TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Nass Timber Supply Area
Analysis Report

June 2001

BRITISH COLUMBIA

Ministry of Forests

Nass
Timber Supply Area
Analysis Report

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Preface

This report contains a timber supply analysis and a social-economic analysis and 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 (FPC)* and official land-use decisions made by Cabinet.

Assessing the implications of only current practices rather than looking at a number of different management schemes expedites 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.

In addition to having an up-to-date assessment of timber supply 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 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 regarding possible timber harvest levels and will provide a focus for public discussion. 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 Nass Timber Supply Area (TSA) and socio-economic implications. The timber supply analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short- (next 20 years) and long-term (next 250 year term). The socio-economic analysis identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in harvest level over time. The timber supply analysis 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. **The forecasts, while made available to the provincial chief forester for his information, are used for discussion purposes; they are not allowable annual cut (AAC) recommendations.**

The Nass TSA is located in the northwestern portion of British Columbia primarily in the interior cedar-hemlock and Engelmann spruce-subalpine fir biogeoclimatic zones. It covers an area of about 1.6 million hectares of which 189 000 hectares are considered available for timber production and harvesting under current forest management practices. Within the timber harvesting land base the dominant tree species are western hemlock and sub-alpine fir (balsam). Current management practices are those practices governed by legislation (*Forest Practices Code*) and criteria, such as the Kwinageese Integrated Management Plan, used by the District Manager to approve forest development plans.

The results of the timber supply analysis suggest that the current allowable harvest level in the Nass TSA of 1 142 000 cubic metres per year cannot be maintained without large and abrupt shortfalls in the future. The analysis indicates that an initial harvest level of 820 000 cubic metres per year is obtainable in the first decade with subsequent reductions of 10% per decade until a long-term harvest level of 407 000 cubic metres per year is reached. Alternatively, the average 1997 to 2000 actual harvest level on the Nass TSA of 553 000 cubic metres per year could be maintained for up to 7 decades before stepping down to the long-term harvest level. These harvest forecasts are influenced by decisions around land base (e.g., Upper Nass zone) and are less sensitive in the short term around management objectives (e.g., visual quality, wildlife tree patches).

In the assessment of current management practices and the modelling assumptions for this timber supply review, it was noted that several major land base changes and the implementation of the *Forest Practices Code* have occurred since the 1996 timber supply review. The most significant land base assumption is that the Upper Nass zone, which covers over one-quarter of the Nass TSA, is not expected to be harvested under current conditions and is excluded from the timber harvesting land base. Additionally, lands under the Nisga'a Treaty, that was ratified in 2000, are also excluded.

Higher initial harvest levels approaching the current AAC level would be possible if the Upper Nass zone was to become accessible within four decades and included in the timber harvesting land base. However, as was also presented in the timber supply review for the 1996 AAC determination, forecasts that maximize the initial harvest level require subsequent reductions each decade until the long-term harvest level is reached. In the Upper Nass zone, uncertainty exists around the available merchantable volume due to recent balsam bark beetle outbreaks not captured in the inventory. Estimated reductions of 20% would prevent the current AAC level from being attained if the Upper Nass zone had been included.

In the current timber supply analysis some uncertainty exists around existing information (e.g., site indices in older stands), forest operations (e.g., harvesting in cable zones), and timber supply modelling assumptions (relative oldest harvest rule, aging on non-timber harvesting land base). In the short- and mid-term the current abundance of stands above minimum harvestable age and the large portion of the land base solely in the integrated resource management (IRM) zone provides flexibility in the harvest forecasts for the next century. However, this flexibility may be less if operationally adjacency requirements are more restrictive than the modelled maximum allowable disturbance of 35% in the integrated resource management (IRM) zone.

The analysis suggests that areas defined as cable operable should be a significant component of the harvest profile, as it was in the period 1991 to 1995. With harvest levels below the current AAC, performance in these zones is reduced. The timber supply analysis suggests that it is possible to maintain higher harvest levels within non-cable zones in the short term but this will place greater emphasis on the cable zones in the mid term. Losses of harvest opportunity in the cable zone due to harvest methods (i.e., hoeing) result in lower harvest forecasts.

The socio-economic analysis for the Nass TSA indicates that base harvest forecast of 820 000 cubic metres per year for the first decade, if fully harvested and processed, can support approximately 683 person-years of direct employment and 815 person-years of indirect and induced employment across the province.

However, this level of potential employment is 490 person-years higher than suggested by the 1997-2000 harvest levels (553 000 cubic metres per year) and 593 person-years less than could be realized at the current AAC level (1 142 000 cubic metres per year).

If fully harvested and utilized, the base harvest forecast in the first decade would generate an estimated $16.5 million in provincial government revenues, an increase of $5.3 million annually from recent levels.

