Cranberry
Timber Supply Area Analysis Report

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Preface

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

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

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the Forest Practices Code and official land-use decisions made by Cabinet. The current nature and capabilities of the local forest industry are also considered.

Assessing the implications of only current practices rather than looking at a number of different management schemes will expedite the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

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

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

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information to provide a focus for public discussions of possible timber harvest levels. The fifth will outline the Chief Forester's harvest level decision and the reasoning behind it.

Executive Summary

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

The Cranberry TSA covers about 76 750 hectares of area in the northern coastal transition area of British Columbia. About 32 832 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 hemlock tree species, although there are also significant areas dominated by balsam, spruce, and pine species. Smaller areas are also dominated by cottonwood, aspen and birch species. Hemlock, balsam, and pine are the tree species most commonly used by the forest industry in the area.

Current forest management practices follow the standards and legislation set out by the Forest Practices Code and therefore the protection of wildlife and the environment will be managed through the Code.

The results of this timber supply analysis suggest that the current harvest level in the Cranberry TSA (110 000 cubic metres per year) can be maintained for up to 9 decades without creating future timber shortages. This is followed by a reduction in the harvest level over the subsequent 3 decades to the long-term harvest level of 87 000 cubic metres per year. This period of reductions will be referred to as the "transition" period.

The above results reflect current knowledge and information on forest inventory, growth, and management. However, it is important to recognize that uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses showed that these uncertainties can affect 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 Cranberry TSA is stable. The only case which affected short-term timber supply was a 5-metre increase in site productivity estimates for regenerated stands, which allowed the short-term harvest level to increase by 25% compared to the base case. Uncertainty generally affected the timing of the transition to the long-term harvest level which occurs from 40 to 150 years from now and in some cases, affected the long-term harvest level itself.

Uncertainty regarding estimates of site productivity had the largest effect on projected harvests over the next 250 years. Site productivity estimates for regenerated stands in adjacent areas have been shown to be significantly underestimated in the past. If site productivity for all regenerating stands were underestimated by 5 metres, the harvest level could be increased immediately to 137 850 cubic metres per year and maintained at this level in perpetuity. Conversely, if site productivity has been overestimated by the same amount, the initial harvest level projected in the base case could only be maintained for 4 decades before declining to a long-term harvest level of 54 000 cubic metres (38% lower than in the base case).

Uncertainty about timber volumes in existing stands, timber volumes in regenerated stands, the maximum amount of disturbance allowed in wildlife and integrated resource management zones, and the size of the timber harvesting land base each have a significant effect on projected harvests. If existing stand volume estimates are decreased by 10%, the initial harvest level projected in the base case can be maintained for only 4 decades; if existing stand volumes are increased by 10% then the initial harvest level can be maintained for 13 decades. The long-term harvest level is virtually unaffected by changes in existing stand volume estimates. An inventory audit completed in 1997 indicated that, for the Cranberry TSA as a whole, current inventory information together with the timber volume estimation model used for this analysis produced accurate estimates of existing stand volumes.

Uncertainty about regenerated stand volume estimates has a small impact on the timing of the transition to the long-term harvest level, but the long-term harvest level is affected proportionately to the size of the increase or decrease in volume estimates. The amount of disturbance allowed in wildlife and integrated resource management areas significantly impacts the timing of the transition to the long-term harvest level; however, the long-term harvest level is only slightly affected by decreases in the maximum amount of disturbance allowed. Uncertainty in the size of the timber harvesting land base affects both the timing of the decline to the long-term harvest level, and the long-term harvest level itself. An increased land base could allow the initial harvest level to be maintained longer than in the base case, as well as a higher long-term harvest level than in the base case; a decreased land base would require earlier harvest level reductions, and would result in a lower long-term harvest level compared to the base case. At this time there is no conclusive information to suggest that the timber harvesting land base is either larger or smaller than defined in the analysis.

Factors with moderate effects on timber supply include estimates of minimum harvestable ages and requirements for the management of visually sensitive areas. Even though visually sensitive areas cover a relatively small portion of the timber harvesting land base, the forest cover requirements applied to these areas in the base case frequently limit timber supply throughout the planning horizon; thus, increasing or decreasing those requirements affects timber availability.

Uncertainty about the age at which stands reach green-up conditions, and requirements for older forests in wildlife management zones have a smaller effect on projected harvests. The amount of time that the initial harvest level can be maintained is affected by only two decades at the most, and the long-term harvest level is only slightly affected, if at all.

In addition, uncertainty about landscape level biodiversity requirements was examined in the analysis. It was found that if more stringent requirements were applied within the Cranberry TSA, which was treated as one landscape unit, the timber supply was unaffected.

One additional area of uncertainty was examined in the analysis to address concerns about the management of areas known to be important for the production of pine mushrooms. If harvesting were deferred in areas of high pine mushroom productivity, timber supply is unaffected compared to the base case. If harvesting were prevented in some of these stands, the initial harvest level could only be maintained for 6 decades, and the long-term harvest level would be decreased by about 5% from that of the base case.

The socio-economic analysis of the Cranberry TSA shows that the current level of harvesting is well below the current AAC. In 1995-1996, the average volume harvested was approximately 20 000 cubic metres per year. The 1996 harvest supported about 58 person-years of direct employment in the harvesting and processing sector. It is projected that the full AAC could support over 100-person years of direct employment.

In conclusion, this analysis indicates that using current inventory and growth and yield information, timber harvests in the Cranberry TSA can be maintained at the current allowable level for the next 90 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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Timber supply is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

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

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

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

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

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

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through 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 Cranberry 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 Cranberry 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 forecasts as projected in the base case.

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

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

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

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.

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

1 Description of the Cranberry Timber Supply Area

The Cranberry Timber Supply Area lies in the northwest part of British Columbia within the Prince Rupert Forest Region (Figure 1), and is administered from the Kispiox Forest District office in Hazelton. It is located approximately 60 kilometres north of Kitwanga village and is bounded by the Nass Timber Supply Area to the west and the Kispiox Timber Supply Area to the east. The Cranberry TSA is the smallest provincial timber supply area, comprising a total of 76 751 hectares. Approximately 13% of the total area of the TSA is alpine; a further 8% is sub-alpine forest, forests not considered productive enough to support timber harvesting, brush, rock, lakes, rivers and swamps. About 79% of the Cranberry TSA is considered productive forest in terms of timber growth. Hemlock, balsam, and pine are the dominant tree species in the area.

Smaller dimension wood, and pulp-quality timber comprises as much as half of the timber volume in the Cranberry TSA. The current allowable annual cut for the Cranberry Timber Supply Area, determined in 1993, is 110 000 cubic metres per year. However, from 1992 to 1996, the average annual harvest has been less than 40 000 cubic metres per year.

There are no settlements located in the Cranberry Timber Supply Area; however, there are rural communities located in the immediate vicinity, including the communities of Kitwanga and Gitanyow. The village of Hazelton and the New Hazelton district municipality, located about 40 kilometres east of Kitwanga, are the closest commercial, administrative and retail centres for the region. The forest industry provides an important source of revenue and employment to these communities. Recreation, tourism, and the commercial harvesting of pine mushrooms are also important sources of economic activity in the area.

The Cranberry timber supply area is located within overlapping traditional territories of both the Nisga'a Tribal Council and the Gitanyow Nation. At this time, the Nisga'a Tribal Council, the Government of Canada and the Province of British Columbia have signed the Nisga'a Treaty Negotiations Agreement-in-Principle and are currently finalizing a treaty. The Cranberry TSA is not a part of the Nisga'a Agreement-in-Principle. The Gitanyow Nation is actively negotiating an agreement in principle which will lead to a treaty.

1.1 The environment

The area contains both coastal and interior biogeoclimatic ecosystems, including parts of the Engelmann spruce-subalpine fir, Mountain hemlock, Coastal western hemlock, Interior cedar hemlock, and alpine tundra biogeoclimatic zones. The topography of the Cranberry TSA ranges from flat and gentle terrain at 300 metres in elevation, to the rounded Mount Weber at 2018 metres in elevation. Most of the Cranberry TSA is located in the mid- and lower-portions of the Cranberry River drainage. The valley bottoms around the Cranberry River are characterized by a floodplains and terraces, with some area with organic soils and wetlands. A very small area in the western part of the Cranberry TSA drains directly into the Nass River. The diversity of ecosystems, and the presence of the Nass River and its tributaries contribute to high biodiversity* values of this area of the province.

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

1 Description of the Cranberry Timber Supply Area

Forest management considerations have been identified in the Cranberry TSA for important wildlife species such as grizzly bear, fisher and northern goshawk. Other important and abundant wildlife include black bear, kermode bear, moose, marten, raptors, owls, other medium-sized carnivores, and smaller mammals.

The Nass River and its tributaries comprise a highly productive system that supports many fish species. This system provides important spawning habitat and migration routes for chinook, coho, sockeye, and pink salmon. These rivers also provide critical habitat for trout and steelhead fish.

1 Description of the Cranberry Timber Supply Area

Figure 1. Map of the Cranberry 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 1994. This file contains a considerable amount of information on the forest land in the Cranberry 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 1995. Also, the file has been updated to account for timber harvesting up to January 1, 1994.

The inventory file represents the land base for the entire TSA. 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 Cranberry TSA is provided below. These types of areas do not contribute to the timber supply of the Cranberry TSA. Before assessing timber supply these non-contributing areas are identified separately from the land base which represents the timber harvesting land base*. When deriving this data file, care is taken to make only a single separation for areas with more than one characteristic that would make it unavailable for harvesting (for example, where a park area is also suitable for wildlife habitat).

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

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

- non-Crown area — areas not managed directly by the B.C. Forest Service.
- non-productive areas — areas not occupied by productive forest cover (e.g. rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- streamside buffers — area otherwise available for timber production that was assumed to be unavailable for harvesting to provide protection for riparian* and stream ecosystems.
- environmentally sensitive areas* — portions of the areas considered sensitive.
- inoperable areas* — areas classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability* include slope, topography (e.g. presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- problem forest types — areas covered by timber stands that are physically operable and have adequate productivity, but are not yet currently utilized or have marginal merchantability.
- recreation areas — areas of recreational significance, such as campgrounds, trails and lookout sites.
- preservation visual quality objective areas — areas where existing visual quality is to be preserved.
- existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- cultural heritage resources — a cultural heritage trail (the "Grease" trail) runs through the Cranberry TSA. No harvesting is allowed within 100 metres of this trail.
- stand level biodiversity — patches of standing timber larger than 2 hectares are maintained within harvested areas to provide for the maintenance of stand structure over time.

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

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

- future roads, trails, and landings — future losses of productive forest land to development. These areas are initially included in the timber harvesting land base, and are subsequently removed as part of the first harvest.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 1 summarizes the areas in each category, and shows the area of the timber harvesting land base.

2 Information Preparation for the Timber Supply Analysis

Table 1. Timber harvesting land base for the Cranberry TSA

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	76 751	100.0	
Not managed directly by the B.C. Forest Service	0	0	
Non-productive	- 16 307	- 21.2	
Total productive forest managed by the Forest Service (Crown forest)	**60 444**	**78.8**	**100.0**
Reductions to Crown forest:			
Non-commercial cover (brush)	1 637	2.1	2.7
Streamside buffers	4 561	5.9	7.5
Environmentally sensitive	8 419	11.0	13.9
Inoperable	2 519	3.3	4.2
Low timber productivity	4 244	5.5	7.0
Problem forest types	2 320	3.0	3.8
Recreation areas	380	0.5	0.6
Areas preserved to protect visual quality	332	0.4	0.5
Existing roads	1 781	2.3	2.9
Cultural heritage resources	620	0.8	1.0
Stand level biodiversity	799	1.0	1.3
Total current reductions[a]	**- 27 612**	**- 36.0**	**- 45.7**
Current timber harvesting land base (includes 1679 hectares not satisfactorily restocked (NSR)* land[b])	**32 832**	**42.8**	**54.3**
Future reductions			
Future roads	- 447	- 0.6	- 0.7
Long-term timber harvesting land base	**32 385**	**42.2**	**53.6**

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

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

Figure 2 represents both the total Cranberry TSA area, and the productive forest land base. The total area chart shows that about one-fifth 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 18% of the forest land in the TSA is considered to be unavailable for harvesting due to environmental sensitivity or physical or economical inoperability at this time. An additional 14% is identified as low timber productivity, problem forest types, and non-commercial cover. Approximately 5% of the productive forest is unavailable for harvesting due to existing roads, the Grease trail, recreation areas, or preservation of visual quality, and 9% of the productive forest is excluded from timber harvesting due to stand level biodiversity and streamside buffers. About 54% of the productive forest is considered available for timber harvesting (including NSR).

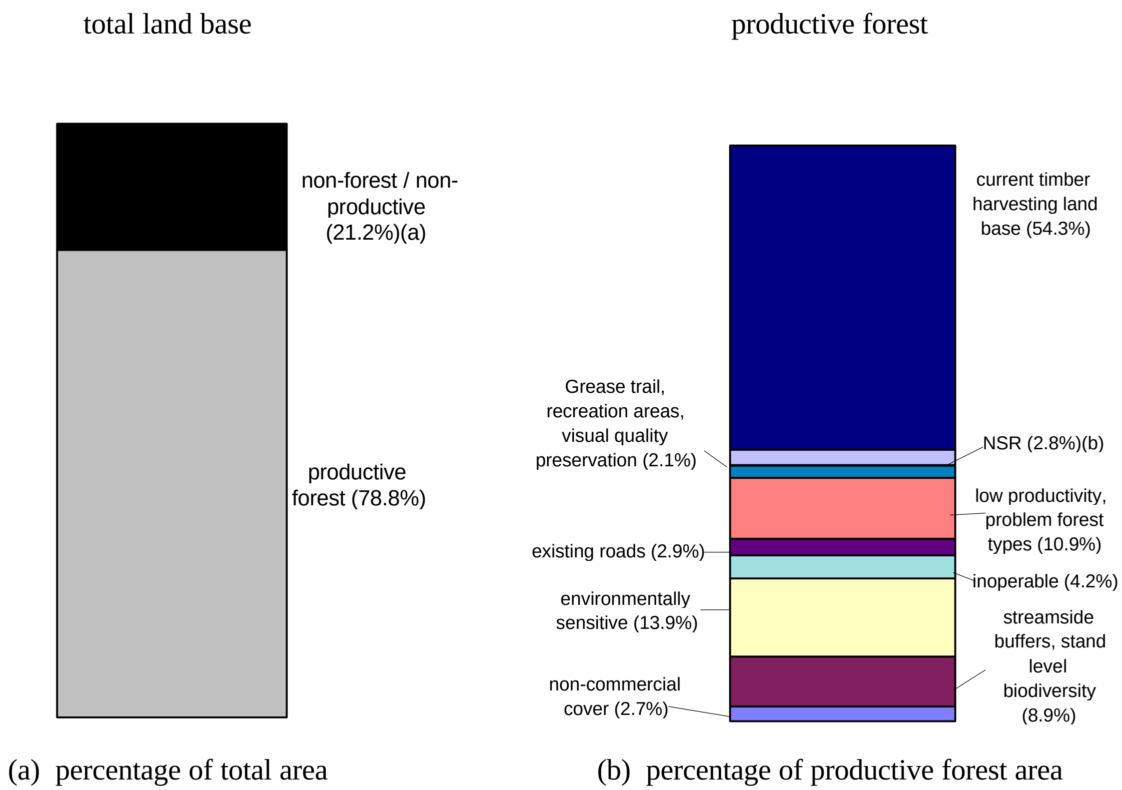


Figure 2. Composition of the total and productive forest land bases — Cranberry TSA, 1997.

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Hemlock species dominate about 58% of stands within the timber harvesting land base, with balsam dominating in 12.5%, and lodgepole pine and spruce in 12% each. After harvest, most stands are expected to be planted to pine and/or spruce, depending on site conditions. Natural regeneration of hemlock, balsam, and deciduous species is also expected to contribute to stand composition in the future.

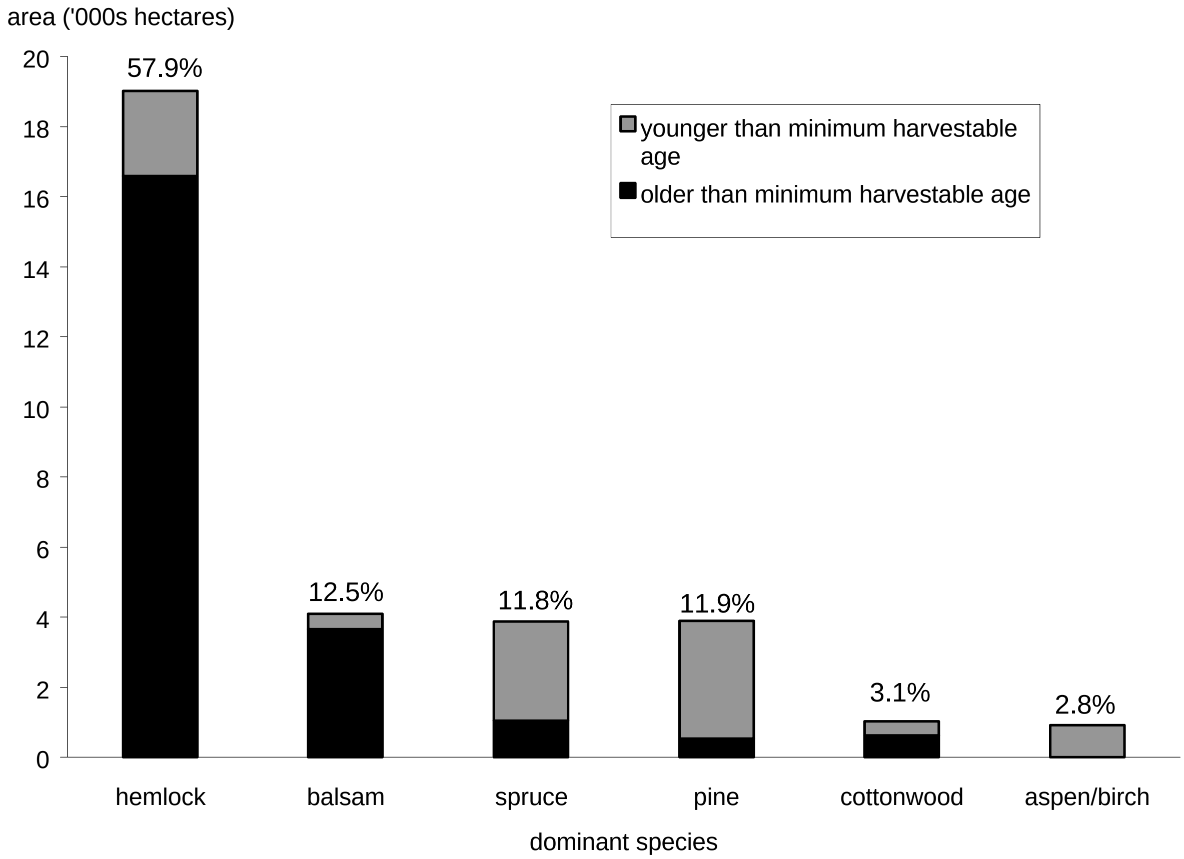


Figure 3. Area by dominant species — Cranberry TSA timber harvesting land base, 1997.

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 68% 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: 87% of hemlock stands, 89% of balsam stands, 60% of cottonwood stands, 27% of spruce stands and 14% of lodgepole pine stands are currently older than the minimum harvestable age. There are no aspen and birch stands older than the minimum harvestable age currently included in the timber harvesting land base.

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

Figure 4 provides an overview of the distribution of site productivity within the harvesting land base, and the relative amount of area in each class that is older than the minimum harvestable age. More than half (64%) of the sites in the timber harvesting land base are classified as having good or medium productivity, and 36% have poor productivity. 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.

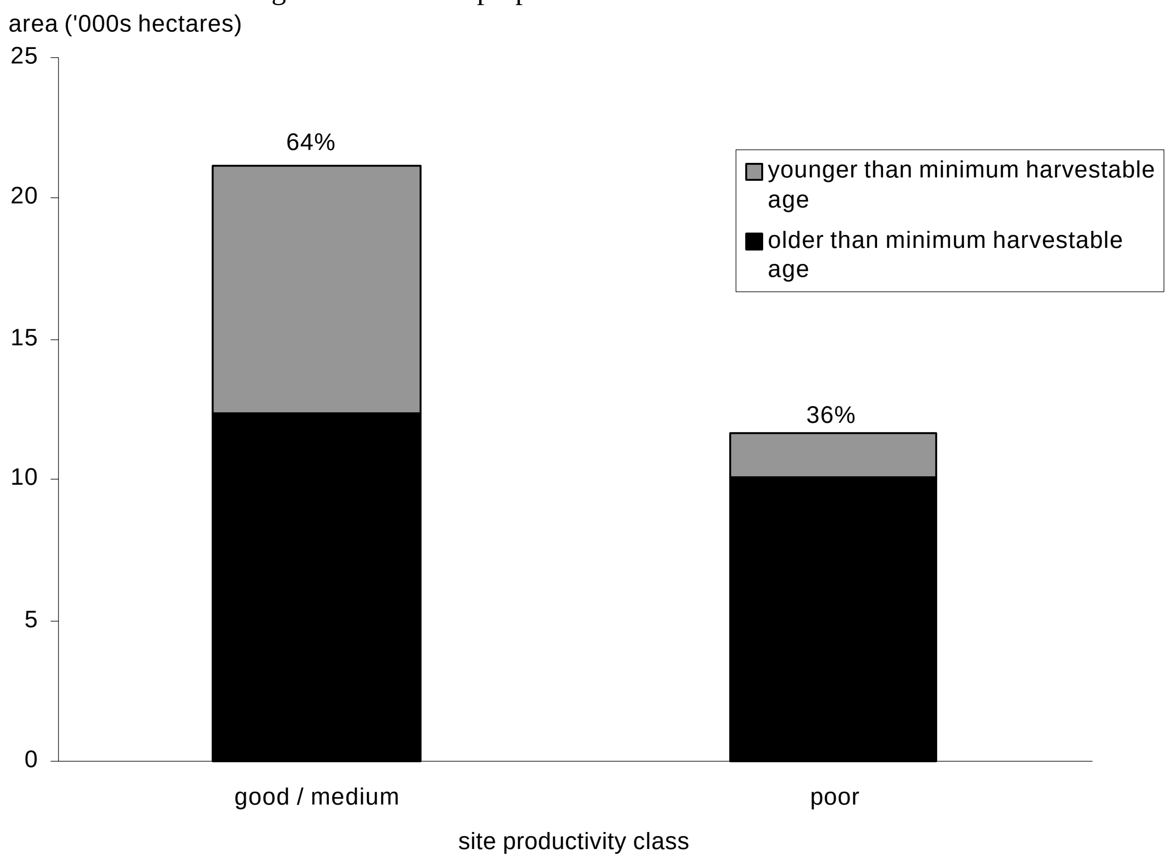


Figure 4. Area by site productivity class — Cranberry TSA timber harvesting land base, 1997.

