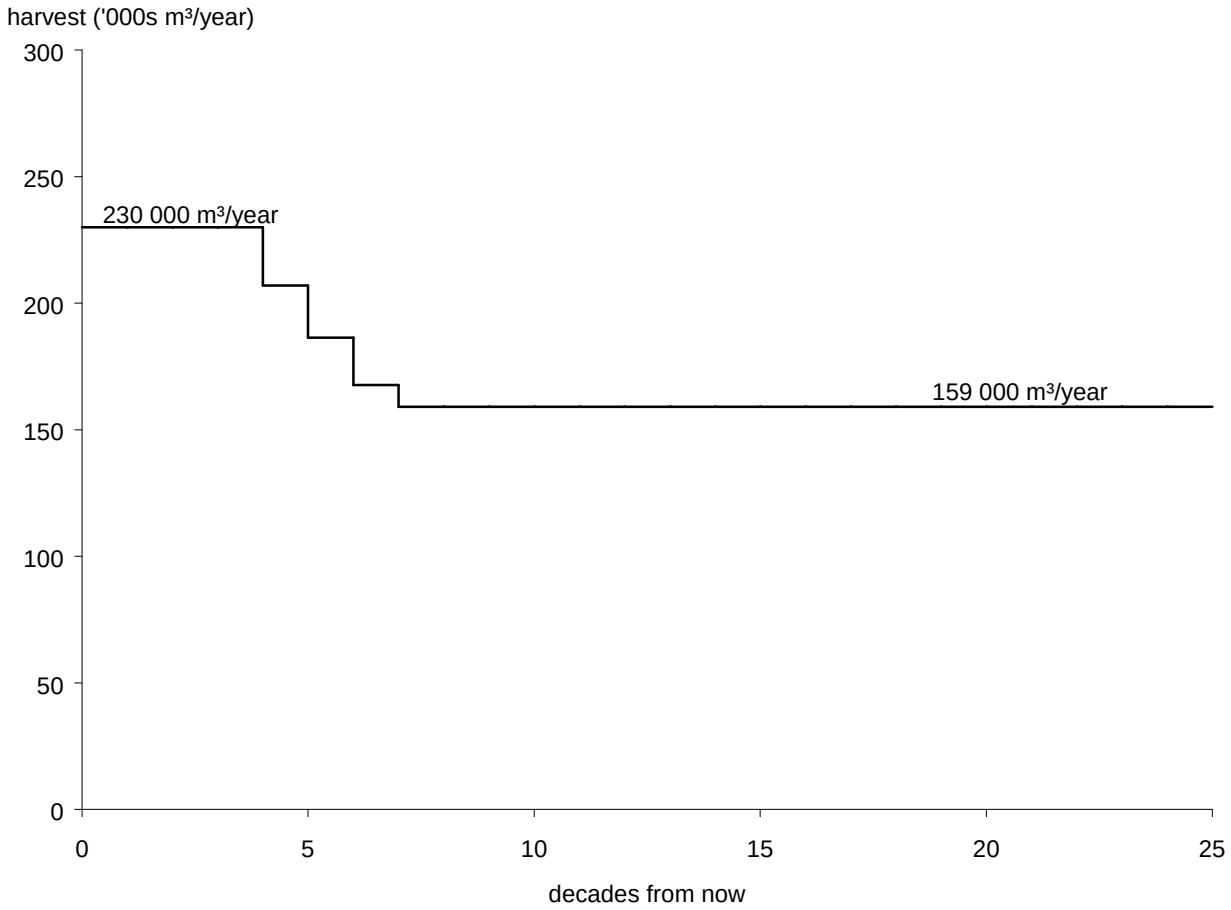

Figure 7. Base case harvest forecast for the Revelstoke TSA, 1998.

Unsalvaged losses to natural forces such as insects and fire are estimated to be 8586 cubic metres per year for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report. Volume associated with new woodlots or woodlot expansions since the AAC was last set is also normally subtracted from all harvest forecasts. In this case there is no woodlot volume of this type to consider.

4 Results

Several criteria were used to define the base case harvest forecast. In the short- and medium-terms, the criteria were to maintain the current harvest level for the Revelstoke TSA (230 000 cubic metres per year) for as long as possible while avoiding substantial timber supply shortages in the future and allowing a gradual, controlled decline to the long-term level. The long-term harvest level was defined as the harvest rate that will maintain the total timber growing stock* at an even level, on average, so that harvesting can continue at that level in perpetuity (see Figure 8). A continually declining growing stock would signify that timber is being harvested above the productive capability of the land. The total growing stock of the timber harvesting land base declines rapidly over the next four decades as existing mature stands are harvested and replaced with younger stands. However, when harvesting occurs predominantly in younger managed stands, the growing stock stabilizes at approximately 10.8 million cubic metres. Harvest levels must decrease to the long-term harvest level shown in the base case because over time, less harvesting occurs in high-volume, older stands and more in second-growth stands which are harvested at younger ages and therefore generally have lower volumes.

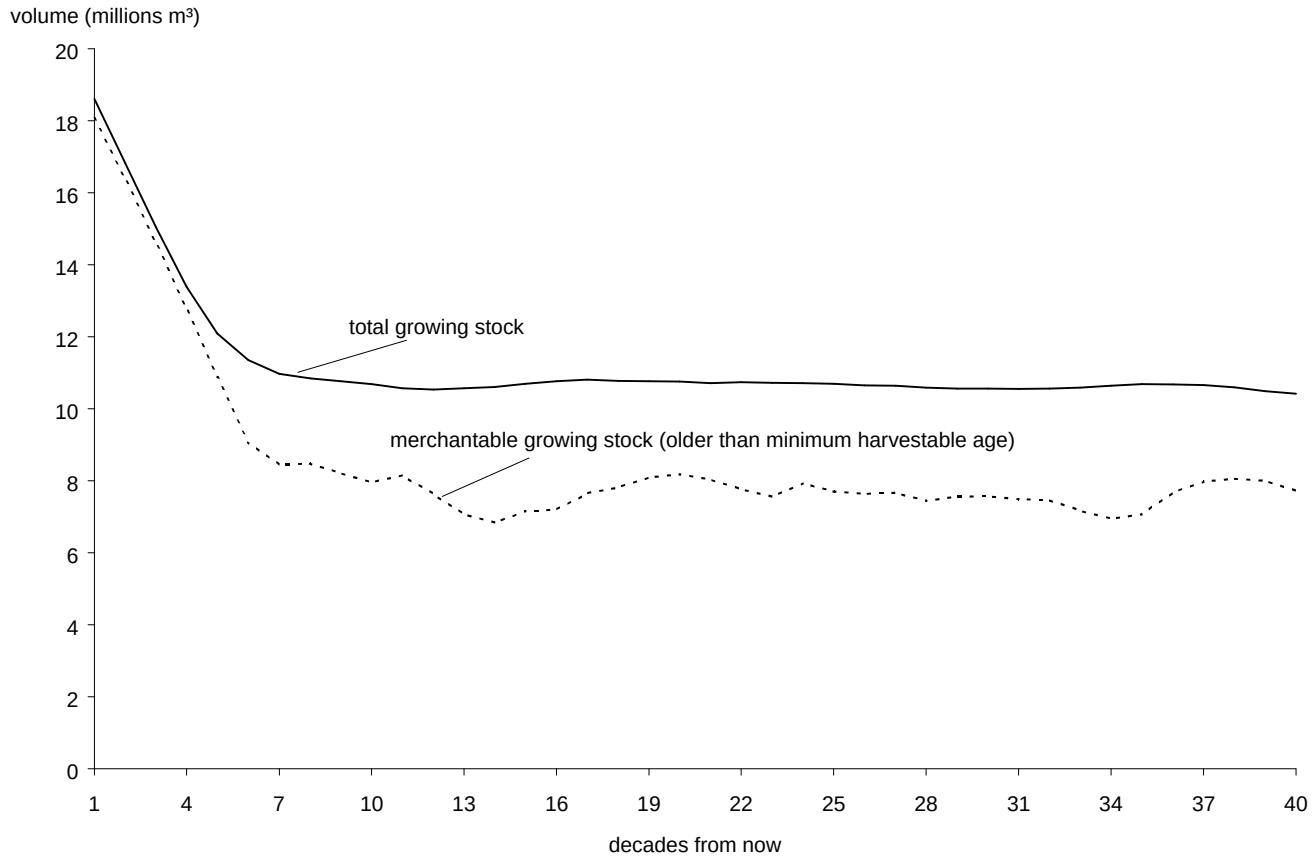

Figure 8. Changes in timber growing stock over time — Revelstoke TSA base case, 1998.

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

4 Results

In defining the base case, one criterion was to manage the transition from the current harvest level to the long-term harvest level. This transition corresponds to a shift from harvesting existing stands to harvesting regenerated, managed stands. A controlled 10% per decade rate of decline was employed, which allowed the current harvest level to be maintained for several decades and prevented timber supply from declining below the long-term harvest level.

As shown in Figure 8, the amount of merchantable timber is at a minimum of approximately 6.8 million cubic metres in decade 14. The availability of stands old enough to harvest in this period affects the rate at which timber can be harvested over the short- and medium-terms, including the initial rates and the decline to the long-term harvest level. These basic factors — controlled, gradual changes in the short- and medium-term, no prolonged declines below the long-term level, and a sustainable long term was signified by stable growing stock — were considered when generating all harvest forecasts in this report.

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 for managed second-growth stands is about 3.23 cubic metres per hectare per year, about 25.5% more than the 2.57 cubic metres per hectare per year for naturally-regenerated stands with no density control (reflected in volume projections for existing stands). This volume increase is expected in managed stands because stocking levels will be controlled to ensure full site occupancy while avoiding over-stocking that would cause severe competition among trees. The full benefit of silvicultural management will not occur until most second-growth stands become available for harvesting, in 60 to 160 years from now. However, because management is anticipated to result in more volume being available for harvest sooner than if future stands grew at the same rate as did existing stands, silvicultural management does allow higher harvests from existing stands in the medium term.

The long-term harvest level is below the maximum productive capacity of the timber harvesting land base because forest cover requirements* for maintaining wildlife habitat and maximum allowable disturbance levels and the objective of maintaining a fairly even harvest flow over time result in stands not necessarily being scheduled for harvest at the point of maximum productivity. If dramatic fluctuations in harvests were acceptable, stands could be harvested at their minimum harvestable age, or even at the age of maximum productivity. Theoretically, if all stands were harvested at the age of maximum productivity, an average annual harvest rate of approximately 204 000 cubic metres (28% higher than in the base case) could be achieved in the long term.

In the long term, requirements for wildlife habitat and older forest cover (see Sections A.4.4, "Forest cover requirements" and A.4.5, "Biodiversity" of Appendix A) do not limit timber supply significantly since forested stands outside the timber harvesting land base are projected to be in a condition to meet those requirements in the long term. Therefore, none of the timber harvesting land base has to be reserved for these purposes. Similarly, medium-term harvest levels and the timing of the decline to the long-term harvest level are not greatly limited by these old-forest cover requirements because such stands are abundant in the medium term, and because currently all older forest requirements are met by areas outside the timber harvesting land base. 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 wildlife habitat and integrated resource management zones.

Forest cover requirements
Specify desired distributions of areas by tree 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 approximated using forest cover objectives (see ***Cutblock adjacency and Green-up****).*

4 Results

4.2 Area, average volume, and average age harvested

Figure 9 shows how annual area harvested would change over the next 250 years if the base case harvest forecast were followed. The area harvested is projected to range from a minimum of 454 hectares per year in decade one, to a maximum of 541 hectares per year in decade 4. During the first four decades, even though the harvest level remains the same, the area harvested is projected to increase as the harvest increasingly comes from younger stands with less volume. After decade 4 the area harvested gradually declines as the harvest level is stepped down to the long-term level. Once the long-term level is reached in decade 8 the area harvested is projected to fluctuate slightly because the harvest comes from stands of different productivities and ages.

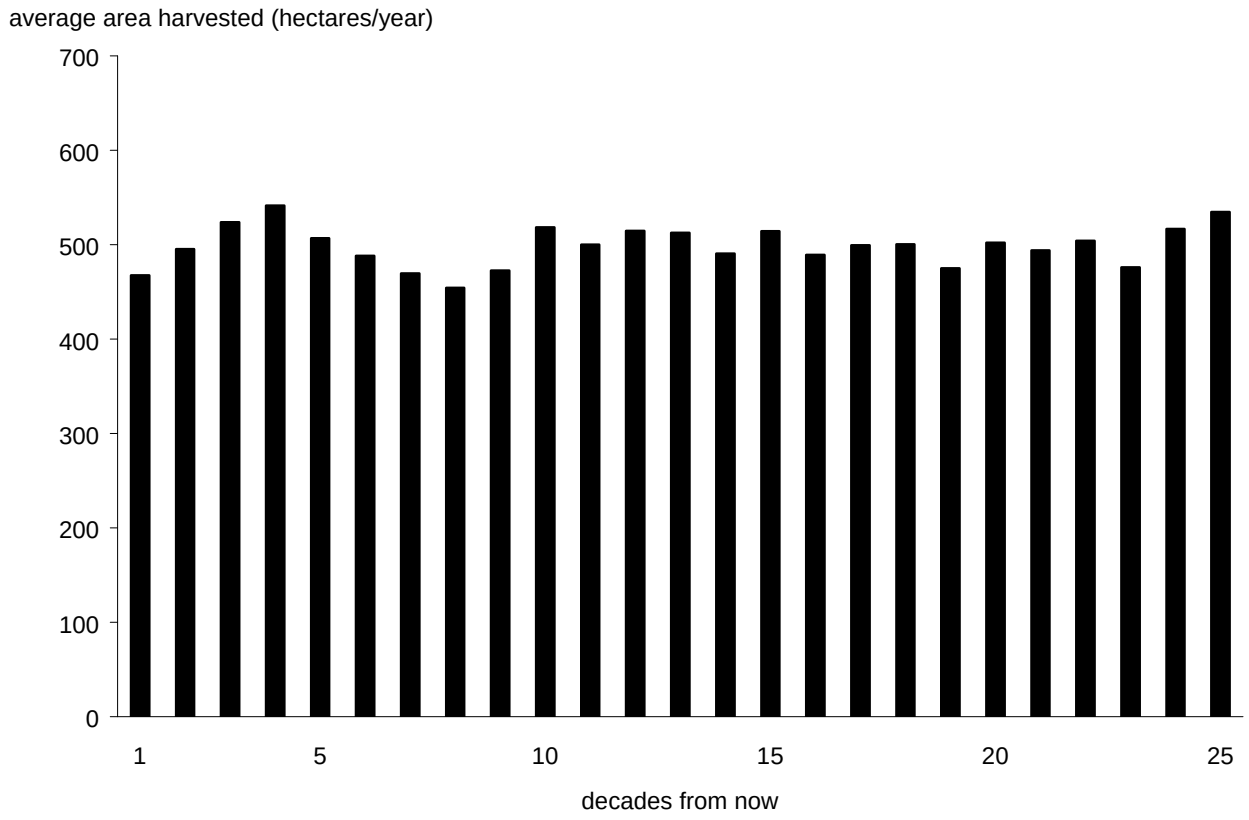

Figure 9. Area harvested over time — Revelstoke TSA base case, 1998.

4 Results

Figure 10 shows the average timber volume per hectare harvested. The average harvested volume ranges from a maximum of 510 cubic metres per hectare in decade one, to a minimum of 313 cubic metres per hectare in decade 25. When Figure 10 is compared to the area harvested graph in Figure 9, it can be seen that the average volume per hectare harvested is higher when the area harvested is lower, and lower when the area harvested is higher. This relationship is expected since the objective is to maintain a steady volume harvested per decade rather than a steady area harvested per decade.

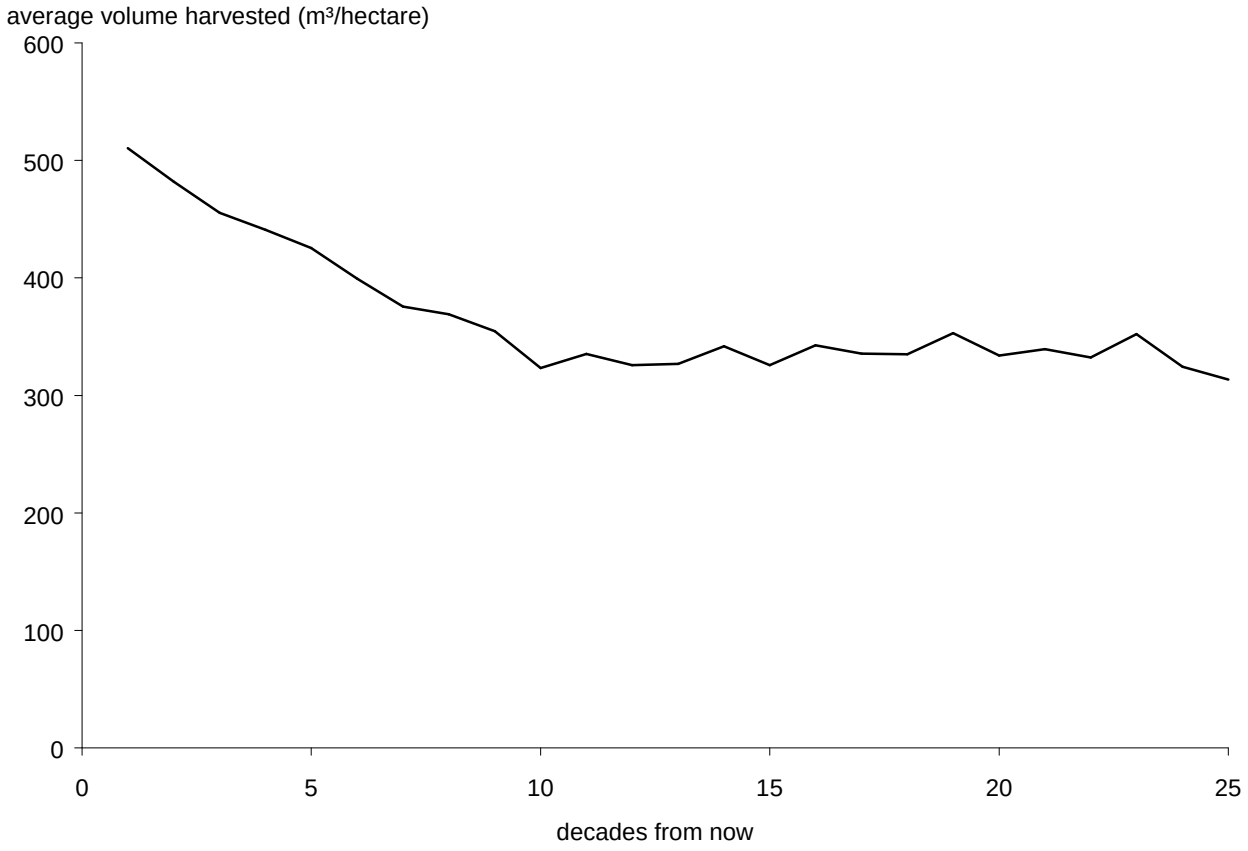

Figure 10. Average volume per hectare harvested over time — Revelstoke TSA base case, 1998.

4 Results

Figure 11 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 110 years from an initial average of 320 years to 105 years. During this time 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, relative to their minimum harvestable age, are given priority for harvest in the analysis. From decade 11 onward, most of the area harvested is from regenerated stands that have only recently reached their minimum harvestable age, which ranges from 60 to 140 years depending on species and site productivity. The average harvested age from decade 14 to decade 25 fluctuates slightly, averaging about 120 years over the long term.

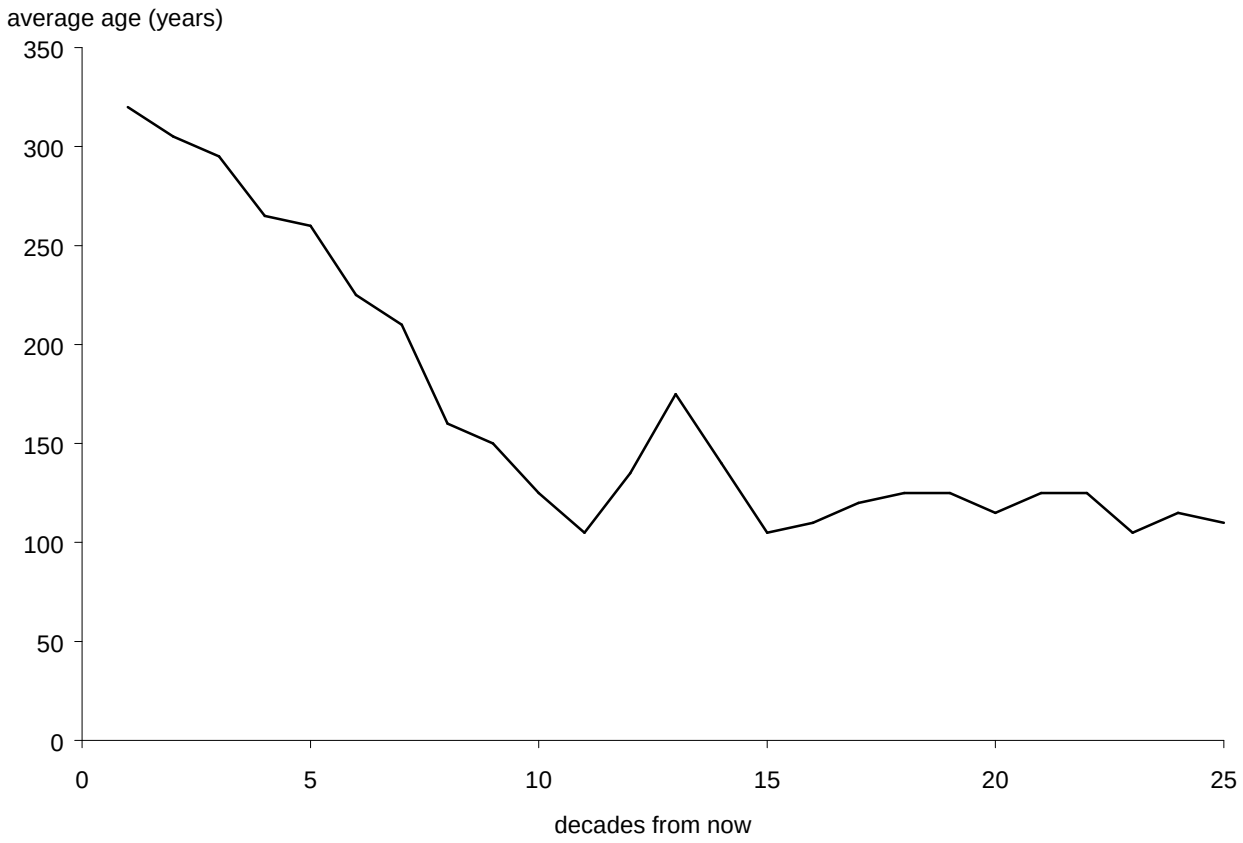

Figure 11. Average harvested age over time — Revelstoke TSA base case, 1998.

4.3 Age class composition over time

The charts in Figure 12 show how the age composition of the forest within the Revelstoke analysis area land base would change over the next 250 years under the base case harvest forecast. The Revelstoke analysis area includes the Revelstoke TSA, the parts of Mount Revelstoke National Park that fall within landscape units 10 and 20 as well as a portion of Glacier National Park. Forests of Mount Revelstoke National Park can contribute to landscape-unit biodiversity and therefore can influence timber supply from the Revelstoke TSA. However, the current age class composition of the Revelstoke TSA (Figure 5) is similar to the current age class composition of the entire Revelstoke analysis area, which means the park has negligible influence on the timber supply available from the TSA (that is, the park does not supply a higher than proportionate amount of old forest, thereby freeing up timber in the TSA, nor is there a relative dearth of old forest in the park, which would require retention of a higher proportion of old forest in the TSA).

Currently, most of the timber harvesting land base (62%) consists of stands at or above minimum harvestable age. The total forested land base also contains forest stands that have been excluded from the timber harvesting land base ("inoperable" stands). While these inoperable stands range significantly in age, enough of them have older forest characteristics, or can meet wildlife habitat criteria so that initially, very little of the timber harvesting land base must be retained to achieve these values. After 50 years, much less of the timber harvesting land base is covered by older forests; however, inoperable stands have continued to age, and add further to meeting wildlife habitat and landscape-level biodiversity requirements for the Revelstoke TSA. After 100 years little older forest remains in the timber harvesting land base; the forested area is roughly evenly distributed in 10-year age classes between 10 and 120 years. This trend to even age-class distribution within the timber harvesting land base is also evident in the chart showing age class distribution at 150 years. While the age class composition of the timber harvesting land base is fairly stable over the last 150 years of the analysis horizon, there is some fluctuation as stands of different productivity, and hence different volumes and harvestable ages are harvested and regenerated. The distribution at 200 years demonstrates this pattern, showing some area in relatively older stands which are from poorer sites with older minimum harvestable ages. By the end of the 250-year planning horizon, all of the inoperable areas are older than 250 years, and the timber harvesting land base is characterized by a relatively even age-class distribution.