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Introduction

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

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

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

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.
Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

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 Nass 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, respectively. Sections 5 and 6 examine the sensitivity of the results to uncertainties in the data and assumptions used, and the critical issue of the Upper Nass exclusion, respectively. This is followed by a summary and conclusions in Section 7. Section 8 examines the social and economic impacts of the Nass TSA timber supply. 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, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the chief forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes. Appendix B contains background information about the socio-economic analysis.

Forest inventory
An 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 other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

1 Description of the Nass Timber Supply Area

The Nass Timber Supply Area (TSA) is situated in the northwestern part of British Columbia in the Prince Rupert Forest Region and covers approximately 1.6 million hectares. This TSA is administered from the Kalum Forest District office in Terrace and a field office in Stewart. The Kalum Forest District includes the Nass and Kalum TSAs, as well as Tree Farm Licences (TFL)* 1 and 41.

The topography of the western part of the Nass TSA is mountainous with coastal plains and rugged ice-capped mountains. Almost all of the forest in this area is either not merchantable or is situated on environmentally sensitive locations, and is therefore unavailable for harvesting. The eastern portion is characterized by wide- and flat-plateaus bordered by the Skeena and Coast Mountain ranges. Overall in this TSA, summers are warm, while cold Arctic fronts frequently descend into the area in the winter.

The forests of the Nass TSA are reasonably homogeneous. Within the land base currently considered available for timber harvesting, western hemlock-leading stands cover about 70% of the area and subalpine fir-leading stands cover about 20%. Lodgepole pine, Sitka spruce and western redcedar also occur in this TSA, as do lesser amounts of deciduous* forests and scattered wetlands.

About 39% of the Nass TSA land base is considered productive forest land managed by the B.C. Forest Service (approximately 639 000 hectares). Currently about 30% of the productive Crown forest land is considered available for harvesting (12% of the total TSA land base).

Following the last timber supply review, the chief forester set the allowable annual cut (AAC) in the Nass TSA at 1.150 million cubic metres, effective January 1, 1996. This level represented an 8% decrease from the previous level. In 2000, the AAC was reduced to 1.142 million cubic metres to reflect land transferred out of the TSA under the Nisga'a Treaty. The AAC is apportioned by the Minister of Forests to various licences. Over the past several years, the actual harvest has been about 40% below the AAC, mainly due to poor market conditions.

Significant changes that influence forest management have occurred since the last timber supply analysis completed in 1993. These changes include:

- implementation of the *Forest Practices Code (FPC)**;
- the Nisga'a Treaty which took effect May 11, 2000; and
- a 28% reduction in the size of the timber harvesting land base*, due to exclusion of the Upper Nass zone from harvesting.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Deciduous
Deciduous trees shed their leaves annually and commonly have broad-leaves.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Timber harvesting land base
Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.

1 Description of the Nass Timber Supply Area

The Nass TSA is remote and sparsely populated with a population of approximately 2,000 people (1996 census). The communities within and adjacent to the area include Stewart, Meziadin, Elsworth Camp, Nass Camp, Van Dyke Camp, Gitlakdamix, Gitwinksihlkw, Gitanyow, Gitwanga, Kitwanga and Lakalzp.

The forests of the Nass TSA provide a wide range of forest land resources, including forest products, recreational opportunities, wild pine mushroom harvesting, minerals, tourism amenities and a variety of wildlife habitats. Parks, recreation sites and trails, glaciers, water bodies, and roaded and non-roaded areas provide opportunities for numerous outdoor activities. Recreation within the TSA is presently limited due to the low population density of the region and because the majority of the area is inaccessible. Within the TSA, Meziadin Lake Provincial Park and Swan Lake-Brown Bear Park are established as protected areas*. Mount Bell Irving/Hanna Ridge, Kwinageese Outlet, Tintina, Nass-Meziadin Junction and Damdochax/Slamgeesh Lake are areas identified by the government as approved official study areas. Recreation activities include back-country touring, sport fishing, hiking, hunting, and wilderness viewing along the Stewart/Cassiar Highway. This highway connects to further recreation opportunities in the Yukon and Alaska.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