Figure 5 shows the current age composition of forested stands in the Cranberry TSA. Within the timber harvesting land base, a substantial portion (23%) of stands are older than 250 years. About 19% of stands are 20 years or younger, 11% are between 21 and 100 years old, and 47% are between 101 and 250 years of age. Almost 70% of the stands in the timber harvesting land base are at or above the minimum harvestable age applicable to the stand, and considering that some area is occupied by stands between the ages of 60 and 100 years, additional area will reach minimum harvestable age in the near future.

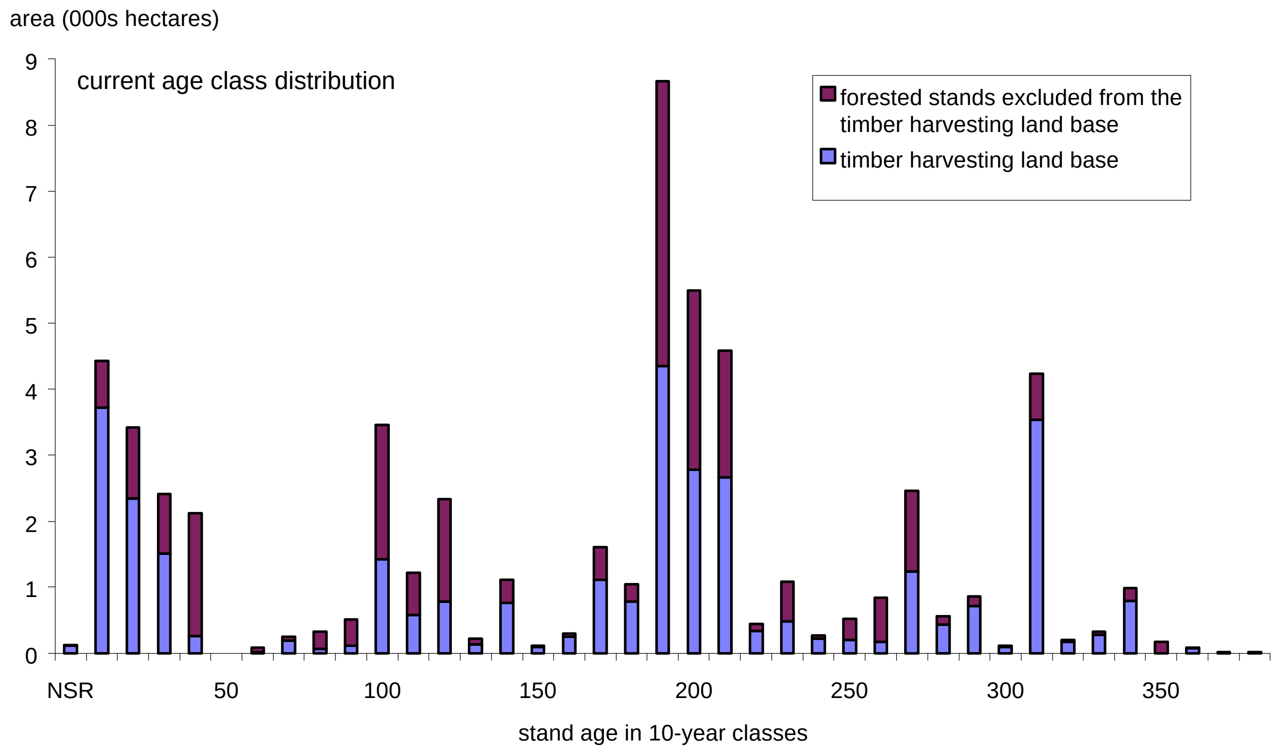


Figure 5. Current age class composition — Cranberry TSA productive forest land base, 1997.

The age class distribution of forested stands excluded from the timber harvesting land base also affect timber supply. In the case of the Cranberry 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 TSA by providing desired stand conditions such as old-forest attributes. About 14% of these 'inoperable' stands are older than 250 years. Only 7% of inoperable stands are 20 years or younger, 23% are between 21 and 100 years old, and 56% are between 101 and 250 years of age. Most of the requirements for old-forest attributes within the Cranberry TSA are met by the area covered by inoperable 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 the Cranberry TSA can be provided by inoperable stands within the next 7 decades.

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 Cranberry 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 stands and for the deciduous component of all managed stands. The Table Interpolation Program for Stand Yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for the coniferous managed stands. All stands harvested over the last 10 years, some stands harvested between 10-20 years ago, and those that will be 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 15.1 million cubic metres. About 9.4 million cubic metres, or 62.5%, of the total, are currently merchantable; that is, older than minimum harvestable age.

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

2.3 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 Kispiox 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 damage are expected to average 397 cubic metres per year.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up* — in the Cranberry TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (3 metres in height), before adjacent stands may be harvested. Furthermore, the area in the timber harvesting land base that does not meet green-up conditions cannot exceed 30% in the wildlife management zones, and 25% in the integrated resource management zones. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.
- Maintenance of wildlife habitat — grizzly bear, fisher, and northern goshawk occur in the Cranberry TSA. Each of these species require specific habitat types to be maintained. For grizzly bear areas, which comprise 2785 hectares (8.5%) of the timber harvesting land base, at least 10% of the forested area must be covered by stands older than 100 years. For fisher areas, which comprise 7760 hectares (23.6%) of the timber harvesting land base, at least 10% of the area covered by coniferous stands must be covered by stands older than 140 years, and at least 15% of the area covered by deciduous stands must be covered by stands older than 100 years. For goshawk nesting areas, which comprise 12 724 hectares (38.8%) of the timber harvesting land base, at least 4% of the forested area must be covered by stands older than 140 years.

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

Cutblock adjacency
The desired spatial relationship among cutblocks as specified in integrated resource management guidelines. This can be approximated by specifying the maximum allowable proportion of a forested landscape that does not meet green-up requirements.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (e.g., height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.

- 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 preservation — 332 hectares — are excluded from timber harvesting. All remaining areas with visual sensitivity* are partial retention VQO* areas, which occupy 2905 hectares (8.8%) of the timber harvesting land base. In these areas, harvesting may be noticeable, but not dominant. At most 9.3% of the visually sensitive areas may be covered by stands less than 6 metres tall (the visual green-up).
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set at the age at which stands reach a minimum volume. 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.
- 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 Cranberry TSA, within each ecosystem type, 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.

Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Visual sensitivity
A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
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).

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

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 Cranberry 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.

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

Figure 6 displays the composition of the timber harvesting land base according to management emphasis (or management zone).

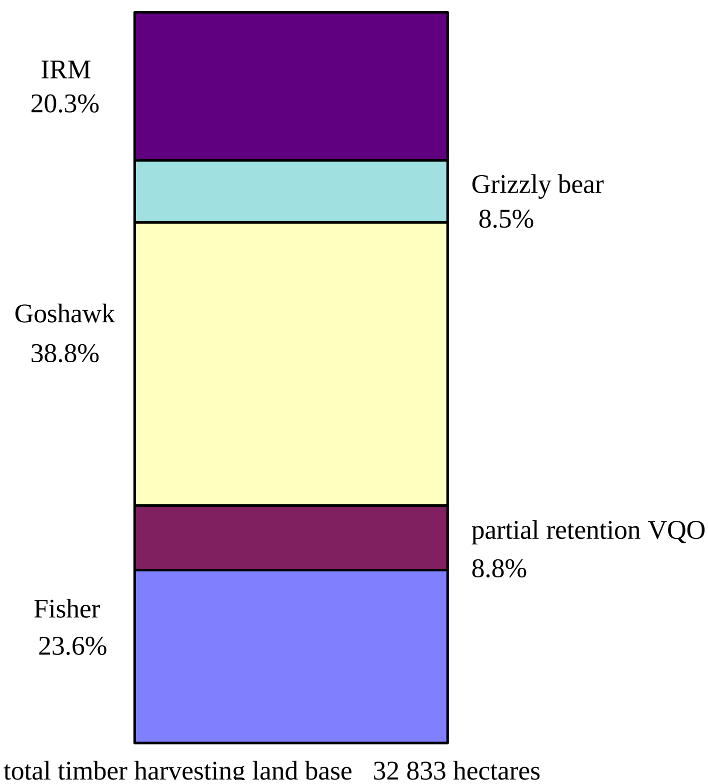


Figure 6. Forest management zones — Cranberry TSA timber harvesting land base, 1997.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Cranberry 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 Cranberry 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 Cranberry 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 Cranberry TSA. The current allowable annual harvest level of 110 000 cubic metres can be maintained for 9 decades, without causing timber supply shortages in the future, if followed by three downward steps of approximately 8% each to a sustainable long-term harvest level* of 87 000 cubic metres per year, which is reached in decade 12. This long-term harvest level is maintained for the remainder of the planning period.

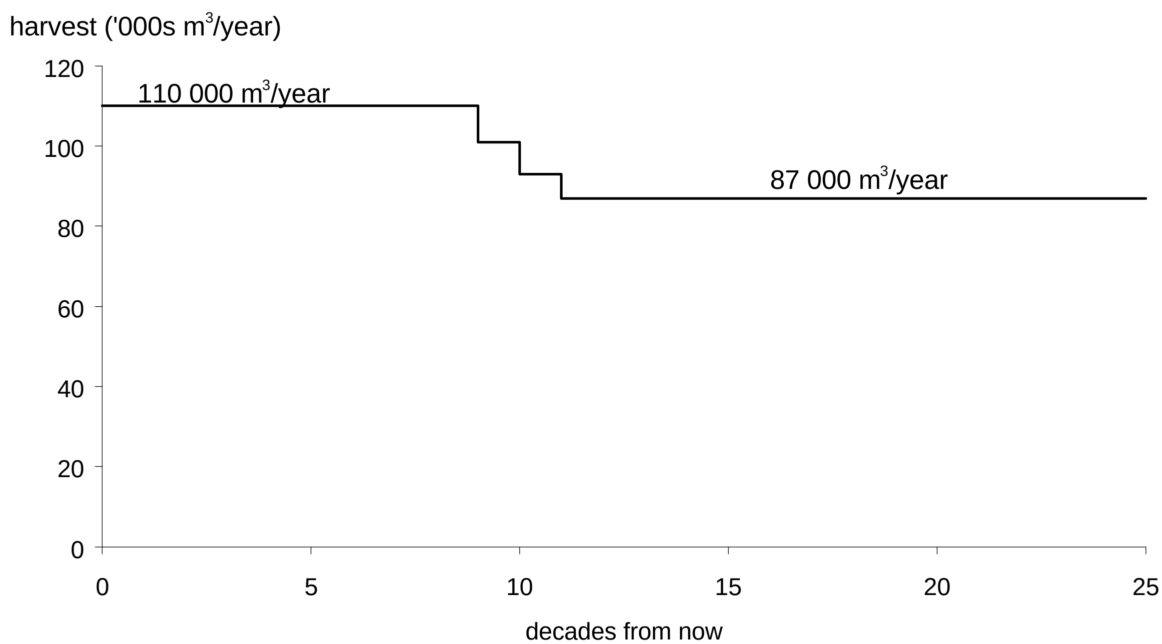


Figure 7. Base case harvest forecast for the Cranberry TSA, 1997.

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.

Unsalvaged losses to natural forces such as insects, fire, small mammals, and disease are estimated to be 397 cubic metres per year for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report.

Several criteria were used to define the base case harvest forecast. The first was to maintain the current harvest level for the Cranberry TSA (110 000 cubic metres per year) for as long as possible while avoiding substantial timber supply shortages in the future. 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 10 decades as the existing mature stands are removed and replaced with younger stands. However, once harvesting occurs predominantly in younger managed stands, the growing stock stabilizes at approximately 4 million cubic metres. Harvest levels must decrease to the long-term harvest level in the base case because over time, harvesting occurs less in the high-volume, older stands that contribute to harvest mainly in the short term, and more in second-growth stands, which are harvested at younger ages and therefore generally have lower harvested volumes.

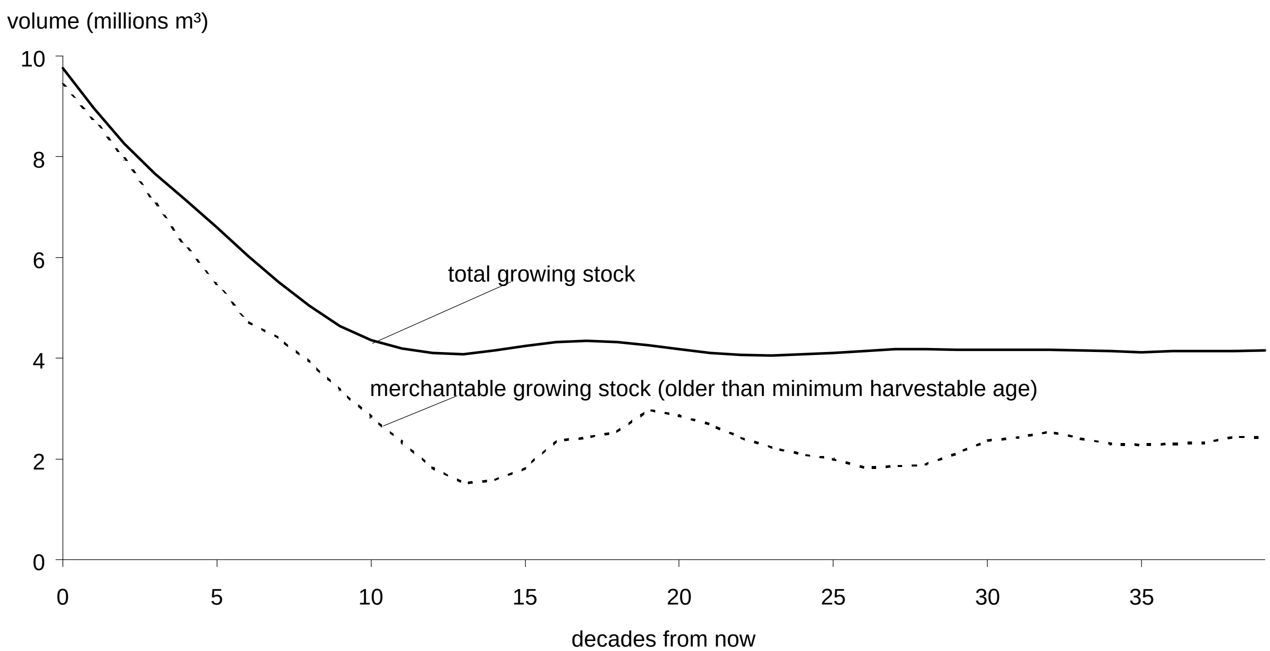


Figure 8. Changes in timber growing stock over time — Cranberry TSA base case, 1997.

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

In defining the base case, another criterion was to manage the transition from the current harvest level to the long-term harvest level, which is mainly dependent on the transition from harvesting existing stands to harvesting regenerated, managed stands. Declines of approximately 8% per decade were necessary to enable the current harvest level to be maintained for the maximum amount of time, ensuring a reasonable rate of decline in timber supply and preventing harvest levels from declining below the long-term harvest level. As shown in Figure 8, the amount of merchantable timber is at a minimum of approximately 1.5 million cubic metres in decade 13, and this relative shortage of stands old enough to harvest in this period affects the rate of decline to the long-term harvest level. These basic criteria were applied 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 from managed second-growth stands is about 1.68 cubic metres per hectare per year, about 23% more than the 1.36 cubic metres per hectare per year 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. While the full benefit of improved management will not occur until most second-growth stands become available for harvesting, in from 70 to 170 years from now, such management does allow maintenance of higher harvests in the medium term than if future stands were expected to grow at the same rate as did existing stands.

However, the long-term harvest level is below the maximum productive capacity of the timber harvesting land base partly because of forest cover requirements* for visual quality and maximum allowable disturbance, and also because areas are not necessarily scheduled for harvest at the point of maximum productivity since it is difficult to schedule areas for harvest at a particular age when there is also an objective of maintaining a fairly even harvest flow over time. 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 90 500 cubic metres could be achieved in the long term.

For the most part, forest cover requirements do not limit the long-term harvest level, since forested stands outside the timber harvesting land base are projected to be in a condition to meet all of the requirements for older forests and wildlife habitat in the long term; thus, 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 particularly limited by these forest cover requirements because older stands are abundant in the medium term, and because after 7 decades, all older forest requirements are projected to be 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 partial retention VQO zone, the grizzly bear habitat zone and the integrated resource management zone.

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

4.2 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 amount of area harvested is projected to range from a minimum of 224 hectares per year in decade 7, to a maximum of approximately 341 hectares per year in decade 16. During the first 10 decades, even though the harvest level remains the same, the amount of area harvested is projected to fluctuate slightly because the harvest comes from stands of different quality and ages over time.

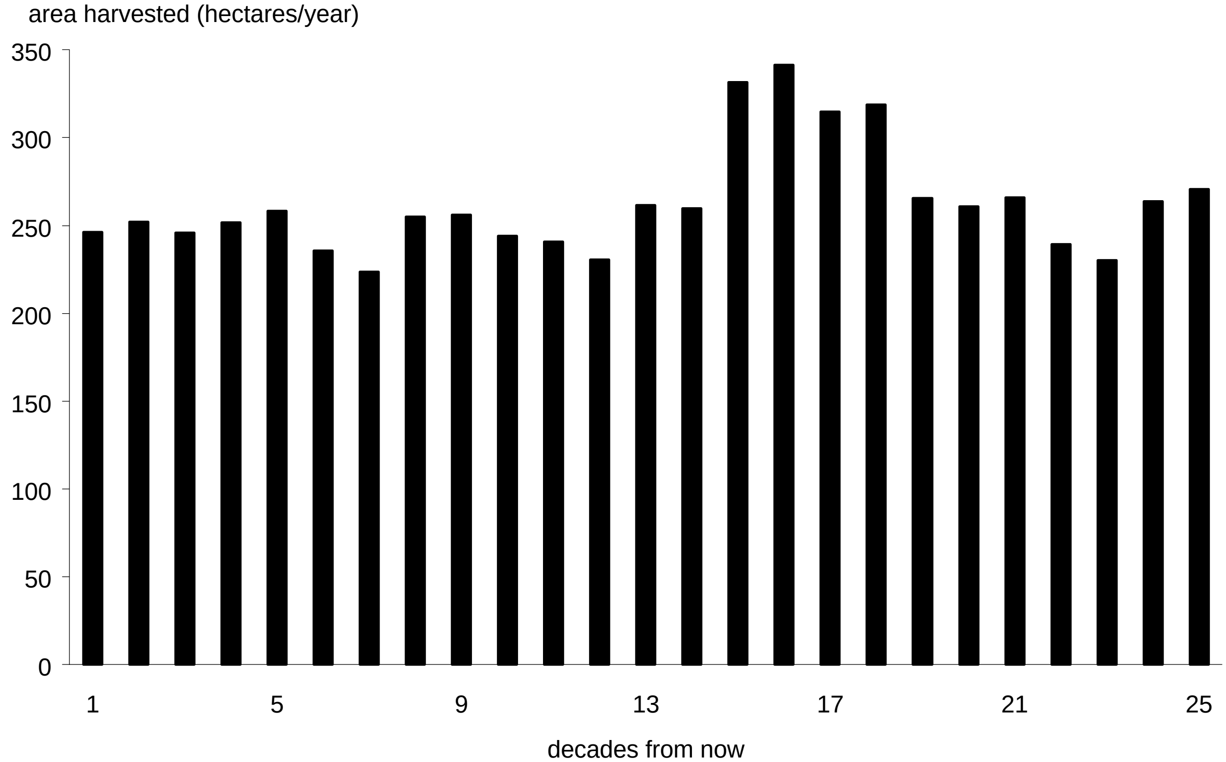


Figure 9. Area harvested over time — Cranberry TSA base case, 1997.

Figure 10 shows the average timber volume per hectare harvested over the same period. The average harvested volume ranges from a maximum of 492 cubic metres per hectare, to a minimum of 255 cubic metres per hectare in decade 16. 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 high when the amount of area harvested is low, and low when the amount of area harvested is high. This relationship is expected since the objective is to maintain a steady volume harvested per decade rather than a steady area harvested per decade.

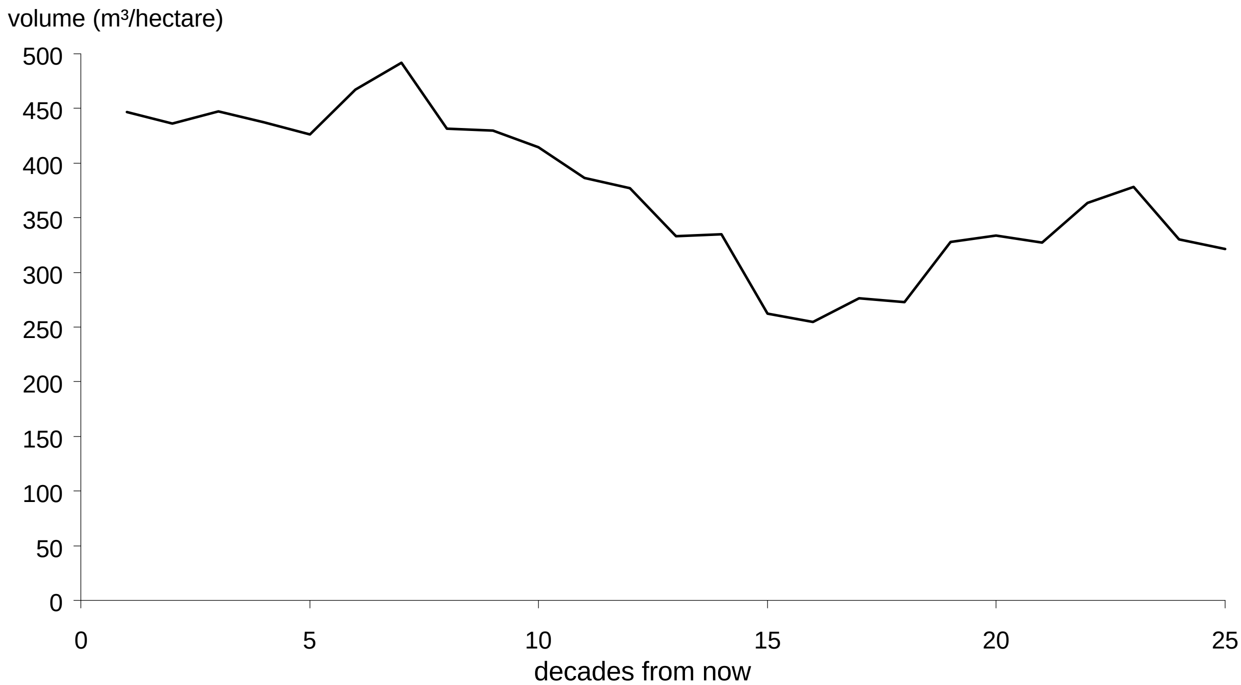


Figure 10. Average volume per hectare harvested over time — Cranberry TSA base case, 1997.