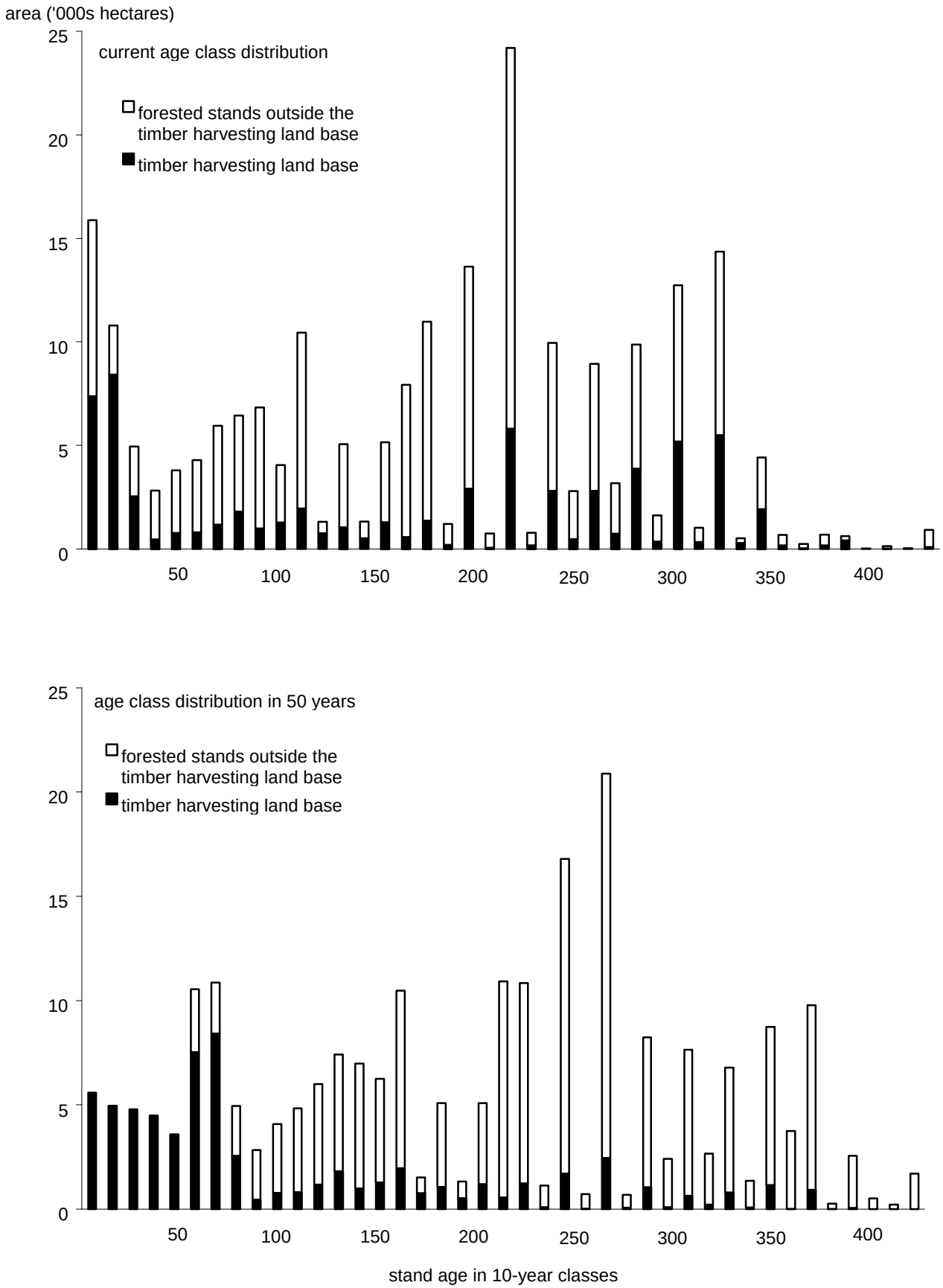

Figure 12. Changes in age composition on forested land base over time — Revelstoke TSA base case, 1998 (continued).

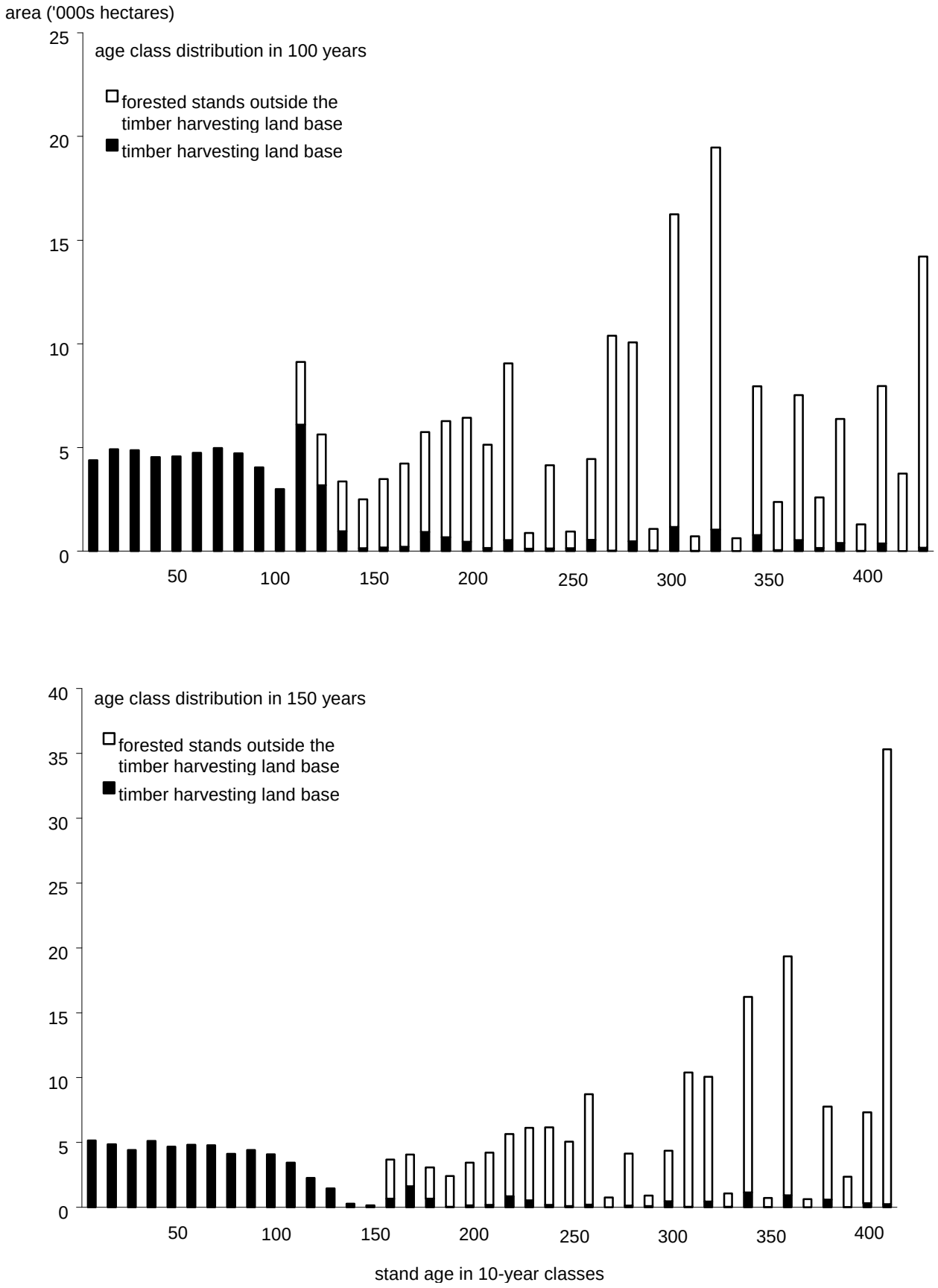

Figure 12. Changes in age composition on forested land base over time — Revelstoke TSA base case, 1998 (continued).

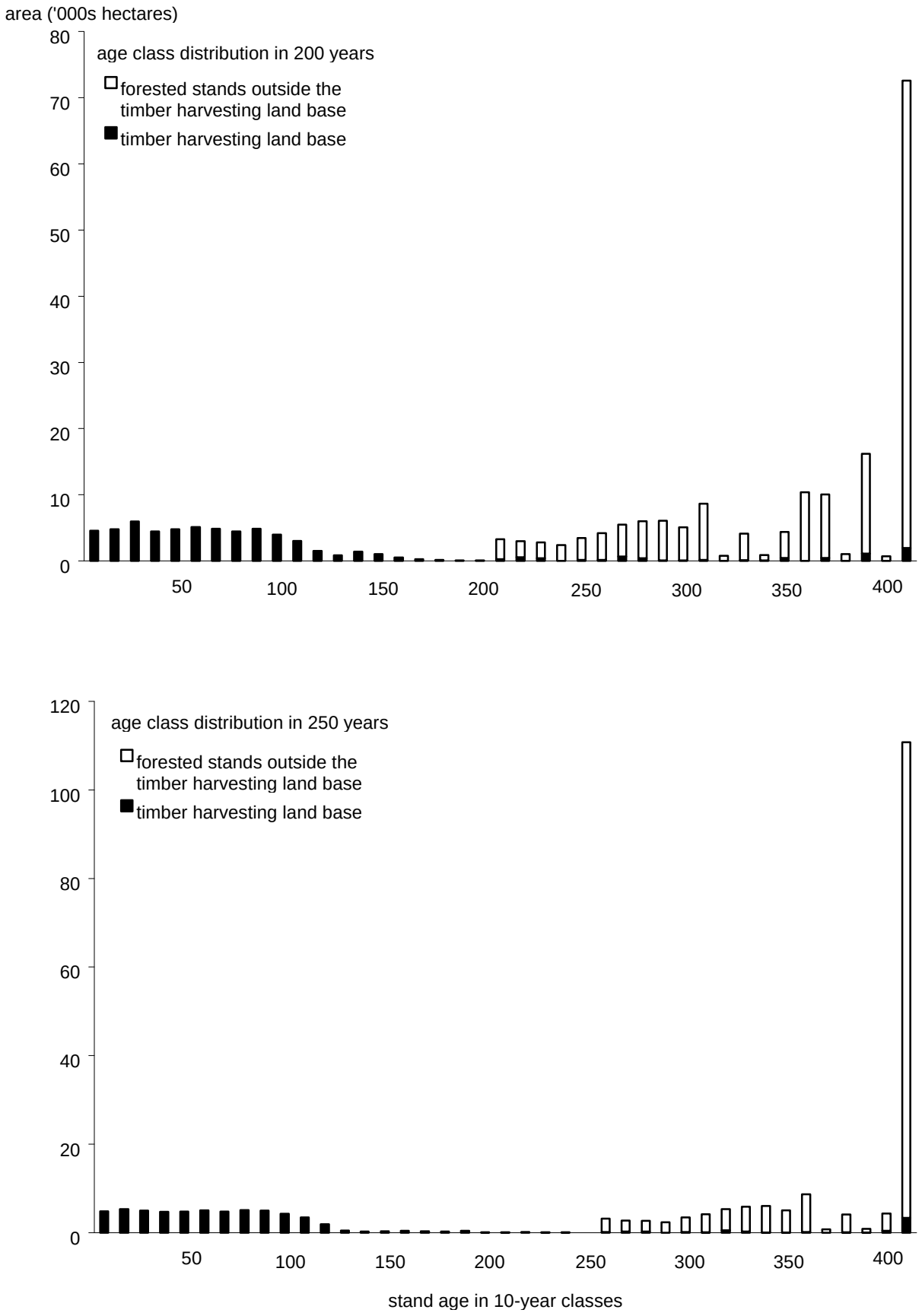

Figure 12. Changes in age composition on forested land base over time — Revelstoke TSA base case, 1998 (concluded).

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 under–estimates 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 7 to 12) 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 7 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.

Figure 13 demonstrates that if a more gradual transition of 4% per decade is used to reach the long-term harvest level, the current harvest level can be maintained for one decade and the long-term harvest level is reached in decade 10. Under this harvest flow pattern about 1.5% less volume could be harvested over the first 100 years compared to the base case. Harvest flow patterns using decline rates more gradual than 4% would require the initial harvest level to be lowered now rather than one decade from now. Figure 13 also shows a harvest forecast in which the current AAC is maintained for as long as possible followed by a decline to the long-term level in one step, rather than many gradual steps. Under this flow pattern the current harvest level can be maintained for six decades, two decades longer than in the base case. The harvest level between decades 7 and 14 dips below the long-term level to compensate for the additional 4.9% volume harvested over the first six decades compared to the base case. During this same period the harvest comes from a mix of natural and regenerated stands having average yields less than what is estimated for harvests after the long-term harvest level is reached. This pattern of lower medium-term yields was more pronounced for this alternative harvest flow than in the base case, or the flow with 4% per decade declines. If the initial harvest level were maintained for only five decades rather than six, no dip below the long-term level would be required.

5 Timber Supply Sensitivity Analyses

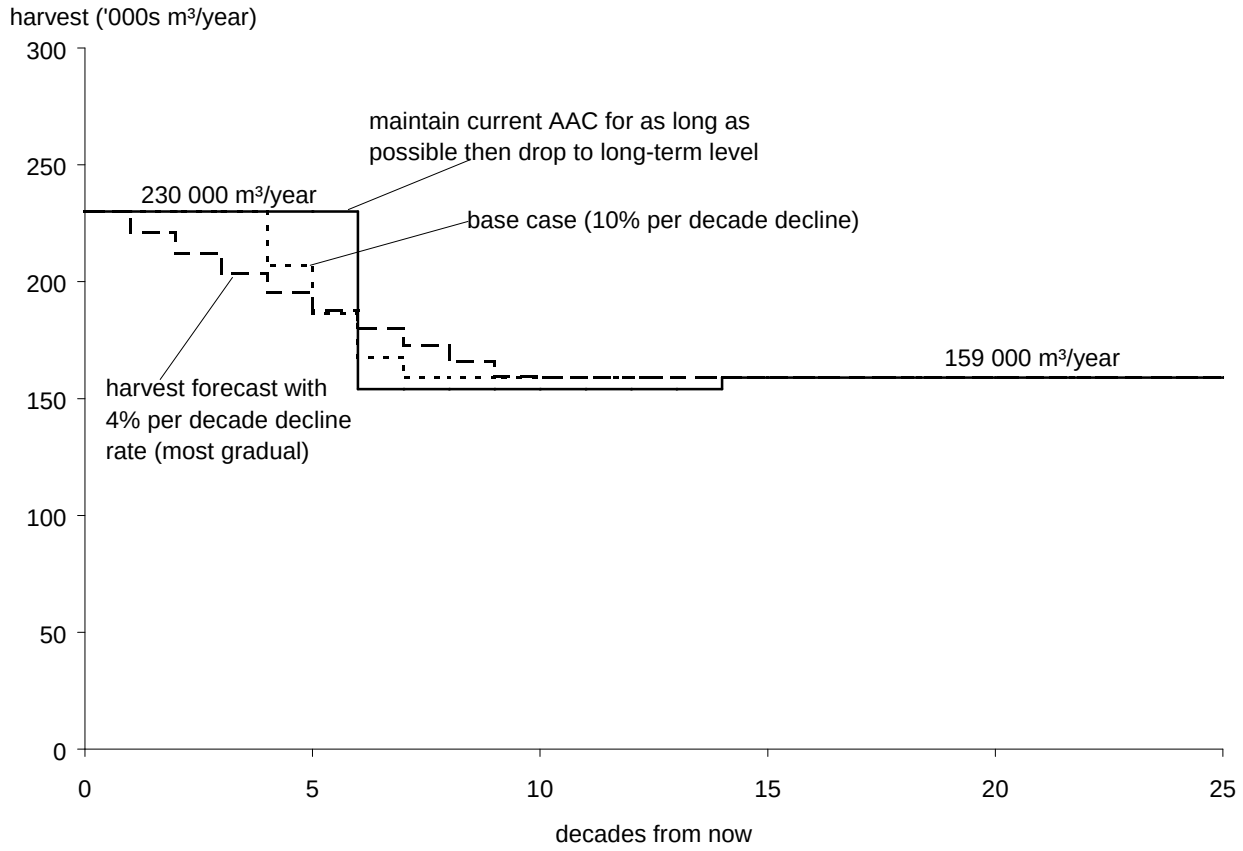

Figure 13. Alternative harvest flow patterns using base case data: 4% per decade and one-step transitions to the long-term harvest level — Revelstoke TSA, 1998.

The above harvest flow alternatives all assume harvesting of both the existing and future 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.

5 Timber Supply Sensitivity Analyses

Figure 14 shows two potential harvest forecasts that would result if the initial harvest level was set at either end of a reasonable range given the criteria for defining a starting level discussed in Section 4.1, "Base case harvest forecast." If the short-term harvest level was increased above that of the base case to the maximum level possible while avoiding large and abrupt harvest shortfalls in the future, substantially more timber could be made available over the three decades. The initial harvest level could be raised to 300 000 cubic metres per year and maintained for one decade before a decline to the long-term level would be necessitated by a shortage of mature available timber in decade 4, and to avoid later timber supply disruptions. This starting level is about 30% higher than in the base case, and the subsequent harvest flow pattern provides about 4.7% more timber volume over the first 80 years.

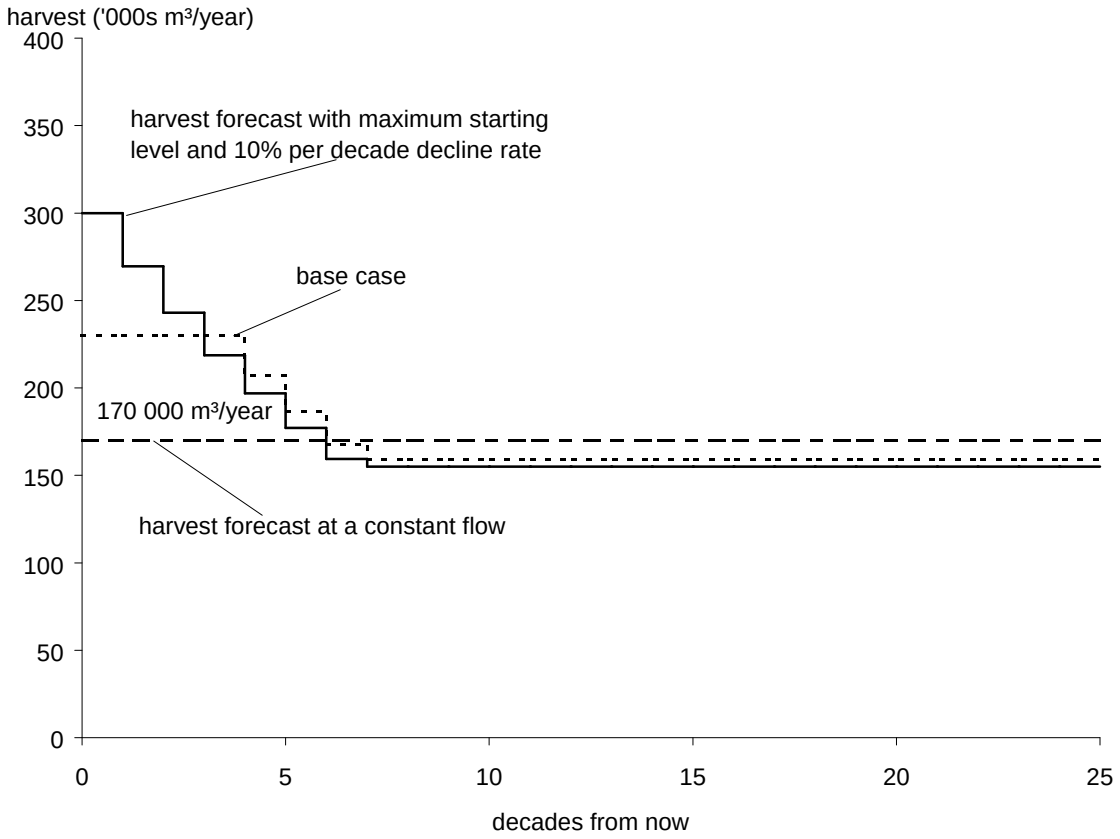

Figure 14. Alternative harvest flow patterns using base case data: range for possible starting harvest levels — Revelstoke TSA, 1998.

If the short-term harvest level was immediately decreased to 170 000 cubic metres no further declines would be required over the next 250 years. Over the 250-year planning horizon, approximately 2% less volume would be harvested under this constant flow pattern than in the base case. Comparison of the constant flow harvest with the base case illustrates that higher harvests over the next few decades, more quickly bring stands under a management regime that promotes higher timber production than has occurred in natural stands, allow increased harvests over the short- and medium-term (first 100 years). The constant flow harvest level is higher than the base case long-term harvest level because the lower rate of harvest has allowed the trees to grow older before being harvested. The harvest level would have to decline from the even-flow shown in Figure 14 to the same long-term harvest level as in the base case by 40 decades from now to avoid disruption in very long-term timber supply.

5.2 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 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 with trees of merchantable size would be considered available for harvest. The 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 objectives such as forest cover requirements and harvest level stability. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Figure 15 shows how timber supply would change if stands in fact become merchantable either 20 years sooner or later than assumed for the base case.

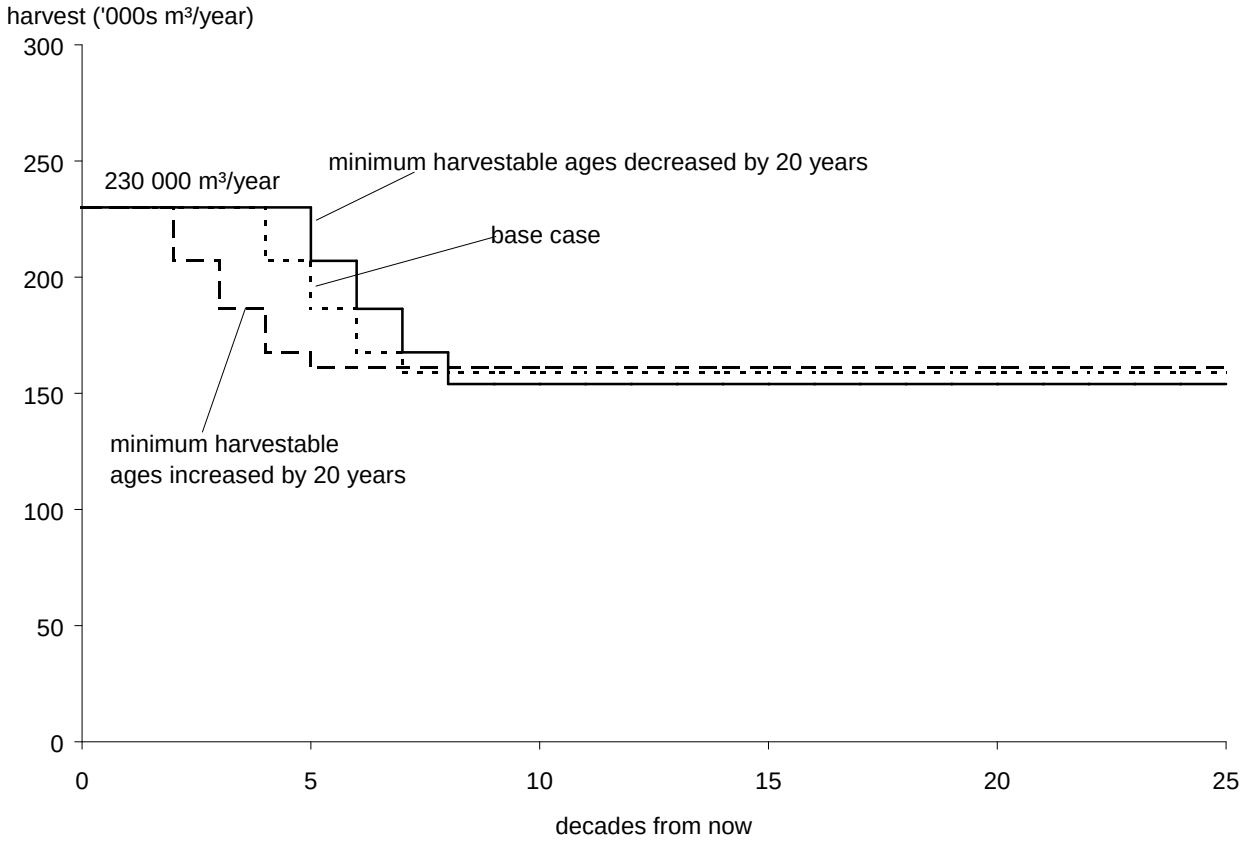

Figure 15. Harvest forecasts if minimum harvestable ages are 20 years younger or older than the base case — Revelstoke TSA, 1998.

If minimum harvestable ages were 20 years older than in the base case, results indicate that in the medium-term, timber supply would be decreased. The harvest forecast shows that the current AAC of 230 000 cubic metres per year could be maintained only for two decades before declining to the long-term harvest level. Most existing stands already exceed minimum harvestable ages at the beginning of the planning horizon; thus, they are unaffected by the increase in minimum harvestable ages. However, regenerating stands, which are critical to timber supply during the transition of harvesting from old-growth to second-growth, must age an additional 20 years before they are considered harvestable. As a result, to avoid serious disruptions in the future existing older stands must be harvested at a slower rate to allow regenerating stands to reach their harvestable age. The overall harvest over the first 80 years of the analysis horizon is about 8% lower than in the base case. The long-term harvest level is slightly higher (1.2%) as a result of this increase in minimum harvestable age since some stands are harvested closer to their age of maximum average productivity.

If minimum harvestable ages were decreased by 20 years, the current AAC could be maintained for 5 decades, one decade longer than in the base case. The long-term level is 3% lower as a result of the decrease in minimum harvestable age. Over a 250-year planning horizon, approximately the same timber supply as in the base case could be obtained.