1 Description of the Nass Timber Supply Area

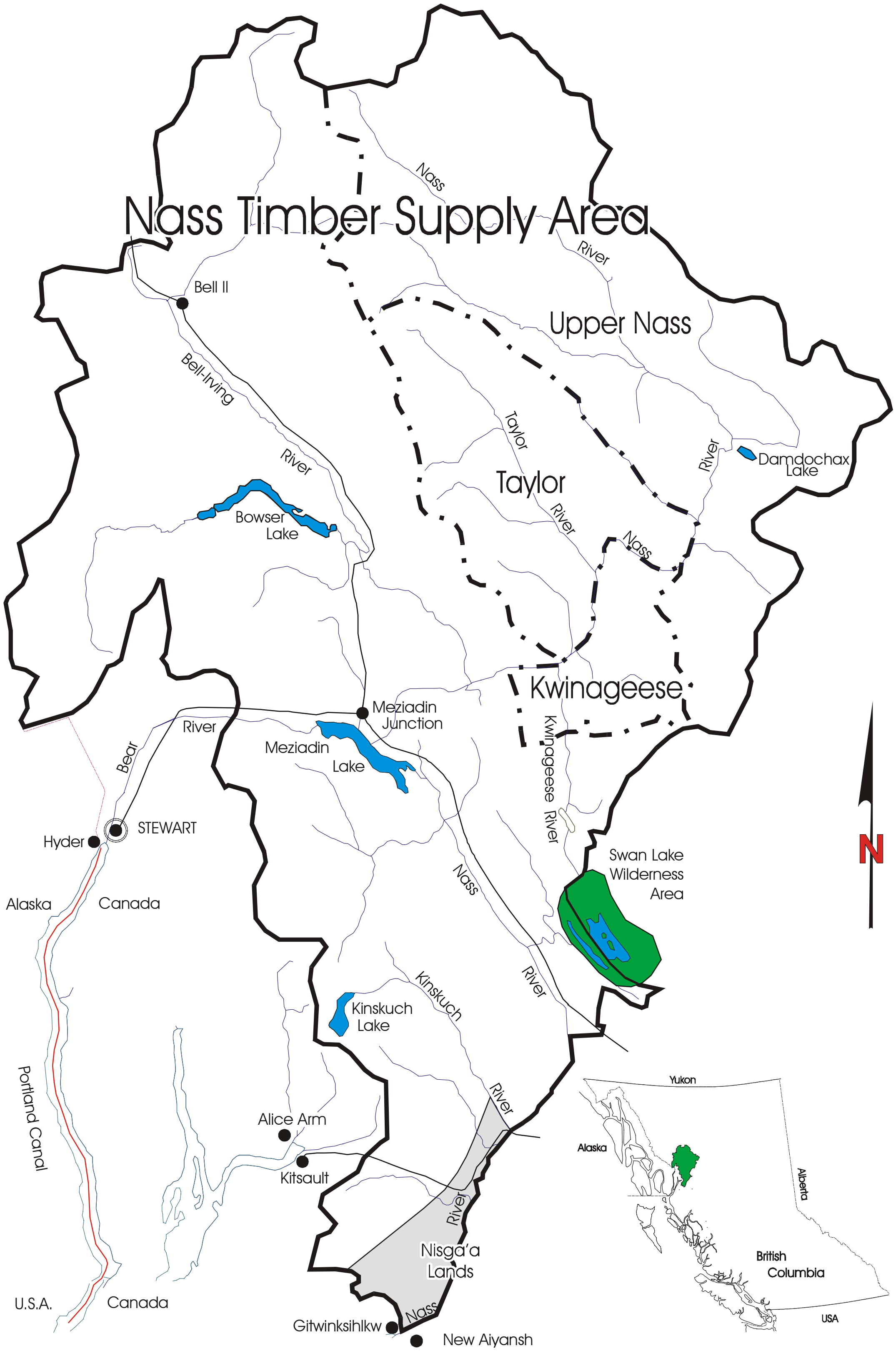

Figure 1. Map of the Nass Timber Supply Area, Prince Rupert Forest Region.

1 Description of the Nass Timber Supply Area

1.1 The environment

The six biogeoclimatic zones* that occur in the Nass TSA reflect the diversity of climates and vegetation in the area. The varied ecological features and unique nature of the area contribute to biodiversity* values found in this TSA.

The Coastal Western Hemlock (CWH) zone occurs at low to middle elevations along river valleys in the western part of this TSA. This zone is on average the rainiest in B.C. with cool summers and mild winters. Western hemlock is the most common tree species, with lesser amounts of amabilis fir, Sitka spruce and western redcedar.

The Mountain Hemlock (MH) zone occurs above the CWH zone in the western part of the TSA along the Coast Mountains. The MH zone's coastal subalpine climate is characterized by short, cool summers and long, cool and wet winters. The deep winter snowpack is slow to disappear and a short growing season results. Mountain hemlock, amabilis fir, yellow cedar are the most common species, with subalpine fir common in areas adjacent to the Engelmann Spruce-Subalpine Fir zone.

The Interior Cedar-Hemlock (ICH) zone is the most common zone in the Nass TSA, occurring at lower to middle elevations (up to 1000 metres) in the Nass River drainage*. This zone is characterized by cold winters and warm, moist summers. The ICH zone has the highest diversity of tree species of any zone in the province. In the Nass TSA, western hemlock, subalpine fir and western redcedar are dominant species with amabilis fir found at higher elevations.

The Sub-Boreal Spruce (SBS) zone has limited occurrence in this TSA, mainly at mid-elevations in the northern portion. This zone is characterized by severe, snowy winters and relatively warm, moist and short summers. Hybrid white spruce and subalpine fir are the dominant species, with lodgepole pine and trembling aspen also occurring.