The harvest initially comes more from stands with poor site productivity than from good- and medium-site productivity stands. This occurs because older stands are targeted for harvest first in the analysis, and the majority of stands older than 200 years in the timber harvesting land base are considered to be on poor-productivity sites. However, after the first few decades, more of the harvest comes from higher quality sites, and the average volume per hectare harvested increases accordingly. After 7 decades, the first regenerated managed stands become available for harvest, and the amount of area harvested is projected to increase because these young stands have a lower average volume per hectare harvested. The average harvested volume per hectare is projected to reach its minimum, and the average harvested area its maximum, in decade 16 because almost no high-volume older stands remain within the timber harvesting land base, and the harvest comes almost exclusively from lower volume, regenerated stands that have just reached their minimum harvestable ages. Furthermore, most of the regenerated stands harvested during this period occupy poor-quality sites. After decade 16, more regenerated stands on higher-quality sites are available for harvest resulting in an increase in the average volume per hectare harvested.

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 305 years to 128 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 are given priority for harvest in the analysis. From decade 11 onward, most of the stands harvested are regenerated stands that have only recently reached minimum harvestable ages, which ranges from 65 to 135 years depending on species and site productivity. The average harvested age from decade 12 to decade 25 fluctuates slightly, averaging about 116 years over the long term.

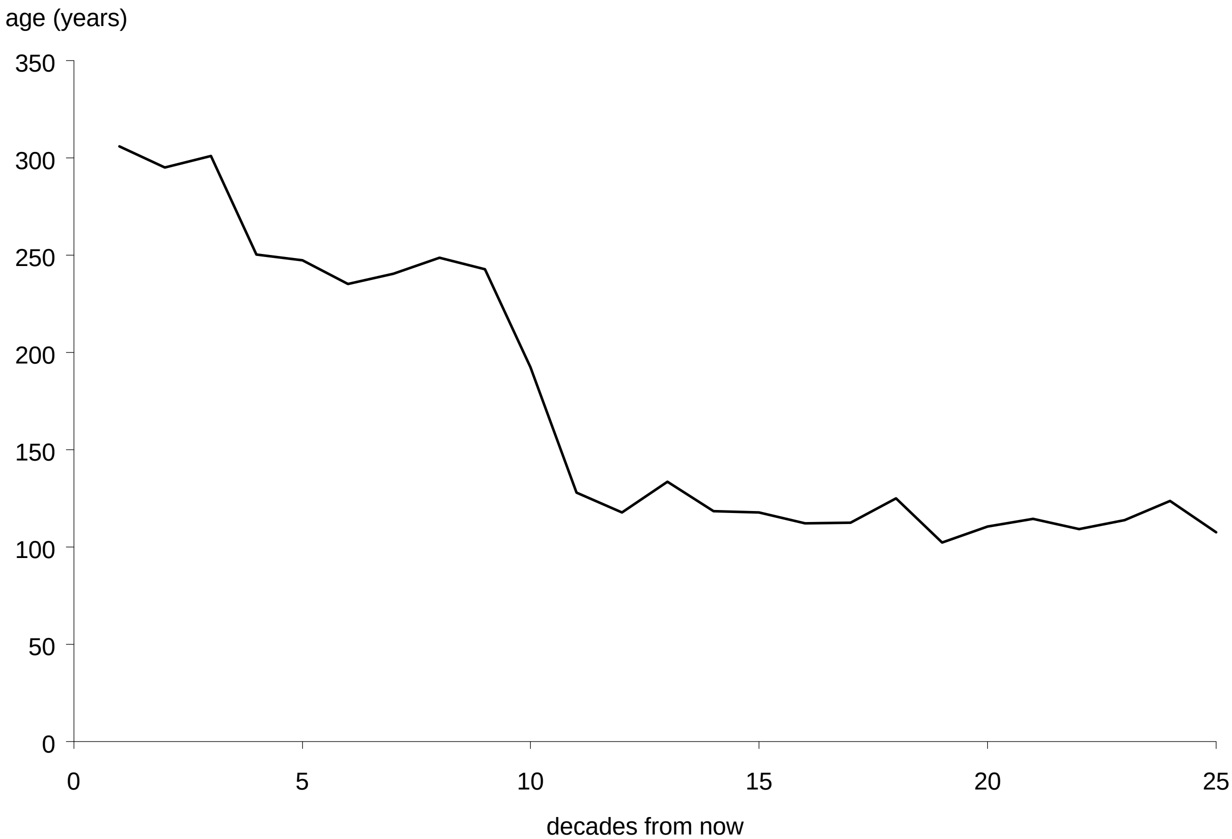


Figure 11. Average harvested age over time — Cranberry TSA base case, 1997.

4.3 Age class composition over time

The charts in Figure 12 show how the age composition of the productive forest within the Cranberry TSA land base would change over the next 250 years under the base case harvest forecast.

Currently, most of the timber harvesting land base (68%) consists of stands at or above minimum harvestable age. The productive forest land base also contains stands which are forested but have been excluded from the timber harvesting land base ("inoperable" stands). While these inoperable stands range significantly in age, enough of these stands have older forest characteristics or can meet wildlife habitat criteria so that initially, very little of the timber harvesting land base must be retained for these values. After 50 years, much less of the timber harvesting land base is covered by older forests; however, the inoperable stands which are ineligible for harvest have continued to age, and after the first 4 decades of the planning horizon, meet all wildlife habitat requirements and most landscape level biodiversity requirements for the TSA. After 100 years very little older forest remains in the timber harvesting land base; the forested area is almost 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. At 200 years in the future, the projected age class distribution is somewhat less even because the relative portion of poor-site productivity stands harvested varies from decade to decade, affecting the amount of area that must be harvested in order to achieve a certain volume, and because some stands become old enough to harvest as early as 65 years of age. By the end of the 250-year planning horizon, all of the inoperable areas are older than 240 years, and the timber harvesting land base is characterized by a relatively even-age class distribution.

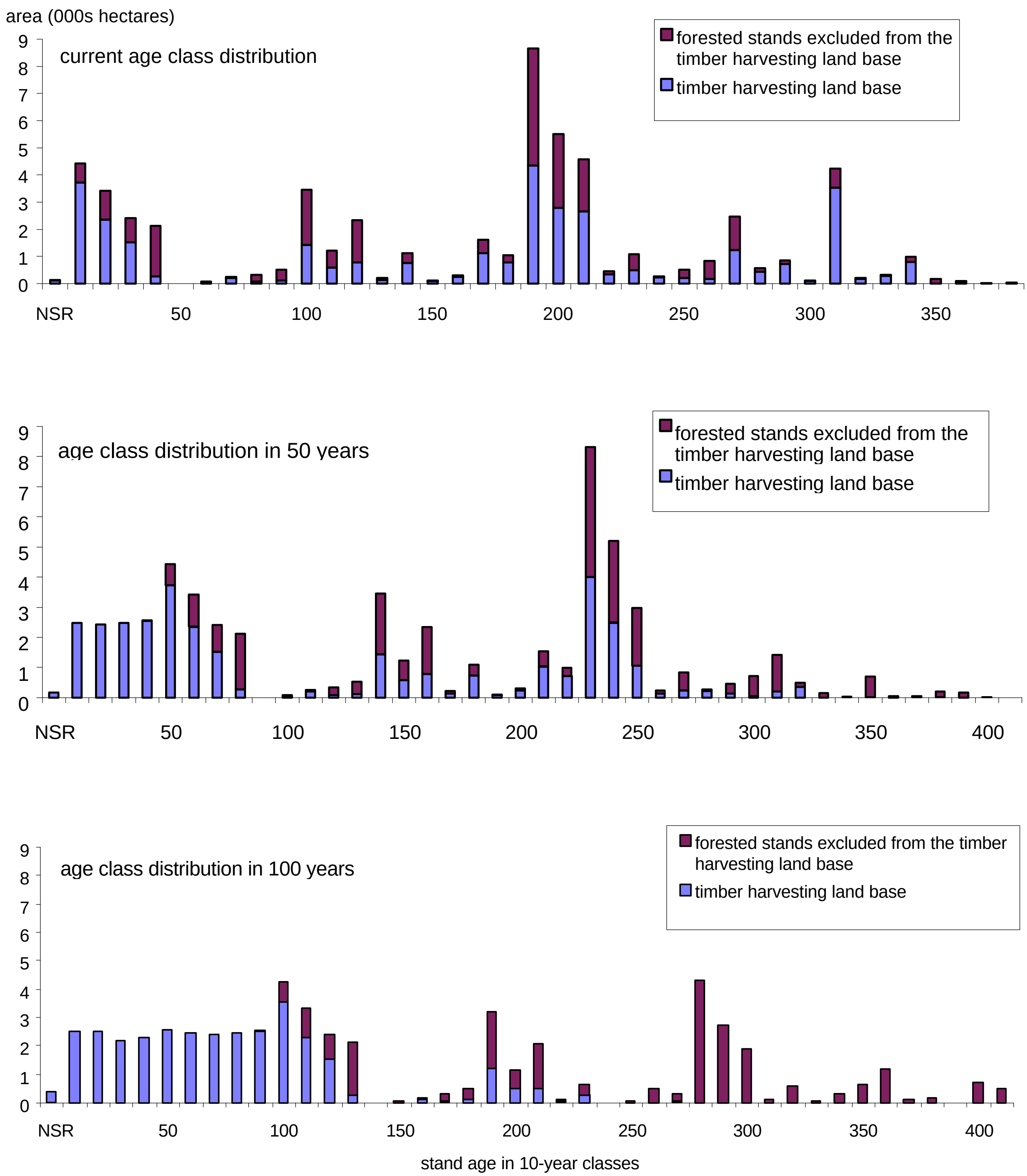


Figure 12. Changes in age composition on productive forest land base over time — Cranberry TSA base case, 1997.

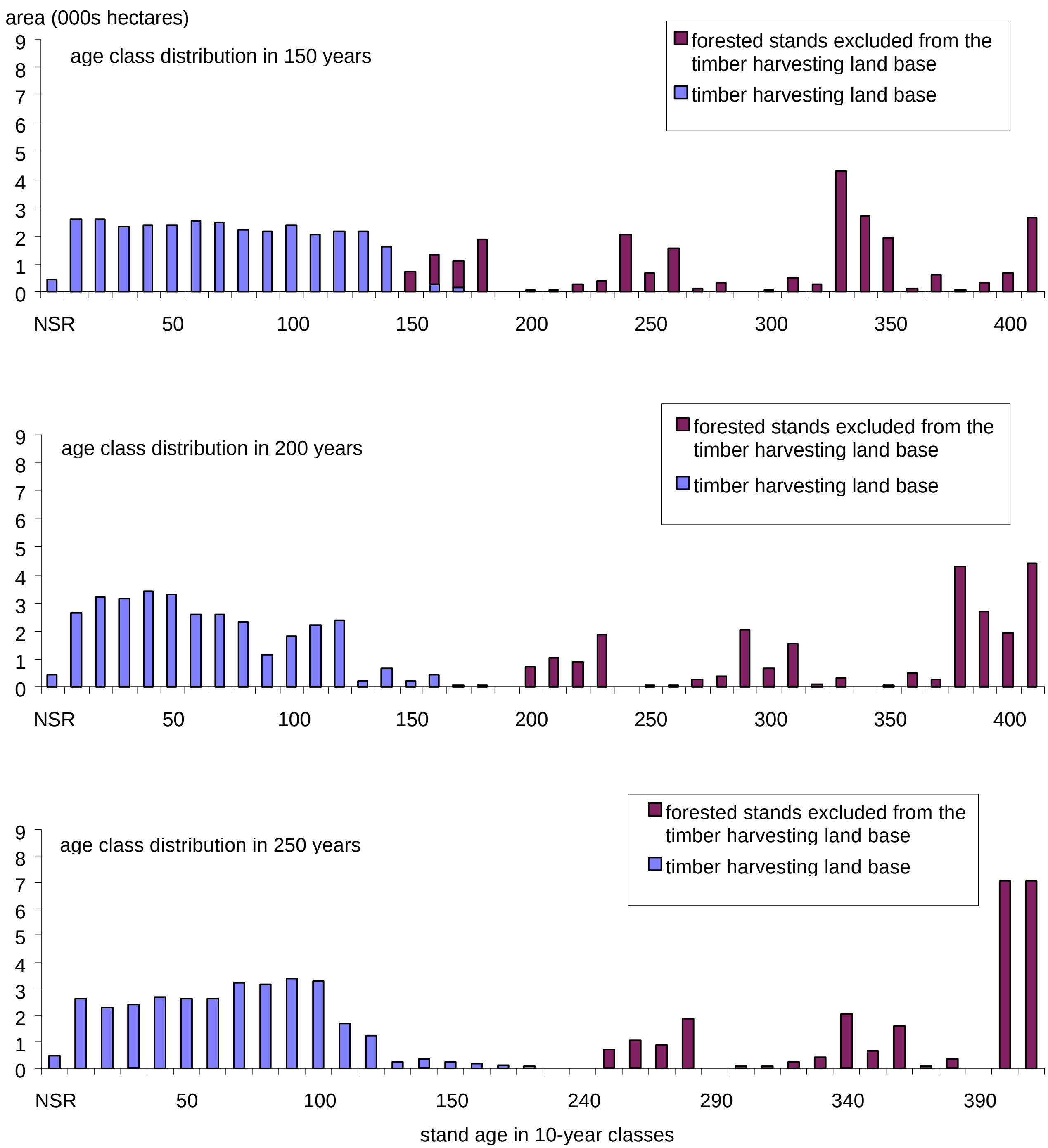


Figure 12. Changes in age composition on productive forest land base over time — Cranberry TSA base case, 1997 (concluded).

5 Timber Supply Sensitivity Analyses

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

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

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

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

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

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions* (shown in Figures 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.

5.1 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.

Figures 13 to 15 compare five harvest flow alternatives to the base case. Figure 13 demonstrates that if a more gradual transition of 2% per decade is used to reach the long-term harvest level, the current harvest level can still be maintained for 4 decades. The long-term harvest level is reached in decade 16. Under this harvest flow pattern, about 1% less volume could be harvested over the first 160 years compared to the base case. Figure 13 also shows a harvest forecast in which a constant flow harvest level of 89 500 cubic metres per year is maintained throughout the planning horizon. Over the 250-year planning horizon, approximately 7% less volume would be harvested under this 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, which 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. Eventually, the harvest level in this scenario would have to decline to the same long-term harvest level as in the base case.

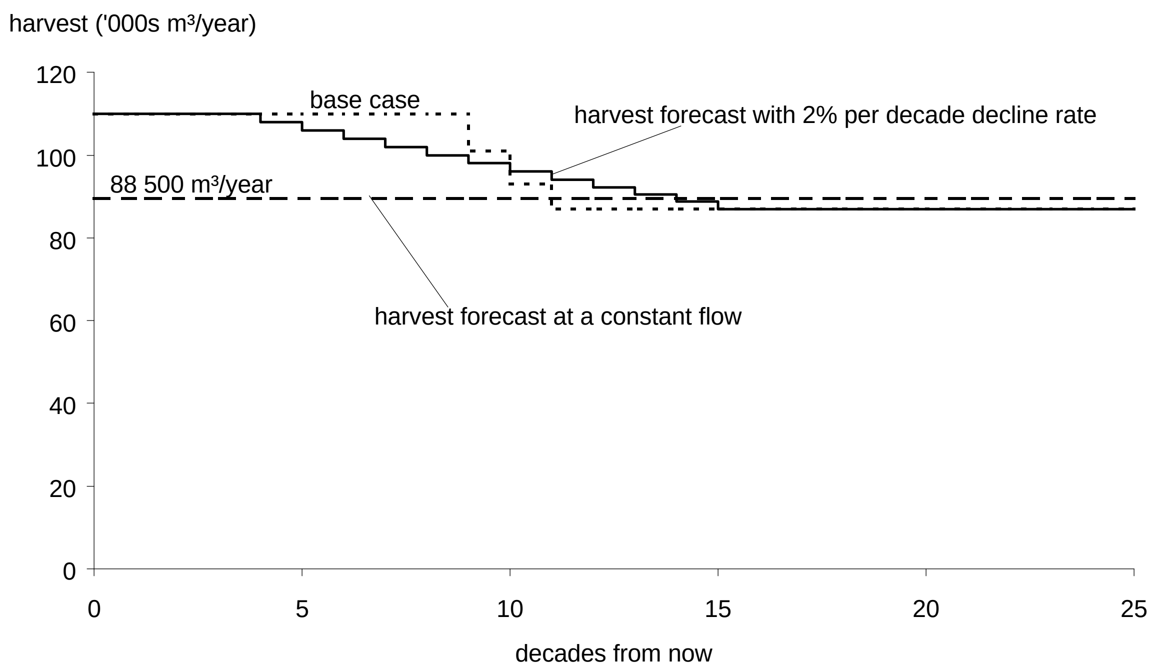


Figure 13. Alternative harvest flow patterns using base case data: 2% transition rate to the long-term harvest level, and constant flow — Cranberry TSA, 1997.

Figure 14 illustrates the effects of maintaining the current AAC for as long as possible without going below the long-term harvest level. The current harvest level could be maintained for 10 decades if followed by a 21% drop in decade 11 to the long-term harvest level. This harvest forecast would provide only 0.2% more timber volume over the first 110 years of the planning horizon than the base case; thus, managing for a more gradual transition to the long-term harvest level does not significantly decrease the amount of timber that can be harvested. If the harvest level is maintained longer than 10 decades, significant timber supply shortfalls are observed immediately after the decline to the long-term harvest level. Therefore, given the current management regime and knowledge base, harvests must decline somewhat over the next 120 years, as shown in the base case, to avoid severe future timber supply shortfalls.

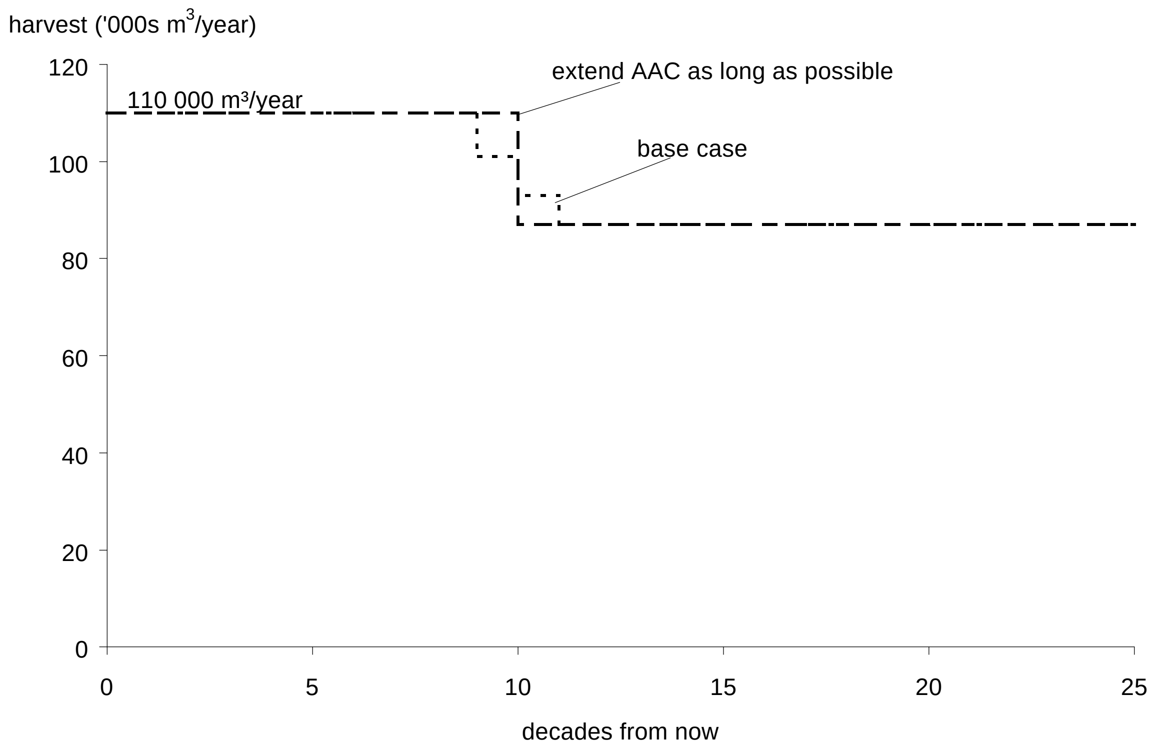


Figure 14. Alternative harvest flow patterns using base case data: maintain current AAC for 11 decades — Cranberry TSA, 1997.

Figure 15 shows two potential harvest forecasts that would result if the short-term harvest level was increased beyond that of the base case. An initial harvest level of 115 000 cubic metres per year, 5000 cubic metres higher than the current AAC, could be maintained for 7 decades before declining to the long-term harvest level at a rate of approximately 8% per decade. This harvest forecast provides only slightly (approximately 0.2%) more timber volume over the first 120 years as the base case because even though a higher initial harvest level is used in this alternative, the harvest level must begin declining to the long-term harvest level 2 decades earlier than in the base case.

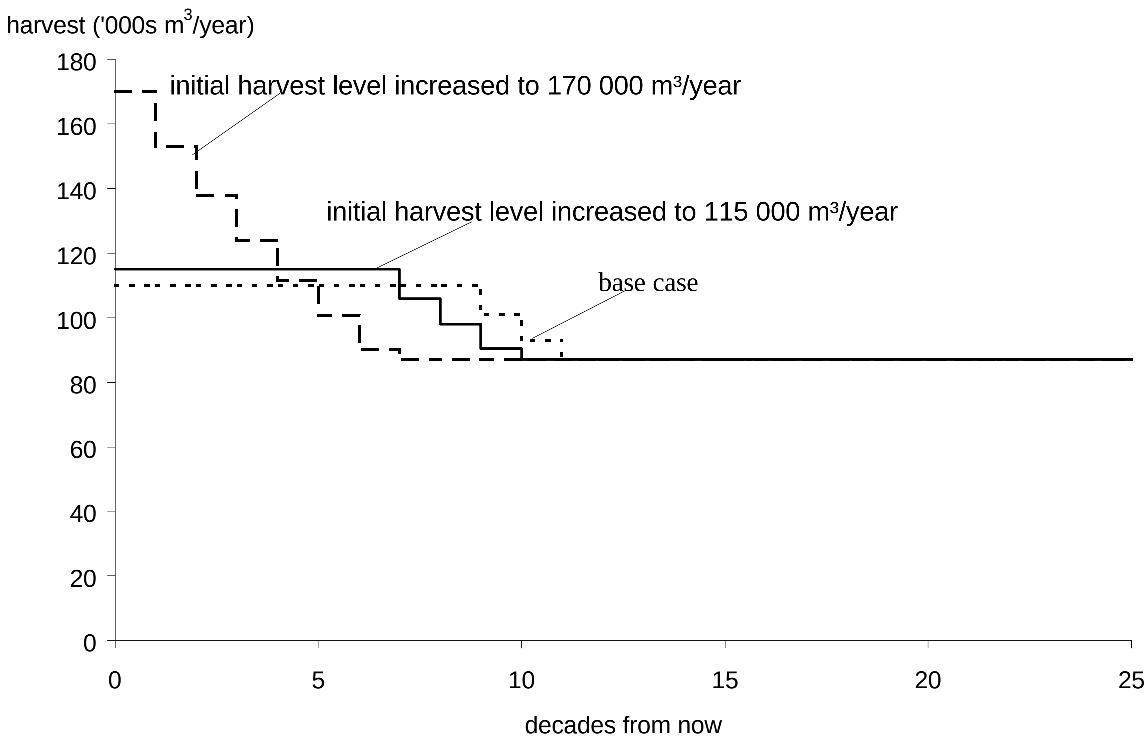


Figure 15. Alternative harvest flow patterns using base case data: initial harvest level increased to 115 000 and increased to 175 000 cubic metres per year — Cranberry TSA, 1997.