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 short-term and long-term timber supply are not highly 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. 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.

5.3 Uncertainty in estimates of timber volumes in existing natural stands

Estimates of standing timber volumes in existing natural 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 16 illustrates that medium-term timber supply in the Revelstoke 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 six decades — two decades longer than in the base case. The cumulative harvest over the next 100 years would be approximately 7% larger than in the base case if existing volumes were in fact 10% higher. The long-term harvest level would be slightly higher because of higher volume estimates for the small number of existing stands that are harvested during the long term.

5 Timber Supply Sensitivity Analyses

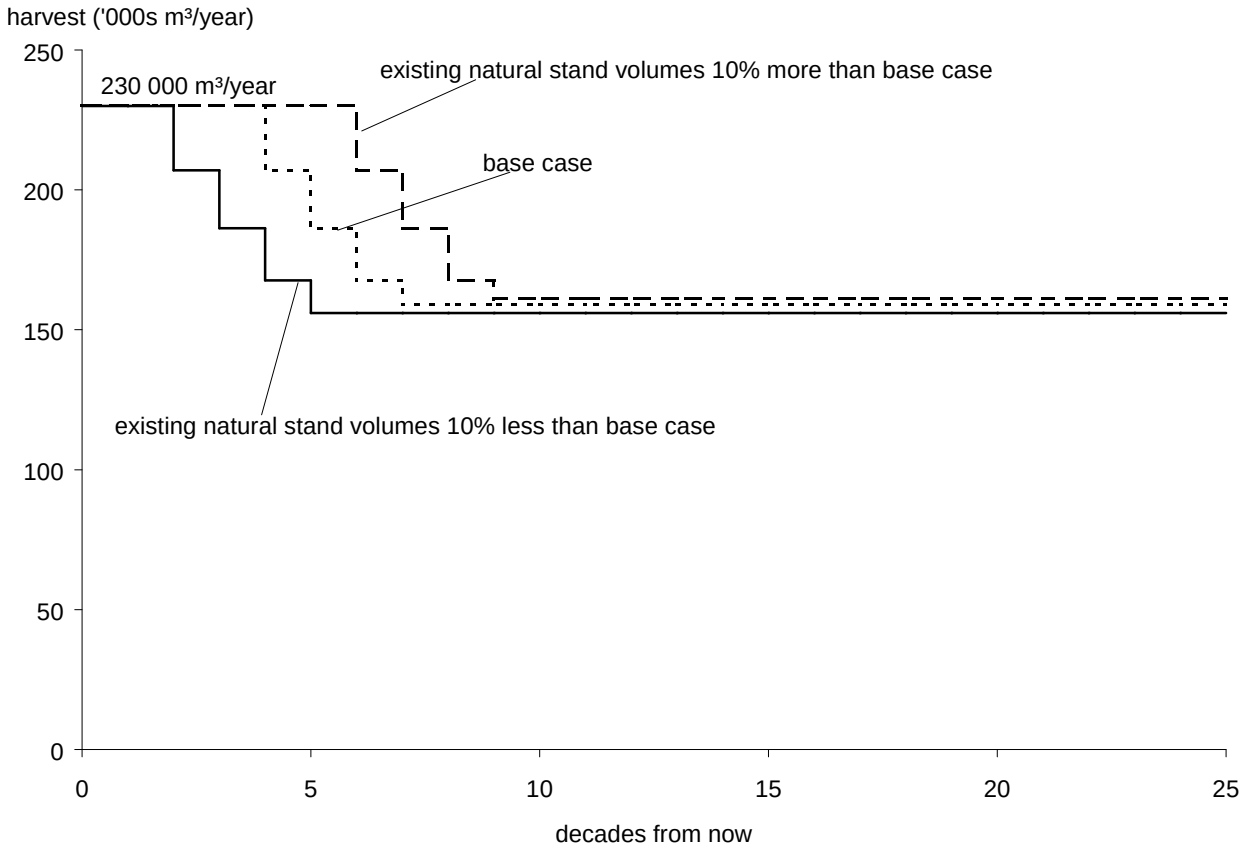

Figure 16. Effect on harvest forecast of 10% uncertainty in existing natural stand volumes — Revelstoke TSA, 1998.

If existing volumes are overestimated by 10% in the base case, the current harvest level could still be achieved, but harvests would need to decline to the long-term harvest level after decade 2. In this case, the total harvest over the next 100 years would have to be about 7.7% less than in the base case to avoid creating severe timber supply disruptions further in the future. The long-term harvest level would be slightly lower because of lower volume estimates for the small number of existing natural stands harvested during the long-term period. Medium-term timber supply is sensitive to uncertainty in existing stand volumes because those volumes determine how much timber inventory is available for harvest during the time regenerating stands grow to a harvestable condition. Therefore, if stands have, on average, less volume than in the base case, harvests must be decreased earlier to ensure a gradual transition to the long-term harvest level. The opposite is the case if stands have higher volumes — more inventory allows higher harvests to be maintained for longer.

This sensitivity analysis shows that timber supply over the medium term 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 for stands on operable forest land.

5 Timber Supply Sensitivity Analyses

5.4 Uncertainty in volume estimates for existing cedar or hemlock stands

Estimates of timber volumes for existing cedar and hemlock-leading stands in particular can vary considerably because of difficulty in estimating volume loss to decay in standing timber. The amount of decay often influences the volume lost to waste and breakage, as well as utilization levels practiced during timber harvesting. The variability between stands can be substantial when considering all these factors. Studies to improve the reliability of decay and waste estimates for existing cedar and hemlock stands are ongoing but no conclusive information from them was available for this analysis.

Figure 17 shows the results if volumes for existing cedar and hemlock stands are varied by 25% from those assumed in the base case. If volumes are actually 25% greater than those used for the base case, the current AAC could be maintained for eight decades, four decades longer than in the base case. In this case, the cumulative harvest over the next 120 years would be approximately 12% larger than in the base.

If volumes in existing cedar and hemlock stands are overestimated by 25%, the current harvest level could still be achieved, but harvests would need to decline to the long-term harvest level after one decade. Total harvest over the next 80 years would need to be about 13.9% less than in the base case to avoid creating severe timber supply disruptions in the future. The long-term level would be about 3.7% lower than in the base case because of the lower volume estimates for the existing cedar and hemlock stands harvested during the long-term period.

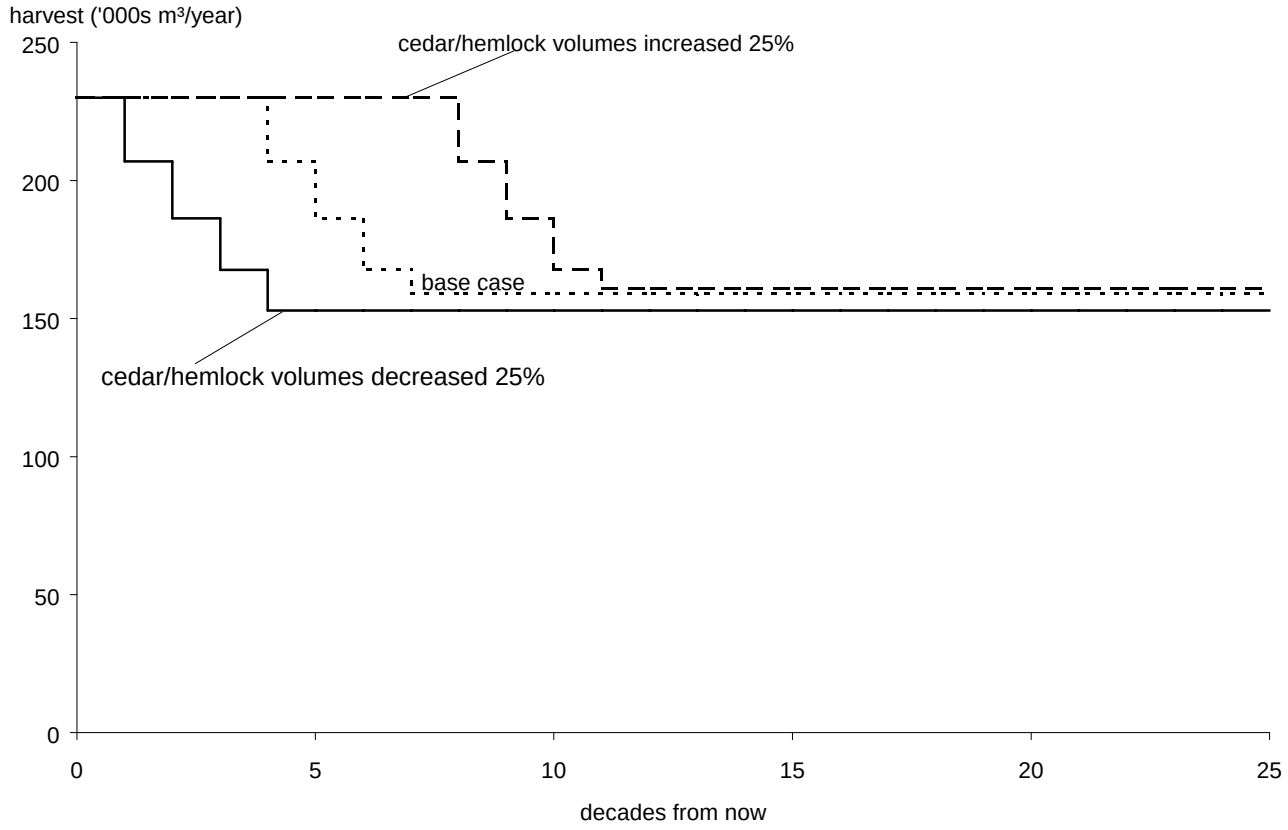

Figure 17. Harvest forecasts with cedar and hemlock stand volume estimates changed by 25% — Revelstoke TSA, 1998.

5.5 Uncertainty in regenerated stand volume estimates

Estimates of timber volumes in regenerated managed stands are uncertain for similar reasons as existing natural stand volumes; however, there is additional uncertainty around the estimates of site productivity (discussed further in Section 5.8, "Uncertainty in site productivity estimates"). In this section, the effects on timber supply of uncertainty associated with using managed stand tables is examined.

Figure 18 shows the results if regenerated volumes are varied by 10% from those assumed in the base case. If managed stand volumes were to exceed present volume estimates by 10%, the higher volume contributions of managed stands to timber supply would cause the long-term harvest level to be approximately 8.8% higher than in the base case. If regenerated stand volume estimates are in fact 10% lower than expected, the long-term harvest level is projected to be 145 000 cubic metres per year, which is approximately 8.8% lower than the base case long-term level. Uncertainty about regenerated stand volumes has a nearly proportional impact on the long-term harvest level projected in the base case, but does not affect short-term timber supply. The long-term effects are not fully proportional to the change in regenerated stand yields because some existing stands continue to contribute to timber supply over the long term.

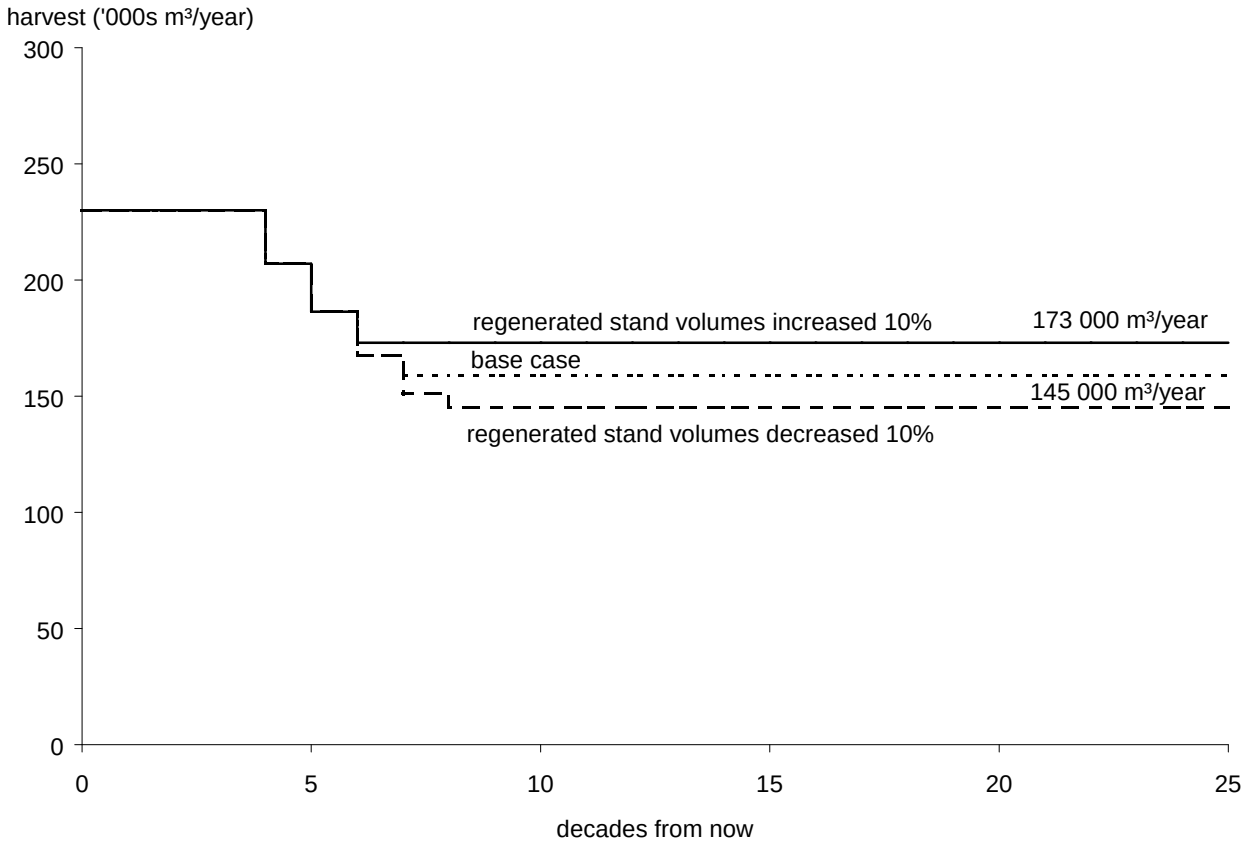

Figure 18. Harvest forecasts with regenerated stand volume estimates changed by 10% — Revelstoke TSA, 1998.

5.6 Uncertainty in green–up requirements

Forest cover requirements for wildlife habitat, visual quality, water quality 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 condition (that is, tree height) 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 19 shows that potential harvest levels over both the short- and long-terms are not sensitive to uncertainty about green-up ages. If green-up ages were actually 10 years less than in the base case, harvest levels in the short- and medium-term would be the same, and the decline to the long-term harvest level would occur at the same time as in the base case. Shorter green-up ages result in a long-term harvest level slightly higher than in the base case harvest forecast.

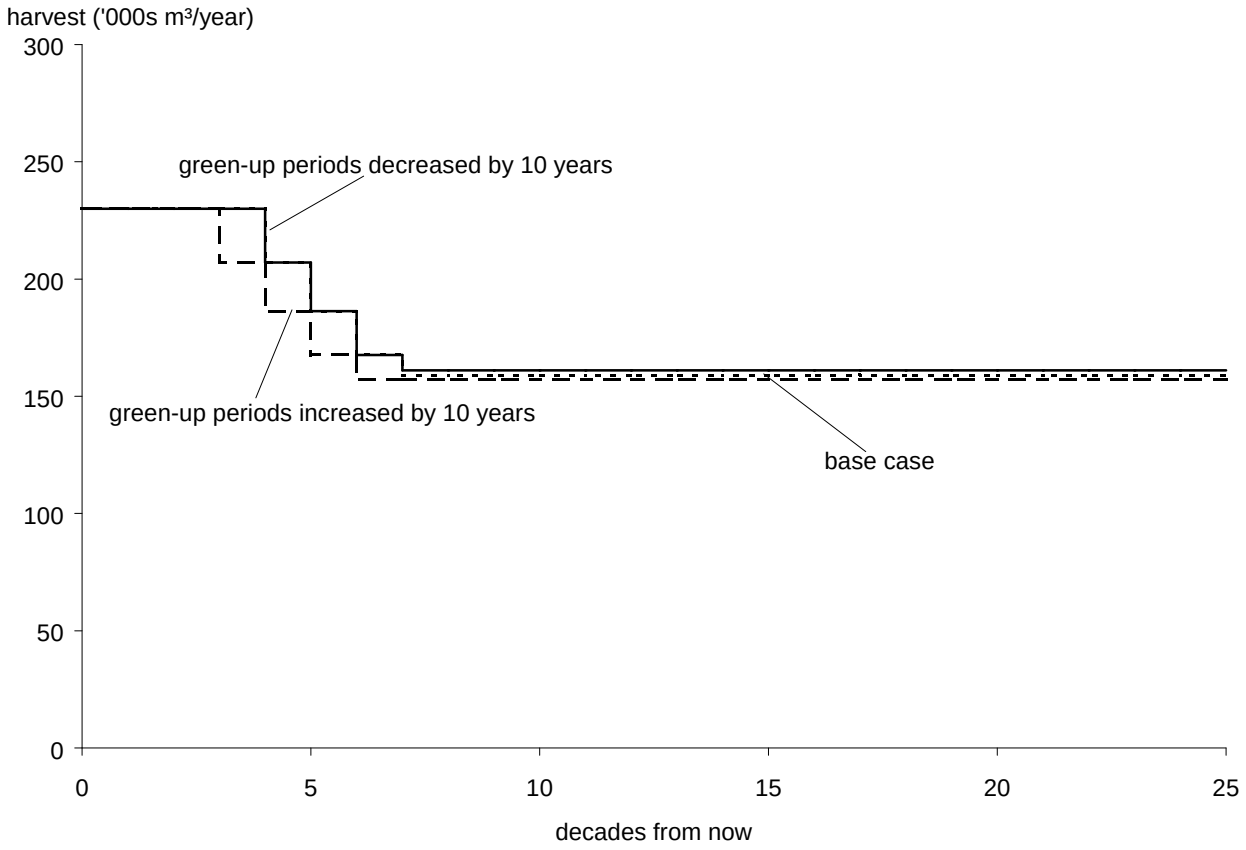

Figure 19. Harvest forecasts if green–up ages were either 10 years longer or shorter than the base case — Revelstoke TSA, 1998.

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.

If green-up ages were actually 10 years more than estimated for the base case, timber supply would be decreased in the medium term relative to the base case. The current harvest level could be maintained for only three decades (one decade less than in the base case). The long-term harvest level would be 157 000 cubic metres per year, about 1.3% lower than in the base case. Over the first 80 years of the analysis horizon, cumulative harvests would be about 4.4% lower than in the base case. An increase in green-up ages restricts timber supply because, at any time, more area is likely to be below green-up age, meaning maximum disturbance limits are met sooner.

The results for changes in green-up age suggest that timber supply is not sensitive to uncertainty or changes in green-up requirements in general, including the amount of area that is allowed to be younger than green-up age. While no related harvest forecasts are shown here, analysis showed that changes to the allowable disturbance in VQO areas — either removing the requirements entirely, or shifting the requirements to the next most restrictive VQO category — had no effect on timber supply relative to the base case. Similarly, changes in green-up requirements in community watersheds would not affect overall timber supply, primarily because the area affected is small (0.6% of the timber harvesting land base). Green-up requirements related to the wildlife habitat and integrated resource management areas are discussed in the following section.

In summary, timber supply is only mildly sensitive to changes in green-up requirements. Increases to green-up ages affect the amount of time that the current AAC can be maintained. Both increases and decreases in green-up ages have a slight impact on the long-term timber supply. Decreases in green-up ages have no effect in the short- and medium-terms. It is worth noting that the 10-year shifts in green-up ages examined here constitute large changes relative to the base case green-up ages (15 years for wildlife and IRM, 30 years for VQOs, 38 years for watersheds). Finally, timber supply shows little sensitivity to changes in the area that may be below green-up age in the VQO, watershed, ungulate winter range, and integrated resource management areas.

5.7 Uncertainty in adjacency restrictions and modelling approximations

The Forest Practices Code (FPC) requires that trees in a harvested area must 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 the green-up condition. In this analysis, it was assumed that a maximum of 25% of the timber harvesting land base of the integrated resource management zones, and a maximum of 25% of the operable forest land base of each caribou habitat and ungulate winter range 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 because they are approximations of the effects of cutblock-level decisions and it is difficult to define the exact forest structure needed to meet the adjacency objectives for a particular area. Furthermore, there is uncertainty about how adjacency requirements will be implemented in the field. Figure 20 illustrates two harvest forecasts that examine the uncertainty about how adjacency is represented in the analysis.

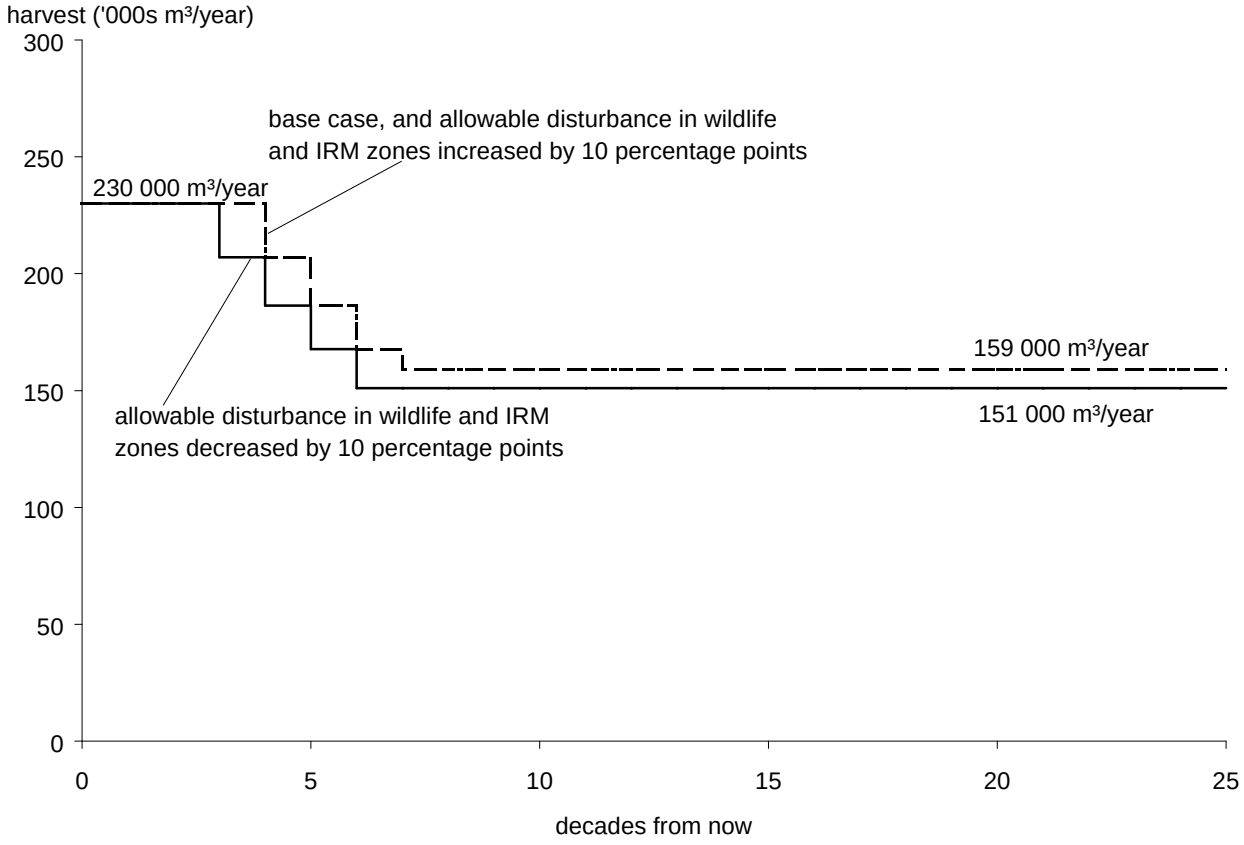

Figure 20. Harvest forecasts if disturbance limits were ten percentage-points higher or lower than the base case — Revelstoke TSA, 1998.

If adjacency requirements are more accurately approximated by decreasing the maximum amount of allowable disturbance by ten percentage points for the wildlife and integrated resource management zones, timber supply in the medium term would be decreased. The AAC could be maintained for three decades (one decade less than in the base case) before declining at the same rate as in the base case to a long-term harvest level of 151 000 cubic metres per year. Analysis results not displayed here showed that the base case harvest forecast could be maintained if the maximum allowable disturbance in the integrated resource management zone was reduced to 20%.

Figure 20 also illustrates that if forest cover requirements for adjacency are increased by ten percentage points for the wildlife and integrated resource management zones, it is not possible to increase harvest levels beyond base case levels. The result indicates that the base case timber supply is not significantly affected by maximum disturbance levels in the wildlife and integrated resource management zones.

In summary, uncertainty about how well the forest cover requirements for wildlife and integrated resource management zones approximate adjacency requirements, and about field implementation of adjacency requirements does not affect short- or long-term timber supply, and only affects medium-term timber supply if the requirements are made significantly more stringent.

5.8 Uncertainty in site productivity estimates

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 trees 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 young- and old-stands is difficult. Currently, about 19% of the Revelstoke 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 has been examined individually in previous sections.

Site productivity is often expressed in terms of the site index*. 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.