The Engelmann Spruce-Subalpine Fir (ESSF) zone is the uppermost forested zone in the Nass TSA, occurring above the ICH zone at elevations from 900 to 1700 metres. The ESSF has a relatively cold, moist and snowy continental climate. Growing seasons are cool, moist and short, while winters are long and cold. Engelmann spruce and subalpine fir are the dominant climax tree species, while lodgepole pine is common after fires.

The Alpine Tundra (AT) zone occurs extensively at high elevations above the ESSF zone. The climate is cold, windy and snowy with a short, cool growing season. By definition this zone is treeless and vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

The forests of the Nass TSA are home to a wide variety of wildlife species including moose, mountain goat, grizzly and black bear. Rivers support a rich variety of habitat and fishery resources. The Nass, Bell Irving and Kwinageese rivers are inhabited by salmon, steelhead, rainbow trout, cutthroat trout and Dolly Varden char. Wetlands and lakes provide habitat for a variety of birds and other species.

The *Forest Practices Code*, outlines the process for identifying species at risk and designating wildlife habitat areas with specific management practices. The species that have been declared Identified Wildlife in the seven ecosections of the Kalum Forest District (including the Nass TSA) are presented in Table 1.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.
Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Drainage
The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Table 1. Species at risk as identified under the Forest Practices Code, Kalum Forest District

	Ecosection						
Common names	**Kitimat Ranges**	**Nass Basin**	**Nass Ranges**	**Alaska Panhandle Mtns.**	**Boundary Ranges**	**Eastern Skeena Mtns.**	**Northern Skeena Mtns.**
Bull trout	X	X	X		X	X	X
Tailed frog	X	X	X	X			
Trumpeter swan	X	X	X			X	X
Northern goshawk atricapillus	X	X	X	X	X	X	X
Marbled murrelet	X	X	X	X	X		
Fisher	X	X	X	X		X	X
Grizzly bear	X	X	X	X	X	X	X
Mountain goat	X	X	X	X	X	X	X

Source: *Forest Practices Code, Managing Identified Wildlife: Procedures and Measures, Volume 1, February 1999.*

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*.

1.2 First Nations

A number of First Nations have traditional territories within the Nass TSA. They are represented by four tribal organizations: Nisga'a, Gitxsan, Gitanyow and Tahltan.

The Nisga'a Treaty — a comprehensive land claim — became effective on May 11, 2000. The Nisga'a lands do not contribute to the Nass TSA.

The Gitanyow First Nation has reached the agreement-in-principle stage of the B.C. Treaty Commission process. Since November 1999, when B.C. and Canada presented a joint land and cash offer to the Gitanyow, treaty negotiations have continued and three treaty-related measures are being implemented. A bilateral forest negotiations table has also been established to address Gitanyow interests within existing policy and legislation.

Treaty negotiations with the Tahltan First Nation are currently suspended. Currently the Tahltan have prioritized their involvement in lands and resource management planning initiatives to areas outside of the Nass TSA. The Gitxsan First Nation is participating in informal discussions with B.C. and Canada regarding the resumption of treaty negotiations.

All of the First Nations have expressed concerns about timber harvesting within their traditional territories. Cultural heritage inventory studies, which identify sites of potential archaeological significance, have been completed. Archaeological impact assessments (AIA) and traditional use studies have also been completed within portions of the TSA. The information gathered from these studies is used to plan forest management operations, while ensuring that cultural heritage resources* are taken into account.

Cultural heritage resource
An object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community or an aboriginal people.

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 as a computer file compiled in 1999 by the Kalum Forest District. This file contains information on the forest land in the Nass 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 1998. Within this timber supply analysis report references to a base year (e.g., years from now) refer to 1998.

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

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

The following 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. The term "contributing non-timber harvesting land base" is also used in this report. This refers to forested area which is not part of the timber harvesting land base which contributes forest cover for management objectives such as landscape-level biodiversity.

Operability
Classification of an area considered available 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.

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.

2 Information Preparation for the Timber Supply Analysis

For the Nass TSA the following types of areas were considered not to contribute to the timber harvesting land base:

- not administered by the province of B.C. — this included areas under federal government jurisdiction and private land.
- not managed by the B.C. Forest Service for timber supply — areas managed by other agencies (e.g., parks) and forest land not administered as part of the TSA (e.g., woodlot licences* and Christmas tree permits).
- non-forest and non-productive forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover — areas occupied by non-commercial tree or brush species.
- not satisfactorily restocked (NSR)* — NSR lands identified and removed from the timber harvesting land base are those areas identified as NSR in the data file and are not expected to become satisfactorily restocked (e.g., old burns). Lands that are expected to become satisfactorily restocked are included within the timber harvesting land base.