Figure 15 also shows that the initial harvest level can be increased to as much as 170 000 cubic metres per year without causing severe future disruptions in timber supply, as long as harvest levels begin to decline to the long-term harvest level immediately after the first decade at a rate of about 10% per decade. Under this flow alternative, total volume harvested over the first 120 years would be 4% higher than in the base case. This alternative illustrates that if existing stands are harvested more rapidly in the short term and replaced with regenerating stands that produce timber volume at a higher rate than in natural stands, the total harvest over the planning horizon can be higher than in the base case. However, a more immediate and rapid decline to the long-term harvest level is required to maintain long-term timber supply stability.

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.

5.2 Uncertainty in adjacency objectives

The Forest Practices Code 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 zone, and a maximum of 30% of the timber harvesting land base of each wildlife management zone, could be covered by stands that have not met the green-up condition.

Forest cover requirements are used in the analysis as a proxy for adjacency requirements. These requirements have some uncertainty as it is not possible to define the exact forest structure needed to meet the management objectives, in this case adjacency, for a particular area. Figure 16 illustrates two harvest forecasts that examine the uncertainty about how adjacency is represented in the analysis.

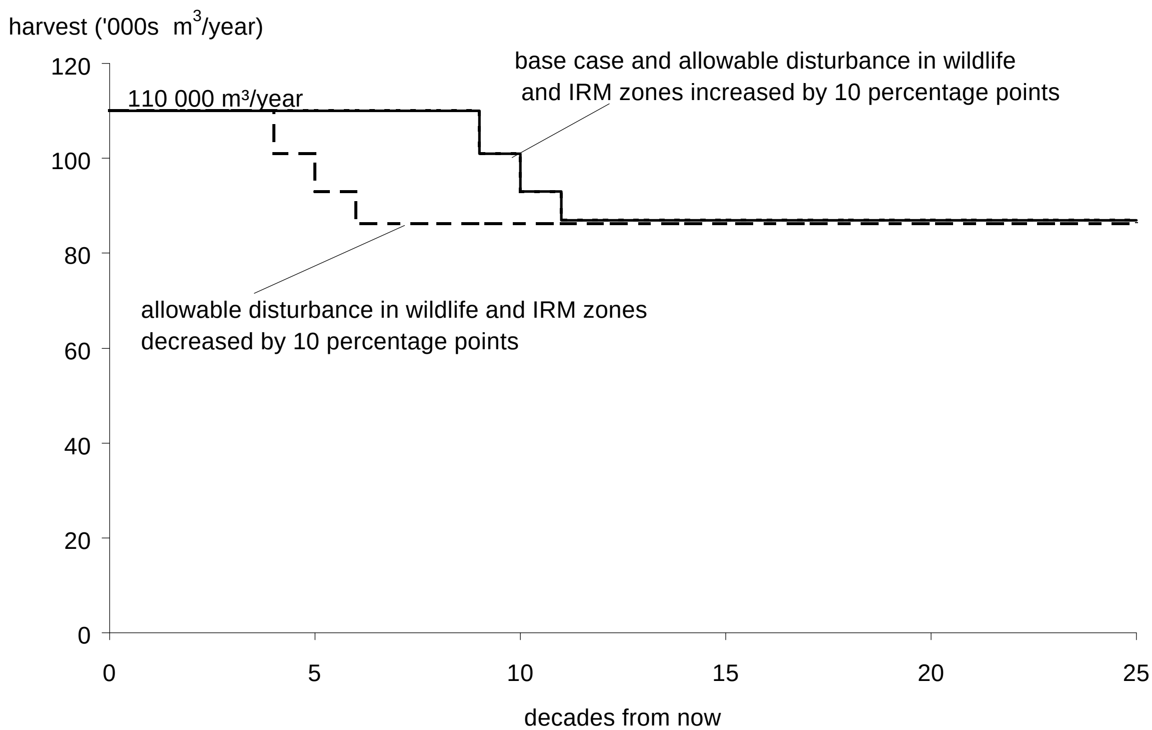


Figure 16. Harvest forecasts if forest cover requirements for disturbance in the wildlife and integrated resource management zones are limited to 12.5% or removed entirely — Cranberry TSA, 1997.

If adjacency requirements were more accurately approximated by decreasing the maximum amount of allowable disturbance by 10 percentage points for the wildlife and integrated resource management zones, timber supply in the medium term would be significantly decreased. The current AAC could be maintained for 4 decades (5 decades less than in the base case) before declining at the same rate as in the base case to a long-term harvest level of 86 250 cubic metres per year. In this sensitivity analysis, the more stringent requirements in the grizzly bear and integrated resource management zones, and to a lesser extent, in the goshawk nesting habitat zone, which combined comprise almost 70% of the timber harvesting land base, decrease the timber supply relative to the base case.

Figure 16 also illustrates the harvest forecast that results if forest cover requirements for adjacency are increased by 10 percentage points for the wildlife and integrated resource management zones. It shows that it is not possible to increase harvest levels beyond base-case levels if the amount of disturbance allowed in the wildlife and integrated resource management zones is significantly increased. Timber supply is not significantly affected because disturbance levels in the wildlife and integrated resource management zones do not significantly limit long-term harvest levels enough in the base case.

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

5.3 Uncertainty in green–up ages

Forest cover requirements for visual quality, wildlife habitat, 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.

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

Figure 17 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 5 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 of 87 750 cubic metres per year, approximately 1% higher than in the base case harvest forecast. Overall, cumulative timber supply would be about 0.5% higher over the 250-year planning horizon if green-up ages were shorter. The slight increase in timber supply is due to the increase in the availability of timber throughout the planning horizon, particularly in the partial retention VQO management zone. The forest cover requirements limiting disturbance in this zone limit timber supply in the base case, and by making these requirements less restrictive in this sensitivity analysis, more timber is made available for harvest from the partial retention VQO zone in the long term.

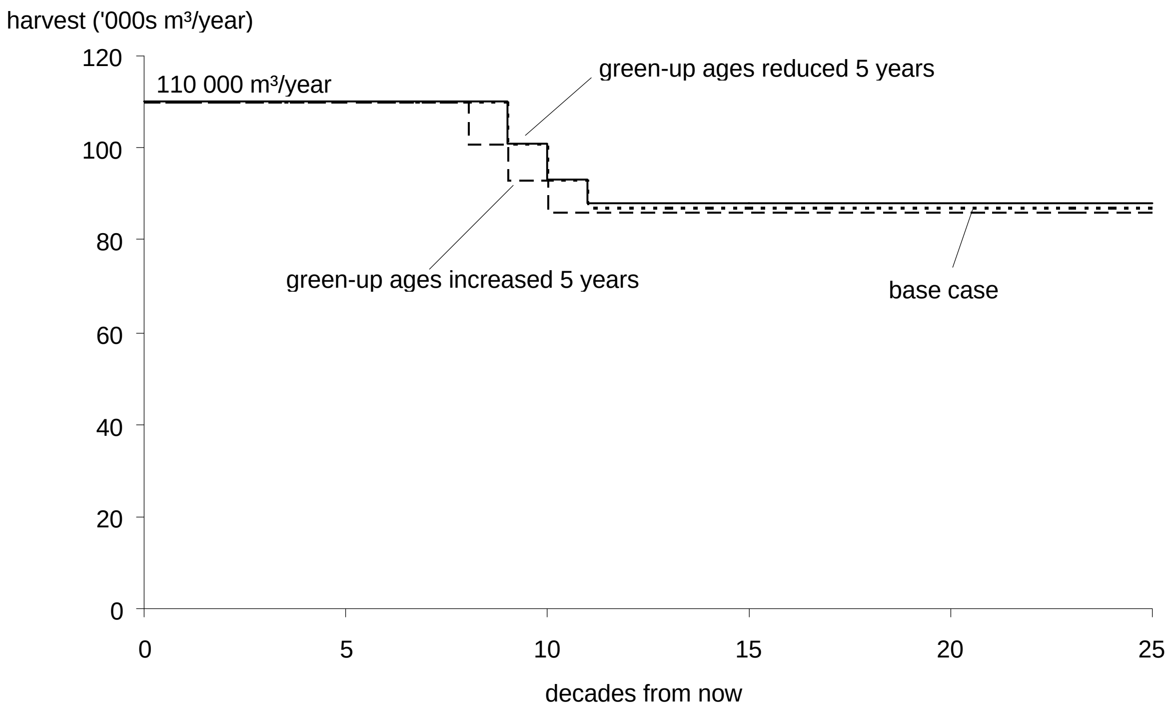


Figure 17. Harvest forecasts if green–up ages were either 5 years longer or shorter than the base case — Cranberry TSA, 1997.

If green-up ages were actually 5 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 8 decades (1 decade less than in the base case). The long-term harvest level would be 86 100 cubic metres per year, about 1% lower than that of the base case. Over the first 120 years of the planning horizon, cumulative harvests would be about 2% lower than in the base case. Timber supply is affected by an increase in green-up ages because more stands are considered below green-up age, and therefore, less disturbance is allowed.

In summary, increases to green-up ages affect the amount of time that the current AAC can be maintained, and both increases and decreases in green-up ages have a slight impact on long-term timber supply.

5.4 Uncertainty in forest cover objectives for old-age forests in the wildlife management zones

Current management as defined for this analysis includes an objective to maintain old-age forests for the habitat of grizzly bear, fisher, and goshawk. These three management zones total 23 270 hectares, or about 71% of the timber harvesting land base. Maintenance of habitat in the grizzly bear management zone is represented by a forest cover requirement that at least 10% of the area be in stands 100 years or older at all times. For the fisher zone, a forest cover requirement is applied to ensure that 10% of all coniferous areas are in stands older than 140 years, and that 15% of all deciduous areas are in stands older than 100 years. In order to maintain goshawk nesting habitat, it was assumed that a minimum of 4% of the area must be in stands older than 140 years. 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. This section examines the effects on timber supply of this uncertainty. Figure 18 shows the implications to timber supply if these requirements are either removed or increased by 20 percentage points.

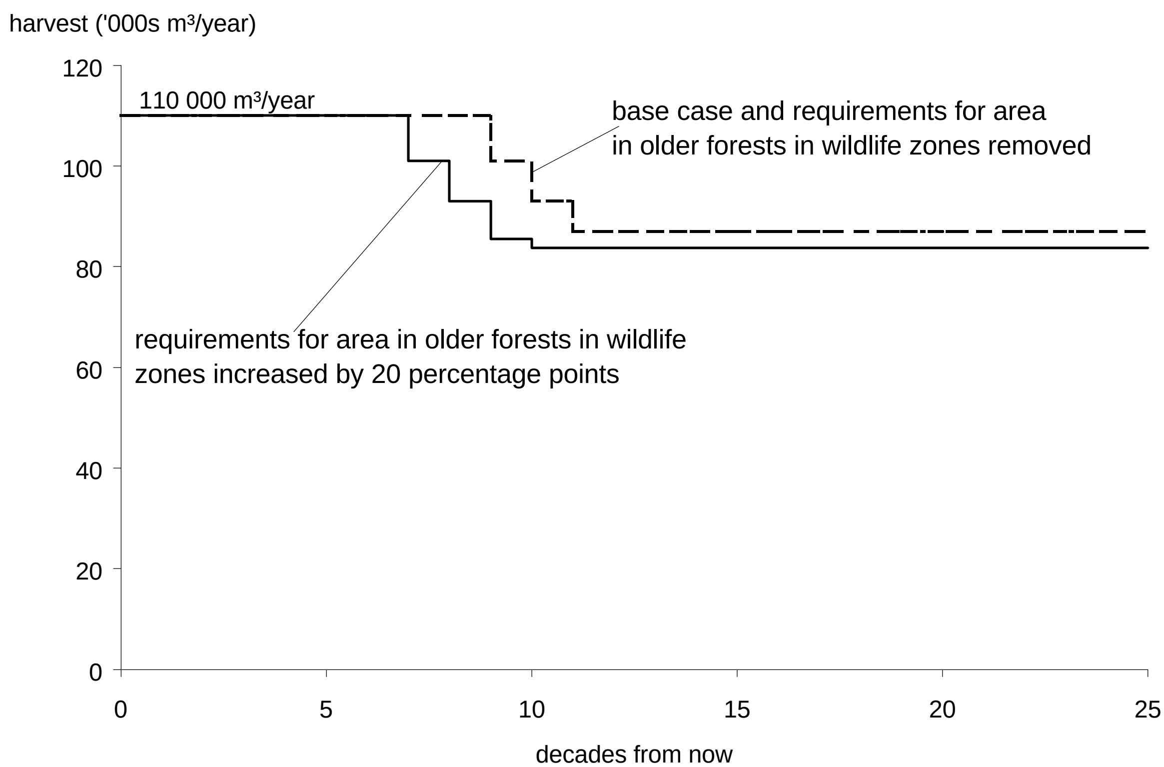


Figure 18. Harvest forecasts if forest cover objectives for older forests in wildlife management zones were different from the base case — Cranberry TSA, 1997.

Increasing older forest cover requirements by 20 percentage points meant that the requirement for fisher, for example, was changed to at least 30% of coniferous areas be in stands greater than 140 years old and at least 35% of deciduous areas be in stands greater than 100 years old.

The increased forest cover requirements for older coniferous stands in the fisher management zone and for older stands in the goshawk nesting habitat management zone limit the amount of timber that could be harvested from these zones throughout the planning horizon. Figure 18 shows that increasing older forest requirements in the wildlife management zones by 20 percentage points would allow the current harvest level to be maintained for 7 decades before declining at a rate of approximately 8% per decade to a long-term harvest level of 83 700 cubic metres, approximately 4% less than in the base case. Total timber supply would be approximately 4% less than in the base case over the first 120 years of the planning horizon, and approximately 4% less over the latter 130 years.

If, however, the forest cover requirements for older forests in all wildlife management zones were increased by 10 percentage points (not shown), there would be very little impact on timber supply compared to the base case because all of the older forest requirements except those for coniferous stands in the fisher management zone would be met by older stands outside the timber harvesting land base. However, some of the old-growth requirements for the fisher zone coniferous stands would have to be provided by stands within the timber harvesting land base, and this slightly constrains the harvest throughout the planning horizon. As a result, the long-term harvest level is decreased by a very small amount (200 cubic metres) compared to the base case.

Removing older forest cover requirements in the wildlife management zones has no impact on timber supply because these requirements are met entirely by stands outside the timber harvesting land base in the base case in all zones except for the fisher coniferous habitat management zone, in which all requirements are met by these stands within 4 decades. Because the requirements do not constrain the harvest in the base case, removing them in this sensitivity analysis does not provide any additional timber supply.

In summary, uncertainty in older forest requirements for wildlife management zones do not have an impact on short-term timber supply, and only impact medium- and long-term timber supply if they are made three times more stringent than in the base case.

5.5 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 FPC biodiversity guidebook provides recommendations for maintaining biodiversity at both the stand level and the landscape level. Stand-level biodiversity has been addressed in this analysis through reductions that remove portions of each stand from the timber harvesting land base. Uncertainty about stand level biodiversity can be assessed through sensitivity analysis that examine the timber supply impacts of land base reductions. Landscape level biodiversity, however, has been modelled in this analysis through the use of forest cover requirements applied to natural disturbance types within landscape units, and there is uncertainty about how the recommendations in the biodiversity guidebook should be interpreted and applied in a modelling environment, as well as how the TSA should be delineated into landscape units. The following sensitivity analyses provide an indication of the risk associated with uncertainty about landscape level biodiversity.

In the assumptions used in the base case, there are no requirements for a portion of the land base to be maintained in stands with mature-seral stage conditions. If mature-seral requirements were applied to each natural disturbance type in the TSA, as outlined in Table 3 and Table 7 of the biodiversity guidebook, with the assumption that 45% of the TSA has a lower biodiversity emphasis, 45% has an intermediate emphasis, and 10% has a high-biodiversity emphasis, the harvest forecast would be the same as the base case. There are currently enough mature forested stands outside the timber harvesting land base to meet the majority of the mature-seral requirements for landscape biodiversity, and the abundance of existing older stands in the timber harvesting land base in the short- and medium-term provides the remainder of mature stands to meet the requirement. Therefore, applying the requirement does not particularly constrain the harvest of stands within the timber harvesting land base, so timber supply is not significantly affected.

Similarly, sensitivity analysis was performed in which the low-emphasis portion of old-seral requirements outlined in the *biodiversity guidebook* were applied in full at the beginning of the planning horizon, rather than increased over 140 years to the full amount, as in the base case. In addition, mature-seral stage requirements were also applied in the sensitivity analysis. In this case, the harvest forecast would be the same as in the base case. As mentioned above, mature-seral requirements are not particularly limiting of timber supply. Older forest requirements must be met initially in part from stands within the timber harvesting land base; however, for the first 70 years of the harvest forecast there is an abundance of older stands within the timber harvesting land base, so these requirements do not limit timber supply in the short- and medium-term. After 7 decades, all old-seral requirements can be met by stands outside the timber harvesting land base. As a result, after 70 years, no old growth must be retained within the timber harvesting land base to meet landscape level biodiversity requirements.

Furthermore, if the entire TSA were assumed to have a high biodiversity emphasis — in other words, the older forest requirements were made more stringent than in the base case — the harvest levels in the base case could be maintained. Even though stands outside the timber harvesting land base cannot immediately provide all the older forests required to meet landscape level biodiversity requirements, there are sufficient older stands in the timber harvesting land base to meet the requirements until enough stands outside the timber harvesting land base have aged to meet the requirements fully (within 17 decades). As a result, the timber supply is not affected; only the order in which stands are harvested changes. In general, some older stands are reserved from harvest longer than in the base case, and some of the younger regenerated stands are harvested earlier.

In summary, the timber supply of the Cranberry TSA is not sensitive to the more stringent landscape level biodiversity requirements examined in this analysis.

In the base case, it was assumed that the entire Cranberry TSA would comprise one landscape unit, within which biodiversity would be applied. However, since the completion of the information package, draft landscape units have been defined for the Cranberry TSA. According to the draft maps, the Cranberry TSA comprise parts of five different landscape units — Lower Kiteen, Cranberry River, Nass River-Kalum, Upper Cranberry, and Brown Bear. However, the Cranberry River landscape unit covers approximately 80% of the Cranberry TSA and thus the timber supply will not likely be significantly changed.

5.6 Uncertainty in forest cover requirements for visual quality

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

Partial retention and retention areas were all treated as partial retention VQO areas because less than 30 hectares of the Cranberry TSA are considered to have a retention VQO*.

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

Figure 19 illustrates that medium-term timber supply is sensitive to uncertainty about current forest cover requirements for VQOs in the Cranberry TSA. If the forest cover requirements applied in the analysis to model partial retention VQOs are changed to those used to model integrated resource management, the current harvest level can be maintained an additional decade over the base case, without causing future timber supply disruptions, if harvests subsequently declined at the same rate as in the base case. A long-term harvest level of 87 500 cubic metres per year, or approximately 0.6% above that of the base case, could be achieved. In total, over the next 130 years, 1.7% more timber supply would be available for harvest than in the base case, while between 140 and 250 years from now, 0.6% more would be available.

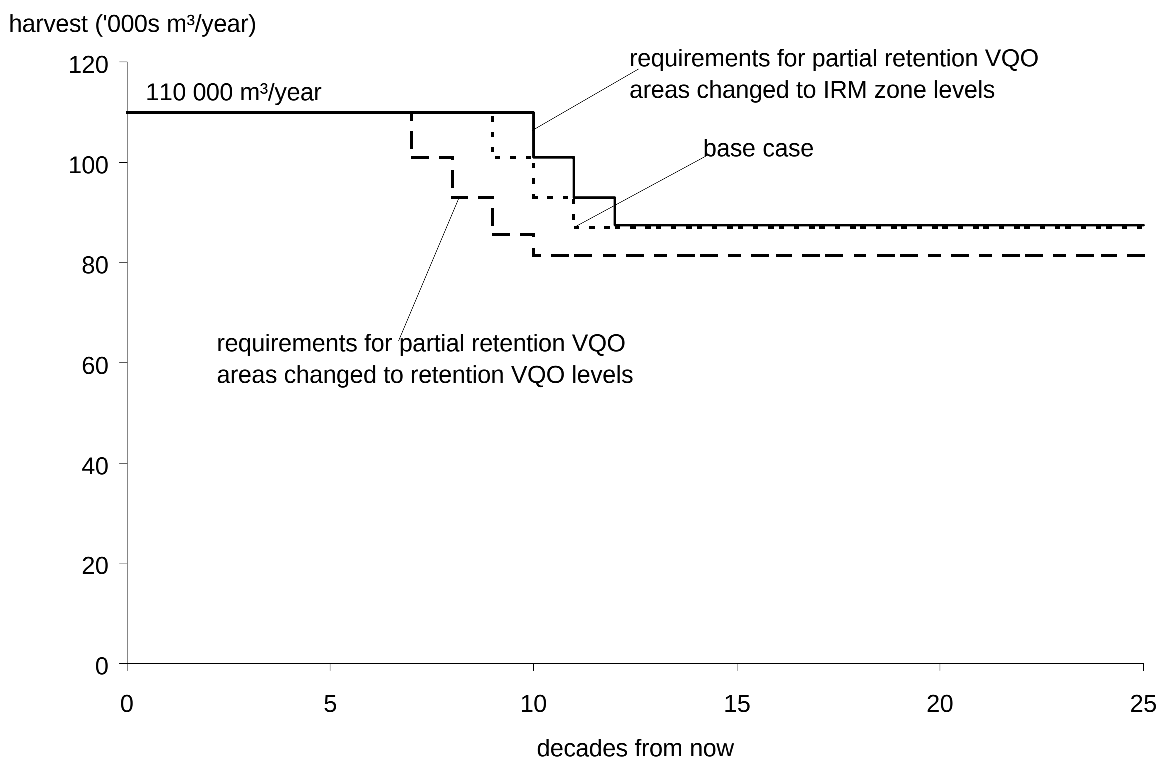


Figure 19. Harvest forecasts if forest cover objectives for partial retention VQO management areas changed to retention levels or changed to integrated resource management zone levels — Cranberry TSA, 1997.

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).

Decreasing the maximum area which is allowed to be in a visually disturbed state, such that the forest cover requirements applied represent more restrictive retention VQO levels, has a significant impact on timber supply. The current harvest level could only be maintained for 7 decades before declining to the long-term harvest level at the same rate as in the base case. The long-term harvest level, reached after decade 10, would be 6% below the base case level. Timber supply over the next 120 years would be decreased by 5%, and the cumulative timber supply from 130 to 250 years would be decreased by 6%.