In 1994, an Old-Growth Site Index (OGSI) Adjustment Project was initiated to address identified problems with application of traditional site index curve to old-growth stands (stands over 140 years in age). The project involved a number of studies. Two of significance for timber supply analysis were a paired-plot study and a veteran study. The objective of both these studies was to develop short-term OGSI adjustments for use in ongoing timber supply analyses. In February 1998, the B.C. Ministry of Forests, Research Branch, (1998b) produced a report containing site index adjustments for old-growth stands for use in timber supply analyses. These adjustments were based on data from the paired-plot and veteran studies.

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 at breast height. Site index curves have been developed for British Columbia's major commercial tree species.

5 Timber Supply Sensitivity Analyses

When OGSI adjustments are made to site indices of eligible regenerated stands, timber volume estimates for those stands increase. The largest overall stand volume increases occur for spruce, cedar and hemlock-leading stands on sites classified with medium or poor site productivity. Adjustments for fir-leading stands and stands occurring on sites classified with good productivity result in small or negligible volume increases. The magnitude of the increase reflects the number of stands eligible for an adjustment (i.e., whether stand age is over 140 and whether its site index falls within the range to which adjustment apply) and the OGSI equation applied based on the stand's leading species. Figure 21 displays how timber supply may change if the OGSI site index adjustments were applied to all eligible stands and alternatively if only the site indices for spruce-leading stands were adjusted, since statistically sound and reliable data from the paired-plot study currently exists for only spruce and lodgepole pine species in the Nelson Forest Region, and all lodgepole pine stands are too young to be eligible for adjustment.

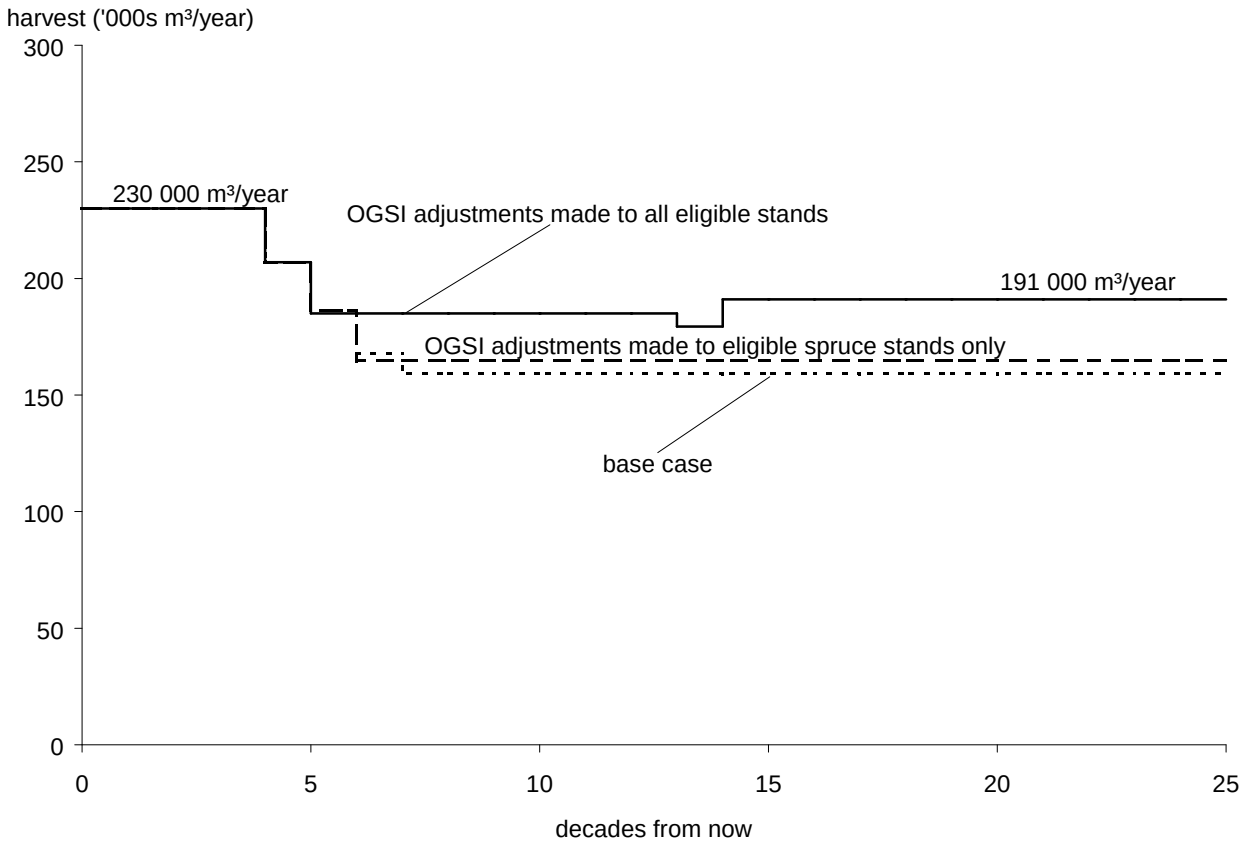

Figure 21. Harvest forecasts if old-growth site index adjustments (OGSI) are made to eligible stands — Revelstoke TSA, 1998.

If OGSI site index adjustments apply to all eligible stands timber supply would increase in the medium- and long-terms. Stands on 58% of the timber harvesting land base are technically eligible for adjustments. Beginning in decade 7, the projected harvest level is 8.3% higher than in the base case. As more regenerated stands contribute to the harvest, further increases above the base case harvest level are possible. Once the long-term level of 191 000 cubic metres per year is reached in decade 14, the harvest level remains 20.1% higher than in the base case. Over the 250-year planning horizon about 11.9% more volume is harvested.

If the OGSI adjustments apply only to eligible spruce stands, a long-term harvest level 3.4% higher than in the base case is possible, as compared to 20.1% higher if the adjustments apply to all eligible stands. When site indices for only eligible spruce stands are adjusted, stands occupying about 9% of the timber harvesting land base are affected.

In summary, uncertainty about site productivity affects medium- and long-term timber supply. If site productivity has been underestimated to the degree suggested by old-growth site index adjustment equations, future timber supply would be significantly higher than in the base case. This sensitivity test examined the impact of under–estimating site productivity only. If site productivity was underestimated in the base case it would follow that minimum harvestable ages and green-up ages for the same stands were also underestimated. Judging from the magnitude of the site index increase after an OGSI adjustment, it is possible that minimum harvestable ages may be 10 to 15 years lower for affected stands, and green-up ages 2 to 3 years lower. Combining all these changes into one sensitivity test would likely show effects in the medium- and long-term timber supply similar to those displayed in Figure 21. This is because the timber supply is not particularly sensitive to lower minimum harvestable ages or green-up ages, as demonstrated in Sections 5.2, "Uncertainty in minimum harvestable ages" and 5.6, "Uncertainty in green–up requirements."

5.9 Alternative harvest queue rules

In the base case, highest priority for harvest is given to stands that are the oldest relative to their minimum harvestable age. This relative oldest first rule is applied only after other requirements and priorities (e.g., forest cover requirements) are taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model permits use of absolute oldest first, absolute youngest first or random queue rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands usually get harvested.

Figure 22 illustrates three harvest forecasts that examine the potential impact on the timber supply of employing scheduling other than relative oldest first as used in the base case. If the absolute oldest first rule is substituted for the relative oldest first rule, the resulting forecast is similar to the base case except for a 3.8% decrease in the long-term level. The number of older, higher volume stands occupying the timber harvesting land base is dramatically reduced over the short- and medium-terms in this forecast resulting in few old stands contributing to harvests in the long term. The relative oldest first rule in comparison results in more old, high volume stands contributing to harvests in the long term. The relative oldest first rule also results in harvesting of stands over the long term at ages closer to their maximum productivity, resulting in a higher long-term level.

If the absolute youngest first harvest rule is substituted for the relative oldest first rule, the resulting forecast shows less potential volume in the medium- and long-terms. The long-term level of 142 000 cubic metres per year, is 10.7% lower than in the base case. Over the 250-year planning horizon 9.3% less volume would be available from cumulative harvests under the youngest first rule. This decrease in timber supply occurs because in many decades this rule causes stands to be harvested closer to their minimum harvestable age. At these younger ages, the stands have less volume per hectare.

5 Timber Supply Sensitivity Analyses

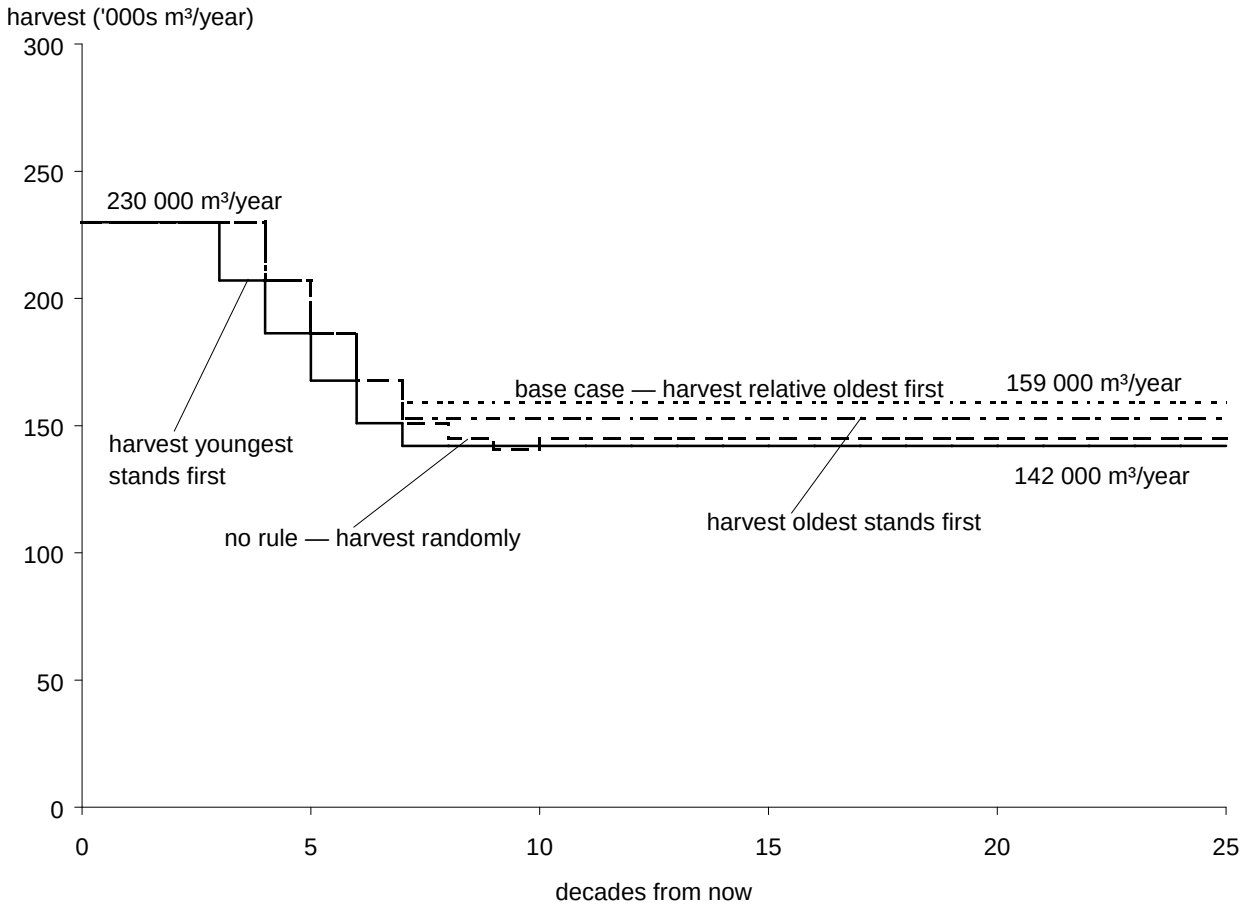

Figure 22. Alternative harvest queue rules: oldest first, youngest first and random — Revelstoke TSA, 1998.

Queuing stands randomly for harvest (no harvest rule) may result in several different harvest forecasts despite all other assumptions and objectives remaining the same. Figure 22 illustrates one of many possible forecasts using random queuing. The forecast follows that resulting with the absolute youngest first harvest rule, showing lower timber supply over the medium- and long-terms. The long-term level of 145 000 cubic metres per year is 8.8% lower than in the base case, and over the 250-year planning horizon, total timber supply would be 5.5% less.

In summary, harvest rules other than the relative oldest first rule assumed in the base case, decrease the potential timber supply in the medium- and long-term. The greatest decrease results when setting highest priority for harvest to youngest eligible stands.

5.10 Uncertainty in the size of area to be managed for caribou habitat

The Revelstoke TSA and the Mount Revelstoke National Park are home to one of only three viable populations of mountain caribou in western Canada. The Revelstoke herd is estimated at 400 animals not including 250 animals in smaller herds south of Revelstoke. Because of the importance of the Revelstoke area to the caribou's persistence, the B.C. Forest Service and Parks Canada have collaborated on an information gathering project to accurately document suitable caribou habitat in the area (the Mountain Caribou Project). Different areas have been identified over the years as better information has become available to identity, categorize and rank suitable caribou habitat. Some uncertainty exists among staff of the Ministry of Forests, Ministry of Environment, Lands and Parks, and Parks Canada about what guidelines to apply, and where, to sustain caribou populations.

Current management as defined for this analysis includes an objective to maintain old-age forests for caribou habitat on 32 979 hectares, or about 49% of the timber harvesting land base. Maintenance of habitat in the caribou zone is represented by a requirement that at least 10% of the physically operable forest area be in stands 250 years or older at all times and that 40% of the operable forest be in stands 140 years or older at all times. Also, these forest cover requirements are to be met within each landscape unit and in both the ESSF and ICH biogeoclimatic zone areas within each landscape unit. The old-forest cover requirements to maintain caribou habitat are much more stringent than old-forest requirements for other values, including landscape-unit biodiversity. Some uncertainty surrounds these requirements since it is possible that habitat objectives could be met by requiring either a smaller or larger amount of older forest within the operable area. This section examines the effects on timber supply of this uncertainty.

Figure 23 shows the implications to timber supply of removing these requirements, and increasing the area to which they apply by 2600 hectares of timber harvesting land base. The 2600 hectares reflect areas identified as "relaxed caribou guideline area" in the *Kootenay-Boundary Land Use Plan* (KBLUP) implementation strategy recommended by the Minister's Advisory Committee. The recommended "relaxed" forest cover requirements corresponding to the relaxed caribou guideline area were not applied in this sensitivity test making the modelled guidelines potentially more constraining than the recommendations.

5 Timber Supply Sensitivity Analyses

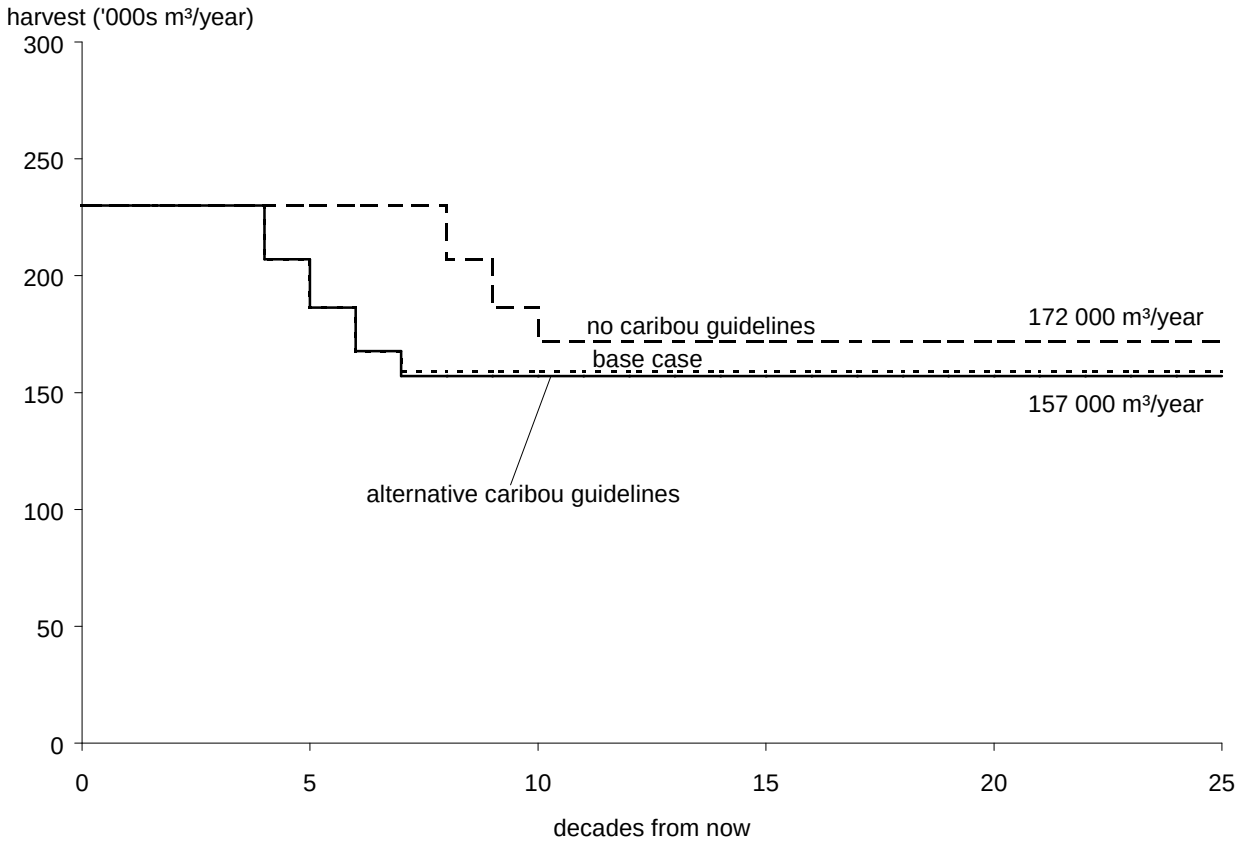

Figure 23. Harvest forecasts if more or less area is managed for caribou habitat — Revelstoke TSA, 1998.

Figure 23 illustrates that increasing the size of the area to be maintained in caribou habitat by 2600 hectares or 4% of the timber harvesting land base has no impact on the short-term timber supply, and only a slight impact on the medium- and long-term timber supply. Over the 250-year analysis horizon the cumulative harvests are about 1% less than in the base case. Figure 23 also illustrates that removing older forest cover requirements in the caribou zone has a large impact on the timber supply. The current AAC could be maintained for eight decades, four decades longer than in the base case, before declining to a long-term level of 172 000 cubic metres per year, 8.2% higher than in the base case. Over the 250-year analysis horizon the cumulative harvests are 10.3% more than in the base case. The large impact results because of the large area released from caribou guidelines that severely restrict timber supply. Other forest cover requirements for the same area, such as old-seral requirements for biodiversity, are less stringent and have little or no impact on timber supply.

In summary, due to the restrictiveness of caribou habitat guidelines, variations in the area of caribou habitat to be maintained can significantly affect the medium- and long-term timber supply forecast. The effects correspond directly with the size of the change in area. Removal of the guidelines affects 49% of the timber harvesting land base leading to a large increase in supply. Application of guidelines to the relaxed habitat area — 4% of the timber harvesting land base — resulted in a small reduction in supply.

5.11 Uncertainty in requirements for wildlife thermal cover

Caribou, mule deer and moose use mature forest for thermal cover. In this analysis, forest cover requirements were applied in the caribou and ungulate winter range zones to represent management for thermal cover. For caribou, the requirement was that a minimum of 40% of the physically operable area be covered by forest 140 years or older. In the ungulate winter ranges, a minimum of 40% of the physically operable must be in forest at least 100 years old. Analysis was performed to assess the timber supply impacts of uncertainty in the area requirements for mature forest cover in the wildlife habitat areas. The results are discussed below, however, no harvest forecasts are shown.

Analysis showed that a five percentage-point increase in the area requirements for mature forest in all wildlife zones (to 45%) would require that the decline from the initial harvest level begin after three decades, one decade less than in the base case, and would reduce the long-term harvest level slightly relative to the base case. A ten percentage– point increase in the requirements (to 50%) in wildlife areas would mean the decline in timber supply would need to begin after two decades to avoid later disruptions, and the long-term level would be about 6% lower than in the base case.

If the thermal cover requirements were increased by five percentage points in only the caribou habitat areas, the initial harvest level could be maintained for four decades, as in the base case, while the long-term harvest level would be about 5% lower than in the base case. With a ten percentage–point increase in requirements for the caribou zones, the initial harvest level in the base case could be maintained for only two decades.

An increase in thermal cover requirements by five percentage-points in only the ungulate winter range areas would require harvests to decline after three decades to a long-term level about 2.5% lower than in the base case. A further increase in the requirements to ten percentage-points above the base case would not noticeably change the harvest forecast relative to that resulting from the five percentage-point increase.

In all cases, reductions in thermal cover requirements increase timber supply to the same degree that increased cover requirements decrease supply. For example, a ten percentage-point reduction in requirements for mature forest cover (to a minimum of 30%) in all caribou and ungulate winter range areas, would allow the initial harvest level to be maintained for two decades longer than in the base case (that is, for six decades), and increase the long-term harvest level by about 6%.

In conclusion, timber supply is moderately sensitive in the medium- and long-terms to substantial increases in area requirements for mature forest for wildlife thermal cover. Increases in thermal cover requirements would not affect the ability to maintain the initial base case harvest level over the next two decades. Decreases in these cover requirements would allow the initial harvest level in the base case to be maintained for longer than four decades.

5.12 Uncertainty in 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 *Forest Practices Code Biodiversity Guidebook* provides recommendations for maintaining biodiversity at both the stand and landscape levels. Stand-level biodiversity has been addressed in this analysis through volume reductions for each stand occurring on the timber harvesting land base. Therefore, uncertainty about stand-level biodiversity can be assessed through the sensitivity analyses that examines the effect of uncertainty about timber yields. Landscape-level biodiversity, however, has been represented in this analysis by forest cover requirements applied to natural disturbance types within landscape units. There is uncertainty about how the recommendations in the *Biodiversity Guidebook* should be interpreted and applied, as well as how the Revelstoke TSA should be delineated into landscape units. The following sensitivity analysis provide an indication of the timber supply impacts associated with uncertainty about landscape-level biodiversity.

In the assumptions used in the base case, biodiversity emphasis options were not specifically modelled because landscape units have not be designated for the Revelstoke area. Instead, to approximate the likely timber supply impacts of the FPC *Biodiversity Guidebook* recommendations for landscape-unit biodiversity a procedure was developed that generally recognizes that low-, intermediate-, and high-emphasis options will be assigned to 45%, -45% and 10% of the management unit respectively. The procedure is meant not to presuppose any specific area as being assigned high, intermediate, or low emphasis before such designations are legally made. Section A.4.5, "Biodiversity" of Appendix A describes this procedure.

Landscape units and corresponding emphasis options have been proposed in the *Implementation Strategy for the Kootenay-Boundary Land Use Plan*, and by the Minister's Advisory Committee (MAC). The MAC has made draft recommendations on the implementation of the land use plan for the Revelstoke analysis area. For the purposes of sensitivity analysis the MAC provided information on where high-, intermediate- and low-emphasis forest cover requirements may be assigned in the future. The MAC also recommended that seral-stage requirements for mature-plus-old and old forest in biogeoclimatic subzones and variants within landscape units be applied separately to the total forested area and physically operable forest area. The intent of this recommendation is to provide for distribution of seral stages across the entire forested land base.

5 Timber Supply Sensitivity Analyses

Figure 24 shows a harvest forecast that includes recommendations from the MAC. Analysis indicates that if MAC recommendations on biodiversity emphasis options were implemented, the harvest forecast follows the base case for seven decades, declining to a long-term level of 158 000 cubic metres per year, slightly lower than in the base case. Over a 250-year planning horizon, 0.4% less volume is harvested compared to the base case.