Woodlot licence
An agreement entered into under the Forest Act. *It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.*

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

- environmentally sensitive areas (ESA)* — areas identified as too sensitive to harvest due to extreme or moderate soil sensitivity, high or moderate wildlife importance, high or moderate recreation value, severe or moderate regeneration problem, high avalanche problems, high management difficulties, and high water quality values. Some of ESA area is totally excluded, whereas other areas are partially excluded (50%).
- inoperable* — areas classified as unavailable for harvest for terrain-related or economic reasons.
- low site — areas with low-timber growing potential occupied by forest.
- problem forest types (PFT) — areas having marginal merchantability. In the Nass TSA these types include stands with low stocking or crown closure and stands which are predominantly broadleaf.
- hemlock looper — areas in the Taylor River zone that have had a high attack from hemlock looper are considered to be currently unsalvageable.
- existing roads, trails and landings (RTL) — areas that no longer support timber production due to access development.
- future road, trails and landings — future losses of productive forest land to access development. These areas are initially included in the timber harvesting land base, and are subsequently removed as part of the first harvest.
- riparian* management areas — streamside buffers to protect riparian and stream ecosystems consist of a riparian reserve zone unavailable for timber harvesting and a riparian management zone in which some harvesting activity may occur.
- inaccessible areas — areas that are not accessible for harvesting, e.g., Meziadin and Bowser Lake.
- map notation — a Use, Recreation, Enjoyment of the Public (UREP) area surrounding Bear Glacier and Strohn Lake will be excluded from the productive land base.
- Upper Nass zone — harvesting has not yet occurred within the Upper Nass geographic area and the potential for long-term development is uncertain. For the base case analysis this zone is unavailable for timber harvesting. A critical issue analysis looks at harvesting of this zone within several decades.

A more detailed description of these categories, including specific criteria for identification is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of 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.

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

2 Information Preparation for the Timber Supply Analysis

The analysis of timber supply on the Nass TSA required first identifying lands on which some timber harvesting activities may occur or likewise those areas in which timber harvesting was excluded. Table 2 presents a summary of the areas excluded from the timber harvesting land base and identifies the area of the timber harvesting land base. For each reduction under the column labelled "Area in gross TSA" the total area that is identified within the boundaries of the 1 620 271 hectares Nass TSA (as per 1999 data file used in the analysis). Within the Nass TSA boundaries there are lands that are not managed by the British Columbia Forest Service (BCFS). Additionally there are lands labelled as non-productive forest that have no forest (e.g., rock and ice). The column labeled "BCFS managed productive forest" reports that amount of area for each reduction that is found in the 639 368 hectares of "productive forest" that is managed by the BCFS. As the area for each reduction may overlap with other reductions (e.g., area may have both a "low site" and an "inoperable" reduction), the column, "Sequential netdown reduction" is provided. The "Sequential netdown reduction" shows the reduction for each factor subsequent to reductions conditional on the factors listed above it in the table. For example, only 28 143 hectares of 1 113 560 hectares of area labelled as "low site" reduction is unique. There is large overlap with other reductions such as "inoperable."

Table 2 shows that 639 368 hectares of the total TSA (39%) is productive forest managed by the B.C. Forest Service. For this analysis a further 6% of the productive forest land, that is identified as non-commercial brush or existing roads, trails, and landings, is not considered to contribute to forest management objectives such as landscape-level biodiversity*. As such the base area considered in modelling timber supply was 601 791 hectares. Of this area, harvesting is modelled to occur on 189 174 hectares (30% of BCFS managed productive forest, 12% of the total TSA). This area is called the timber harvesting land base. If the Upper Nass zone were not excluded, the timber harvesting land base would have included a further 60 117 hectares.

Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

Table 2. Derivation of the timber harvesting land base — Nass TSA base case harvest forecast, 2001.

Classification	Area in gross TSA		B.C.F.S. managed productive forest		[a]Sequential netdown reduction	
	hectares	%	hectares	%	hectares	%
Gross area within TSA boundary	1 620 271					
Nisga'a lands	28 754	(1.8%)				
Other land not managed by the B.C. Forest Service	4 457	(0.3%)				
Non-productive forest	960 450	(59.3%)				
Total productive forest managed by B.C. Forest Service (Crown forest)	639 368	(39.5%)	639 368			
Reductions to the Crown Forest available for timber supply						
Non-contributing areas						
Non-commercial brush	34 890	(2.2%)	34 614	(5.4%)	34 614	(5.4%)
Existing roads, trails and landings					2 962	(0.5%)
Contributing areas[b]						
Upper Nass exclusion	455 626	(28.1%)	156 773	(24.5%)	155 842	(24.4%)
Not satisfactorily restocked lands	18 558	(1.1%)	18 437	(2.9%)	14 125	(2.2%)
Inoperable	1 158 528	(71.5%)	234 721	(36.7%)	174 328	(27.3%)
Low site	1 113 560	(68.7%)	154 089	(24.1%)	28 143	(4.4%)
Environmentally sensitive areas					11 945	(1.9%)
– 100% exclusion	78 778	(4.9%)	72 017	(11.3%)		
– 50% exclusion	55 490	(3.4%)	52 632	(8.2%)		
Problem forest types	193 369	(11.9%)	104 977	(16.4%)	20 514	(3.2%)
Looper – 100% reduction	4 041	(0.2%)	4 033	(0.6%)	3 062	(0.5%)
UREP	3 948	(0.2%)	177	(0.03%)	0	(0.0%)
Meziadin and Bowser Lake inaccessible	155 361	(9.6%)	2 710	(0.4%)	53	(0.0%)
Riparian management areas					4 235	(0.7%)
Wildlife tree patches	8 730	(0.5%)	8 730	(1.4%)	0	(0.0%)
Kwinageese integrated resource management (IRM)	37 271	(2.3%)	30 111	(4.7%)	372	(0.1%)
Total reductions					450 195	(70.4%)
Current timber harvesting land base					189 174	(29.6%)
Future reductions[c]						
Future roads, trails and landings					13 242	(2.1%)
Future timber harvesting land base					175 932	(27.5%)