In summary, these results show that uncertainty about forest cover requirements needed to meet currently defined VQOs has an effect on timber supply over both the medium- and long-terms. This is primarily because of all the management zones in the Cranberry TSA, the partial retention VQO zone is the only one in which harvesting is consistently limited in the base case. Therefore, either relaxing or restricting these requirements directly impacts the availability of timber. However, partial retention VQO areas represent a relatively small portion of the timber harvesting land base of the Cranberry TSA (8.8%). If VQOs were set for a larger area, the potential effects of uncertainty about forest cover requirements would be larger.

5.7 Uncertainty in management of botanical forest products

Within the Cranberry TSA, and in the surrounding region, harvesting of botanical forest products, and particularly pine mushrooms, generates a significant amount of revenue and employment. Currently, no specific management regime is applied in the Cranberry TSA to manage botanical forest products. However, Figure 20 shows the timber supply implications of limiting the amount of harvesting in stands that are prime pine mushroom producers. These stands include all hemlock and pine-dominated stands with a poor timber growing potential within the Interior Cedar-Hemlock moist-cool biogeoclimatic subzone.

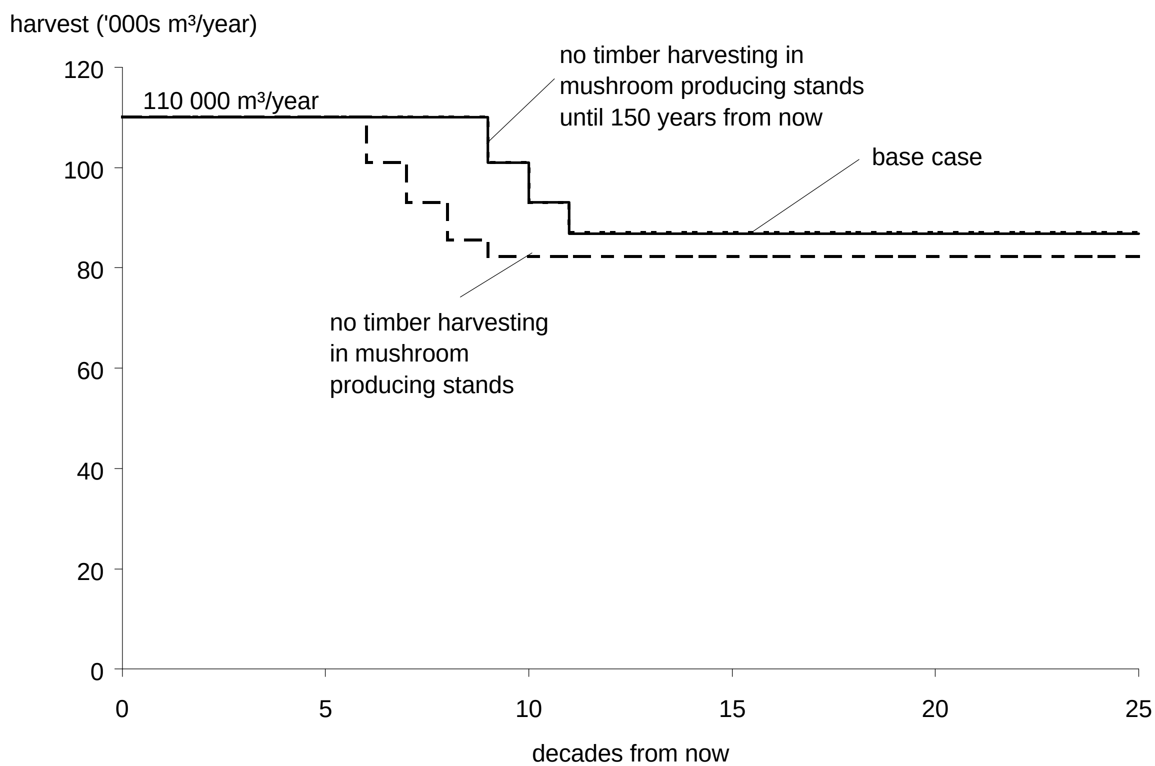


Figure 20. Harvest forecasts if harvesting in prime pine mushroom stands is permitted only after 150 years of age, or if harvesting is prohibited — Cranberry TSA, 1997.

Figure 20 shows that if harvesting were not allowed in stands that meet these criteria until after they reach 150 years of age (the age at which it is assumed the production of pine mushrooms decreases or stops) the short- and medium- term timber supply is unaffected compared to the base case. The long-term harvest level would be decreased slightly to 86 750 cubic metres per year. Delaying the availability of these stands for harvesting does not have a significant impact on timber supply in this case because the stands are still available for harvesting in the long-term; only the order in which stands would be harvested and the age of stands at harvest would be changed from the base case. As a result, slightly less volume (0.3%) can be harvested from these stands over the long term compared to the base case.

Figure 20 also shows the timber supply implications if all existing stands that are prime pine mushroom producers are permanently excluded from timber harvesting. These stands cover approximately 3400 hectares of timber harvesting land base in the base case. If they are excluded from timber harvesting, the initial harvest level projected in the base case can still be maintained for 6 decades before declining to the long-term harvest level. The total volume of timber harvested over the first 120 years of the harvest forecast would be decreased by approximately 7% compared to the base case. The long-term harvest level would also be reduced by about 5% from that of the base case to 82 250 cubic metres per year.

Overall, these sensitivity analyses show that if harvesting were limited or prohibited in stands which are expected to be the most prolific producers of mushrooms, the short-term timber supply is unaffected. However, timber supply would be reduced during the transition period when harvesting shifts from mainly older stands to mainly younger, regenerated stands, and to a lesser extent, reduced in the long term.

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

Figure 21 shows how timber supply would change if stands in fact become merchantable either 10 years sooner or later than assumed for the base case.

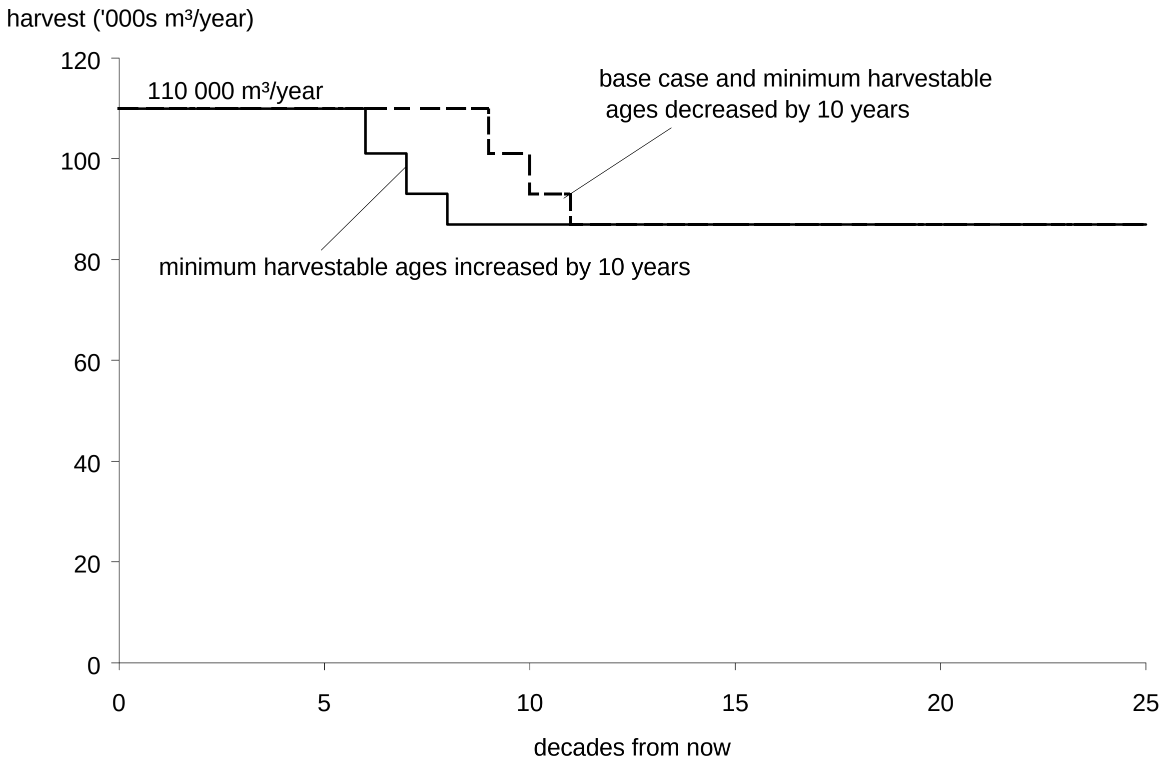


Figure 21. Harvest forecasts if minimum harvestable ages are 10 years younger or older than the base case — Cranberry TSA, 1997.

If minimum harvestable ages were 10 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 110 000 cubic metres per year could only be maintained for 6 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 decade before they are considered harvestable. As a result, when existing older stands are unavailable for harvest during the transition period, there are not as many regenerating stands old enough to be harvested under this management regime as there are in the base case. Thus, the harvesting of existing timber must occur at a slower rate to avoid serious timber supply disruptions in the future, and the overall harvest over the first 120 years of the planning horizon is about 4% lower than in the base case. The long-term harvest level is unaffected by this increase in minimum harvestable age.

If minimum harvestable ages were decreased by 10 years, no additional timber supply could be gained over the base case.

In this analysis, minimum harvestable ages are not viewed as decisions made to meet forest management objectives, but rather as approximations of the timing of merchantability. This analysis highlights that timber supply is sensitive to uncertainty about this timing. Whether minimum harvestable ages used in the base case are appropriate, optimistic, or pessimistic is largely a matter of opinion. 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.

5.9 Uncertainty in estimates of timber volumes in existing stands

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

Figure 22 illustrates that timber supply in the Cranberry 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 13 decades — 4 decades longer than in the base case. The long-term harvest level would be unaffected. The cumulative harvest over the next 160 years would be approximately 6% larger than in the base case if existing volumes were in fact 10% higher.

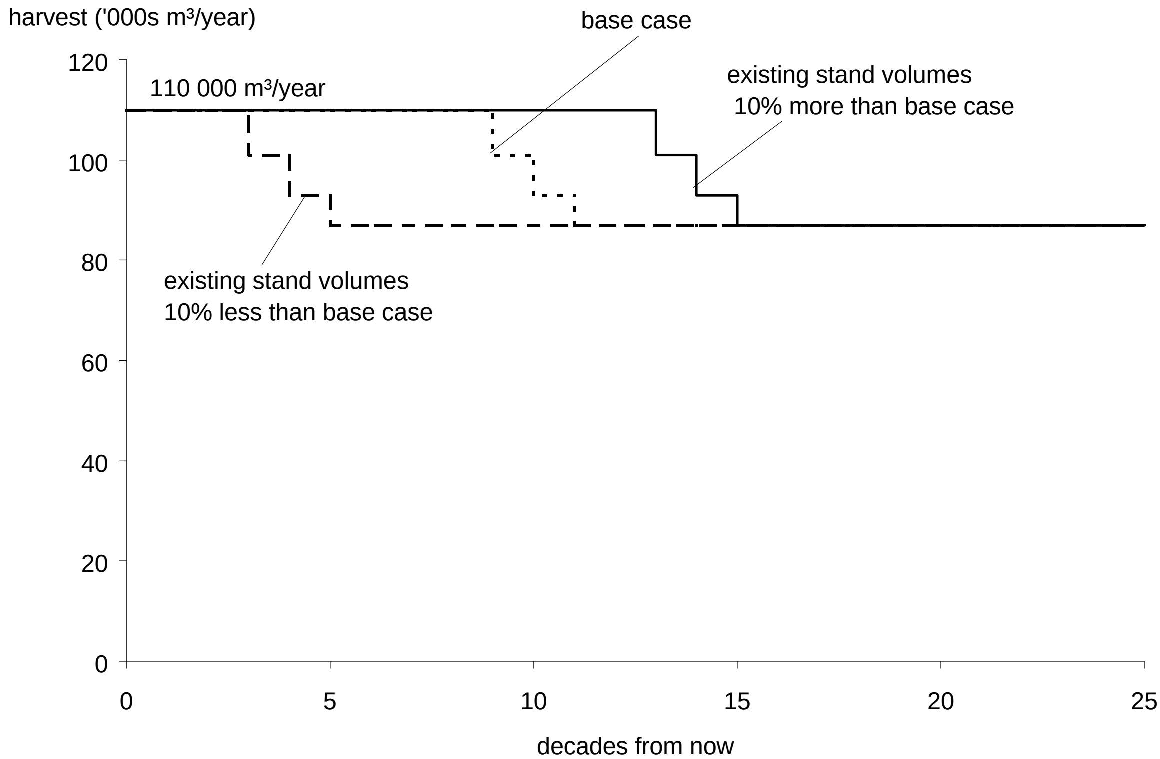


Figure 22. Effect on harvest forecast of 10% uncertainty in existing stand volumes — Cranberry TSA 1997.

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 4. If existing volumes are 10% lower than estimated for the base case, the total harvest over the next 120 years would have to be about 11% less than in the base case to avoid creating severe timber supply disruptions further in the future. The long-term harvest level would not be affected. The timber supply is highly sensitive to overestimation of existing stand volumes because as the volume of timber that is obtained from each stand harvested decreases, harvesting must occur on more area to obtain the same total harvest volume. Thus, as the area covered by existing unmanaged stands will be harvested at a faster rate than in the base case, the harvest level must be decreased earlier to ensure a gradual transition to harvesting in the second-growth forest.

This sensitivity analysis shows that timber supply 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.

5.10 Uncertainty in regenerated stand volume estimates

Estimates of timber volumes in regenerated managed stands are uncertain for similar reasons as existing stand volumes; however, there is additional uncertainty around the estimates of site productivity (discussed further in Section 5.11, "Uncertainty in site productivity estimates"). In this section, the effects on timber supply of using managed stand tables and their associated uncertainty are shown.

Figure 23 shows the results if regenerated volumes are varied by 20% from those assumed in the base case. If managed stand volumes were to exceed present volume estimates by 20%, the noticeably higher volume contributions of managed stands to timber supply would cause the long-term harvest level to be approximately 20% higher than in the base case. The harvest forecast in Figure 23 shows two alternative harvest flows if regenerated stand volumes are 20% higher than assumed in the base case. Alternative 1 shows that that the current AAC could be maintained for 5 decades before declining by 5% to the long-term harvest level of 104 250 cubic metres per year. Cumulative harvests over the first 120 years would be approximately 1% higher than in the base case. Alternative 2 shows that the initial harvest level could be maintained for as many decades as in the base case as long as harvest levels decline by 8% to 101 000 cubic metres per year for 5 decades before increasing by 3% to the long-term harvest level. Increased medium-term harvest levels can be attained in both cases compared to the base case because the increased regenerated stand volumes are realized as soon as these stands start being harvested in decade 7. These alternatives illustrate two of the possible approaches to the transition from harvesting predominantly existing unmanaged stands to managed stands.

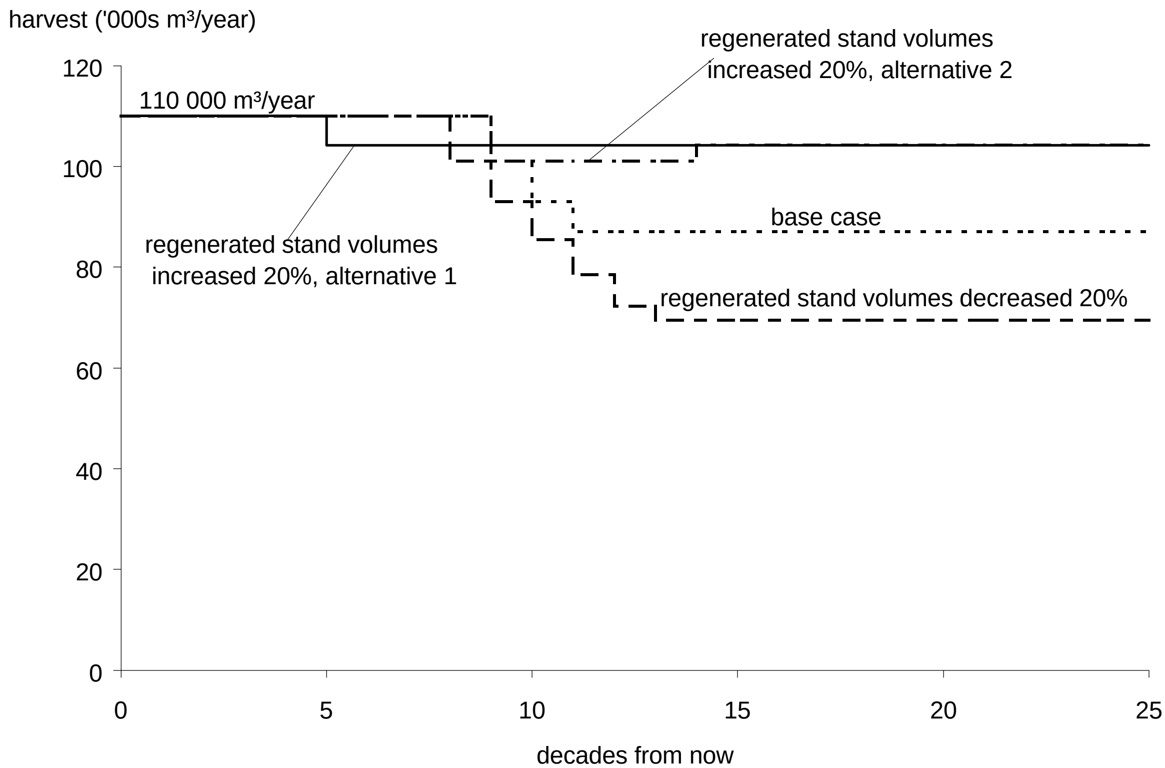


Figure 23. Harvest forecasts with regenerated stand volume estimates changed by 20% — Cranberry TSA, 1997.

If regenerated stand volume estimates are in fact 20% lower than expected, the long-term harvest level is projected to be 69 500 cubic metres per year, which is approximately 20% lower than the base case long-term harvest level. In this harvest forecast, the current AAC can be maintained for 8 decades (1 decade less than in the base case) before declining at a rate of approximately 8% per decade to the long-term harvest level, which is reached after 140 years. Harvest levels must decline an additional 3 decades in this case to reach the lower long-term harvest level at a reasonable transition rate. As a result, over the first 140 years of the planning horizon, timber supply is decreased by about 5% compared to the base case.

In summary, uncertainty about regenerated stand volume estimates has a proportional impact on the long-term harvest level projected in the base case, and affects the medium-term timber supply as harvesting transfers from predominantly older stands to younger, regenerated stands.

5.11 Uncertainty in site productivity estimates

The productivity of a site largely determines how quickly trees will grow. It therefore affects both expectations of timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate assessments of site productivity come from stands between 30 and 150 years old. Estimating site productivity in both young- and old-stands is difficult. Currently, about 14% of the Cranberry TSA timber harvesting land base comprises stands between 30 and 150 years old. Thus, a substantial area lies outside the age range that provides accurate estimates. This section examines how timber supply is affected by uncertainty in site productivity estimates which affect regenerated stand volumes, green-up ages, and minimum harvestable ages. Each of these have been examined individually in previous sections.

Site productivity is often expressed in terms of the site index* at a breast-height age of 50 years. If site indices were underestimated, regenerated stands would grow faster than estimated in the base case. As a result, they would reach the required green-up height sooner, and would achieve minimum merchantable volumes, and thus, minimum harvestable ages, sooner than estimated in the base case. Figure 24 displays how timber supply would change if current data underestimate actual site productivity by 5 metres. The harvest forecast shows that it would be possible to increase the harvest level immediately to 137 850 cubic metres per year, which could be maintained throughout the planning horizon. This long-term sustainable level would be 58% higher than the long-term harvest level in the base case. Over the next 120 years, the timber supply would be increased by approximately 30% over that of the base case. The increased timber supply is due mainly to the higher volume production in regenerated stands. Furthermore, because these regenerated stands reach green-up conditions sooner in this case, more stands are available for harvest over time compared to the base case.

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

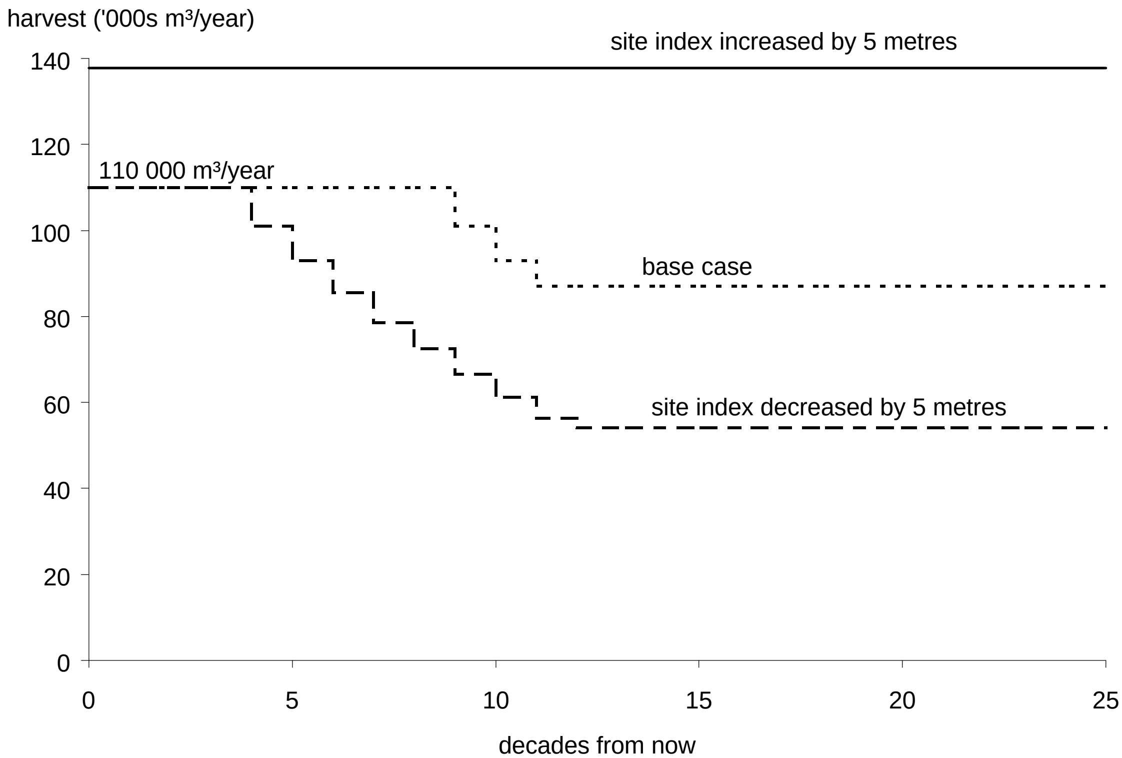


Figure 24. Harvest forecasts if site index is 5 metres different than in the base case — Cranberry TSA, 1997.