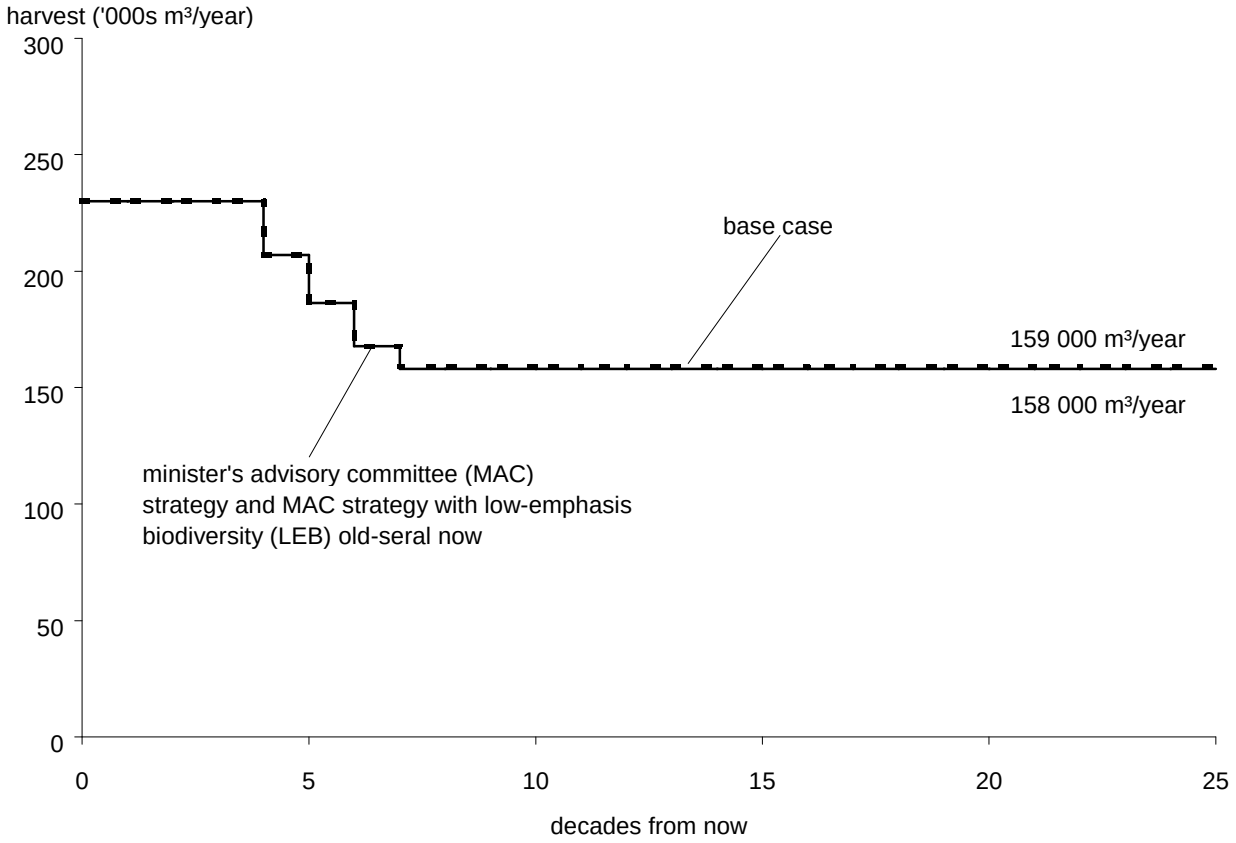

Figure 24. Harvest forecast with the Minister's Advisory Committee (MAC) strategy for biodiversity emphasis options — Revelstoke TSA, 1998.

A sensitivity analysis was also performed in which the low-emphasis biodiversity (LEB) portion of old-seral requirements outlined in the *Biodiversity Guidebook* were applied in full at the beginning of the analysis horizon, rather than being phased in over 140 years to the full amount, as in both the first MAC strategy sensitivity run, and, in the base case. Applying old-seral requirements at the beginning of the analysis horizon did not change the MAC strategy forecast.

Timber supply is not highly sensitive to changes in implementation of landscape biodiversity guidelines because mature and old forest stands outside the timber harvesting land base on both operable and inoperable forest land are sufficient to meet most mature- and old-seral requirements. Therefore, landscape-unit biodiversity requirements do not limit timber supply within the timber harvesting land base.

5.13 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 the watershed stream atlas (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.

One concern specific to the Revelstoke TSA is the difference between the amount of Crown land classified as productive forest in the inventory used for the 1993 timber supply review and this one. Since the last timber supply review a new inventory was completed. For the same management unit area, the new inventory classifies approximately 19 000 hectares more area as Crown productive forest land. After considering the types of land and forest where timber harvesting is not likely to occur under current management, 4942 hectares (7%) more area is available for timber harvesting in this analysis than in the 1993 timber supply review.

Figure 25 shows how a 7% decrease in the timber harvesting land base would affect potential harvests. The initial harvest level projected in the base case could still be maintained for three decades, and the total timber supply over the next 90 years would be 5.5% less than in the base case. The long-term harvest level would 7.2% lower, and cumulative harvests from 100 to 250 years from now would be 6.2% lower than in the base case.

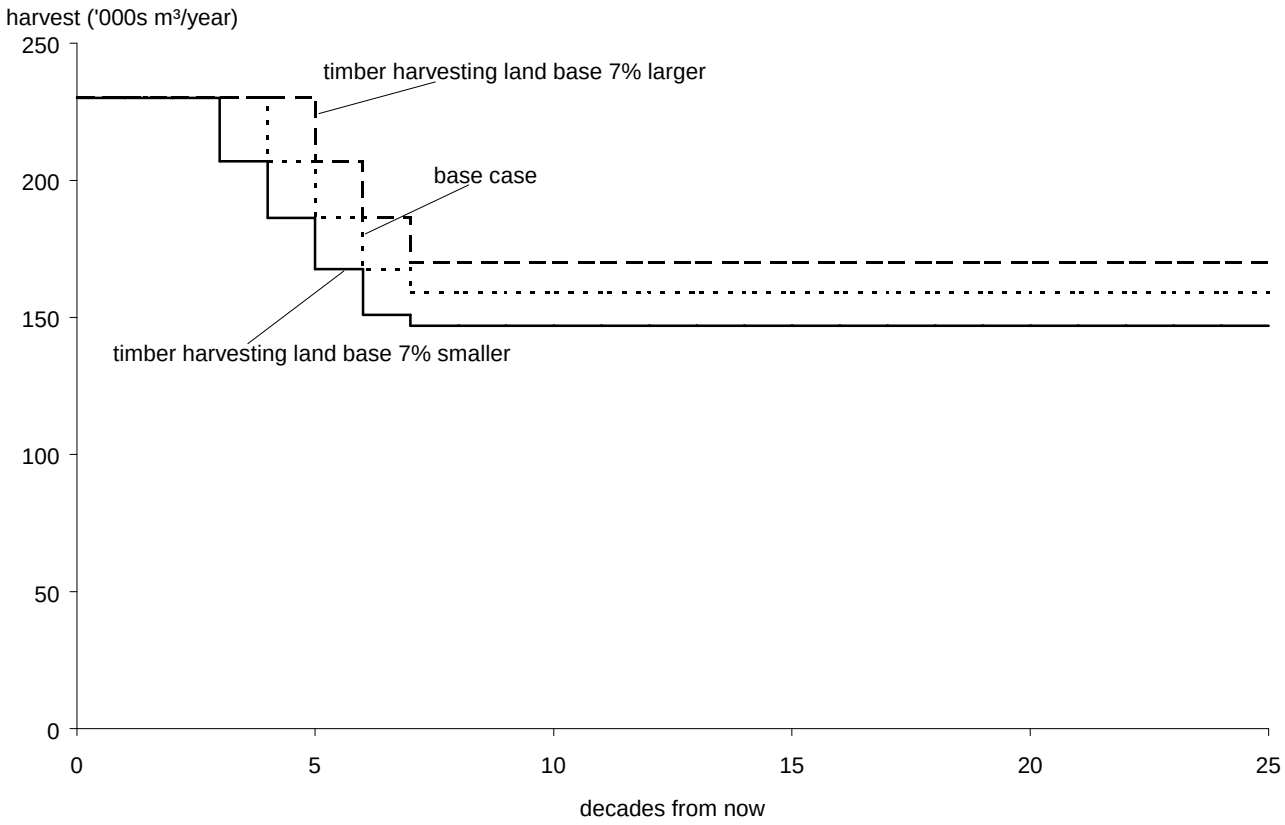

Figure 25. Harvest forecasts reflecting uncertainty in size of the timber harvesting land base — Revelstoke TSA, 1998.

5 Timber Supply Sensitivity Analyses

If the timber harvesting land base were in fact 7% larger than defined for the base case, the current harvest level could be maintained for five decades before declining to a long-term level 6.9% (170 000 cubic metres per year) higher than in the base case, while over the remainder of the analysis horizon, timber supply would be 6.6% greater.

In summary, timber supply is sensitive to uncertainty about the size of the timber harvesting land base. Short-term timber supply is not affected in the cases examined here. However, changes in the size of the timber harvesting land base do affect timber supply from 30 to 90 years from now, and in the long term. 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 either require earlier harvest level reductions, or larger declines further into the future.

6 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current allowable harvest level in the Revelstoke TSA of 230 000 cubic metres per year can be maintained for up to 40 years while allowing for controlled future harvest level reductions and avoiding severe future timber disruptions. Based on current inventory and timber growth information, and assuming continuation of current forest management practices, harvests could be maintained at the current level for 40 years, if followed by reductions of 10% per decade between 41 and 80 years from now to the long-term harvest level of 159 000 cubic metres per year, 31% 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 to varying degrees.

Uncertainty involving estimates of timber volumes in existing stands, particularly in hemlock or cedar-leading stands, had the largest potential effect on projected harvest levels over the next 250 years. Five factors were shown to have a moderate to large effect on timber supply either in the medium- or long-term, or both. These include estimates of: size of timber harvesting land base, timber volumes in regenerated stands, estimates of minimum harvestable ages, queuing of mature stands for harvest, size of area mapped as caribou habitat, requirements for mature forest for wildlife, and estimates of site productivity. Areas of uncertainty which have only a small impact on medium-term timber supply include: maximum amount of disturbance allowed in wildlife and integrated resource management zones, the age at which stands reach green-up conditions, and the manner in which biodiversity requirements are implemented.

The forest inventory and management factors discussed above could affect timber supply over the next 10-100 years, but in all but one case (25% reduction in timber volume estimates for hemlock and cedar stands) uncertainties about these factors did not reduce timber supply over the next 20 years. None of the analyses suggested that timber supply might need to drop below base case levels over the next 20 years to avoid creating severe timber supply disruptions in the future.

Over the long term, that is during the period from 100 to 250 years from now, site productivity, regenerated stand volume estimates, size of the timber harvesting land base, and the queuing of mature stands for harvest have moderate to large effects on timber supply. Minimum harvestable ages, green-up ages, maximum disturbance objectives for integrated resources management areas and wildlife management zones, size of area mapped as caribou habitat, 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 Revelstoke TSA can be maintained at the current allowable level for the next 40 years. Several factors related to the current forest inventory and management regime could affect timber supply over the next 10-100 years. 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 Revelstoke TSA. It compares the level of forestry activity currently supported by timber harvested from the Revelstoke TSA to the level of activity that could be supported as the Revelstoke timber supply moves towards the 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 Revelstoke TSA, which is part of the Columbia Forest District, has a population of approximately 8,600. The major community in the Revelstoke TSA is the city of Revelstoke. From 1991 – 1996, the population of the Revelstoke TSA grew by four per cent or less than one per cent annually. By 2001 the population of the area is projected to increase by approximately eight per cent.

Table 4. Population statistics — Revelstoke TSA

Communities	Population 1991 census	Population 1996 census	Population 2001 estimate[a]	Per cent (%) change 1996-2001
City of Revelstoke	7,729	8,047	8,675	7.8
Revelstoke TSA[b]	8,311	8,639	9,328	8.0

Source: 1991 and 1996 Census data.

(a) Estimates by Population Section, BC STATS, with local health area population projections.

(b) Estimated by BCSTATS to be about 90% of Columbia-Shuswap Subdivision B.

7.1.2 Economic profile

From 1991 to 1996, the experienced labour force in the Revelstoke TSA increased by 4.6% to 4,770. In comparison, the experienced labour force for the province increased by 14.0 % over the same period. The unemployment rate in the Revelstoke TSA was 14.3% in 1996, compared with 11.3% in 1991. As Figure 26 illustrates, the major employment sectors in the Revelstoke TSA are forestry, the public sector (which includes education, health, and federal, provincial and local public services) tourism, and transportation (primarily rail) and communications. Figures from the 1996 census indicate that the forest sector directly accounted for approximately 14% of employment in the Revelstoke TSA.

Tourism, which includes portions of several service sectors including accommodation services, retail trade and transportation, has demonstrated significant growth and investment in recent years. An estimated 600 persons are employed in the Revelstoke TSA's accommodations sector, catering to both tourist and business travellers. More than 150 businesses in the Revelstoke area service visitors' needs, including outdoor recreation facilities, tours and attractions, retail and service businesses, food and beverage facilities, and accommodations.

Other important sectors in the Revelstoke TSA are transportation, communications and water resource utilities, which account for approximately 16% of the labour force in the Revelstoke TSA. The transportation services sector is a stable component of the area's economic base due to Revelstoke's location on national east-west transportation routes.

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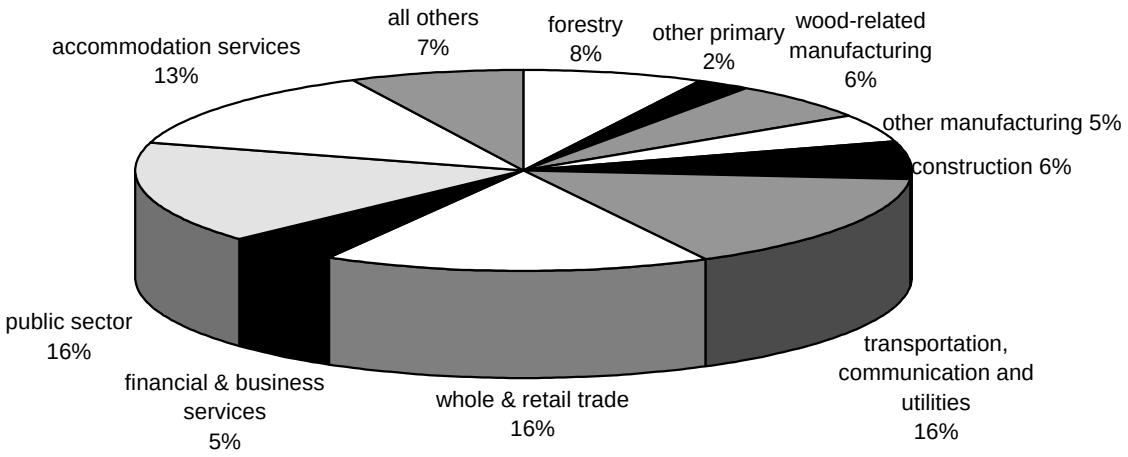
Water resource utilities include two large and two smaller hydro-electric dams and a natural water bottling plant. The construction and operation of the dams have added significantly to the economic base of the Revelstoke area. Canadian Hydro Development has announced plans to investigate installing additional electricity generating capacity at Pingston Creek. There is also potential for the future expansion of water bottling opportunities, considering the excellent quality of an abundant mountain water resource.



Source: 1996 census.

Figure 26. Estimated employment by industry, 1996 — Revelstoke TSA.

Income, whether business or personal, is another indicator of a sector's contribution to the economy. Jobs in sectors with high income levels tend to support more employment per job than those in sectors with lower income levels. Statistics Canada labour force data, comparing average weekly earnings in different sectors of the economy, indicate that the forest 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 wages than forestry. In 1997, the average weekly earnings in the forest sector were approximately $903, compared to $1,050 for the mining sector. Other sectors' average weekly earnings were $709 for the construction industry; $266 for the accommodation, food and beverage services industries; and $785 for the public sector.

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Employment multipliers reflect the income effect: the greater the multiplier, the greater the impact that each job in this sector has on the economy. For example, estimates by the Ministry of Finance and Corporate Relations indicate that for every 100 full-time direct forestry jobs in the Revelstoke TSA, another 23 to 57 indirect and induced jobs* are supported, depending on the forestry activity (harvesting or timber processing). In comparison, for every 100 full-time direct jobs in the tourism sector, an estimated additional five to 10 indirect and induced jobs are supported. The differences are a result of greater spending patterns by both forest sector businesses and their employees. Table 5 compares estimated employment, average weekly earnings and employment multipliers for selected sectors of the Revelstoke TSA economy.

Table 5. Average weekly earnings and employment multipliers — Revelstoke TSA.

Industry sector	1997 average weekly earnings ($)	Employment multiplier[a]
Forestry and related	903	1.23 — 1.57
Mining and related	1,050	1.24 — 1.47
Construction	709	1.23 — 1.38
Tourism	266	1.05 — 1.10
Public sector	785	1.08 — 1.21

Sources: Employment multiplier: Ministry of Finance and Corporate Relations, *The Revised Forest District Tables*, March, 1996. Refers to 1991 data.
Average weekly earnings: Statistics Canada, *Survey of Employment, Payroll and Hours*. 1997 data.

(a) Includes direct, indirect and induced jobs.

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.

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7.2 Revelstoke TSA forest industry

7.2.1 Current allowable annual cut

The allowable annual cut (AAC) for the Revelstoke TSA is 230 000 cubic metres, effective as of January 1995; a reduction from the previous level of 269 000 cubic metres. Forest licences account for more than 70% of the apportioned volume in the Revelstoke TSA, and the Ministry of Forests' Small Business Forest Enterprise Program (SBFEP) accounts for nearly 20% of the apportioned volume. Table 6 indicates the current apportioned allowable annual cut by type of licence.

Table 6. Allowable annual cut apportionment, 1995 — Revelstoke TSA

Type of licence	Volume (m^3)	Per cent (%)
Forest licences, replaceable	169 603	73.7
Timber sale licence (TSL) > 10 000 m^3, replaceable	0	0.0
TSL < 10 000 m^3, replaceable	12 901	5.6
Small business forest enterprise program (SBFEP)	42 841	18.6
Forest Service reserve	4 600	2.0
Woodlot licences	55	0.0
Forest licences, non-replaceable	0	0.0
Total	230 000	100.0

Source: Ministry of Forests, Resource Tenures and Engineering Branch.

7.2.2 Recent harvest history

The actual annual harvest level is an important indicator of forestry activity in the Revelstoke TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity.[1] If actual annual harvest levels are less than the AAC, then economic activity is less than the TSA's full potential. A constant gap between the AAC and the actual annual harvest level could influence the potential short-term impacts of changes in the AAC.

Table 7 summarizes the volume of timber harvested in the Revelstoke TSA from 1993-1997. Harvest from forest licences have been very close to the apportioned volume for forest licences.

1. Cut control legislation permits licensees to vary the volume harvested from the AAC by +/- 50% per year and by +/- 10% over a 5-year period. This flexibility allows licensees to adapt to changing conditions, including changing markets.

Table 7. Volume (cubic metres) billed, by type of licence, 1993-1997, Revelstoke TSA

Type of licence[a]	1993 (m^3)	1994 (m^3)	1995 (m^3)	1996 (m^3)	1997 (m^3)	Average 1993-1997 (m^3)
Forest licence	218 312	132 841	178 861	166 171	152 597	169 757
SBFEP	58 647	50 839	42 783	25 870	53 697	46 367
Road permit[b]	0	11 440	23 117	64 827	52 271	30 331
TSL	2 959	8 424	12 839	16 676	14 044	10 988
Total	279 918	203 544	257 600	273 544	272 609	257 443
Allowable annual cut	269 000	269 000	230 000	230 000	230 000	

Source: Ministry of Forests, Harvest Database.

(a) Timber harvested from private lands and woodlots is not included in this analysis. Average annual harvest from private lands for the same period was 68 988 cubic metres and from woodlots was 4913 cubic metres.

(b) Includes rights-of-way clearing, roads, beachcombing, trespass and other miscellaneous harvests.

7.2.3 Revelstoke TSA major licensees and processing facilities

Downie Street Sawmills Ltd. (Downie) has a replaceable forest licence to harvest 132 152 cubic metres per year, reduced in 1995 from 151 050 cubic metres, as part of the reduction in the AAC. More than 85% of Downie's harvest from this licence is processed within the Revelstoke TSA at the company's lumber mill in Revelstoke. The remaining volume is processed outside the Revelstoke TSA. Based on 1995-1997 data, Downie's annual average harvest supported an estimated 148-153 person-years of harvesting, silviculture, timber processing and related employment. Almost all of the workers who are employed by Downie live within the Revelstoke TSA.

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Table 8. Downie harvest and employment statistics

Allowable annual cut	132 152 cubic metres
Annual average harvest (1993-1997)	128 303 cubic metres
1997 harvest	115 733 cubic metres
Estimated employment[a]	Person-years
Harvesting and administration	42 – 46
Log transport and road construction and maintenance	23 – 24
Silviculture	5
Timber processing	78
Total	148 – 153

Source: Ministry of Forests, Harvest Database.

(a) Based on 1995-1997 annual average harvest of 124 947 cubic metres. Estimates of employment are derived from information supplied by licensee and include employment associated with TSA timber which is processed outside the TSA.

Joe Kozek Sawmills Ltd. (Kozek) has a replaceable forest licence to harvest 18 373 cubic metres per year, reduced from 21 000 cubic metres in 1995; and a replaceable TSL to harvest 7496 cubic metres per year; totalling 25 869 cubic metres. About 75% of Kozek's harvest from these licences is processed within the Revelstoke TSA at the company's lumber mill in Revelstoke. The remaining volume is processed outside the Revelstoke TSA. Based on 1995-1997 data, Kozek's annual average harvest supported an estimated 62-67 person-years of harvesting, silviculture, timber processing and related employment. All Kozek employees live within the Revelstoke TSA.

Table 9. Kozek harvest and employment statistics

Allowable annual cut	25 869 cubic metres
Annual average harvest (1993-1997)	28 460 cubic metres
1997 harvest	39 610 cubic metres
Estimated employment[a]	Person-years
Harvesting and administration	18 – 23
Log transport and road construction and maintenance	6
Silviculture	3
Timber processing	35
Total	62 – 67

Source: Ministry of Forests, Harvest Database.

(a) Based on 1995-1997 annual average harvest of 29 096 cubic metres. Estimates of employment are derived from information supplied by licensee and include employment associated with TSA timber which is processed outside the TSA.

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Bell Pole Co. Ltd. (Bell) has a replaceable forest licence to harvest 19 290 cubic metres per year, reduced from 21 806 cubic metres in 1995. Only about 5% of the harvest from this licence is processed within the Revelstoke TSA at the company's pole mill in Revelstoke because of the mill's log size, species and quality requirements. The company trades or purchases more than 90% of the mill's timber supply from outside the Revelstoke TSA. Based on 1995-1997 data, Bell's annual average harvest supported an estimated 14-29 person-years of harvesting, silviculture, timber processing and related employment. Approximately 25% of Bell employees associated with this licence live within the Revelstoke TSA.

Table 10. Bell harvest and employment statistics

Allowable annual cut	19 290 cubic metres
Annual average harvest (1993-1997)	18 239 cubic metres
1997 harvest	7 745 cubic metres
Estimated employment[a]	Person-years
Harvesting and administration	2 – 13
Log transport and road construction and maintenance	2 – 4
Silviculture	2 – 4
Timber processing	8
Total	14 – 29

Source: Ministry of Forests, Harvest Database.

(a) Based on 1995-1997 annual average harvest of 19 424 cubic metres. Estimates of employment are derived from information supplied by licensee and include employment associated with TSA timber processed which is outside the TSA.

Other Timber Sale Licences (TSL)

There are four replaceable TSLs in the Revelstoke TSA with a total harvest volume of 12 597 cubic metres per year. For this analysis, Kozek's TSL, A19000, to harvest 7496 cubic metres annually has been combined with its forest licence. The three remaining TSL holders have a combined volume of 5096 cubic metres per year. Table 11 presents harvest and employment information for these TSLs.

Table 11. Summary of other timber sale licences harvest and employment statistics

Allowable annual cut[a]	5 096 cubic metres
Annual average harvest (1993-1997)[b]	5 743 cubic metres
1997 harvest	6 389 cubic metres
Estimated employment[c]	Person-years
Harvesting and administration	3 – 6
Log transport and road construction and maintenance	2 – 3
Silviculture	1
Timber processing	6
Total	12 – 16

Source: Ministry of Forests, Harvest Database.

(a) Excludes TSL A19000, Joe Kozek Sawmills Ltd., with AAC of 7496 cubic metres.

(b) Excludes 1993-1997 annual average harvest from TSL A19000, Joe Kozek Sawmills Ltd., of 5245 cubic metres.

(c) Based on 1995-1997 annual average harvest of 9273 cubic metres. Estimates of employment are derived from information supplied by licensee and include employment associated with TSA timber which is processed outside the TSA.

Small Business Forest Enterprise Program (SBFEP)

The SBFEP accounts for more than 18% of the Revelstoke TSA's apportioned allowable annual cut. Annual harvests in recent years have averaged approximately 46 400 cubic metres, or about 18% of the total harvest in the Revelstoke TSA. Using scale-site information and averages for the Revelstoke TSA, an estimated 75% of the volume harvested under the SBFEP is processed within the TSA, while the remaining 25% is processed outside the TSA. Based on 1995-1997 data, the volume harvested under the SBFEP supported an estimated 54-67 person-years of harvesting, silviculture, timber processing and related employment (Table 12). Approximately 60% of this timber is harvested by SBFEP registrants who reside within the Revelstoke TSA.

Table 12. Small business forest enterprise program harvest and employment statistics

Allowable annual cut	42 841 cubic metres
Annual average harvest (1993-1997)	46 367 cubic metres
1997 harvest	53 697 cubic metres
Estimated employment[a]	Person-years
Harvesting and administration	12 – 22
Log transport and road construction and maintenance	7 – 8
Silviculture	1 – 3
Timber processing	34
Total	54 – 67

Source: Ministry of Forests, Harvest Database.

(a) Based on 1995-1997 annual average harvest of 40 783 cubic metres. Estimates of employment are derived from industry averages of licensees and operators in the TSA and include employment associated with TSA timber which is processed outside the TSA.

Revelstoke TSA timber supply and processing capacity

Approximately 75% of the annual harvest (1995-1997 average) in the Revelstoke TSA was processed within the TSA, while the remaining 25% was processed outside the TSA. Timber processing plants in the Revelstoke TSA include two lumber mills, a pole mill, a value-added remanufacturing facility and two shake and shingle mils, although one of the shake and shingle mills recently ceased operations. There are also a number of small-scale lumber mills in the Revelstoke TSA which collectively process less than 10 000 cubic metres of timber annually. Altogether, the processing plants in the Revelstoke TSA have an estimated annual capacity of between 375 000 and 400 000 cubic metres. Between 1993 and 1997, annual harvests in the Revelstoke TSA have averaged approximately 257 000 cubic metres. Additional timber supply to processing plants in the TSA comes from nearby tree farm licences (TFLs), TSAs and private sources.