Note: Existing roads, trails and landings, riparian management areas, wildlife tree patches, and Kwinageese IRM were modelled as general percentage reductions. The reduction "Environmentally sensitive areas – 50% exclusion" reports 100% of the area with this classification, however, 50% of this classification remains in the timber harvesting land base.

(a) The areas for sequential netdown reduction will be less than the total area within the timber harvesting land base where some of the area is included in a previous netdown classification. For example, only 28 143 hectares of low site in netted out because significant areas of low site were excluded in previous netdowns, such as non-productive and inoperable.

(b) Contributing areas comprise the land base that was modelled within the timber supply analysis for management objectives such as old-seral stage biodiversity.

(c) The timber harvesting land base is reduced as harvesting occurs on existing forest due to new roads, trails, and landings. The reduction for future roads, trails, and landings reports the timber harvesting land base once all existing stands have been harvested.

Figure 2 shows the current composition of the productive forest by leading tree species identified on the forest inventory. Stands dominated by hemlock cover about 70% and balsam cover about 20% of the timber harvesting land base. The percentage of balsam in the timber harvesting land base reflects that the Upper Nass zone was excluded. Additionally, all broadleaf-leading species stands were excluded from the timber harvesting land base. Only 863 hectares of cedar-leading stands are identified in the productive forest land base.

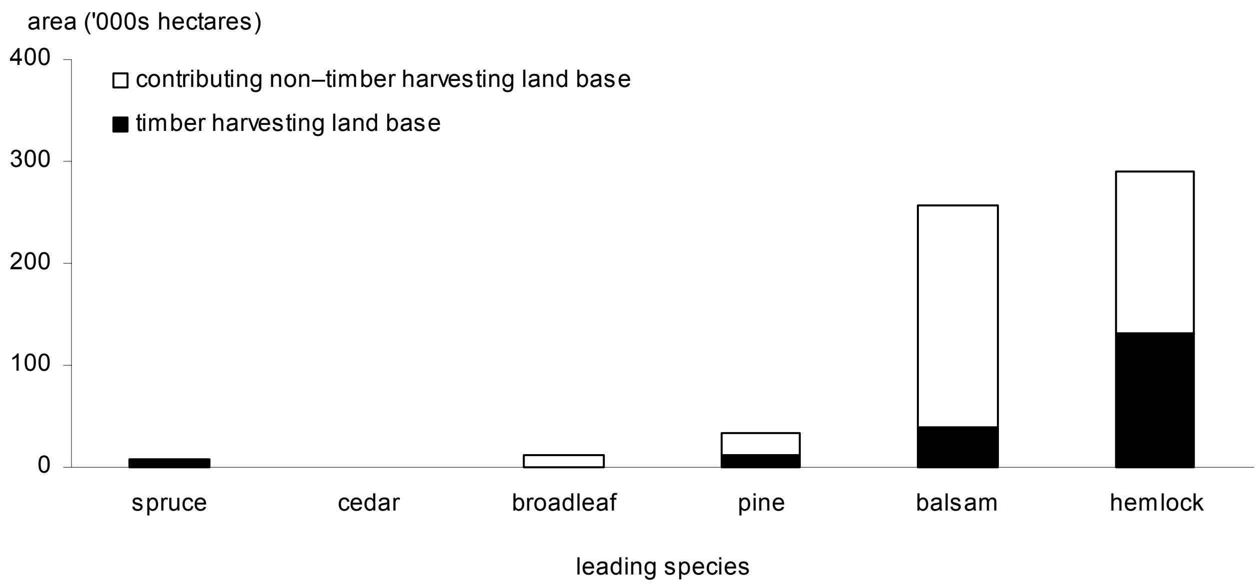

Figure 2. Area of leading species in productive forest land base — Nass TSA base case harvest forecast, 2001.