The increases in timber supply over the next 100 years shown in these results stem from increases in timber volumes in stands available for harvest several decades from now. The volume of timber in stands available for harvest over the next few decades would not change if volumes in managed regenerated stands were different than predicted for the base case. As a result, higher short-term harvests may place medium-term timber supply at risk if the higher stand-volume predictions did not actually come to bear.

If site indices were overestimated, the volumes of regenerated stands would be smaller than estimated in the base case, and these stands would not grow as quickly, increasing the number of years required to reach green-up conditions and minimum harvestable age. Figure 24 also shows how a reduction in site index of 5 metres would affect timber supply. If site indices are actually 5 metres less than estimated in the base case, the current AAC could still be maintained for 4 decades before declining to the long-term harvest level at a rate of 8% per decade. However, the long-term harvest level of 54 000 cubic metres per year would be 38% lower than the long-term harvest level projected in the base case. Over the next 130 years, cumulative timber supply would be 18% less than in the base case.

The results show that if current estimates of site productivity overestimate actual potential, harvests over the next few decades would not need to decline from base case levels to avoid causing severe timber supply disruptions further in the future. While the long-term harvest level would be well below the current harvest level, sufficient volume exists so that harvests could be reduced in a controlled fashion over the next 130 years to reach a sustainable level.

In summary, uncertainty about site productivity quite dramatically affects long-term timber supply. If site productivity has been overestimated in the base case, immediate harvest level reductions relative to the base case would not be required to avoid severe future timber shortages. However, in the case of site productivity underestimation, even the short-term harvest level is affected, and can be increased significantly due to the higher volumes from regenerated stands, lower green-up ages, and lower minimum harvestable ages.

5.12 Uncertainty in land base available for harvesting

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

One concern specific to the Cranberry TSA is that floodplain areas around the Cranberry River have not yet been mapped to standards. These areas may not be available for harvesting in the future. To address this concern, and other areas of uncertainty in defining the timber harvesting land base, the area in all stand types and ages within the timber harvesting land base in the base case was both increased and decreased by 5% and 10%. In the case of timber harvesting land base increases, the additional area was assumed to come from inoperable areas. In the case of timber harvesting land base decreases, the area removed from the timber harvesting land base was assumed to be inoperable, so while it did not contribute to timber supply, it continued to contribute to forest cover requirements for wildlife and old growth.

If the timber harvesting land base were in fact 5% larger than defined for the base case, the current harvest level could be maintained for 10 decades before declining to a long-term harvest level 3% (89 750 cubic metres per year) higher than in the base case (Figure 25). Over the first 130 years, the total timber supply in this forecast would be 2% higher than in the base case, while over the remainder of the planning horizon, timber supply would be 3% greater.

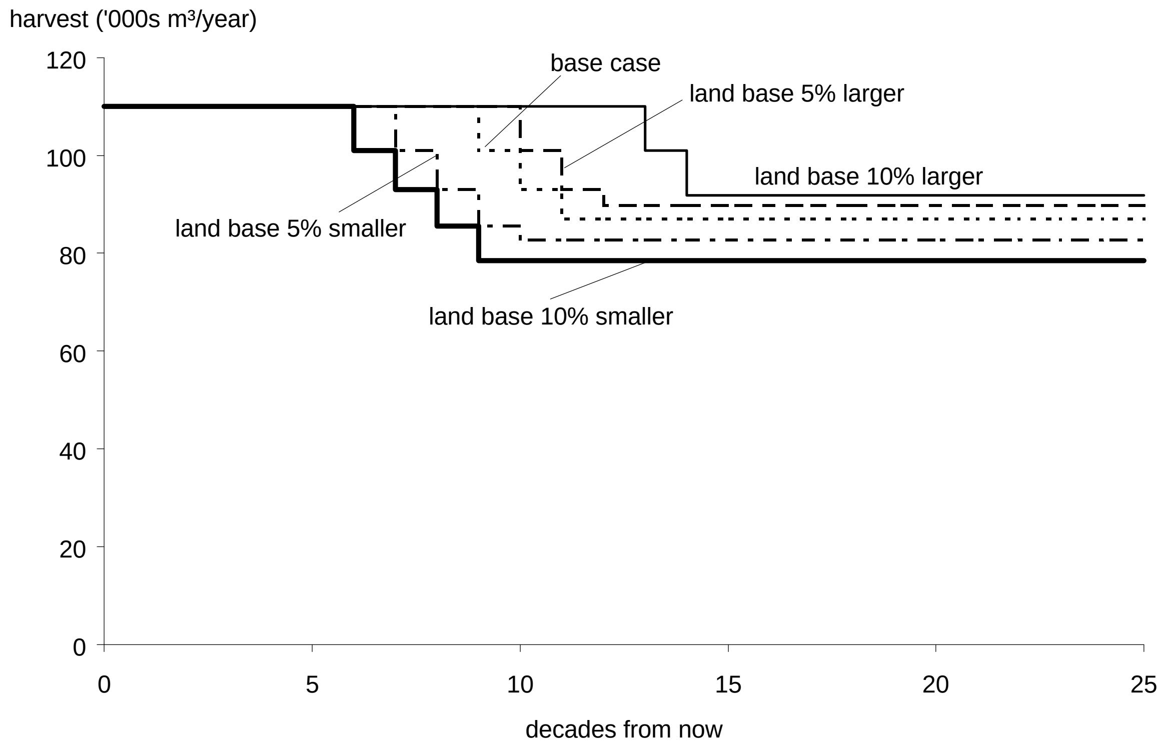


Figure 25. Harvest forecasts reflecting uncertainty in size of the harvesting land base — Cranberry TSA, 1997.

Figure 25 also shows how a 10% increase in the land base would affect potential harvests. The current harvest level could be maintained for 13 decades before declining to a long-term harvest level 6% (91 890 cubic metres per year) higher than in the base case. Cumulative timber supply over the next 150 years would be 6% greater than in the base case.

Results displayed in Figure 25 indicate that if the land base were 5% smaller than in the base case, the current harvest level could be maintained for the next 70 years. Timber supply over the next 110 years would be 4% lower than in the base case. In addition, the timber supply would have to decline to a long-term harvest level of 82 700 cubic metres, approximately 4% lower than the base case long-term harvest level.

If the timber harvesting land base of the Cranberry TSA were 10% smaller than defined for the base case, the initial harvest level projected in the base case could still be maintained for 6 decades, but overall, the total timber supply over the next 120 years would be 8% less than in the base case. The long-term harvest level and cumulative harvest from 130 to 250 years from now would be 10% lower than in the base case.

In summary, timber supply is sensitive to uncertainty about the size of the timber harvesting land base. Short-term timber supply is not affected in any of the cases examined here. However, changes in the size of the timber harvesting land base do affect timber supply from 50 to 150 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 Cranberry TSA of 110 000 cubic metres per year can be maintained for up to 90 years without requiring substantial future harvest level reductions, or creating severe future timber disruptions. Using current inventory and timber growth information, and assuming continuation of current forest management practices, harvests could be maintained at the current level for 90 years if followed by reductions of 8% per decade between 91 and 120 years from now to the long-term harvest level of 87 000 cubic metres per year, or 21% below the current level.

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

Uncertainty involving estimates of site productivity had the largest potential effect on projected harvest levels over the next 250 years. Four factors were shown to have a significant effect on timber supply either in the medium- or long-term, or both. These include estimates of: existing stand volumes, regenerated stand volumes, the maximum amount of disturbance allowed in wildlife and integrated resource management zones, and the size of the timber harvesting land base. Uncertainty about minimum harvestable ages, and forest cover requirements to maintain visual quality have a moderate impact on timber supply during the transition to harvesting mainly second-growth stands, and in the long term. Areas of uncertainty which have only a small impact on medium-term timber supply include: the age at which stands reach green-up conditions, requirements for older forests in wildlife management zones, and management of areas known to be of importance for pine mushroom production. The more stringent landscape level biodiversity requirements examined in this analysis have no impact on timber supply.

The forest inventory and management factors discussed above could affect timber supply over the next 40-150 years, but uncertainties about these factors did not require reduced harvests over the short term, that is, the next 20 years. None of the uncertainty examined in this analysis would require short-term harvest reductions. This analysis showed that uncertainties about other factors can affect overall timber availability over the next 150 years, but would not require that harvests drop below base case levels over the next 40 years to 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, and the size of the timber harvesting land base have large effects on timber supply. Uncertainty about the older-forest cover requirements for wildlife management zones, forest cover requirements for visual quality, and pine mushroom stand management all have moderate effects on long-term harvest levels. Minimum harvestable ages, green-up ages, maximum disturbance objectives for integrated resources management areas and wildlife management zones, and estimates of timber volumes in existing stands have low to no effect on long-term timber supply.

In conclusion, this analysis indicates that based on current inventory and growth and yield information, and the current management regime, timber harvests in the Cranberry TSA can be maintained at the current allowable level for the next 90 years. Several factors related to the current forest inventory and management regime could affect timber supply over the next 40-150 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 socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the Cranberry TSA within the context of regional timber supplies and milling facility capacities. The following socio-economic analysis has five parts: the socio-economic setting, the forestry sector, other sectors, the assessment of harvest forecast implications and the timber requirements of processing facilities.

7.1 Socio-economic setting

7.1.1 Population and demographic trends

Population, in the vicinity of the Cranberry TSA, is scattered throughout a dozen small communities. The village of Hazelton and the New Hazelton District Municipality are the principal commercial, administrative and retail centres for the area. According to the Statistics Canada 1991 Census, the population of the closest centres; Kitwanga, Gitwangak, and Gitanyow, and their surrounding rural area, is approximately 1,400. Between 1986 and 1991 the local population grew by about 2% per year, although early indications, from the 1996 Census, suggest growth may have slowed to about 1% per year since then. The unemployment rate in the area is about 25%.

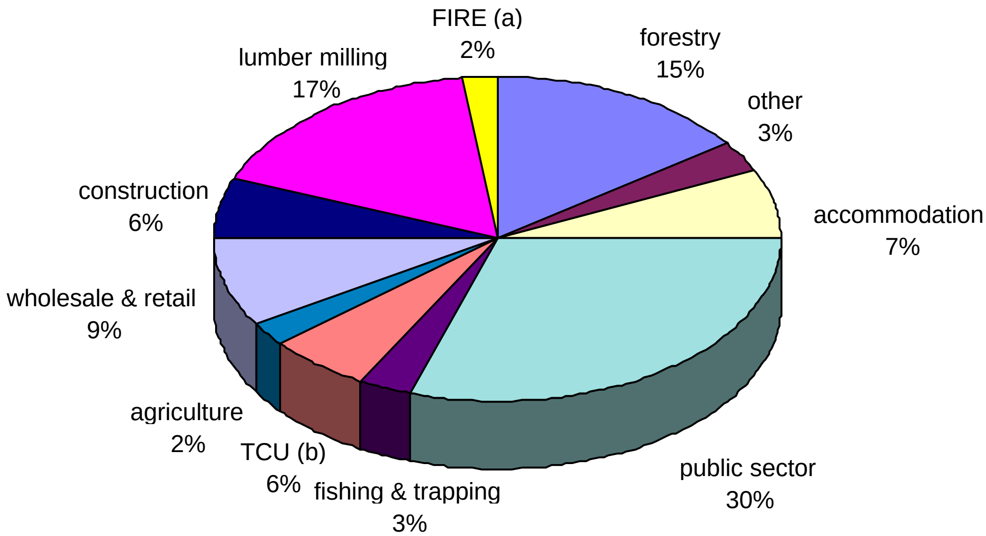
Table 2. Population trends in the Hazelton-Kitwanga area (1986-1996)

Community	1986	1991	1993	1996	% chg/year 1991-96
Hazelton (village)	440	340	351	384	1.8
New Hazelton district municipality	800	785	792	826	0.8
Hazelton-Kitwanga area	1 350	1 400	N/A	1 420 (est)	1.4

Source: B.C. Stats 1991.

7.1.2 Basic sector dependence

With approximately 50% of the local area population between the ages of 20 and 55, the per capita workforce, in the Hazelton area, is larger than the provincial average however, reported incomes are only about 70% of the provincial average. Apart from resource industries and a fishing based tourism sector employment opportunities are very limited. Figure 26 shows the distribution of sectoral employment in the area in 1991. About 32% of the local area employment was forestry and lumber milling related. In addition, each of these positions supports an additional 0.24 person-years of local indirect "spin-off" employment.



(a) FIRE — consists of finance, insurance, and real estate and other business services.
(b) TCU — consists of transportation, communications and utilities.

Figure 26. Hazelton area employment by sectors (1991) — Cranberry TSA, 1997.

About 39% of basic sector (the basic sector is comprised of direct activity as well as indirect supply and service industries) income in the Hazelton area results from forestry related activities. Timber harvesting and processing employment directly associated with timber from the Cranberry TSA contributes to about 5% of this total.

7.1.3 First Nations

According to the records of Indian and Northern Affairs, Canada, the on-reserve native population as of December 31, 1991 numbered 3401, or approximately 53% of the total population in the larger Hazelton-Kitwanga area. (More native people are living off-reserve, but no population estimates are available).

The Cranberry TSA is located within overlapping territories of both the Nisga'a Tribal Council and the Gitanyow Nation. One of the primary objectives of the initial Cranberry Forest Licence, as awarded to C-Ged Forest Products in 1995, was to provide opportunities to enhance the involvement of the First Nations community in the forestry sector. There are currently 15 to 20 First Nations persons employed in TSA related operations.

7.2 Forestry Sector

7.2.1 Harvesting history

As previously noted, the current AAC for the Cranberry TSA is 110 000 cubic metres per year. Ninety per cent of the AAC (100 000 cubic metres per year) is allocated to one forest licence which is currently held by C-Ged. The C-Ged licence, as well as the C-Ged timber mill in Kitwanga, is owned and managed by the Gitwangak band of the Gitksan First Nation. The remaining AAC is allocated to the Small Business Forest Enterprise Program (SBFEP) administered by the Forest Service.

A review of recent harvest levels provides a context within which to analyse associated economic activity supported by the AAC. An examination of recent harvests can also indicate gaps between the allowable annual cut and the actual harvest. Generally, a licensee's harvest will approximate the AAC[1]; however, the harvest can be substantially below the AAC, as has occurred in the Cranberry TSA. As a result, even without changes to the AAC, employment could rise if the AAC were fully harvested.

Prior to the establishment of the Cranberry TSA, in mid-1995, the area was managed as a Tree Farm Licence (TFL 51) by Repap B.C., and before that by Westar Timber Ltd. During the 1990 to 1992 period the average annual harvest was 59 000 cubic metres per year. While the proportion varies by year and area, pulp volumes normally comprise about 50% of the harvest. Since 1992 harvest activities have been intermittent. There was no harvesting in the area in 1993 or 1995, and 1994 saw harvesting only under the province's SBFEP (88 000 cubic metres per year). In 1996, the harvest reached 39 705 cubic metres per year.

7.2.2 Pattern of wood flow

In 1996, only about 3% of all timber processed in the Hazelton area came from the Cranberry TSA. Table 3 describes the interrelationships between the Cranberry TSA harvest and local processing facilities. Lumber mills are located in or near Kitwanga (C-Ged Forest Products, Kitwanga Lumber Company), and New Hazelton (Kispiox Forest Products, Skeena Cellulose Inc.). The Skeena Cellulose chip mill is also located in New Hazelton. Two small specialty mills are located in the area; one at Kispiox and the other just east of Hazelton (Seaton Timber). Most of the mills' timber requirements are met by the harvesting activities from the adjoining Nass, Kalum and Kispiox TSAs. Only the C-Ged mill is significantly dependent on the Cranberry TSA timber supply.

Table 3. Cranberry TSA wood flow, 1996

Processing in area	Product	Capacity	Capacity utilization ('96) %	Chip output '000 BDU	Input '000 m³		Cranberry source ('96)	
					('95)	('96)	%	'000 m³
C-Ged forest products	Lumber	43 mbf	33	28	26	53	59	31.4
Other lumber mills	Lumber	221 mbf	49	74	710	624	0.3	2.0
Chip mills	Chips	288 bdu	37	170	409	433	0	0
Total Hazelton Area			41	272	1145	1110	3	33.4
Cranberry timber processed elsewhere								6.3
Total Cranberry harvest								39.7

Source: Ministry of Forests

(1) A licensee’s rate of harvest may range from 50% to 150% of the licence AAC in any one year, but must be within 10% at the end of a 5-year cut control period.

All of the wood chips produced locally are transported to pulp mills outside the area. Wood chips from the C-Ged mill are trucked to the Eurocan pulp facility in Kitimat (6,300 BDU in 1995 or about 2% of the total Eurocan chip input).

7.2.3 Employment associated with the Cranberry TSA AAC

In 1996, C-Ged's timber harvest operations employed about 43 individuals for part-time logging, planning and administration activities. This is equivalent to approximately 25 full-time person-years. Silvicultural activities associated with the harvest contributed another five full-time equivalents, while related timber processing supports about 48 jobs. Fifteen to 20 of these 78 positions are held by Gitwangak band members.

C-Ged's lumber mill, in Kitwanga, has been shut-down since mid-December, 1996; before that it was operating at less than half capacity on a one-(short)-shift per day cycle. During the year, 52 500 cubic metres of timber were processed at the mill. Sixty per cent of the timber supply originated in the Cranberry with the balance coming from purchases from the Nass, Kalum and Kispiox TSAs.

During 1996, Skeena Cellulose acquired Orenda Forest Products, including 342 000 cubic metres of wood in the Meziadin Lake area (Nass TSA). Terms of the acquisition require Skeena Cellulose to supply C-Ged with 35 000 cubic metres of timber per year for 3 years. However, given Skeena's current financial difficulties, the effective status of this arrangement remains uncertain.

Employment levels associated with the 1996 TSA harvest have been converted into coefficients and (Table 4). The coefficients are based on the current level of harvesting and processing activity. The coefficients appear high in relation to other figures for similar areas of the province; however, if the harvest increases to the allowable annual cut level and as the C-Ged mill increases its production, the coefficients will likely decline as operations achieve economies of scale and the current labour force is more fully and efficiently utilized.

Table 4. Cranberry TSA harvest dependent employment and employment coefficients (based on 40 000 cubic metres per year)

	Hazelton area		Province	
Activity	**Employment (PYs)**	**Coefficient per '000 m^3 harvested**	**Employment (PYs)**	**Coefficient per '000 m^3 harvested**
Harvesting	15	0.38	25	0.63
Silviculture	5	0.13	5	0.13
Processing	38	0.95	48	1.20
Total	58	1.45	78	1.95

The employment coefficients, noted above, suggest that utilization of the full Cranberry TSA AAC could support approximately 40 local person-years in harvesting and an additional 10 to 15 person-years in silviculture. At this level of activity, wood processing and forestry service jobs would contribute another 100 local person-years. The coefficients suggest that an annual timber supply of 200 000 cubic metres would bring the mill up to a full capacity, two-shift operation, contributing in the order of 190 full-time positions. Additional spin-off or 'induced' employment would also be generated through forest company and direct wage and salary re-spending.

7.3 Other Sectors

7.3.1 Pine mushroom harvest

In 1994, in the Nass Valley area of British Columbia, which includes the Cranberry TSA, the harvesting of pine mushrooms generated an estimated value of $3.4 million in 1994. The harvest provided approximately 30,500 person-days (120 PYs) of employment during the year, mostly in the months of September and October. Only about 5% of this total, though, can be attributed to the Cranberry TSA. Approximately 50% of the mushroom harvesting workforce reside in the Nass Valley area while 46% reside elsewhere in British Columbia. Four per cent of the workforce are non-resident. Many First Nations residents from the Nass Valley area participate in the harvest and mushroom sales has become an important part of their income.

At present, the Ministry of Forests does not regulate the majority of more than 200 botanical products harvested in the province, although the *Forest Practices Code Act of British Columbia* enables the development of licensing regulations. Resource use conflicts between the pine mushroom industry and forestry are a concern. However, pine mushroom patches in areas that have been selectively logged continue to produce good crops. The importance of logging roads in providing access to mushroom areas is also notable.

7.3.2 Tourism

Tourism is another primary industry which has been growing since the 1960's, mostly as a result of improvements in the transportation system. Historically, the tourism industry is largely associated with fishing and hunting. Many of the top steelhead producing rivers in the province are found near Hazelton. More recently, cultural resources such as the 'Ksan Historical Indian Village Museum and the area's Tour of the Totems are attracting more European visitors. The region also provides river rafting and hiking opportunities. According to a Village of Hazelton Economic Development Profile, there are about 90 jobs in the area directly associated with tourism.

7.3.3 Agriculture

Cattle ranching is the main form of commercial agriculture in the region. In 1991 there were 22 census farms in the area reporting sales of $10,000 or more.

7.4 Harvest forecast and implications

The base case harvest forecast in this report suggests that the current AAC could be maintained for 9 decades. After this, in decade 10 and again in decade 11 the harvest is expected to decline by approximately 8. This is followed by a final 7% decrease in decade 12 to the long-term harvest level of 87 000 cubic metres.

The economic sector profile relies on statistics, on employment and income, where employees live, silvicultural activities, harvest volumes, timber flows, and processing operations, which have been gathered from licensees, processing facilities, the B.C. Forest Service and other stakeholders. Employment multipliers from the Ministry of Finance and Corporate Relations can then be applied to estimate indirect and other related employment and income at both the local and provincial level. Finally, total employment, wages and salaries, and government revenue coefficients, developed per 1000 cubic metres of harvested timber, provide estimates of the impacts of changes in timber harvest levels.

7.4.1 Short- and long-term implications of the harvest scenario

The economic impacts of the base case harvest scenario (see Table 5) are projected within a range between an upper and lower bound. The upper bounds are derived from the current level of harvesting and processing activity which, again, is much lower than the AAC. As a result, the labour utilization per cubic metre of harvest is unusually high and the employment impact estimates are significantly different than for other areas of the province. It is likely that if the harvest increases to the allowable annual cut level, the actual impacts on employment will be significantly lower; closer to the lower bounds of the ranges indicated in the table. Harvesting and processing operations should be able to achieve economies of scale as the current labour force is more fully and efficiently utilized. (See Appendix B, Socio-Economic Analysis).

7.4.2 Regional impacts

Based on 100% utilization of the AAC, it is estimated that the base case scenario could support between 92 and 126 person-years of direct employment in the region for the next 90 years. This translates into a net increase of 42 to 83 direct person-years. After the first 9 decades, employment declines associated with reduced harvests begin. The long-term harvest level, reached in decade 12, supports from 73 to 99 person-years of direct employment.

Population in the local area has recently been growing at about one per cent per year. Under the base case forecast, however, the positive impacts on local employment of increased harvest activities may translate into more robust population growth. On the other hand, with 25% of the region's population unemployed, job increases may go to local unemployed or under-employed persons. Any increases in employment will have positive impacts on the local First Nations community's involvement. The effects will be the greatest in the communities with the highest concentrations of First Nations workers such as Kitwanga, Gitwangak and Gitanyow.

A change in harvest levels will also result in increases to tax revenues flowing to all levels of government. Increases in local government revenues will affect the region's ability to support infrastructure and benefit the service related components of the economy.