7.2.4 Forest sector employment and employment coefficients

Harvesting and employment information is used to estimate employment coefficients which will be used to project future employment levels in the forest sector. For this purpose, the forest sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage, log scaling, and harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning; and
- primary timber processing employment, such as manufacturing activities at lumber mills, veneer and plywood mills, shake and shingle mills and pulp and paper mills.

Harvesting employment

The harvesting employment component is very closely related to the volume that is harvested and is, therefore, the first sub-sector affected by changes in the Revelstoke TSA's harvest level. This sub-sector includes employees who work in the harvesting operations of a forest company as well as those who work as contract loggers. Harvesting activity in the Revelstoke TSA usually occurs between mid-May to late-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 Revelstoke 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.

Silviculture employment

The silviculture employment component is not as closely related to the AAC because an amount of time can elapse between when harvesting takes place and when replanting the harvested areas begins.[2] Basic silviculture consists of surveys, site preparation, planting, brushing, cone collection and spacing. Enhanced silviculture includes spacing, fertilization and pruning. In the Revelstoke TSA, 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.

Primary timber processing employment

The timber harvested from the Revelstoke 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 TSA and in neighbouring areas, including the Golden and Arrow TSAs. Information supplied by licensees indicates that some timber from their harvests has also been shipped to the coast for processing.

Ministry of Forests employment

The Revelstoke TSA was administered by the Revelstoke Forest District until January 1997, when the district was combined with the Golden Forest District to form the Columbia Forest District. Approximately 50 people work in the Revelstoke office of the Columbia Forest District. District staff oversee the management of forestry-related activities on Crown land in the Revelstoke TSA. Employment in the Ministry of Forests is not included as part of direct employment in the forest sector because public sector activities are more related to government policy rather than to the timber harvest, and would not be affected by marginal changes in the timber supply. Ministry employees are, nevertheless, an important component of total employment in the Revelstoke TSA and are accounted for in the government services component of the TSA's economic base.

Employment coefficients

Employment coefficients, expressed as person-years of employment per 1000 cubic metres of harvest, have been calculated using harvesting and employment information from licensees and operators. Table 13 summarizes employment supported by the 1995-1997 harvests in the Revelstoke TSA and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

1) TSA employment and employment coefficients, which comprise residents of the Revelstoke TSA who are employed in the forest sector within the Revelstoke TSA; and

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

2. In addition to replanting the harvested area, there are requirements for the harvested stand to be re-established first to a green-up state and then to a free-to-grow state. The time for a replanted area to reach green-up state varies, depending on the requirements for visual, hydrological and wildlife resource values. In the *Kootenay-Boundary Land Use Plan*, the minimum green-up height is two metres. In other resource zones, the height requirement may be greater. The time required for the replanted stands to reach the free-to-grow state (when the planted commercial species are as high or higher than competing non-commercial species or brush vegetation) varies according to the silviculture system being used and the ecological association of the stand. Previous experiences indicate that this time period can range from 7 to 20 years after harvest. Silviculture activity in harvested areas continues until the stands reaches to free-to-grow state.

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

The *1994 Revelstoke TSA Socio-Economic Assessment* indicated that the previous AAC of 269 000 cubic metres supported an estimated 321 person-years of direct employment in the province; a provincial employment coefficient of 1.19 person-years of direct employment per 1000 cubic metres. The current timber supply review indicates that harvesting, silviculture and processing activities associated with Revelstoke TSA's 1995-1997 average annual harvest of 267 918 cubic metres supported an estimated 330 person-years of direct employment in the province; a provincial employment coefficient of 1.23[3] person-years of direct employment per 1000 cubic metres.

A more detailed discussion regarding employment coefficients is presented in Appendix B, "Socio-Economic Analysis Background Information."

Table 13. Forest sector employment and employment coefficients, Revelstoke TSA (average 1995-1997)

Activity	Within TSA		Provincial	
	TSA employment (person-years)	TSA employment coefficient (person-years per '000s m³)	Province employment (person-years)	Province employment coefficient (person-years per '000s m³)
Harvesting	91	0.34	112	0.42
Silviculture	3	0.01	16	0.06
Timber processing	161	0.60	202	0.75
Total — direct employment	255	0.95	330	1.23
Indirect / induced employment	118	0.44	422	1.58
Total	373	1.39	752	2.81

Note: Employment estimates are reported in person-years and are based on 1995-1997 average employment and annual average harvest 267 918 cubic metres in the Revelstoke TSA. Due to rounding, some totals are not the sum of their components.

3. Differences in employment coefficient ratios 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 be similar.

7.2.5 Revelstoke TSA forest sector employment income

In 1997 the average annual income of direct forestry employees was: $47,850 for those working in logging and forestry services; $46,250 for those working in solid wood manufacturing; and $54,990 for those working in pulp and paper mills. For those engaged in indirect and induced employment (such as construction, transportation, business services, retail trade, etc.) the estimated average annual income in 1997 was $34,075. Based on 1995-1997 annual averages, the Revelstoke TSA's timber harvest supported approximately $15.7 million in direct employment income and an additional $14.4 million of indirect and induced employment income. Altogether, the harvest supported an estimated total of $30 million in employment income, or about $112,219 per 1000 cubic metres harvested.

Table 14. Estimate of forest sector provincial employment income, 1995-1997, Revelstoke TSA[a]

Employment component	Estimated person-years of employment	Average annual income per worker[b]	Total employment income (1997 $million)	Employment income ($ per '000s m³)
Direct employment				
Logging and forestry services	128	$47,850	$6.12	$22,861
Solid wood processing	177	$46,250	$8.19	$30,555
Pulp and paper processing	25	$54,990	$1.37	$5,131
Indirect / induced employment	422	$34,075	$14.38	$53,672
Total	752		$30.06	$112,219

(a) Based on 1995-1997 annual average harvest of 267 918 cubic metres.
(b) Estimates from Statistics Canada: Survey of Employment, Payroll and Hours, 1997.

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 1995 and 1997, the timber harvest in the Revelstoke TSA contributed approximately $3.70 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 $2.32 million annually. In addition, the provincial government received approximately $2.57 million in income taxes paid by forest sector employees (see Table 15).

Table 15. Estimate of provincial revenues, 1995-1997, Revelstoke TSA

Provincial revenues from	Average volume harvested (m^3)	Estimate of total revenue ($ million)	Revenue per volume ($ per '000s m^3)
Stumpage and related revenues[a]	267 918	3.70	13,820
Forest industry taxes[b]	267 918	2.32	8,664
Employment income taxes[c]	267 918	2.57	9,579
Total		8.59	32,063

(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) Estimated from 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 that the AAC can be maintained at its current level of 230 000 cubic metres per year for the next four decades. The forecast indicates that timber supply will then decline by 10% per decade for the following three decades to a long-term harvest level of 159 000 cubic metres per year.

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 Revelstoke TSA and the province;
- possible impacts on the communities within the Revelstoke TSA;
- timber requirements of processing facilities within the Revelstoke 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 proportions 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 harvested and processed). 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 or processed. While this method can be reasonably accurate for short-term forecasts (within the next three to five years), employment coefficients 20 years from now may be very different due to changes in forest sector market conditions, timber processing technologies, etc. The analysis provides an indication of the magnitude of impacts on employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

7.3.1 Revelstoke TSA employment and employment income impacts

Based on 1995-1997 annual averages, the base case harvest forecast of 230 000 cubic metres per year will support an average of 320 person-years of employment (direct, indirect and induced) in the Revelstoke TSA. Employment will tend to fluctuate around this level as companies respond to market changes and adjust harvesting activities under cut control regulations. Employment income generated in the Revelstoke TSA is estimated to be $13.8 million annually.

7.3.2 Provincial employment and employment income impacts

Provincial employment includes all forest sector employment supported by the timber harvested from the Revelstoke TSA. The harvest level in the base case over the next four decades would support an estimated 645 person-years of employment in the province and generate an estimated $25.8 million in employment income annually.

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Table 16. Socio-economic impacts: base harvest forecast, Revelstoke TSA

	At current AAC[a]	At base case harvest forecast decades 1-4
Timber supply ('000s m^3)	230	230
Harvest level (1995-1997 average)	268	—
Difference from current AAC	+ 28	0
Revelstoke timber supply area		
Employment (person-years)		
Direct	219	219
Indirect / induced	101	101
Total	320	320
Range of employment gain[b] (loss)		0
Employment income ($ millions/year)		
Direct	$10.3	$10.3
Indirect / induced	$3.5	$3.5
Total	$13.8	$13.8
Range of income gain (loss)		0
Province[c]		
Employment (person-years)		
Direct	283	283
Indirect / induced	362	362
Total	645	645
Range of employment gain (loss)		0
Employment income ($ millions/year)		
Direct	$13.4	$13.4
Indirect / induced	$12.3	$12.3
Total	$25.8	$25.8
Range of income gain (loss)		0
Provincial government revenues	($ millions/year)	($ millions/year)
Stumpage and related payments	$3.18	$3.18
Forest industry taxes	$1.99	$1.99
Employee income taxes	$2.20	$2.20
Total	$7.37	$7.37
Gain (reduction) in revenues		

(a) Estimates for current employment differ from those in Tables 13 and 14. Employment figures in this table are based on the current AAC of 230 000 cubic metres, while the figures in Tables 13 and 14 are based on the 1995-1997 annual average harvest volume of 267 918 cubic metres. Due to rounding, some totals in this table 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 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. Additional explanations and details are in Appendix B, "Socio-Economic Analysis Background Information".

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

7.3.3 Provincial government revenues

The base case harvest forecast of 230 000 cubic metres per year would generate, on average, an estimated $7.4 million annually in provincial government revenues. Assuming no changes to tax rates or to stumpage-related charges, and harvesting and full utilization of the timber supply indicated in the base case, provincial government revenues would remain at an estimated $7.4 million for the next four decades.

7.3.4 Community impacts

The impacts of short-and long-term changes in timber supply will be much greater on an economy which is dependent on the local timber supply than on one which is more diversified. Although the economy of the Revelstoke TSA is dependent on the forest sector, the base case harvest forecast indicates that the current AAC can be maintained for the next four decades, providing a degree of stability to the level of forestry activity in the Revelstoke TSA.

7.3.5 Timber requirements of processing facilities in the Revelstoke TSA

Approximately 75% of the timber harvested in the Revelstoke TSA is processed within the TSA, while most of the remaining volume is processed in the Golden, Arrow and Okanagan TSAs. Since the AAC in the Revelstoke TSA is 230 000 cubic metres and the current timber processing capacity in the Revelstoke TSA is estimated to be 375 000 cubic metres per year, processing facilities obtain additional timber supply from nearby tree farm licences (TFLs), TSAs and private sources.

7.3.6 Regional timber supply issues

An estimated 25% of the Revelstoke TSA harvest is processed outside the TSA. Logs from the Revelstoke TSA harvest which are processed outside the TSA go to a wide variety of plants, most of which are located in neighbouring TSAs. Timber from the Revelstoke TSA makes up a relatively small portion of these plants' requirements.

The movement of timber across forest district boundaries means that communities in the Revelstoke TSA are also vulnerable to timber supply changes in other districts. Information from the previous timber supply review indicates that the timber supply in the north-west Kootenay region could decline by about 15% or approximately 658 000 cubic metres within the next 20 years.[4] Since mills in the Revelstoke TSA depend on neighbouring management units for about 50% of their timber supply, future reductions could affect the timber supply available to these mills. However, this outlook may change as each successive timber supply review re-examines the timber supply in the region. 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 processes may eventually impact the Revelstoke TSA depends on actual timber supply changes, industry milling structure, and timber flows at the time.

4. These estimates are based on the most recent timber supply review base case forecasts for the Arrow TSA, Golden TSA, Okanagan TSA, TFL 23, TFL 55 and TFL 56. The combined timber supply volume for these management units is currently 4.654 million cubic metres per year and the harvest level is forecast to be 3.996 million cubic metres per year by the year 2017.

7 Socio-Economic Analysis

7.4 Summary

The forest sector is the major resource sector in the Revelstoke TSA's economy. Major licence holders in the TSA include Downie Street Sawmills Ltd., Joe Kozek Sawmills Ltd. and Bell Pole Co. Ltd. Together, they account for more than 70% of the licence volume in the Revelstoke TSA. In addition, the Ministry of Forests' Small Business Forest Enterprise Program (SBFEP) accounts for almost 20% of the licensed harvest. Primary timber processing plants include two lumber mills (Downie and Kozek), a pole plant (Bell) and two shake and shingle plants. Recently one of the shake and shingle plants, Revelstoke Cedar Products Ltd., ceased operations.

The base case harvest forecast for the Revelstoke TSA indicates that the current harvest level of 230 000 cubic metres per year can be maintained for the next four decades. This level of forestry activity would support an estimated 645 person-years of employment (includes direct, indirect and induced jobs) and annual employment income of $25.8 million in the province. Within the Revelstoke TSA, an estimated 320 person-years of employment would be supported and an estimated $13.8 million would be earned by residents of the TSA. An estimated $7.4 million in provincial government revenues would be generated annually.

Since the base case harvest forecast indicates the current AAC can be maintained for the next four decades, it is likely that employment, employment income and provincial government revenues will remain at current levels. Licensees should be able to maintain their current level of activity and operators will continue to rely on timber supply from both TSA and non-TSA sources.

In the coming years, it is possible that other sectors, such as transportation services and tourism, will be able to increase their importance in the local economy, providing additional stability and diversification to the economy in the Revelstoke TSA.

8 References

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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*.
Biodiversity	The diversity of plants, animals and other living organisms in all their forms and levels of organization, which 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 1.0 person-years of employment; or 500 000 cubic metres supports 500 person-years of employment.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover requirements	Specify desired distributions of areas by tree 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 approximated using forest cover objectives (see **Cutblock adjacency** and **Green–up**).
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.

9 Glossary

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 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. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution, landscape connectivity, stand structure and species composition.
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.
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.

9 Glossary

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.
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 at 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.
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.

9 Glossary

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.
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.

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 Revelstoke 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 1991 Ministry of Forests forest cover inventory for the Revelstoke TSA and several additional non-standard inventories were used to determine the timber harvesting land base and to represent forest management activities. The data source and reliability of the information, including any irregularities in the data and assumptions used in deriving the information, and quality assurance measures taken for non-standard data are shown in Table A-1.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Source scale
Revelstoke TSA forest cover FC1 files	Ministry of Forests (MoF) standard inventory files	1991/92	1:20,000
Federal (National) park forest cover	MoF Nelson Forest Region files	1956	1:32,000
Operability	MoF non-standard inventory files	May 1997	1:20,000
Biogeoclimatic subzone (including natural disturbance types)	MoF standard inventory files	1991/92	1:20,000
Road systems	MoF standard inventory files	1991/92	1:20,000
Caribou habitat	MoF forest district non-standard inventory files	June 1995	1:250,000
Ungulate winter habitat (non-caribou)	MoF forest district non-standard inventory files	June 1997	1:250,000 (some digitizing done from 1:20,000 contour)
Terrain resource information management (TRIM) data	Land Data BC	1980s — depends on area of interest	1:20,000
Draft landscape units boundaries	MoF forest district non-standard inventory files	1996/97	1:250,000
Visual landscape inventory	MoF forest district non-standard inventory files	1993	1:50,000
Connectivity corridors for biodiversity	MoF forest district non-standard inventory files	1997	1:50,000
Timber licence areas	MoF standard inventory files	1991/92	1:20,000

(continued)

A.1 Inventory Information

Table A-1. Inventory information (concluded)

Data	Source	Vintage	Source scale
Land ownership	MoF standard inventory files	1991/92	1:20,000
Watershed atlas (includes stream classification and community and domestic watersheds)	MoF Nelson Forest Region non-standard files	1997	1:20,000
1996 Forest Development Plan proposed cutblocks and roads	MoF forest district non-standard file	1996	1:20,000
A Tactical Landscape Analysis System (ATLAS) model harvest block and road data	Forest district non-standard files	1992	1:20,000

Forest cover

The Columbia Forest District is covered by NAD 83 mapsheets that are based on August 1992 air photography for the northern part of the Columbia Forest District and September 1991 air photography for the southern half of the forest district. These standard inventory files contain biogeoclimatic subzones, timber licence areas and land ownership.

Federal (National) park forest cover

Forest cover information for parks does not contribute to the harvest forecasts, but is used to contribute to seral-stage targets in landscape units 10 and 20.

Operability

Operability lines were revised in May 1997. The operable land base has been delineated according to whether it is operable using conventional equipment or innovative methods such as skyline and helicopter logging. Two operability lines were determined. The conventional line defines the operable land base in the base case.

Biogeoclimatic (BEC) subzones and natural disturbance types

The biogeoclimatic inventory was completed in 1992. Natural disturbance types have been derived from the biogeoclimatic classification.

Existing and planned road systems

Length for roads systems were generated using *A Tactical Landscape Analysis System* (ATLAS) database.

A.1 Inventory Information

Caribou habitat

The caribou habitat maps initially developed by the Ministry of Environment, Lands and Parks (MELP) in June 1995 have been revised through the radio telemetry work done by the Ministry of Forests (MoF) staff in 1996. The revised maps identify moderate- and high-value habitat only. The directions to licensees regarding preparation of the 1998-2002 forest development plans define the landscape units where Caribou habitat guidelines will apply.

Ungulate winter habitat

This non-standard overlay identifies important winter habitats for moose and mule deer. Boundaries were based on elevation bands and the professional judgment of district and regional Ministry of Environment, Lands and Parks staff.

Terrain resource information management (TRIM) data

Elevational data from the Ministry of Environment, Lands and Parks in 20 metre contours.

Draft landscape unit boundaries

Landscape unit boundaries were proposed in 1995. Minor revisions were made in 1996. Landscape unit boundaries and objectives have not been legally established by the Columbia Forest District manager but reference has been made to them in the last set of development plan directions approved by the forest district manager. Sixteen landscape units have been proposed for the Revelstoke area.

Visual landscape inventory

In 1993 the Revelstoke Forest District hired Mirkwood Consultants Ltd. to prepare a visual landscape inventory for the Trans-Canada and Highway 23. In accordance with the *Kootenay-Boundary Land Use Plan* (KBLUP), only the visual inventories for landscape units R4 and R20 will be considered in the timber supply analysis.

Connectivity corridors

This non-standard layer was developed by MoF district and MELP in 1995 for deployment of high- and intermediate-biodiversity emphasis in the district. Based on this information about 16% of the Revelstoke TSA gets assigned to a high-emphasis biodiversity option and 16% to an intermediate option, leaving potentially 68% for low emphasis. However, about 20% of the Revelstoke TSA that is in low-emphasis areas is also managed according to caribou habitat guidelines stringent enough to meet intermediate-emphasis biodiversity requirements. Thus, intermediate-biodiversity requirements effectively apply on 36% of the Revelstoke TSA when caribou habitat management is taken into account. In the Revelstoke TSA**,** biodiversity emphasis management will be managed using a corridor method rather than via landscape units. Generally, the high-emphasis corridors travel in a north-south direction along Lake Revelstoke and Upper Arrow Lake. The intermediate corridors extend in a east-west direction along the Downie, Goldstream, and Kirbyville drainages. Biodiversity objectives, and thus emphasis assignment have not been legally established by the forest district manager.

A.1 Inventory Information

Watershed atlas

This non-standard layer contains information on streams, wetlands and lakes. It was the source for determining areas in riparian reserve zones. This overlay also contains the boundaries of community and domestic watersheds. The following are identified community watersheds: Greeley Creek, Hamilton Creek, Bridge Creek and Dolan Creek. Domestic watersheds are also identified in areas adjacent to the City of Revelstoke.

1996 Forest Development Plan

This file contains the 1996 to 2000 Forest Development Plan maps for the Revelstoke TSA. Its purpose is to evaluate management trends in the future (i.e., area of problem forest types harvested, area harvested in the helicopter zone, etc.).

A Tactical Landscape Analysis System (ATLAS) blocks and roads

In 1992 work was done to map existing and proposed roads and blocks on the entire Revelstoke TSA land base. This work was done in preparation for running the ATLAS computer model. The existing and proposed roads identified in this database will provide the basis for determining the land base reductions required to account for existing and future roads in the timber supply analysis.

A.2 Zone and Analysis Unit Definition

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

Management zones were defined to distinguish management emphasis within the Revelstoke area landscape units, excluding Tree Farm Licences (TFL). The Revelstoke analysis area comprises the Revelstoke TSA, Mount Revelstoke National Park and a small portion of Glacier National Park. The portions of these parks that fall within Revelstoke area landscape units is relatively minor compared to the Revelstoke TSA.

For this analysis, a management zone is area within a landscape unit subject to the same combination of forest cover objectives. A management zone, for example, could be all land in landscape unit R20 classified as Englemann spruce — subalpine fir — very wet cold (ESSFvc biogeoclimatic subzone), subject to both ungulate and visual management guidelines.

Management zones are grouped in various ways for applying and tracking forest cover objectives. Forest cover objectives are the means by which some forest management requirements are modelled. One forest cover objective may wholly or partially overlap with another. In this analysis, such objectives were applied by landscape unit and biogeoclimatic zone and subzone/variant for the purpose of assessing *Biodiversity Guidebook* requirements. Forest cover objectives representing current forest management were also applied by resource emphasis area (REA) within each landscape unit.

The following groups of management zones were created for each Revelstoke landscape unit to model landscape-level biodiversity objectives:

BEC 11. Engelmann spruce — subalpine fir, very wet cold — ESSFvc (NDT1)

BEC 12. Engelmann spruce — subalpine fir, wet cold — Columbia ESSFwc1 (NDT1)

BEC 13. Engelmann spruce — subalpine fir, wet cold — North Monashee ESSFwc2 (NDT 1)

BEC 14. Engelmann spruce — subalpine fir, wet cold — Selkirk ESSFwc4 (NDT 1)

BEC 15. Interior cedar-hemlock, most warm — Columbia-Shuswap ICH mw2 (NDT2), (mis-mapped as ICH mw3)

BEC 16. Interior cedar-hemlock, very wet cold — ICH vk1 (NDT1)

BEC 17. Interior cedar-Hemlock, wet cool — Wells Gray ICH wk1 (NDT1)

BEC 25. Alpine forest

A.2 Zone and Analysis Unit Definition

The following groups of management zones were created for each landscape unit to model current forest management. In this discussion operable forest area means all physically accessible area, represented in the forest inventory as areas below the operability line. Some operable areas may not contribute to the timber harvesting land base, for example, because they contain non-merchantable timber or fall within riparian reserves.

Group 4. Caribou habitat zone — areas within the Revelstoke TSA that have been identified by MELP and MoF staff as important habitat (1996). Forest cover requirements apply separately to the ESSF and ICH BEC areas within the caribou zone. At least 10% of the operable forest area must be maintained in stands that are 250 years or older, 40% of the operable forest must be maintained in stands that are 140 years or older, and a maximum of 25% of the operable forest can be less than two metres in height (15 years) at any time.

Group 5. Visual quality objectives (VQO) zone — areas within the Revelstoke TSA and landscape units 4 and 20 that have been identified in a visual landscape inventory prepared by Mirkwood Consultants Ltd. in 1993. Within retention VQO areas, a maximum of 5% of the operable forest can be less than six metres in height (29 years). Within partial retention VQO areas, a maximum of 15% of the operable forest can be less than six metres in height (29 years).

Group 6. Important watershed zone — areas within the Revelstoke TSA that have been identified in the watershed atlas as being in a community or domestic watershed. These areas include the Greeley Creek, Hamilton Creek, Bridge Creek and Dolan Creek community watersheds , and domestic watersheds adjacent to the City of Revelstoke. Within each community watershed areas in each landscape unit, a maximum of 25% of the operable forest can be less than nine metres in height (38 years). Within each domestic watershed areas within each landscape unit, a maximum of 25% of the operable forest can be less than six metres in height (29 years).

Group 7. Ungulate winter habitat zone — ungulates use areas within fairly specific elevational lands. MELP staff have delineated winter habitat zone using elevation maps together with professional judgment. In these areas, at least 40% of the operable forest must be maintained in stands that are 100 years or older, and a maximum of 25% of the operable forest can be less than two metres in height (15 years).

Group 8. Integrated resource management (IRM) zone — all areas not assigned to one of the other management zones. In the IRM zone, a maximum of 25% of the area can be covered by stands less than two metres in height (15 years old).

A.2 Zone and Analysis Unit Definition

Table A-2. summarizes the area in each group — notwithstanding overlapping group areas.

Table A-2. Timber harvesting land base by resource emphasis group

Resource emphasis	Timber harvesting land base (hectares)[a]	Per cent of timber harvesting land base[a]
4 — Caribou ESSF	11 083.6	16.4
4 — Caribou ICH	21 895.8	32.4
5 — VQO — retention	1 430.1	2.1
5 — VQO — partial retention	2 963.8	4.4
6 — Community watershed	378.4	0.6
7 — Ungulate winter range except caribou	10 035.0	14.8
8 — Integrated resource management	26 647.7	39.4

(a) Hectares and percentages are not additive because different zone types may overlap.