Figure 3 provides an overview of the distribution of site productivity within the productive forest land base. About 70% of the area in the timber harvesting land base is classified as having a site index* of 11.1 to 15.0 metres (estimated potential stand height at 50 years). Site indices below 9.0 metres are excluded from the timber harvesting land base. As such all the timber harvesting land base in the class 6-10 reflect stands with a site index above 9.0 metres.

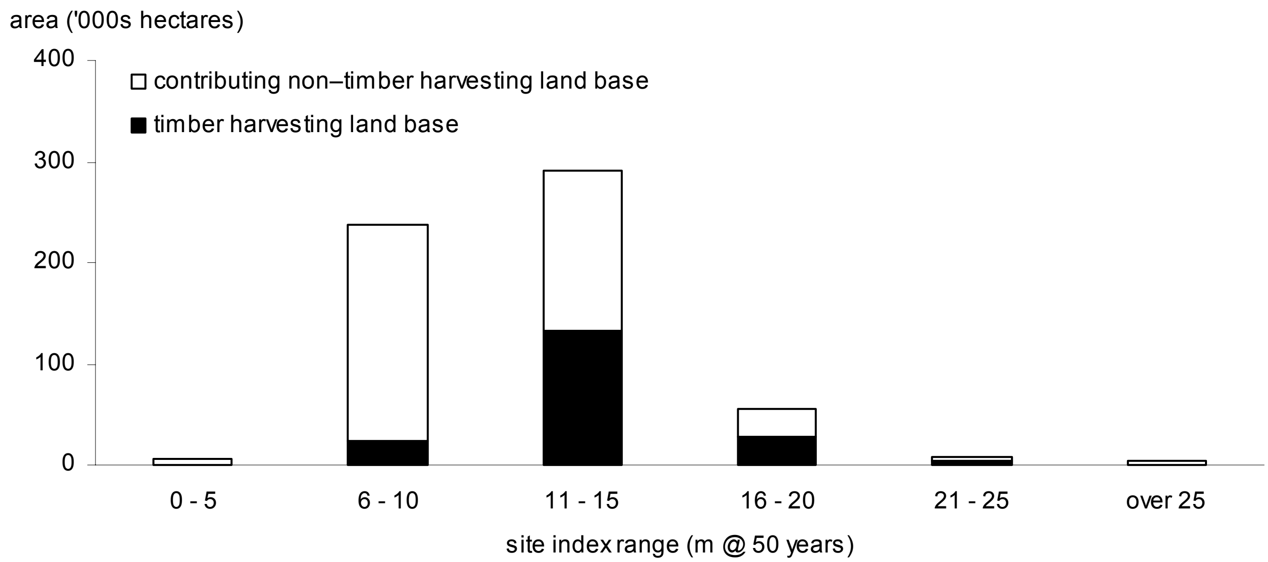

Figure 3. Area by site productivity class in productive forest land base — Nass TSA base case harvest forecast, 2001

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 4 provides an overview of the distribution of site productivity within leading species group on the timber harvesting land base. Balsam-, hemlock-, and spruce-leading stands are dominated by sites of mid-productivity (i.e., site indices 11 to 15 metres). Pine-leading stands, of which most have been previously harvested, are seen to have a larger proportion of higher productive stands. Broadleaf-leading species groups and stands of site index less than 9.0 metres @ 50 years were excluded from the timber harvesting land base.