7.4.3 Provincial impacts

Provincial employment and income associated with the harvest scenario will also be positively affected if actual harvest levels increase. For the first 9 decades, direct employment will increase by between 28 and 82 person-years (to between 106 and 160 person-years) generating incremental employment income of between $1.2 and $3.4 million (dollar value in 1996). Beginning in decade 10 the three 8% per decade reductions will result in corresponding reductions in employment levels. By decade 12 the long-term harvest level will result in a net total (i.e., direct plus indirect plus induced) provincial impact of between 12 and 113 person-years, up to $3.0 million in associated employment income and between $0.8 and $1.3 million in stumpage fees and other industry related provincial government revenue.

Table 5. Cranberry TSA — regional and provincial economic impacts of harvest forecast

		Base case harvest forecast			
	Current	Decade 1 - 9	Decade 10	Decade 12	Decade 13 +
AAC					
Harvest level (m³)	110 000	110 000	101 000	93 000	87 000
Difference to current AAC	39 705	0	-9 000	-17 000	-23 000
Hazelton area					
Employment (PYs)					
Direct	58	92 - 126	85 - 116	78 - 106	73 - 99
Indirect/induced	13	20 - 28	19 - 25	17 - 23	16 - 22
Total	71	113 - 154	104 - 141	95 - 130	89 - 121
Difference to current		42 - 83	33 - 70	24 - 59	18 - 50
Employment income ($1996 mil)					
Direct	2.6	- 5.8	3.9 - 5.3	3.6 - 4.9	3.4 - 4.5
Indirect/induced	0.4	0.7 - 0.9	0.6 - 0.8	0.6 - 0.8	0.5 - 0.7
Total	3.0	5.0 - 6.7	4.6 - 6.2	4.2 - 5.7	3.9 - 5.3
Difference to current		2.0 - 3.7	1.6 - 3.2	1.2 - 2.7	0.9 - 2.3
Province					
Employment (PYs)					
Direct	78	106 - 160	97 - 147	89 - 135	83 - 126
Indirect/induced	105	143 - 216	131 - 199	121 - 183	112 - 170
Total	183	248 - 376	228 - 346	210 - 318	195 - 296
Difference to current		65 - 193	45 - 163	27 - 135	12 - 113
Employment income ($1996 mil)					
Direct	3.5	4.7 - 6.9	4.3 - 6.4	4.0 - 5.9	3.7 - 5.4
Indirect/induced	3.3	3.6 - 5.5	3.3 - 5.1	3.1 - 4.7	2.9 - 4.3
Total	6.8	8.4 - 12.4	7.7 - 11.4	7.1 - 10.5	6.8 - 9.8
Difference to current		1.6 - 5.6	0.9 - 4.6	0.3 - 3.7	0.0 - 3.0
Government revenues ($1996 mil)					
Province of B.C. (Income tax, stumpage & other provincial revenue)	1.0	- 3.0	2.1 - 2.7	1.9 - 2.5	1.8 - 2.3
Difference to current		1.3 - 2.0	1.1 - 1.7	0.9 - 1.5	0.8 - 1.3
Federal					
Government revenues ($1996 mil)					
Federal (income tax & GST)	1.1	2.3 - 3.4	2.1 - 3.1	1.9 - 2.9	1.8 - 2.7
Difference to current		1.2 - 2.3	1.0 - 2.0	0.8 - 1.8	0.7 - 1.6

(Note: On-reserve First Nations workforce pays no income or sales tax.)

The harvest level as projected in the base case harvest, will contribute to community stability, and also to enhanced economic activity, if the harvest levels increase from the current level. The economic nature of a provincial sub-region, over a long-term forecast horizon, is impossible to predict. Clearly though, the assurance of a relatively stable wood supply for many decades will contribute to stability. In the event of AAC reductions in the longer term, local economies, though not currently well diversified, may be more able at that time to adapt.

7.5 Timber requirements of processing facilities

7.5.1 TSA assessment

The harvest forecast is not expected to pose either a short-or a long-term risk to local mill timber requirements. In the short term, the region's timber supply initially will be enhanced if the Cranberry AAC is more fully utilized. Full use of the AAC is most important for the C-Ged mill, although the Cranberry forest licence will still only supply 50% of its total requirements.

In terms of Kitwanga mills' total rated capacity, timber supply from Cranberry sources can supply only about 25% of these requirements. This suggests a tighter than optimal supply-to-requirements ratio and the existence of a degree of regional processing over-capacity.

7.5.2 Regional assessment

In 1996, only about 3% of all timber processed in the Hazelton area came from the Cranberry TSA. The C-Ged mill is the only local facility significantly dependent on the Cranberry harvest. The bulk of the other area mills' timber requirements are met by Nass, Kalum and Kispiox TSA harvests.

With respect to medium term (10 to 30 year) regional economics and timber supplies for area facilities, Table 6 presents the recent history of AAC determinations for the Cranberry, Kispiox, Kalum and Nass TSAs.

Table 6. Hazelton area — current 1997 AACs and projected harvest levels (million m^3/year)

	Early-90s AACs	Current AACs	Projected harvest levels 2015
Kispiox TSA	1.09	1.09	1.09
Kalum TSA	0.48	0.46	0.42
Nass TSA	1.25	1.15	1.05
Cranberry TSA	0.11	0.11	0.11
Total region	2.93	2.81	2.67

Under the projected levels outlined above, the total regional harvest level could fall by up to 9% from early 1990s levels, by the year 2015. This translates into about a 5% reduction from today's levels. While this order of projected decline is significant, it is not dramatic, and local successes in developing the value-added product sector could easily deliver additional forest jobs while the total timber harvest declines.

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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, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
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.
Environmentally sensitive areas	Areas with significant non-timber values or fragile or unstable soils, or where there are impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	Desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives.
Forest cover requirements	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).
Forest inventory	Assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of additional forest values such as recreation and visual quality.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (e.g., top height) to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics.
Growing stock	The volume estimate for all standing timber, of all ages, at a particular time.

9 Glossary

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.
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.
Not satisfactorily restocked (NSR)	An area not covered by a sufficient number of tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. If the expected regeneration delay (the period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees) has not elapsed, the land is defined as current NSR. If the expected delay has elapsed, the land is classified as backlog NSR.
Operability	A classification of the availability of an area for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations are visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see Visual quality objective).

Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Retention VQO	Alterations are not easy to see. Up to 5% of the visible landscape can be altered by harvesting activity (see Visual quality objective).
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Site index	A measure of site productivity. Site indices in British Columbia are based on heights of free-growing dominant trees of a given species at a reference age of 50 years above breast height. Site index curves have been developed for British Columbia's major commercial tree species.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	The portion of the total land area of a management unit considered to contribute to, and be available for, long-term timber supply. The harvesting land base is defined by separating non-contributing areas from the total land base according to specified management assumptions.
Timber supply area (TSA)	An integrated resource management unit established in accordance with Section 7 of the Forest Act.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimate (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands. Yield projections can be based on a number of mensurational approaches and procedures, including the use of site index curves and generalized growth models.

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 Cranberry 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 1994 Ministry of Forests forest cover inventory for the Cranberry TSA is the inventory used to determine the timber harvesting land base and the associated management themes to be used in defining forest management activities. This 1:20 000-scale inventory was performed by Westar Timber, and provided to the Ministry of Forests when TFL 51 (which subsequently became the Cranberry TSA) was surrendered to the Crown. The inventory is updated to Forest Service standards.

A.2 Zone and Analysis Unit Definition

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

Five resource emphasis groupings, or zones, were defined for this analysis. Zone delineation is based on common forest management objectives such as forest cover requirements or geographic location. For the wildlife habitat management zones, specific forest cover polygons were identified; a detailed listing of the polygons in each zone is available from the Kispiox Forest District office. The following zones were identified for the purpose of modelling current forest management:

1. Fisher zone — areas within the TSA that have been identified by the Ministry of Environment, Lands and Parks staff as prime fisher habitat. Within deciduous areas in the fisher zone, at least 15% of the area must be maintained in stands that are 100 years or older. At least 10% of coniferous stands in the fisher zone must be maintained in stands that are older than 140 years. In addition, a maximum of 30% of the forest in the zone can be less that 3 metres in height (15 years old).
2. Partial retention VQO zone — for areas with a recommended recreation management code of partial retention and retention on the inventory file (less than 30 hectares of the TSA are described as retention VQO areas so they were treated as part of the partial retention VQO zone), an overall forest cover requirement was derived allowing a maximum of 4.8% of the area to be below 6 metres in height (26 years old).
3. Goshawk nesting habitat zone — areas identified as valuable goshawk nesting habitat were identified by the Ministry of Environment, Lands and Parks personnel. In these areas, a maximum of 30% of the forest in the zone can be less that 3 metres in height (17 years old). In addition, at least 4% of the stands must be maintained in stands that are older than 140 years.
4. Grizzly bear zone — the Ministry of Environment, Lands and Parks staff identified important grizzly bear habitat in the TSA. In these areas, a maximum of 30% of the forest in the zone can be less that 3 metres in height (20 years old), and at least 10% of the stands must be maintained in stands that are older than 100 years.
5. 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 3 metres in height (20 years old).

With the exception of the partial retention VQO zones, the land considered unavailable for timber harvesting did not contributed to the attainment of green-up forest cover objectives. All lands considered unavailable for timber harvesting did contributed to the attainment of old forest cover objectives

A.2 Zone and Analysis Unit Definition

Table A-1. Timber harvesting land base by management zone

Zone	Timber harvesting land base (hectares)	Per cent of timber harvesting land base
(1) Fisher zone	7 760.98	23.6
(2) Partial retention VQO	2 905.49	8.8
(3) Goshawk nesting habitat	12 724.20	38.8
(4) Grizzly bear	2 785.16	8.5
(5) Integrated resource management	6 657.11	20.3
Total	32 833	100.0

Grouping enables the analyst to apply constraints to different parts of the land base or zones as well as to enhance reporting structures. Groups may be thought of as layers of different objectives which must be tracked over time. Groups were identified on the basis of biogeoclimatic zone and subzone in order to model landscape level biodiversity. The following groups were created to model landscape level biodiversity objectives in the Cranberry TSA:

61. Alpine tundra — no landscape level biodiversity requirements were applied to this group since it is all unavailable for harvesting.
62. Coastal western — hemlock (CWH).
63. Engelmann spruce — subalpine fir (ESSF).
64. Interior cedar —hemlock moist cold Nass (ICHmc1).
65. Interior cedar — hemlock moist cold Hazelton (ICHmc2).
66. Mountain hemlock (MH).

A.2.2 Analysis unit characteristics

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

Table A-2. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-17. for existing natural stands and Table A-19. 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.1.1, "Management zone characteristics."

A.2 Zone and Analysis Unit Definition

Table A-2. Definition of analysis units

Analysis unit number	Leading species	Inventory type groups	Site index range	Timber harvesting land base (includes NSR) (hectares)	Per cent of total timber harvesting land base
01	Hemlock/cedar	9–12, 14–17	12.5 or greater	10 199.72	31.1
02	Hemlock/cedar	9–12, 14–17	9.0 - 12.5	8 810.00	26.8
03	Balsam	18-20	11.2 or greater	2 452.52	7.5
04	Balsam	18-20	8.8 - 11.2	1 643.29	5.0
05	Spruce	21, 23-26	15.0 or greater	3 214.64	9.8
06	Spruce	21, 23-26	10.0 - 15.0	658.61	2.0
07	Pine	28, 30, 31	16.0 or greater	3 337.61	10.2
08	Pine	28, 30, 31	11.0 - 16.0	560.50	1.7
09	Cottonwood	35, 36	18.0 or greater	1 032.07	3.1
10	Aspen and birch currently younger than 40 years	40-42	18.0 or greater	924.32	2.8
	Total			32 833.29	100.0

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Cranberry 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. The characteristics of each of these types are discussed below in the order in which they were performed.

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) and 69 C (forest reserves) contributes to timber harvesting. All areas within the Cranberry TSA are identified as ownership 62 C, and are thus considered to be managed by the B.C. Forest Service.

A.3.2 Non-forest land

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

A.3.3 Non-commercial (brush) cover

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

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

To account for protection of riparian and stream values within the Cranberry TSA, 4561 hectares were excluded from the timber harvesting land base. Table A-3. describes the information used to derive this reduction.

Table A-3. Riparian management areas

Riparian class	Reserve width (metres)	Reserve reduction area (hectares)	Management zone width (metres)	Management zone area (hectares)	Management zone reduction area (hectares)
S1	50	700	20	280	70
S2 — S3	20	2 867	20	2 867	717
Lakes and wetlands	10	138	40	552	69
Total		3 705			856
Total reduction 4 561					

The riparian analysis was conducted using TRIM water coverage (1:20,000) with GIS. Streams identified as S1 included the Cranberry, Kiteen and Nass Rivers and some larger tributaries which had a 50 metre buffer applied to reserves and 20 metre width assumed for management zones. Streams requiring riparian reserves (S2, S3) were identified and assigned a 20 metre width to both reserves and management zones. However due to the difficulty in distinguishing some of the S4 streams from S2 and S3 streams it is possible that some S4 streams were included as S3 streams. Since S4 streams do not require a buffer and since some S3 streams are buffered by less than 30 metres, the normal S2/S3 buffer of 30 metres was decreased to 20 metres for the purpose of the timber supply analysis. The smaller S5 and S6 streams do not require buffers and they were not included in the analysis. All lakes and wetlands over five hectares were identified and a 10 metre buffer was applied for reserves, and a 40-metre management zone width assumed.

The ratio of the management zone width to the reserve width was applied to the reserve reduction area to obtain the management zone area. The maximum mature forest cover retention percentages recommended in the *Riparian Management Area Guidebook* are 50% for S1-3 streams and 25% for lakes and wetlands. It was assumed that on average, one-half of this maximum value would be retained across the land base in the riparian management zones. To approximate the timber supply implications of this level of retention, 25% of the area in the riparian management zone of S1-S3 streams and 12.5% of the lakes and wetlands management zone was considered unavailable for timber harvesting. The remainder of the riparian management zone was treated in the analysis as part of the timber harvesting land base.

A.3.5 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as wildlife habitat, sensitive soils and regeneration. A portion of areas classified as environmentally sensitive were excluded from the timber harvesting land base according to Table A-4.

Table A-4. Per cent of area considered unavailable for timber harvesting due to environmental sensitivity

ESA code (1- high sensitivity) (2- moderate sensitivity)	Per cent of area unavailable for timber harvesting
Es1 (soils)	100
Es2	75
Ep1 (regeneration difficulty)	100
Ew1 (wildlife)	75
Ew2	50

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 not identified in the inventory files are part of existing management zones. Sensitive recreation areas were addressed through recreation reserves identified in the inventory files as well as through specific management zones. The ESA exclusion factors shown in Table A-4. were applied in all management zones.

The ESA definitions are:

- Es — areas with unstable soils that may deteriorate unacceptably after forest harvesting.
- Ep — areas where regeneration will likely be difficult.
- Ew1 — areas of critical importance to wildlife for food, shelter or reproduction.
- Ew2 — wildlife values are important but less so than Ew1.

A.3.6 Inoperable areas

The inventory file contains an operability classification for Cranberry TSA. All areas that were inoperable (OPERABLE = I or N) were excluded from the timber harvesting land base. The original operability lines were obtained from Westar Timber when TFL 51 (which subsequently became the Cranberry TSA) was surrendered to the Crown.

A.3.7 Sites with low timber growing potential

Sites may have low timber growing potential either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.), or because they are not fully occupied by commercial tree species. Typically, these stands are intermixed with other stands within the forested land base. Any of these stands not considered to be harvestable were identified through an examination of the distribution of sites in the forested land base and removed from consideration for the timber harvesting land base. The stands excluded from the timber harvesting land base due to low timber growing potential are described in Table A-5.

Table A-5. Description of sites with low timber growing potential

		Characteristics	
Species	Inventory type group	Site index (metres in height at age 50)	Reduction per cent (%)
Hemlock and cedar	9-17	< 9.0	100
Fir	18-20	< 8.8	100
Spruce	21, 23-26	< 10.0	100
Pine	28, 30, 31	< 11.0	100
Deciduous	35, 36, 40-42	< 18.0	100

A.3.8 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-6. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

Table A-6. Non-merchantable forest types criteria

Species	Inventory type group	Characteristics			
		Age class	Height class	Stocking class	Reduction per cent (%)
Lodgepole pine	28, 30, 31			2, 3, 4	100
All types except Lodgepole pine	9-11, 12-21, 23-26, 35, 36	> 7	< 2		100
Lodgepole pine	28, 30, 31	> 5	< 2		100
Aspen/birch	40, 41 & 42	> 2			100

A.3.9 Recreation areas

Recreation areas such as campgrounds, trails and lookout sites are identified in the forest inventory file. As outlined in Procedures for Factoring Recreation Resources into Timber Supply Analyses and discussed with the Kispiox Forest District staff, 50% of all areas identified as having a high capability to attract recreational use (REC_SIG = B) and for which a management prescription of preservation is approved (REC_MGTC = 01) were excluded from the timber harvesting land base.

A.3.10 Area managed for preservation visual quality objective (VQO)

Some areas where visual quality is an important value are being managed according to a preservation VQO (REC_MGT = 06). Under this designation, no timber harvesting should be visible. Accordingly, such areas were deducted from the land base available for harvesting.

A.3.11 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. Kispiox Forest District staff estimated that unclassified roads, trails, landings, and dispersed disturbance due to harvesting activity cover about 1780.5 hectares. Table A-7. shows how this figure was calculated.

Table A-7. Estimates for existing unclassified roads and landings

	Road length (kilometres)	Road width (metres)	Reduction area (hectares)
Existing RTLs			
Secondary roads	57	25	142.5
Logging roads	272	20	544
Trails	299	10	299
Landings			250
Dispersed disturbance			545
Total			1 780.5

Road lengths were obtained from a Geographic Information System (GIS) analysis conducted in the fall of 1996. Road width estimates were obtained from the forest district engineering staff. A soil survey conducted in the fall of 1995 estimated losses due to landings to be 1.6% of the gross logged area. This gross area was obtained from silviculture records (ISIS). From the same survey, dispersed disturbance was estimated to be 10.4% of the net logged area. According to FRDA research[1], about 40% of dispersed disturbance areas represent a loss in productivity. Therefore, losses due to dispersed disturbance represent 4.2% of the net logged area.

The total area was deducted only from stands younger than 20 years, based on the assumption that the majority of harvesting has occurred over the past 20 years.

A.3.12 Cultural heritage resource reductions

A portion of the "Grease Trail" runs through the Cranberry TSA. The portion of the trail within the TSA is approximately 36 kilometres in length, and has a 100-metre no-harvest buffer applied to each side of the trail, for a total buffer of 200 metres. Thus, the total area excluded from timber harvesting for the Grease Trail covered 720 hectares. However, 100 hectares of the trail falls within a riparian reserve on the Cranberry River; thus, the net reduction is 620 hectares.

A.3.13 Stand level biodiversity reductions

Wildlife tree patches are retained on cutblocks within the Cranberry TSA to provide for the maintenance of stand structure over time. Kispiox Forest District staff indicate that in all management zones within the TSA, wildlife tree patches larger than 2 hectares in size will be retained in perpetuity within a cutblock boundary. Thus, these patches are expected to contribute to old-forest retention requirements at the landscape level. There was no available information within the Cranberry TSA to approximate the amount of area affected by wildlife tree patches. However, from sampling of wildlife tree patches conducted within the neighboring Kispiox TSA, it was estimated that wildlife tree patches represented a 2.5% volume reduction. Thus, for the Cranberry TSA analysis, wildlife tree patches were assumed to represent a 2.5% reduction to the net land base.

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(1) Evaluation of Soil Degradation as a Factor Affecting Productivity in B.C.: A Problem Analysis (Phase 1). Utzig, G. and Walmsley, M. 1988. FRDA Report #25.

A.3.14 Estimated area of future roads, trails and landings

To account for the loss of productive forest land during future timber harvesting and development, a portion of the timber harvesting land base is not considered to contribute to further timber production after it is harvested for the first time. In estimating losses to future roads, trails, landings and dispersed disturbance, it was estimated that 80% of the land base is currently accessed (based on discussion with the Kispiox Forest District staff). An analysis conducted in 1996, estimated that of a harvestable land base of 39 254 hectares, 7850 hectares of the Cranberry TSA remain to be accessed by road. Assuming that the same rate of loss of productive forest land applies as estimated for existing roads, trails and landings, then approximately 437 hectares of the unaccessed portion of the TSA should be excluded from the timber harvesting land base. This area was deducted only from stands older than 20 years (since presumably all stands younger than 20 years have already been accessed). Future roads, trails and landings are modelled by removing the specified percentage from all areas not subject to the existing roads reduction. Approximately 27 341 hectares of the current timber harvesting land base are covered by stands older than 20 years; thus a reduction of 1.68% was applied to these stands.

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 Cranberry TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-8.

Table A-8. Utilization levels

	Utilization		
Analysis unit	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
All Pl units	12.5	30	10
All other conifer units	17.5	30	10
Deciduous	17.5	30	10

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-9. These criteria apply to both existing and regenerated stands. In the case of Spruce, lodgepole pine, hemlock, balsam (Sx, Pl, Hw, Bl) stands on poor sites, both diameter and volume criteria were to be met. Thus, the criterion which results in the higher age would be used as the minimum harvestable age. In all cases, the volume criteria produced the higher minimum harvestable age. For regenerated stands of predominantly deciduous species, the minimum harvestable age of 80 years was chosen by the Kispiox Forest District staff since by this age, the coniferous species within these stands would also be of a merchantable size when harvesting takes place.

Table A-9. Minimum harvestable age criteria

		Minimum criteria		
Analysis unit		**Diameter**	**Volume**	**Minimum harvestable age**
Pl	(G/M)		250	
Sx, Hw, Bl	(G/M)		300	
Sx, Pl, Hw, Bl	(P)	17.5	200	
Act				80
At, Ep				80

A.4 Forest Management Assumptions

The age was determined by examining the volume tables for each analysis units, and using linear interpolation to determine the age at which the minimum volume was attained. Table A-10. lists the minimum harvestable ages for each of the analysis units.

Table A-10. Minimum harvestable age

Analysis unit			Minimum harvestable age
1	Hw/Cw	G/M	111
2	Hw/Cw	P	118
3	Bl	G/M	151
4	Bl	P	157
5	Sx	G/M	114
6	Sx	P	126
7	Pl	G/M	103
8	Pl	P	132
9	Act	G/M	80
10	At/Ep	G/M	80
101	Sx50Pl25HW25	G/M	103
102	Hw50Pl50	P	136
103	Sx75Bl25	G/M	111
104	Pl75Bl25	G/M	120
105	Sx70Act30	G/M	82
106	Pl60Sx40	P	103
107	Pl60Hw20Sx20	G/M	65
108	Pl60Hw40	P	102
109	Act50Sx50	G/M	80
110	At/Ep50Pl30Hw20	G/M	80

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 Cranberry 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 2.0) 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.