Table A-3. summarizes for each group the area in each management zone — notwithstanding overlapping group areas. The first section lists areas in biodiversity management groups; the second section shows caribou habitat units; the third, ungulate winter range; the fourth, VQO areas; the fifth, community watersheds; and the sixth, IRM areas. The area in each group 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 integrated resource management (IRM) group the requirements are imposed on the timber harvesting land base. In the remaining groups the requirements are 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 by management group

Group definition			Area (hectares)		
Group	Landscape unit	Group feature	Inoperable forest	Operable excluded forest	Timber harvesting land base
1	R02	ICH mw3	20.7	200.1	159.7
2	R03	ESSF wc	104.9	6	0
3	R03	ESSFwc4	6 335.4	976	475.6
4	R03	ICH mw3	3 568.6	4 117.7	5 698.7
5	R03	ICH wk1	2782	2 366.9	673.5
6	R03	AT	765.8	0	0
7	R04	ESSF vc	617.4	36.8	34.9
8	R04	ESSFwc4	852.8	49.4	15.6
9	R04	ICH mw3	313.4	666.4	1 512.1
10	R04	ICH wk1	1 256.5	214.7	359.1
11	R04	AT	159	0	0
12	R07	ESSF vc	3 225.6	1 709.9	1 473
13	R07	ICH mw3	0.1	43.8	46.6
14	R07	ICH vk1	437.6	299.7	382.8
15	R07	ICH wk1	743.6	718.9	2 182.6
16	R07	AT	201.7	0	0
17	R08	ESSF vc	2 570.9	890.1	1 501.9
18	R08	ICH vk1	36.5	69.9	36.4
19	R08	ICH wk1	469.6	1 354.2	5 527
20	R08	AT	403.5	0	0
21	R09	ICH vk1	7.3	7.1	51.2
22	R09	ICH wk1	35.6	27.9	136.5
23	R10	ESSF vc	9 540.1	796.8	1 496.8
24	R10	ICH mw3	8.6	0	0
25	R10	ICH wk1	5 895.1	1 484.5	4 149.7
26	R10	AT	1 713.8	1.5	2.3
27	R11	ESSF vc	2 699.8	229.3	738.4
28	R11	ESSF wc	23.3	0	0
29	R11	ICH wk1	2 865.6	526.4	2 537.6
30	R11	AT	469.6	4.7	12.7
31	R12	ESSF vc	62.4	0	0
32	R12	ICH vk1	0	0	0
33	R12	ICH wk1	22.1	42.7	203.3
34	R12	AT	24.1	0	0
35	R14	ESSF vc	3 047.2	3 426.3	4 977
36	R14	ICH vk1	452.3	355.2	1 902.4
37	R14	ICH wk1	1 312.9	971.5	5 986
38	R14	AT	704.1	575.5	85.7
39	R15	ESSF vc	7 984.8	1 706.7	1 055.5
40	R15	ESSF wc	0.3	0	0
41	R15	ICH vk1	4 164.2	1 473.5	4 186.6
42	R15	AT	1 258.1	3.6	7.4
43	R16	ESSF vc	11 806.6	255.4	3 517.2
44	R16	ESSFwc2	1 234.1	0.1	0
45	R16	ICH vk1	2 944.5	315.7	2 040

continued

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting by management group

Group definition			Area (hectares)		
Group	**Landscape unit**	**Group feature**	**Inoperable forest**	**Operable excluded forest**	**Timber harvesting land base**
46	R16	ICH wk1	971.6	10.2	150.9
47	R16	AT	1 525.9	0.4	8.8
48	R17	ESSF vc	0	0	0
49	R17	ESSF wc	0	0	0
50	R17	ESSFwc2	1 675.5	244.4	1 511.4
51	R17	ICH vk1	1 199.2	270.6	3 303.6
52	R17	ICH wk1	177.3	47.2	656
53	R17	AT	433.1	16.4	2.1
54	R18	ESSF vc	8 270.3	334.1	964.4
55	R18	ESSFwc2	1.6	0	0
56	R18	ICH vk1	2 979.1	612.6	2 594.3
57	R18	ICH wk1	0.1	0	0
58	R18	AT	1 548.9	142.4	12.4
59	R19	ESSF vc	4.4	0	0
60	R19	ICH vk1	0	0	0
61	R19	ICH wk1	25.6	5.6	83.3
62	R19	AT	7.7	0	0
63	R20	ESSF vc	9 829.7	156.9	229.3
64	R20	ESSF wc	387.8	8.6	0
65	R20	ESSFwc4	7 318.4	1 030.6	918.3
66	R20	ICH mw3	1 517.4	1 167.6	0
67	R20	ICH vk1	1 521	257.6	1 001.5
68	R20	ICH wk1	9 277.6	3 127.3	3 034.6
69	R20	AT	4 709.7	7.2	30.5
Total biodiversity			136 524.0	33 364.6	67 667.2

continued

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting by management group

Group definition			Area (hectares)		
Group	**Landscape unit**	**Group feature**	**Inoperable forest**	**Operable excluded forest**	**Timber harvesting land base**
1	R07	Caribou - ESSF	167.1	475	713.7
2	R07	Caribou - ICH	67.4	48	44.6
3	R08	Caribou - ESSF	1 031.9	429.2	875.9
4	R08	Caribou - ICH	27.9	502.9	2 765.7
5	R09	Caribou - ICH	6.9	9	31.3
6	R10	Caribou - ESSF	4 252.8	793.8	1 472.7
7	R10	Caribou - ICH	2 900.7	1 319	3 879
8	R11	Caribou - ESSF	150.4	184.1	586.8
9	R11	Caribou - ICH	86.6	270.1	1 400.6
10	R12	Caribou - ESSF	0	0	0
11	R12	Caribou - ICH	22.1	42.5	202.7
12	R14	Caribou - ESSF	995.8	2 709.2	4 390.3
13	R14	Caribou - ICH	1 073.8	968.6	6 911.7
14	R15	Caribou - ESSF	1 131	770.1	812.8
15	R15	Caribou - ICH	327.1	424.8	2 690.1
16	R16	Caribou - ESSF	989.5	105	1 928.7
17	R16	Caribou - ICH	628.8	151.1	1 622.1
18	R17	Caribou - ESSF	295	122.2	90.7
19	R17	Caribou - ICH	371.4	21.3	72.7
20	R18	Caribou - ESSF	64.3	0	0
21	R18	Caribou - ICH	238.8	6.7	122.5
22	R19	Caribou - ESSF	0	0	0
23	R19	Caribou - ICH	25.6	5.6	83.3
24	R20	Caribou - ESSF	3 376.6	153.8	212.1
25	R20	Caribou - ICH	1 341	1 423.9	2 069.5
Total Caribou			19 572.5	10 936.0	32 979.4
1	R02	UWR		16.9	101.8
2	R03	UWR	356.8	469.7	1 109.3
3	R04	UWR	0	2.5	3.2
4	R07	UWR	20.5	44.8	38
5	R08	UWR	7.4	430.7	1 089
6	R09	UWR	34.2	33.6	179.7
7	R10	UWR	1 210	811.1	1 592.8
8	R11	UWR	328.2	53.4	217.8
9	R12	UWR	13.3	37.2	153
10	R14	UWR	182.6	195.3	1 754.3
11	R15	UWR	72.8	85.4	607.3
12	R16	UWR	152.4	104.3	883.9
13	R17	UWR	448.9	169.4	1 701.4
14	R18	UWR	284.1	80.3	522.2
15	R19	UWR	17	5.3	72.2
16	R20	UWR	129.7	619.5	9.1
Total ungulate winter range			3 274.8	3 258.9	10 035.0

continued

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

Group definition			Area (hectares)		
Group	**Landscape unit**	**Group feature**	**Inoperable forest**	**Operable excluded forest**	**Timber harvesting land base**
1	R04	VQO - R	1 538.6	3 79.7	501.7
2	R04	VQO - PR`	121.3	5 12.3	1 374.7
3	R20	VQO - R	3 586.6	2 398.8	928.4
4	R20	VQO - PR	4 567.4	1 301.9	1 589.1
Total visual quality objectives			9 813.9	4 592.7	4 393.9
1	R04	Community watershed	7.1	77.2	378.4
2	R20	Community watershed	1 341.4	1 127.3	0
Total community watershed			1 348.5	1 204.5	378.4
1	R02	IRM	3.8	83.8	57.8
2	R03	IRM	13 199.9	6 996.9	5 738.5
3	R04	IRM	1 539.2	75.2	45.4
4	R07	IRM	4 353.6	2 204.5	3 288.7
5	R08	IRM	2 413.3	1 085.3	3 004.6
6	R09	IRM	8.7	1.3	7
7	R10	IRM	9 956.9	83.2	236.2
8	R11	IRM	5 493.1	270.3	1 162.5
9	R12	IRM	86.5	0	0
10	R14	IRM	3 421.4	1 638.7	1 552.4
11	R15	IRM	11 949	1 988.2	1 740.6
12	R16	IRM	16 864.4	322.6	2 157.8
13	R17	IRM	2 519.3	286.9	3 681.1
14	R18	IRM	12 404.7	1 003.7	2 961.7
15	R19	IRM	12.1	0	0
16	R20	IRM	21 505.9	526.3	10 12.4
Total integrated resource management			105 731.8	16 566.9	26 646.7

To simplify the analysis, individual forest stands were grouped into analysis units according to dominant tree species (inventory type group), silvicultural regime, and timber growing capability (site index).

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-20. for existing natural stands and Tables A-21. and A-22. 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 zones and tracking multiple objectives."

A.2 Zone and Analysis Unit Definition

Table A-4. Definition of analysis units

Analysis unit number	Leading species	Inventory type groups	Site index range (metres @ 50 years)	Age range (years)	Timber harvesting land base (includes NSR) (hectares)
11	Douglas-fir/larch/pine	1-8, 27-34	21.1+	20+	1 608.1
12	Douglas-fir/larch/pine	1-8, 27-34	17 to 21	20+	2 983.6
21	Douglas-fir/larch/pine	1-8, 27-34	8 to 16.9	20+	2 093.7
31	Western hemlock	12-17	16.1+	20+	3 926.1
32	Western redcedar	9-11	17.1+	20+	4 505.8
33	Western hemlock	12-17	13 to 16	20+	9 533.9
34	Western redcedar	9-11	14 to 17	20+	5 456.6
41	Western hemlock	12-17	8 to 12.9	20+	7 290.1
42	Western redcedar	9-11	8 to 13.9	20+	793.1
51	Spruce/subalpine fir	20-26	19.1+	20+	3 006.4
52	Spruce/subalpine fir	20-26	12 to 19	20+	6 259.7
56	Subalpine fir (balsam)	18-19	8+	20 to 140	430.72
61	Spruce/subalpine fir	20-26	8 to 11.9	20+	3 509.3
95	Stands outside timber harvesting land base	All	All	All	—
118	Douglas-fir/larch/pine	1-8, 27-34[a]	8+	0 to 20	4 134.8
138	Hemlock/cedar	9-17[a]	8+	0 to 20	3 941.0
158	Spruce/subalpine fir	18-26[a]	8+	0 to 20	6 384.9
146	Backlog ≥ 60% MSS[b]	1-34[a]	8+	0 to 20	1 284.8
147	Backlog < 60% MSS	1-34[a]	8+	0 to 20	524.9
	Total				67 667.3

(a) Also includes NSR land having type identity 4 or 9.
(b) MSS: minimum stocking standards.

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Revelstoke TSA area. 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. Table 3 in the main report lists the areas in each category of land. However, one area could have more than one characteristic that would identify it as falling outside the timber harvesting land base: it could be both a park and wildlife habitat, for example. The areas in Table 3 were derived by examing the characteristics of the land in a particular order; the areas could be different if the characteristics were examined in a different order. The discussion below follows the order used in compiling Table 3.

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 ownerships 62 C (forest management unit) 69 C (forest reserves) or 70 N (timber licence area) contribute to timber harvesting and are considered to be managed by the B.C. Forest Service. All land not classified as ownerships 62 C, 69 C and 70 N is considered land not directly managed by the B.C. Forest Service.

All timber licence area (70 N) except for licences 451 and 467 have expired. Licences 451 and 467 are due to expire in 2025. Between now and 2025 these licences will be gradually harvested.

A.3 Definition of the Timber Harvesting Land Base

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

Ownership classification	Total area within analysis area (hectares)	Land not managed for timber supply within the Revelstoke analysis area (hectares)
Area within the Revelstoke TSA		
40-N private	5 570.8	5 570.8
50-N Federal Reserve	174.6	174.6
61-N UREP	206.3	206.3
62-C	485 685.4	0.0
62-N	22.3	22.3
63-N Park class A	20.8	20.8
69-C Miscellaneous reserves	4 643.3	0.0
69-N Miscellaneous reserves	406.5	406.5
70-N Timber licence in a TSA	3 969.7	0.0
77-N Woodlot licence	771.5	771.5
Total Revelstoke TSA	501 471.2	7 172.8
National Parks - Mount Revelstoke and Glacier	48 898.8	48 898.8
Total Revelstoke analysis area	550 370.0	56 071.6

A.3 Definition of the Timber Harvesting Land Base

A.3.2 Non-forest and non-productive forest land

Non-forest and non-productive forest land (TYPID_PR = 6) - 250 968.9 hectares - and non-typed (TYPID_PR = 8) - 149.1 hectares – areas do not contribute to timber harvesting. These categories include areas such as sparse alpine forest, ice, swamps, water, and rock.

A.3.3 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5) - 69.3 hectares – were not included in the timber harvesting land base.

A.3.4 Inoperable areas

The inventory file contains a 1997 operability classification for most of Revelstoke TSA. All areas that were inoperable (OPERABLE = I,M or N) based on this classification – 120 376.2 hectares – were excluded from the timber harvesting land base. For a small percentage of area not covered by the 1997 classification a 1994 operability classification was used to identify inoperable (OPERABLE = I,M,N) area.

A.3.5 Exclusion of specific, geographically defined areas

The Greeley Creek watershed (MAPSHEET = 82K091, 82L100 or 82M010 in the inventory file) — an area of 8592.4 hectares — was not included in the timber harvesting land base. This watershed is comprised mostly of hemlock-leading stands older than 140 years, which are considered a problem forest type. Significant geotechnical and engineering constraints must be overcome to harvest in the area, and much of the area is classified as inoperable or environmentally sensitive. Given low timber value, high costs for road building and harvesting, and high risk to water quality for the City of Revelstoke, this area was excluded from the timber harvesting land base.

A.3.6 Existing unclassified roads, trails, and landings

Many roads, trails and landings constructed for forest access and harvesting are not large enough to be classified on the inventory file. Columbia Forest District staff estimated that unclassified permanent roads occupy 2262 hectares of land that would otherwise be included in the timber harvesting land base. This estimate was based on geographic information system (GIS) data obtained from A Tactical Landscape Analysis System (ATLAS) database used in planning and spatial modelling exercises. The database included information on existing and proposed roads.

From the database it was determined that 1 131 000 metres of existing unclassified road run through the productive forest (Crown forest) after non-commercial cover, inoperable land and the Greeley Creek watershed are excluded. Assuming road right-of-way widths are 20 metres on average, the area in existing roads was calculated by multiplying road length by width.

To represent the area of existing roads, the area of all stands within the currently roaded area was reduced by 2.44725%.

Existing trails and landings include landings and on-block roads used in harvesting operations over the last twenty years that are not re-stocked, and continue to be unproductive for growing merchantable timber. An estimate of area lost to these trails and landings was based on advice from the regional pedologist for four time periods when different standards applied. The estimate was an average of 5.74% of the area harvested over the last twenty years. More detail on the derivation of this estimate can be found in Table 8 of the *Revelstoke TSA Timber Supply Review Data Package* (November 1997).

Volume estimates for existing stands regenerated in this same period were reduced by 5.74% to account for productivity losses due to existing trails and landings.

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as sensitive soils, avalanches and regeneration. Environmental sensitivity is designated as high (ESA1) or moderate (ESA2), depending on the degree of sensitivity or value for other resources. The high ESA class is applied where very high environmental sensitivity or value for other resources precludes timber harvesting. The moderate ESA class is given to areas where significant sensitivity or value for other resources results in conditions or restrictions being applied to timber harvesting. Portions of areas classified as highly environmentally sensitive (ESA1) were excluded from the timber harvesting land base using the percentages shown in Table A-6.

Table A-6. Per cent of area considered unavailable for timber harvesting due to environmental sensitivity

ESA 1 code(s) (high sensitivity)	Description	Per cent of area unavailable for timber harvesting	Area reduction (hectares)
A,AP	Avalanche	100	12.1
P,PR	Regeneration difficulty	90	2 342.8
S,SA,SAP,SAR,SH,SP,SPR,SR,SW	Soils	90	10 466.7
H,HR,R,RW,W	Recreation, wildlife, watershed	0	0.0

The ESA definitions are:

- A — areas of avalanche instability.
- H — areas important for maintenance of water quality.
- P — areas where regeneration will likely be difficult.
- R — areas of importance for recreation.
- S — areas where unstable soils may deteriorate unacceptably after harvesting.
- W — areas of critical importance to wildlife for food, shelter or reproduction.

Areas classified as ESA2 were not deducted when defining the timber harvesting land base. Many of these areas are in management zones subject to forest cover requirements to protect non-timber values. In all cases, special attention is taken when planning and operating in environmentally sensitive areas to protect the related value.

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. Additional wildlife habitat areas, important watersheds, and recreation areas not identified in the forest inventory file were identified by GIS overlays. Forest cover objectives rather than land base reductions were applied to these areas to address management concerns. Forest cover objectives are discussed later in Section A.4.4, "Forest cover requirements."

A.3 Definition of the Timber Harvesting Land Base

A.3.8 Estimated area in riparian reserves and riparian management zones

To account for protection of riparian and stream values within the Revelstoke TSA, 2048.1 hectares were excluded from the timber harvesting land base. Table A-7. describes the information used to estimate the riparian area.

Table A-7. Riparian management areas

Riparian class	Stream length (metres)	Reserve zone width (metres)	Management zone width (metres)	Retention in management zone (%)	Total riparian reduction area width (metres)	Reduction area (hectares)
S2	136 337.5	30	20	50	40	1 090.7
S3	51 551.6	20	20	50	30	309.3
S5	281 687.5	0	30	25	8	450.7
W	13 600.0	NA	NA	NA	15	20.4
L	141 600.0	NA	NA	NA	12.5	177.0
Total						2 048.1

- S2, S3, S5 — stream class according to the FPC *Riparian Management Area Guidebook.*
- W — wetland.
- L — lake.

Riparian management area (RMA) classifications for the Revelstoke TSA were done using a methodology developed by the Ministry of Environment, Lands and Parks and the Ministry of Forests at Nelson for this timber supply analysis. GIS layers and inputs such as the watershed atlas stream network, watershed atlas lake and wetland polygons, community watershed polygons and the Forest Renewal British Columbia (FRBC) fish inventory provided the base line information for determining riparian management area classifications. Field sampling was done to check some of the assumptions used in the GIS model. Details of this classification procedure are described in a report produced by Nanuq Consulting Ltd. (May 1997) available in the Nelson Forest Region office. Riparian area exclusions were performed on specific geographic areas based on the information discussed above.

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

Reserve zone	30 metres
Management zone	20 metres
Retention in management zone	50%
Implied reserve in management zone	(20 * 0.5) = 10 metres
Total riparian area reserve	40 metres (reserve zone 30 metres plus implied management zone 10 metres)

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Sites with low timber growing potential

Sites may have low timber growing potential either because of inherent site factors (nutrient availability, exposure, excessive moisture), or because they are not fully occupied by commercial tree species. Typically, these stands are intermixed with other stands within the forested land base. The forest inventory rates growing potential of stands using a site index (height at 50 years breast height age). Stands with a site index of less than eight (SITE_IDX < 8) — 1175.8 hectares, after deductions discussed to this point — are excluded from the timber harvesting land base due to low timber growing potential. Trees would not likely attain a 25 cm dbh before 120 years of age on these excluded sites.

A.3.10 Deciduous types

The deciduous component of the forest can occur as relatively minor components of stands of mixed coniferous and deciduous species, and as predominately deciduous stands. Forest inventory type groups 35 to 42 have deciduous species leading and have a smaller proportion of coniferous trees. These type groups (ITG_NO = 35, 36, 37, 38, 39, 40, 41 or 42) were removed from the timber harvest land base, resulting in an exclusion of 1596.5 hectares.

A.3.11 Non-merchantable 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-8. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

Table A-8. Non-merchantable forest types criteria

Species	Inventory type group	Projected age	Reduction per cent (%)	Area reduction (hectares)
Western hemlock	12 (pure stands)	140+	100	3 472.7
Alpine fir (balsam)	18 – 19	140+	100	1 395.2

A.3.12 Estimated area of future roads, trials 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. Columbia Forest District staff estimated that future roads will occupy 4703 hectares of land that would otherwise be included in the timber harvesting land base. Like existing roads, this estimate was based on GIS information obtained from an ATLAS database used in planning and spatial modelling exercises.

From the database it was determined that 2 351 524 metres of future roads may be built through the current timber harvesting land base. Assuming road right-of-way widths are 20 metres on average, the area in future roads — 4703 hectares — was calculated by multiplying road length times width.

The area of stands harvested for the first time were reduced by 6.95% to account for future roads. This percentage was calculated by dividing 4703 hectares by the portion of the timber harvesting land base not subject to deductions for existing roads. Since not all eligible stands on the timber harvesting land base were harvested in the base case forecast, 4381 hectares, not the estimated 4703 hectares, are lost to future roads.

A.3 Definition of the Timber Harvesting Land Base

Volume estimates for future regenerated stands were reduced by 3.3% to account for productivity losses due to future trails and landings. This estimate, which is an average for recent operations, was based on advice given by the regional pedologist. More detail on the basis for this estimate can be found in the *Revelstoke TSA Timber Supply Review Data Package* (1997).

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization level defines the maximum allowable stump height, and the diameters at breast height (1.3 metres) and at the top of the tree used to calculate merchantable timber volumes.

In the Revelstoke TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-9.

Table A-9. Utilization levels

Analysis unit	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib[a] (cm)
All pine units	12.5	30	10
Cedar > 140 years old	17.5	30	15[b]
Cedar ≤ 140 years old	17.5	30	10
All other conifer units	17.5	30	10

(a) Diameter inside bark.

(b) Although standard is 15 cm — the volume curves reflect 10 cm dib.

A.4.2 Minimum harvestable age by analysis unit

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-10., and by professional judgment of Ministry of Forests' district staff. These criteria apply to existing natural and managed second-growth stands, and future regenerated stands.

A.4 Forest Management Assumptions

Table A-10. Minimum harvestable age criteria

Analysis unit	Minimum age to achieve 25 cm average diameter		Minimum age to achieve 150 m³/ hectare[c]		Culmination age (maximum MAI)		Minimum harvestable age natural stands	Minimum harvestable age managed[d] stands
	VDYP[a]	TIPSY[b]	VDYP	TIPSY	VDYP	TIPSY		
11 Fir, good site	75	50	55	50	106	105	90	90
12 Fir, medium site	85	65	70	65	125	125	100	100
21 Fir, poor site	85	90	90	95	134	145	110	120
31 Hemlock, good site	65	55	65	55	109	100	90	80
32 Cedar, good site	55	55	60	55	113	95	90	80
33 Hemlock, medium site	80	70	95	75	130	120	100	100
34 Cedar, medium site	70	65	70	70	126	110	100	90
41 Hemlock, poor site	95	95	90	100	148	155	120	125
42 Cedar, poor site	80	80	95	85	139	135	110	110
51 Spruce, good site	55	40	60	45	84	70	70	60
52 Spruce, medium site	80	65	85	70	124	115	100	100
56 Alpine fir-leading	85	75	85	85	150	135	120	120
61 Spruce, poor site	105	95	135	105	173	170	140	140
118 Fir second growth	N/A	80	N/A	80	N/A	140	N/A	110
138 Cedar second growth	N/A	55	N/A	60	N/A	105	N/A	85
158 Spruce second growth	N/A	65	N/A	70	N/A	115	N/A	90
146 Backlog	N/A	80	N/A	100	N/A	200	N/A	160
147 Backlog — low stocking	N/A	130	N/A	210	N/A	250	N/A	200

(a) VDYP is the Variable Density Yield Prediction model developed and supported by MOF Resources Inventory Branch, and used to project yields for naturally regenerated stands.

(b) TIPSY is the Table Interpolation Program for Stand Yields model developed and supported by MOF Research Branch, and used to project yields for managed plantations.

(c) For utilization levels described in Section A.4.1, "Utilization levels."

(d) Managed stands include existing (second growth) and future plantations. In this context management connotes control of stocking and competition.

A.4 Forest Management Assumptions

A.4.3 Harvest profile

The harvest profile describes any characteristics desired from the timber harvest, for example, the proportion of the total harvest made up of a particular tree species. No harvest profile requirements were applied in the Revelstoke TSA analysis.

A.4.4 Forest cover requirements

This analysis did not involve an explicitly spatial 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.

The forest cover requirements shown in Table A-11. are meant to be consistent with the *Kootenay-Boundary Land Use Plan Implementation Strategy* and the latest Minister's Advisory Committee (MAC) recommendations to government on how the *Kootenay-Boundary Land Use Plan* should be implemented in the Revelstoke TSA portion of the Columbia Forest District. In addition, the forest cover requirements also reflect the *Supplement to the Forest Development Plan Guidebook for the Nelson Forest Region and Columbia Forest District, 1998-2002 Forest Development Plans*, and a Memorandum of Understanding between Ministry of Forests and Ministry of Environment, Lands and Parks Regarding Instructions for the Preparation of the 1998 Forest Development Plans, released in October 1997.

The forest cover requirements for caribou habitat apply to areas identified on maps by the Ministry of Environment, Lands and Parks as of 1996. The maps identify high and moderate value habitat. The directions to licensees regarding preparation of the 1998-2002 Forest Development Plans identify the guidelines and where they are to be considered.

Forest cover requirements for ungulate winter habitat requirements apply to areas identified on maps by the Ministry of Environment, Lands and Parks as of 1997. Habitat boundaries were based on elevation bands and the professional judgment of district Ministry of Forests and regional Ministry of Environment, Lands and Parks staff. This habitat inventory was overlaid with the forest cover inventory for use in the timber supply analysis.

Forest cover requirements for visual quality objectives apply to areas identified in a visual landscape inventory prepared by Mirkwood Consultants Limited in 1993. Only the visual inventories for landscape units R4 and R20 were used, in accordance with the KBLUP. Local knowledge and estimates were used to determine a green-up height of six metres and the per cent allowable disturbance for any visual quality objectives. In the Revelstoke TSA the maximum allowable disturbance in areas managed for visual quality are reflected in *Procedures for Factoring Visual Resources into Timber Supply Analysis* (B.C. MoF, Forest Practices Branch, 1998).

A.4 Forest Management Assumptions

Forest cover requirements for community and domestic watersheds were applied to areas identified in the watershed atlas provided by the Ministry of Environment, Lands and Parks. Community watersheds include Greeley Creek, Hamilton Creek, Bridge Creek and Dolan Creek. Domestic watersheds include areas adjacent to the City of Revelstoke, but because most of the area is private land, no forest requirement for Crown land is applied for modelling purposes.

A growth-yield model, Site Tools v3.0, B.C. Ministry of Forests, Research Branch, 1998a was used to estimate when trees will reach a top height of two metres (integrated resource management zone, wildlife zones), six metres (VQO zones) or nine metres (community watershed zones). While recognizing that the TSA land base will support a range of growth rates, average green-up ages based on forest stand type (analysis unit) distribution throughout the Revelstoke TSA were used to simplify the analysis. These green-up ages do not include regeneration delay; the delays are dealt with separately in the simulation model.

Table A-11. specifies the forest cover requirements for the Revelstoke TSA. Except for the integrated resource management zone, the cover requirements apply to the total physically operable forest land base. In the integrated resource management zone they apply to the timber harvesting land base.

Table A-11. Resource emphasis area forest cover requirements

Zone type	Green-up age (years)	Maximum per cent area younger than green-up age	Old-age forest (years)	Minimum per cent of area covered by old-age forest
Caribou ESSF	15	25	140	40
			250	10
Caribou ICH	15	25	140	40
			250	10
Ungulate winter range	15	25	100	40
VQO — retention	29	5	N/A	N/A
VQO — partial retention	29	15	N/A	N/A
Domestic watersheds	29	25	N/A	N/A
Community watersheds	38	25	N/A	N/A
Integrated resource management	15	25	N/A	N/A

A.4 Forest Management Assumptions

A.4.5 Biodiversity

Landscape-level biodiversity

Sixteen proposed landscape units make up the Revelstoke analysis area. Situated within the Revelstoke analysis area is the Revelstoke TSA and all or parts of: TFL 23, TFL 55, TFL 56, Mount Revelstoke National Park and Glacier National Park. The assessment of landscape-level biodiversity in this analysis included forests of the Revelstoke TSA, Mount Revelstoke National Park and a portion of Glacier National Park only.

Forests of the Mount Revelstoke National Park contribute to landscape biodiversity in just two of the sixteen landscape units — units 10 and 20. In the context of affecting timber supply, the park contribution to landscape biodiversity is likely negligible because most seral-stage targets can be met without it.

Landscape units have not been officially and legally designated, and no objectives have been set for them. Therefore, it was assumed that a 45%-45%-10% low- intermediate- high-emphasis option weighting would apply to each area now being proposed as a landscape unit within the Revelstoke area. The 45%-45%-10% emphasis option weighting does not presuppose any landscape unit as being either low-, intermediate- or high-emphasis yet it approximates on average the forest cover requirements for landscape-level biodiversity within the Revelstoke area. Generalized forest cover requirements to approximate landscape-level biodiversity objectives were determined in accordance with the Memorandum from the director of the Ministry of Forests, Timber Supply Branch regarding incorporating biodiversity and landscape units in the Timber Supply Review dated, December 1, 1997. The *Forest Practices Code Biodiversity Guidebook* describes the following forest cover requirements for each natural disturbance type (NDT) and emphasis as shown in Table A-12.

Stand-level biodiversity

Both wildlife trees (WTs) and wildlife tree patches (WTPs) are used to provide structure to retain stand-level biodiversity, as described in the FPC *Biodiversity Guidebook*. For conditions in the Revelstoke TSA, Table 20a of the guidebook recommends an overall average retention of 6% of cutblock area in each landscape unit. Recognizing the contribution of forest outside the timber harvesting land base (e.g., riparian areas, non-merchantable stand types) to stand-level biodiversity, it is estimated that WTs and WTPs will reduce timber yield from cutblocks by 3%. To represent retention of WTs and WTPs, timber yield projections for both existing and future stands were reduced by 3%.

According to the *Biodiversity Guidebook*, WTPs larger than two hectares could contribute to seral-stage requirements (landscape-level biodiversity). However, because such larger patches are not common in the Revelstoke TSA, their potential contribution to landscape biodiverstiy was not modelled in this analysis.

A.4 Forest Management Assumptions

Table A-12. Landscape-level biodiversity: biodiversity guidebook distribution objectives for each seral stage, by emphasis option, for the NDTs in the Revelstoke area

Biogeoclimatic unit subzone/variant	Distribution objectives in per cent for each seral stage, by emphasis option								
	Early			Mature + old			Old		
	Low	Inter-mediate	High	Low	Inter-mediate	High	Low	Inter-mediate	High
ESSFwc1	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28
ESSFwc2	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28
ESSFwc4	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28
ESSFvc	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28
ICHmw2	N/A	< 30	< 23	> 17	> 34	> 51	> 13	> 13	> 19
ICHvk1	N/A	< 30	< 23	> 17	> 34	> 51	> 13	> 13	> 19
ICHmw2	N/A	< 30	< 23	> 17	> 34	> 51	> 13	> 13	> 19

The ages for early-, mature- and old-seral stages are as listed in Table A-13.

Table A-13. Seral stage definitions by biogeoclimatic subzone/variant

Biogeoclimatic unit (subzone/variant)	Age (years)		
	Early	Mature + old	Old
ESSFwc1	< 40	> 120	> 250
ESSFwc2	< 40	> 120	> 250
ESSFwc4	< 40	> 120	> 250
ESSFvc	< 40	> 120	> 250
ICHwk1	< 40	> 100	> 250
ICHvk1	< 40	> 100	> 250
ICHmw2	< 40	> 100	> 250

A.4 Forest Management Assumptions

As specified in the aforementioned letter, early-seral requirements were not applied. Furthermore, old-forest requirements for low emphasis landscape-level biodiversity were designed to be met by the end of three rotations of 70 years each, with one-third of the percentage required over the first 70 years, two-thirds of the requirements applied from 71-140 years from the present, and the full requirement applied from 141 years onward. The full requirement is applied at the beginning of the third rotation to ensure that it will be fully achieved by the end of that rotation.

Table A-14. Calculation of low-emphasis biodiversity option older forest cover requirements

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

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

Time 0: old forest % = 19% * 0.33 = 6.27

Time 70: old forest % = 19% * 0.66 = 12.54

Time 140: old forest % = 19% * 1.00 = 19.00

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, each landscape unit proposed for the Revelstoke area 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 and biogeoclimatic zone variant 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 ESSFvc would be calculated as follows:

Time 0: old forest % = (19% * 0.45) * 0.33
+ 19% * 0.45
+ 28% * 0.10
14.17%

Time 70: old forest % = (19% * 0.45) * 0.66
+ 19% * 0.45
+ 28% * 0.10
16.99%

Time 140: old forest % = (19% * 0.45) * 1.00
+ 19% * 0.45
+ 28% * 0.10
19.90%

A.4 Forest Management Assumptions

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

Table A-15. Forest cover requirements applied for landscape-level biodiversity

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)
ESSFwc1	Now – 70	1	30.2	120	14.2	250
ESSFwc2	Now – 70	1	30.2	120	14.2	250
ESSFwc4	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
ICHmw2	Now – 70	2	28.1	100	9.7	250
ICHmw3	Now – 70	2	28.1	100	9.7	250
Parkland[a]	Now – 70	5	30.2	120	14.2	250
ESSFwc1	71 – 140	1	30.2	120	17.0	250
ESSFwc2	71 – 140	1	30.2	120	17.0	250
ESSFwc4	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
ICHmw2	71 – 140	2	28.1	100	11.6	250
ICHmw3	71 – 140	2	28.1	100	11.6	250
Parkland[a]	71 – 140	5	30.2	120	17.0	250
ESSFwc1	141+	1	30.2	120	19.9	250
ESSFwc2	141+	1	30.2	120	19.9	250
ESSFwc4	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
ICHmw2	141+	2	28.1	100	13.6	250
ICHmw3	141+	2	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. These areas are most likely in the ESSF zone. Cover requirements for NDT1 ESSF will be used, and are listed in this table.

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 (so-called 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-16. summarizes the estimate used in this analysis for unsalvaged losses coming from the timber harvesting land base in the Revelstoke TSA.

Table A-16. Unsalvaged losses

Cause of loss	Unsalvaged loss (hectares/year)	Unsalvaged loss (m^3/year)
Wildfire	18.3	3 239
Broadcast/fringe burn	11.2	4 389
Total fire	**29.5**	**7 628**
Hemlock looper	1.5	450
Spruce bark beetle	0.0	0
Douglas-fir bark beetle	0.6	210
Total pests/insects	**2.1**	**660**
Windthrow/blowdown	**0.7**	**228**
Avalanche	**0.2**	**70**
Total loss	**32.5**	**8 586**

Information about unsalvaged losses was collected from forest district staff, licensees, the regional protection fire reporting system, major licensee silviculture information system (MLSIS), integrated silviculture information system (ISIS) (harvesting databases), annual reports, and Forest Insect Disease Survey (FIDS) reports. The best data available was used for the analysis; professional judgment was often necessary to define which losses occurred on the timber harvesting land base. A permanent database has been constructed to update unsalvaged losses on an annual basis which will provide more accurate results for future timber supply reviews.

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 Revelstoke TSA. Table A-17. 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 knowledge of forest region and district silvicultural staff.

A.4 Forest Management Assumptions

Table A-17. Regeneration assumptions

					OAFs		Method		Species		Density
	Analysis unit	Composition	SI BHA 50	Regen delay	1	2	Type	%	Code	%	Initial
11	Fir, good site	F, L, Pl	23.4	2	15	5	Plant	100	F L Pl	60 30 10	1500
12	Fir, medium site	F, L, Pl	19.0	2	15	5	Plant	100	F L Pl	60 30 10	1500
21	Fir, poor site	F, Pl	15.2	2	15	5	Plant	100	F Pl	50 50	1500
31	Hemlock, good site	S, F, C, H	18.4	2			Plant	100	S F C H	50 20 20 10	1500
32	Cedar, good site	S, C, F	18.7	2	15	5	Plant	100	S C F	60 30 10	1500
33	Hemlock, medium site	S, F, C, H	14.3	2	15	5	Plant	100	S F C H	50 20 20 10	1500
34	Cedar, medium site	S, C, F	15.8	2	15	5	Plant	100	S C F	60 30 10	1500
41	Hemlock, poor site	F, S, H	11.4	2	15	5	Plant	100	F S H	50 40 10	1500
42	Cedar, poor site	S, F, C, H	12.8	2	15	5	Plant	100	S F C H	50 20 20 10	1500
51	Spruce, good site	S, B	23.0	2	15	5	Plant	100	S B	90 10	1500
52	Spruce, medium site	S, B_1	15.1	2	15	5	Plant	100	S B	90 10	1500
56	Alpine fir, not low site	S, B	13.0	2	15	5	Plant	100	S B	90 10	1500
61	Spruce, poor site	S, B	10.3	2	15	5	Plant	100	S B	90 10	1500

continued

A.4 Forest Management Assumptions

Table A-17. Regeneration assumptions (concluded)

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs 1	OAFs 2	Method Type	Method %	Species Code	Species %	Density Initial
Second growth										
118 Fir	F, L, Pl	16.8	2	15	5	Plant	100	F Lw Pl	60 30 10	1500
138 Hemlock	S, F, C, H	17.9	2	15	5	Plant	100	S F C H	50 20 20 10	1500
158 Spruce	S, B	15.0	2	15	5	Plant	100	S B	90 10	1500
146 Backlog ≥ 60% MSS	H, C, S, B	14.0	3	15	5	Natural	100	H C S B	40 30 20 10	550
147 Backlog < 60% MSS	H, C, S, B	10.0	3	15	5	Natural	100	H C S B	40 30 20 10	350

A.4 Forest Management Assumptions

Regeneration delay is the average time between the completion of harvesting and the time needed to establish more than 1400 well spaced stems per hectare, less the age of the stock if planting is used to establish the next stand. Planting stock on average is assumed to be one year old and this age is factored into the regeneration delay.

Provincial average operational adjustment factor (OAF) values are assigned as no local values are available. OAFs used in managed stand yield table generation were:

OAF1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand);, and

OAF2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age).

Table A-18. identifies stands of existing immature forest where stand management has likely occurred. These stands were assigned to managed stand yield curves at the beginning of the analysis horizon**.**

Table A-18. Immature plantation history

	Area managed (per cent)	
Analysis unit	**Age 1-10**	**Age 11-20**
All	100	100

A.4.8 Not satisfactorily restocked (NSR) areas

Land coded as not satisfactorily restocked (TYPID_PRJ = 4 or 9) in the inventory file is included in the timber harvesting land base. A total of 4917.91 hectares of timber harvesting land base is coded as not satisfactorily restocked (NSR). Forest district silviculture data and ISIS/MLSIS data on not satisfactorily restocked areas assisted in assigning NSR areas to analysis units and in developing volume tables.

Forest district data indicated 1809.7 hectares of NSR area harvested before 1987 with low stocking. For these areas, if the reported stocking was greater than 60% of the minimum stocking standard, 400 to 700 stems per hectare was assumed for modelling projected yields, and the area was assigned to backlog analysis unit 146. If the reported stocking was 60% or less, 300 – 399 stems per hectare was assumed for projecting yields, and the area was assigned to backlog analysis unit 147. Not satisfactorily restocked areas harvested after 1987 were assigned to either analysis unit 118, 138 or 158 depending on the inventory type group code and projected age. Normal stocking of 1,500 stems per hectare was assumed for NSR area harvested after 1987.

A.4 Forest Management Assumptions

Table A-19. shows the area distribution and ages of the 4917.9 hectares typed as NSR on the inventory file.

Table A-19. Not satisfactorily restocked (NSR) areas

Analysis unit	Timber harvesting land base (hectares)			
	Total NSR area on inventory file	Age > 10 years backlog NSR 300-399 stems/hectare	Age > 10 years backlog NSR 400-700 stems/hectare	Age 0-10 current NSR
118 – Fir leading	2 193.4	0.0	0.0	2 193.4
138 – Cedar/hemlock leading	1 248.8	(366.2)	(882.6)	0.0
158 – Spruce/balsam leading	1 475.7	(167.4)	(373.4)	934.9
146 – Backlog 60% MSS[a]			1 256.0	
147 – Backlog < 60% MSS[a]		533.6		
Total	4 917.9	533.6	1 256.0	3 128.3

(a) MSS — minimum stocking standard.

A.4.9 Rehabilitation of problem forest types, and non-commercial cover areas

Rehabilitation of non-commercial cover occurs on a very small portion of the Revelstoke TSA land base. Due to the small area treated, these activities are not included in the analysis.

A.5 Volume Estimates for Existing Natural Stands

The variable density yield prediction (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-20. shows the volume estimates by analysis unit for existing natural stands.

Table A-20. Timber volume tables for existing natural stands (cubic metres/hectare)

	Volume table number and analysis unit number						
Age	**11 Fir, good site**	**12 Fir, medium site**	**21 Fir, poor site**	**31 Hemlock, good site**	**32 Cedar, good site**	**33 Hemlock, medium site**	**34 Cedar, medium site**
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	13	2	0	4	0	0	0
40	61	29	5	51	56	7	27
50	118	69	27	111	111	51	74
60	172	108	56	165	161	98	118
70	224	145	85	213	205	141	157
80	272	181	112	255	246	180	192
90	314	213	138	289	276	211	219
100	350	242	161	316	299	238	240
110	380	268	183	339	318	261	257
120	407	291	202	357	333	280	271
130	434	312	221	382	357	304	292
140	459	332	237	405	381	325	313
150	482	350	253	425	404	345	332
160	503	366	266	443	425	363	351
170	523	380	278	459	444	379	368
180	541	394	290	474	463	395	384
190	558	407	301	488	481	408	400
200	575	420	312	502	499	422	415
210	591	432	323	514	516	436	430
220	606	443	333	526	535	449	447
230	620	454	343	536	555	461	464
240	634	464	352	547	573	473	481
250	647	474	361	556	591	484	497
260	649	476	363	561	592	489	499
270	650	477	365	565	594	494	501
280	651	478	367	568	595	499	502
290	652	479	369	572	596	503	503
300	653	480	370	575	597	508	505
310	654	481	372	578	597	511	506
320	655	482	373	581	598	515	507
330	656	483	375	583	599	519	508
340	657	484	376	586	600	522	509
350	657	485	377	588	600	525	510

continued

A.5 Volume Estimates for Existing Natural Stands

Table A-20. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

Age	Volume table number and analysis unit number						
	41 Hemlock, poor site	42 Cedar, poor site	51 Spruce, good site	52 Spruce, medium site	56 Alpine fir, not low site	61 Spruce, poor site	95 Outside timber harvesting land base
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0
40	0	0	47	0	0	0	0
50	10	34	126	27	0	0	0
60	43	68	193	70	62	0	13
70	78	99	250	115	97	33	35
80	111	128	297	155	127	57	65
90	139	151	334	189	152	81	90
100	164	169	363	218	175	104	112
110	185	184	387	242	195	124	132
120	204	197	407	263	212	142	149
130	225	214	426	284	233	160	168
140	244	231	443	303	252	177	186
150	261	247	458	320	271	193	203
160	277	261	471	335	288	208	208
170	292	275	482	349	305	221	232
180	305	288	491	361	321	234	246
190	317	300	500	372	336	246	259
200	329	313	508	382	350	258	272
210	341	325	514	392	364	268	284
220	353	338	521	401	377	279	296
230	364	352	526	409	390	288	308
240	375	365	531	416	402	297	318
250	385	378	536	423	414	306	329
260	392	380	538	426	416	310	332
270	399	383	540	429	418	313	336
280	405	385	541	432	420	316	339
290	411	387	542	435	422	319	342
300	416	389	543	437	424	322	345
310	421	390	544	439	425	325	345
320	426	392	544	440	427	327	345
330	430	393	545	442	428	329	345
340	434	394	545	443	429	331	345
350	437	395	545	444	431	333	345

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 along with the regeneration assumptions in Table A-17 were used as inputs to TIPSY. Section A.4.7, "Basic silviculture and regeneration assumptions" documents which stands were assumed to be managed in the analysis.

Table A-21. displays the volume tables for existing managed stands. Volumes are assumed to remain constant after 300 years of age. Table A-22. displays the volume tables for future managed stands.

These volume tables are based on the information displayed in Table A-17., including site index, operational adjustment factors, regeneration method and establishment density.

Table A-21. Timber volume tables for existing managed stands (cubic metres/hectare)

	Volume table number and analysis unit number				
Age	**118 Fir**	**138 Hemlock**	**158 Spruce**	**146 Backlog > 60% MSS**	**147 Backlog < 60% MSS**
10	0	0	0	0	0
20	0	0	0	0	0
30	0	0	0	0	0
40	0	22	0	0	0
50	37	92	25	2	0
60	76	171	83	19	2
70	125	241	149	49	4
80	167	307	207	88	6
90	202	364	259	129	15
100	234	413	316	171	25
110	266	452	359	212	38
120	293	485	392	250	51
130	317	514	415	288	63
140	341	539	433	323	75
150	362	560	447	357	87
160	382	578	458	389	99
170	399	592	468	418	110
180	414	604	476	445	122
190	427	614	481	470	132
200	438	623	486	496	142
210	449	631	489	520	151
220	459	640	489	545	160
230	468	647	488	568	168
240	476	653	487	590	176
250	484	659	485	613	184
260	491	664	484	633	191
270	496	669	481	652	198
280	501	673	479	670	204
290	503	677	476	687	210
300	503	677	475	703	215

A.6 Volume Estimates for Regenerated Stands

Table A-22. Timber volume tables for future managed stands (cubic metres/hectare)

	Volume table number (present analysis unit number)						
Age	**111 (11)**	**112 (12)**	**121 (21)**	**131 (31)**	**132 (32)**	**133 (33)**	**134 (34)**
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	9	0	0	0	0	0	0
40	70	13	0	0	32	2	0
50	174	73	19	110	111	21	42
60	248	135	45	193	197	71	105
70	318	187	79	265	270	129	170
80	384	232	117	334	339	182	229
90	443	278	152	392	396	230	284
100	488	316	180	439	440	277	331
110	533	352	205	478	476	319	369
120	568	386	228	512	507	353	401
130	596	416	252	541	533	381	427
140	619	442	272	565	553	406	449
150	640	463	290	585	570	427	468
160	659	484	305	602	586	446	485
170	676	503	321	616	599	462	500
180	692	520	335	629	611	476	511
190	705	532	349	639	620	489	521
200	717	543	361	648	627	499	529
210	727	554	371	656	633	509	533
220	734	562	380	664	640	519	539
230	740	568	389	671	646	527	544
240	742	575	397	678	652	533	549
250	742	580	403	684	658	538	555
260	742	585	410	690	664	542	560
270	742	589	414	696	669	546	564
280	742	594	419	700	673	550	568
290	742	596	423	704	677	552	572
300	742	598	425	706	678	553	574
310	742	598	425	706	678	553	574
320	742	598	425	706	678	553	574
330	742	598	425	706	678	553	574
340	742	598	425	706	678	553	574
350	742	598	425	706	678	553	574

continued

A.6 Volume Estimates for Regenerated Stands

Table A-22. Timber volume tables for future managed stands (cubic metres/hectare) (concluded)

	Volume table number (present analysis unit number)					
Age	**141 (41)**	**142 (42)**	**151 (51)**	**152 (52)**	**156 (56)**	**161 (61)**
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	0	0	0	0
40	0	0	116	0	0	0
50	8	0	227	27	0	0
60	18	36	334	86	35	17
70	48	81	409	153	84	32
80	87	130	454	210	140	49
90	127	175	485	262	190	90
100	146	214	507	320	234	133
110	163	252	520	363	279	172
120	194	290	521	394	324	207
130	222	321	521	418	357	240
140	252	347	519	435	384	274
150	279	367	517	449	403	309
160	302	386	516	460	419	336
170	321	401	514	470	431	359
180	337	415	514	477	441	377
190	352	427	514	482	450	391
200	365	438	514	487	457	403
210	376	448	514	490	463	412
220	387	458	514	490	467	420
230	396	466	514	489	471	427
240	405	473	514	487	473	433
250	412	480	514	486	476	438
260	419	486	514	484	477	442
270	424	491	514	482	476	446
280	429	495	514	489	474	449
290	433	498	514	476	472	451
300	437	499	514	476	472	452
310	439	499	514	476	472	452
320	439	499	514	476	472	452
330	439	499	514	476	472	452
340	439	499	514	476	472	452
350	439	499	514	476	472	452

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 BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by 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 forest sector was divided into three sub-sectors:

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

The procedure for estimating employment and income impacts was undertaken in 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 Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forest sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using 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 or hauling, road building or maintenance work as indirect employment rather than direct employment because they are services which the forest sector and other basic sectors purchase.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the 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.

B.2 Economic Impact Analysis Methodology

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.

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 was gathered from mills pertaining to their employment, production and sources of timber. 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.

B.2 Economic Impact Analysis Methodology

Indirect and induced employment estimates

Indirect employees in the forest sector are those who work to provide goods and services to firms directly engaged in the basic forest sector, for example, those who provide log transport services. Induced employment refers to those who work to provide the goods and services purchased by employees who are directly and indirectly engaged in the industry. An example of induced employment is 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.

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

Table B-1. Employment multipliers

Forest sub-sector	Revelstoke TSA migration multiplier	Revelstoke TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.57	1.37	2.14	1.80
Solid wood processing	1.40	1.23	2.29	1.93
Plywood	1.40	1.23	1.93	1.64
Pulp	N/A	N/A	3.02	2.48

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

Employment income estimates

Employment income was calculated using average income estimates for workers in the forest industry. Based on *Statistics Canada* data, the weighted average annual pre-tax income (less benefits) for forest sector workers in 1997 were:

$47,850 for those working in logging and forestry services;

$46,250 for those working in solid-wood manufacturing; and

$54,990 for those working in pulp and paper mills.

and approximately $34,075 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.

B.2 Economic Impact Analysis Methodology

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast 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 B-2.

Table B-2. Estimates of provincial government revenues, annual average 1995-1997, Revelstoke TSA

	Annual average revenue ($1997 millions)	Revenue per '000s m³ ($ per '000s m³)
Stumpage and related payments[a]	3.70	13,820
Forest Industry taxes[b]	2.32	8,664
Employee income tax[c]	2.57	9,579
Total	8.59	32,063

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