VQO guidelines as reflected in *Procedures for Factoring Recreation Input into Timber Supply Analysis* were used to derive forest cover requirements for the VQO zones. For the partial retention VQO zone, a green-up of 6 metres was used, as per local estimates and the report *Procedures for Factoring Recreation Resource into the Timber Supply Analyses*. This recreation resource book was also used as a basis for determining the per cent allowable denudation and the dispersion pattern in the Cranberry TSA.

Since the retention VQO area in the Cranberry TSA is very small this area was combined with the partial retention VQO areas for the analysis. The forest cover guidelines (maximum per cent below green-up age) for the partial retention VQO zone were determined by first assessing the portions of the PR areas in each visual absorption capability (VAC) category. The following calculation was performed:

Weighted % Disturbance = (% High VAC area)*(15%) +

(% Medium VAC area)*(10%) + (% Low VAC area)*(6%)

Table A-11. Per cent allowable denudation, partial retention VQO management zone

	VAC (visual absorption capability)						
	High		Medium		Low		
VQO class	% area	% denudation	% area	% denudation	% area	% denudation	Weighted average % denudation
Partial retention	7.5	15	65.6	10.0	26.9	6	9.3

Next, in order to account for dispersion of the operable area the allowable denudation was adjusted by the ratio of operable area to the total forested areas, also known as the "operable-to-green" ratio. This ratio, which was calculated to be 0.382, was determined by dividing the area of the timber harvesting land base within the PR VQO zone by the amount of total forested area in this zone.

A.4 Forest Management Assumptions

The final step in determining the forest cover requirements was combining the weighted forest cover guideline with the operable-to-green ratio. This step required an estimate of how forest within the timber harvesting land base is distributed across the landscape. That is, the harvesting land base could be a fairly solid area separated from inoperable areas by a distinct line. Conversely, area both available and unavailable for harvesting could be fairly evenly dispersed. The intermediate condition is that harvestable forest is distributed in clusters within the landscape. Whether the available forest is solid, clustered, or dispersed determines how to employ the operable-to-green ratio. In solid landscapes the full ratio is used (available and unavailable areas are separated); that is, the weighted forest cover guideline is multiplied by the operable-to-green ratio. In dispersed areas, the operable-to-green ratio is not used (available and unavailable areas are in cutblock-sized pieces which are essentially adjacent). In clustered areas, the average of the dispersed and solid factors is used. More detail is available in the procedures document referred to above.

For this analysis, it was assumed that in 10% of the inoperable and operable areas are evenly dispersed, 25% are clustered, and 65% are solid. These figures were developed for the Kispiox Forest District, and were felt by staff to be appropriate for the Cranberry TSA.

The final forest cover guidelines were calculated as:

Table A-12. Forest cover requirement derivation, partial retention VQO management zone

Distribution of disturbance	% of area	Operable-to-green ratio applied
Dispersed	10	0.9299
Clustered	25	1.6071
Solid	65	2.3125
Weighted total		4.8494

Thus, a maximum forest cover requirement of 4.8% (rounded up) was applied to partial retention VQO areas in the analysis.

The remainder of disturbance and older forest cover requirements applied in the analysis were provided by the Forest Ecosystem Specialist for the Kispiox Forest District (wildlife habitat management zones) and by the professional judgment of the Kispiox Forest District staff (integrated resource management zone).

A growth-yield model, FREDDIE, B.C. Ministry of Forests, 1990 was used to estimate when trees will reach a top height of 3 metres (IRM zone, wildlife zones) or 6 metres (PR VQO zone). Since each area will support a range of growth rates, average green-up ages (based on average zonal site index) were used for each zone to simplify the analysis. These green-up ages do not include regeneration delay; the delays are dealt with in the simulation model by giving the model the number of years of the regeneration delay.

Table A-13. specifies the forest cover requirements for the Cranberry TSA.

A.4 Forest Management Assumptions

Table A-13. Management emphasis zone forest cover requirements

Zone	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
Fisher (coniferous)	15	30	140	10
Fisher (deciduous)	15	30	100	15
Partial retention VQO	26	4.8	—	—
Goshawk nesting habitat	17	30	140	4
Grizzly bear	20	30	100	10
Integrated resource management	20	25	—	—

A.4.5 Landscape level biodiversity

It was assumed for the analysis that the entire TSA forms one landscape unit, and that within that landscape unit, forest cover requirements can approximate landscape level biodiversity objectives. The forest cover requirements used in the analysis were determined in accordance with the letter from John Allan and Cassie Doyle to field operations staff of the Ministry of Forests and the Ministry of Environment, Lands and Parks regarding *Achieving Acceptable Biodiversity Timber Impacts,* dated August 25, 1997. The *Biodiversity Guidebook (FPC)* describes the following forest cover requirements for each natural disturbance type (NDT) and emphasis as follows:

Table A-14. Landscape level biodiversity: biodiversity guidebook distribution objectives for each seral stage, by emphasis option, for the NDTs in the Cranberry TSA

Group	Description	Distribution objectives for each seral stage, by emphasis option								
		Early			Mature + old			Old		
		L	I	H	L	I	H	L	I	H
61	AT		None			None			None	
62	CWH	N/A	< 36	< 27	> 17	> 34	> 51	> 9	> 9	> 13
63	ESSF	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28
64	ICHmc1	N/A	< 36	< 27	> 15	> 31	> 46	> 9	> 9	> 13
65	ICHmc2	N/A	< 36	< 27	> 15	> 31	> 46	> 9	> 9	> 13
66	MH	N/A	< 22	< 17	> 19	> 36	> 54	> 19	> 19	> 28

Where the ages for early, mature and old seral stages are as follows:

Table A-15. Seral stage definitions by biogeoclimatic zones

		Age		
Group	Description	Early	Mature + old	Old
61	AT			
62	CWH	< 40	> 80	> 250
63	ESSF	< 40	> 120	> 250
64	ICHmc1	< 40	> 100	> 250
65	ICHmc2	< 40	> 100	> 250
66	MH	< 40	> 120	> 250

As specified in the aforementioned letter, early- and mature-seral requirements were not applied. Furthermore, old-forest requirements for low-emphasis landscape level biodiversity were designed to be met within 3 rotations of 70 years each, with one-third of the percentage met over the first 70 years, two-thirds of the requirements met from 71-140 years from the present, and the full requirement applied from 141 years onward, as follows:

Table A-16. Calculation of low-emphasis biodiversity option older forest cover requirements

Time	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 CWH portions of the TSA, the following calculation was used:

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

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

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

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

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

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

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

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

Time 70: old forest % = (9% * 0.45) * 0.66
+ 9% * 0.45
+ 13% * 0.10
8.1%

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

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

Table A-17. Forest cover requirements applied for landscape level biodiversity

		Per cent older forest		
Group	**Description**	**0-70 years**	**71-140 years**	**141 years -->**
61	AT		None	
62	CWH	6.7	8.1	9.4
63	ESSF	14.2	17.1	19.9
64	ICHmc1	6.7	8.1	9.4
65	ICHmc2	6.7	8.1	9.4
66	MH	14.2	17.1	19.9

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-18. summarizes the estimate for unsalvaged losses in the Cranberry TSA used in this analysis.

Table A-18. Unsalvaged losses

Cause of loss	Total loss (m^3/year)	Annual unsalvaged loss (m^3/year)
Fire	397	397
Total	397	397

History records indicate an estimate for fire loss over the last 10 years of 397 cubic metres per year. This volume is attributed to isolated fire occurrence (lightning) and it is anticipated that harvesting will not occur due to access limitations. It is possible that some large fires may occur even with improved fire fighting ability; however, under current management practices, these areas would be salvaged. No unsalvaged catastrophic losses due to insects or wind are anticipated.

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 Cranberry TSA. Table A-19. outlines the regeneration regime for each analysis unit, and specifies the expected regeneration delay following harvesting, based on immature plantation history (ISIS), Prince Rupert Forest Region free-growing stocking standards, and local knowledge.

A.4 Forest Management Assumptions

Table A-19. Regeneration assumptions

Analysis unit	Composition	Regen delay	OAFs 1	OAFs 2	Method Type	Method %	Species Code	Species %	Density Initial	Density Thin
Hw (G/M)	Sx 50 Pl 25 H25	2	15	5	plant	30	Sx	50	800	1400
							Pl	25	600	
					natural	70	Hw	25	2000	
							At[a]		3000	
Hw (P)	Hw 50 Pl 50	2	15	5	plant	30	Pl	50	1400	1400
					natural	70	Hw	50	3000	
							At[a]		2000	
Bl (G/M)	Sx 75 Bl 25	2	15	5	plant	40	Sx	75	1400	1400
					natural	60	Bl	25	500	
							At[a]		2000	
Bl (P)	Pl 75 Bl 25	2	15	5	plant	40	Pl	75	1400	1400
					natural	60	Bl	25	500	
							At[a]		2000	
Cw (G/M)	Cw 50 Sx 30 Act 20	2	15	5	plant	60	Cw	50	900	1400
							Sx	30	500	
					natural	40	Act	20	2000	
Cw (P)	Cw 40 Hw 30 Pl 30	2	15	5	plant	50	Cw	40	800	1400
							Pl	30	600	
					natural		Hw	30	3000	
Sx (G/M)	Sx 70 Act 30	2	15	5	plant	35	Sx	70	1600	1400
					natural	65	Act	30	3000	
Sx (P)	Pl 60 Sx 40	2	15	5	plant	50	Pl	60	800	1400
							Sx	40	600	
					natural	50	At/Ep[a]		2000	
Pl (G/M)	Pl 60 Hw 20 Sx 20	2	15	5	plant	35	Pl	60	800	1200
							Sx	20	600	
					natural	65	Hw	20	3000	
							At/Ep[a]		3000	
Pl (P)	Pl60 Hw 40	2	15	5	plant	25	Pl	60	1400	1200
					natural	75	Hw	40	2000	
							At/Ep[a]		2000	
Act (G/M)	Act 50 Sx 50	2	15	5	plant	20	Sx	50	1400	1400
					natural	80	Act	50	5000	
At/Ep (G/M)	At/Ep 50 Pl 30 Hw 20	2	15	5	plant	20	Pl	30	1400	1600
					natural	80	Hw	20	1000	
							At/Ep	50	5000	

(a) The deciduous component shown is natural ingress, which is thinned out and therefore not represented in the final stand composition.
(b) The species per cent shown represents the post thinning proportions.
(c) Thinning (free-growing obligation) occurs generally between age 10 and 20 years.

Regeneration delay is the time between the completion of harvesting and the germination of the new seedlings.

In general, there is an abundance of species and stocking. High initial stocking levels are expected due to the natural ingress of hemlock and deciduous. Normal silviculture operations reduce stocking to less than 2000 stems per hectare to meet free-growing obligations.

Provincial average operational adjustment factor (OAF) values are assigned as no local values are available. It should be noted that spruce leader weevil infestation is common. Loss in productive growth has not been quantified for this insect. In most cases it appears, that the stands survive the attack (often 2–4 attacks per stem) and will still attain merchantable size and stem quality.

Deciduous analysis units were modelled using VDYP. The deciduous components of coniferous leading stands were also modelled using VDYP.

Table A-20. identifies stands of existing immature forest where the density (stems per hectare) was controlled. These stands will be immediately assigned to a managed stand yield curves (TIPSY). The remainder of these stands (those stands with less than 700 well-spaced conifers per hectare), have a large component of deciduous crop trees; as a result, the use of TIPSY is not appropriate for modelling their growth and yield. These stands are expected to regenerate and grow like existing natural stands.

Table A-20. Immature plantation history

	Area managed (per cent)	
Analysis unit	**Age 1-10**	**Age 11-20**
Hw (G/M)	100	100
Hw (P)	100	0
Cw (G/M)	0	100
Sx (G/M)	100	85
Sx (P)	100	65
Pl (G/M)	100	95
Pl (P)	100	0

A.4.8 Not satisfactorily restocked (NSR) areas

The inventory file shows a total of 1679 hectares of NSR within the timber harvesting land base. However, the Ministry of Forests' ISIS records show only 1142 hectares of this area is actually NSR; the remainder is already restocked but the records in the inventory file have not been adjusted. The discrepancy likely occurs because of the inventory file and ISIS are updated to different dates. It was assumed that the NSR area derived from the ISIS records (1142 hectares) was correct. The area of NSR by analysis unit according to ISIS is shown in Table A-21.

A.4 Forest Management Assumptions

The NSR area of 1142 hectares will be restocked over the next 10 years. The remainder of the area on the inventory file typed as NSR (537 hectares) was assumed to have been restocked from 6 to 15 years ago, in the same proportion as the distribution of "Restocked" stands in the ISIS records. Table A-21. shows the resulting area distribution and ages of the 1679 hectares typed as NSR on the inventory file.

Table A-21. Not satisfactorily restocked (NSR) areas, ISIS records

	Hectares of NSR			
Analysis unit	**Total area of NSR on inventory file (hectares)**	**Restocked within 1-10 years (ISIS)**	**Restocked now in ISIS (%)**	**Restocked in analysis (aged 6-15 years)**
Hw (G/M)		10	14.5	78
Sx (G/M)		610	32.0	172
Pl (G/M)		35	53.4	287
Act (G/M)		300		
At/EP (G/M)		187		
Total	1 679	1 142		537

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

No rehabilitation activities are planned in the Cranberry TSA.

A.5 Volume Estimates for Existing Stands

The variable density yield projection (VDYP) model, Version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-22. shows the volume estimates by analysis unit for existing natural stands.

Table A-22. Timber volume tables for existing natural stands (cubic metres)

Age	Analysis unit 1	Analysis unit 2	Analysis unit 3	Analysis unit 4	Analysis unit 5	Analysis unit 6	Analysis unit 7	Analysis unit 8	Analysis unit 9	Analysis unit 10
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	1	0
30	1	0	1	0	0	0	1	0	40	3
40	14	0	8	0	8	0	27	1	94	36
50	59	4	31	9	39	1	69	10	141	79
60	110	28	62	26	92	14	110	27	179	118
70	156	65	101	49	145	31	147	55	210	155
80	197	99	133	71	190	63	181	83	234	188
90	234	130	162	91	229	98	213	109	254	218
100	267	157	188	109	262	130	241	133	270	242
110	296	182	213	127	291	159	268	155	283	262
120	323	205	235	143	315	185	292	176	294	280
130	350	228	258	159	337	209	314	196	304	294
140	373	248	279	175	355	229	329	212	312	303
150	394	266	299	190	371	248	341	224	319	311
160	412	283	317	205	383	263	348	234	321	315
170	428	297	335	218	393	277	353	241	322	319
180	442	311	351	232	401	289	355	246	323	321
190	454	322	366	244	408	299	356	249	324	323
200	467	334	381	257	415	309	358	253	325	326
210	479	346	395	269	422	319	361	258	326	328
220	491	357	409	280	427	327	364	262	327	330
230	502	368	422	292	432	335	367	266	327	333
240	512	379	435	303	437	342	370	270	328	334
250	522	389	447	313	442	349	373	273	328	336
260	530	398	451	314	445	355	375	276	329	338
270	537	407	455	316	448	360	377	278	329	339
280	543	416	458	317	451	365	379	280	330	340
290	550	424	461	318	454	369	381	282	330	341
300	555	431	464	319	456	373	383	283	330	342
310	561	438	467	320	458	377	385	285	330	343
320	566	445	470	321	460	380	386	286	331	344
330	571	452	473	322	461	383	387	286	331	345
340	575	458	475	323	462	386	388	287	331	346
350	580	463	477	324	464	388	388	287	331	346

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index for each analysis unit was used, along with regeneration assumptions, as input to TIPSY. Section A.4.7 and Table A-20. document which stands were assumed to be managed in the analysis.

Operational adjustment factors (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-23. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age.

Table A-23. Timber volume tables for existing and future managed stands (cubic metres)

Age	Analysis unit 101	Analysis unit 102	Analysis unit 103	Analysis unit 104	Analysis unit 105	Analysis unit 106	Analysis unit 107	Analysis unit 108	Analysis unit 109	Analysis unit 110
0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	3	0	0	0
30	0	0	0	1	0	2	36	2	75	3
40	8	0	0	9	18	15	98	16	170	56
50	40	5	8	31	91	35	159	44	242	111
60	94	15	45	53	167	66	222	77	297	166
70	150	41	98	84	228	102	277	114	341	220
80	199	73	157	113	289	133	325	143	377	267
90	245	100	205	137	339	164	368	170	405	309
100	290	126	249	160	375	192	402	195	429	346
110	328	148	294	181	402	218	429	220	448	376
120	362	170	336	200	424	243	454	244	466	399
130	388	189	368	221	444	268	476	266	481	417
140	411	208	392	239	460	288	495	285	494	432
150	430	226	411	257	472	304	512	301	505	444
160	447	243	426	271	479	318	527	318	509	452
170	462	259	439	283	482	329	539	333	513	457
180	477	272	450	292	482	338	549	347	516	460
190	489	284	459	300	482	345	557	359	519	462
200	500	296	468	307	481	352	564	370	521	466
210	510	307	475	313	479	358	572	380	524	469
220	519	318	480	318	477	363	578	389	526	472
230	525	328	484	322	475	368	578	397	527	476
240	530	337	488	327	473	372	578	404	529	479
250	535	345	491	330	471	375	578	410	530	482
260	539	352	491	333	470	378	578	417	531	484
270	542	359	490	336	468	380	578	424	532	487
280	545	365	489	339	466	381	578	429	533	489
290	546	370	488	340	464	383	578	435	534	491
300	546	370	488	340	464	383	578	435	535	493

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Multipliers

The report identifies three types of employment that would be affected by changes in the Cranberry TSA timber harvest level. Direct employment impacts consists of forest sector jobs occurring in the areas of harvesting, silviculture, saw milling, and pulp milling. Indirect employment is generated in supplier businesses by direct forest companies purchasing goods and services, including transportation and road building and maintenance. Induced employment is generated through the spending of direct and indirect employment income, for example at local retail outlets.

These impacts rely on certain assumptions, and are subject to certain limitations, which are noted below.

- Employment coefficients — direct employment impacts are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that future employment levels can be predicted based on current conditions. While this may be reasonably accurate for the short term, future employment coefficients may be very different than those today, as a result of unpredictable future factors, such as changing market conditions or production technologies.
- Timing of impacts — employment losses are shown as occurring simultaneously with a change in the level of harvest. This, however, may not be the case for all industry sectors. Spin-off impacts in particular may arise over a longer period of time, rather than immediately, as business and consumer spending levels adjust.
- Response rate and thresholds — processing job impacts are unlikely to be directly proportional to harvest changes. Impacts are more likely to occur in a step-wise manner related to production thresholds where, at some quantity of timber supply, the number of shifts may be reduced or a mill shut down. The timber supply level at which thresholds may be reached cannot accurately be predicted, and the proportionality assumption is considered to be reasonably accurate for estimates over long periods of time and a number of mills. Moreover, because of the possibility of fibre substitution, job loss projections in the processing sector are less certain than for harvesting.
- Distribution of impacts — impacts may either be dispersed over a large number of operations or concentrated on a few. While the aggregate job estimates indicated here should be generally valid, the distribution of these impacts among individual licensees, companies, and communities within a TSA could vary significantly. The closing of camps, the elimination of specific shifts, even the elimination of entire operations, are examples of the kinds of threshold (or non-proportional) impacts that could characterize the reaction of individual operators and operations. Conversely, operations not pushed to a threshold point may make very few changes.
- Government expenditures — these are assumed to remain unchanged despite harvest changes. In reality, public expenditures in a number of areas, such as schools and hospitals, are likely to change as community population levels change. This would amplify the community impacts of forestry job losses.
- Proportional harvest reductions — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

B.2 Economic Impact Methodology

To estimate the employment and income impacts associated with TSA timber harvests the forest sector has been divided into three parts: harvesting and other woodlands related, processing, and silviculture. Employment is measured in terms of person years. A person-year is defined as a full-time full year job, which is assumed to be at least 200 days per year. All reported part-time positions have been converted to person-years.

Data sources:

Data for the economic impact section were drawn from several sources. Harvest volume and stumpage data came from the Ministry of Forests' harvest database system. Timber flow and employment data were obtained through surveys of licensees, smaller operators, and processing facilities operating within the TSA. Other general economic data came from BC STATS, the Ministry of Finance and Corporate Relations, and Statistics Canada.

Harvesting:

Harvesting employment is comprised of all woodlands related jobs including planning and administration functions. It does not include log hauling, road building or maintenance work. The latter activities are captured in the indirect impacts by employment multipliers.

Data on employment, place of residence, and timber flow were obtained by surveying licensees and smaller operators. The information was used to estimate employment averages associated with the harvest and the proportion of workers living within the TSA.

Two estimates of direct harvesting employment were generated:

- TSA direct harvesting employment — consisting of direct harvesting related employees who work in the TSA and reside in communities within the TSA; and
- provincial direct harvesting employment — consisting of the employment included above, plus those individuals who reside outside the TSA, but who come to the TSA to work in harvesting related activities.

The estimates of local and provincial direct employment are used to determine ratios of employment per 1000 cubic metres. These employment coefficients can then be used to estimate harvesting employment associated with any harvest level.

Processing:

Questionnaires were sent to primary processors associated with the TSA to verify employment and production levels and to obtain timber flow information. The timber flow information from the harvest and processing questionnaires were used to determine where TSA timber was processed, and the dependence of local mills on TSA timber. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the contribution of TSA timber to a mills' total timber requirement.

Employment supported by chip by-products from milling operations was also estimated by considering the volume of chip by-products and the locations of mills subsequently using these chips, employment at the downstream mill, and the percentage of TSA chips to total chip inputs. Again, two estimates of direct processing employment were generated: TSA direct processing employment, and provincial direct processing employment.

The resulting employment components were then used to calculate direct processing employment coefficients similar to the harvest employment coefficients.

Silviculture:

Silviculture employment consists of all basic and enhanced reforestation efforts, including surveys, site preparation, planting, fertilizing, pruning and spacing. Silviculture data was collected from the B.C. Forest Service and licensees whose tenures require them to undertake silviculture. Employment information was generally reported in part-time units and converted into person-years. Respondents were also asked to provide estimates of the percentage of silviculture employees residing within the TSA.

Indirect and induced employment estimates:

Indirect impacts are the result of affected businesses purchasing goods and services; induced impacts result from employees spending wages and salaries on final demand categories. Indirect and induced employment were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

The TSA employment multipliers used in the Cranberry analysis are as follows:

Harvesting	1.32
Solid wood processing	1.23

Separate provincial employment multipliers are available for coastal and interior regions of the province. The coastal employment multipliers used in this analysis are as follows:

Harvesting	2.02
Lumber and other solid wood processing	2.31

Employment income estimates:

Employment income was calculated using average industry income estimates. Average 1996 pre-tax income for the forest sector is roughly $44,300, and for indirect and induced occupations, approximately $32,500. Income taxes were calculated based on marginal tax rates of 23 to 27% with one-third of the tax total accruing to the province.

Assessment of harvest flows:

To estimate employment from alternative harvest rates, the harvest level is 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 should only be viewed as order of magnitude indicators.