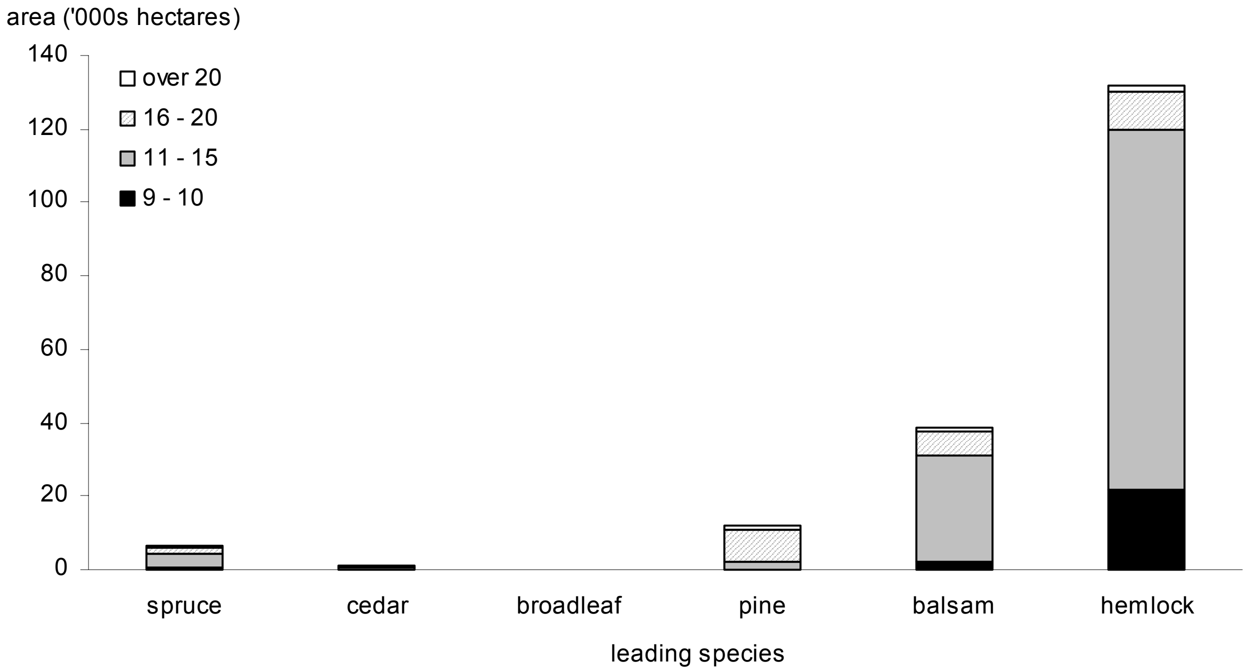

Figure 4. Area by leading species and site productivity class in timber harvesting land base — Nass TSA base case harvest forecast, 2001.

Figure 5 shows the current age class distribution of forest stands on the productive forest land base. Stands are grouped into 10-year age classes. The left most bar consists of stands ages — 3 to 0 years (i.e., negative ages reflect regeneration delays*). The contributing non-timber harvesting land base in this bar is composed primarily of not satisfactorily restocked burned areas. For the analysis these burned areas, which are considered in the seral stage management objectives, were assigned to age 0 regardless of the time since the burn. The right most bar in Figure 5 represents stands greater than 350 years of age. On the timber harvesting land base about 46% of the stands are older than 250 years and 71% of stands are older than 140 years.

Crown forested stands outside the timber harvesting land base may contribute to landscape-level seral stage targets and other biodiversity requirements but are not subject to timber harvesting. Landscape-level biodiversity requirements vary with natural disturbance types (NDT)* and biogeoclimatic units. About 54% of the Crown forested land base outside of the timber harvesting land base is comprised of stands older than 250 years old. As such, significant area is present outside of the timber harvesting land base to address old-seral* biodiversity requirements.

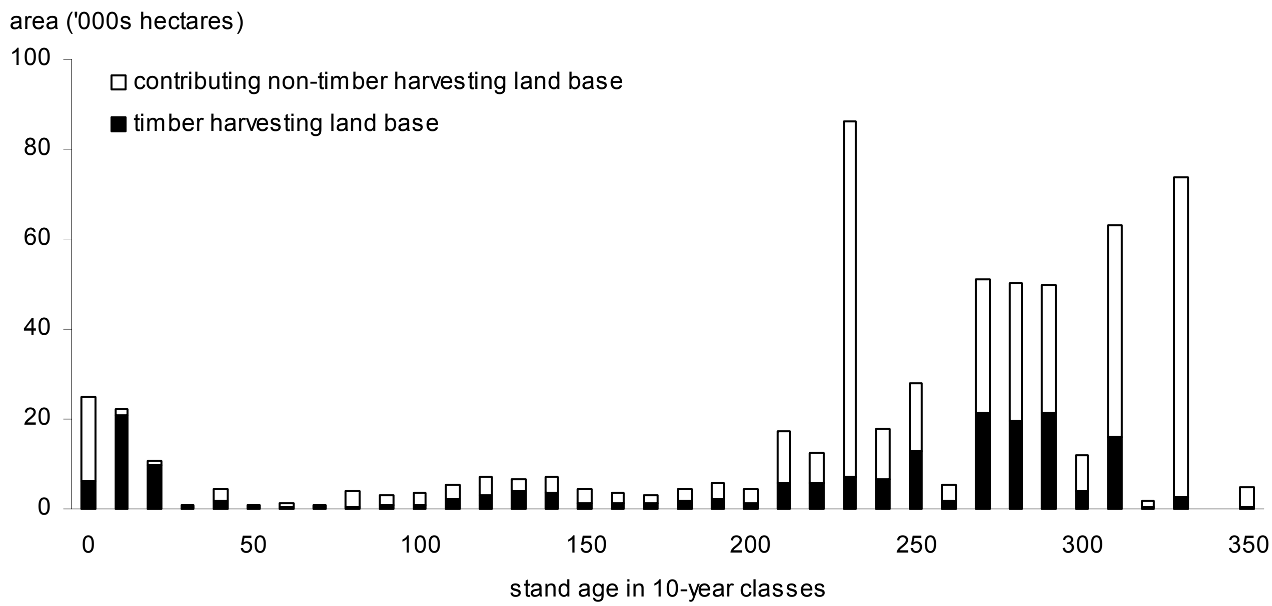

Figure 5. Current age class (10-year classes) composition of the productive forest — Nass TSA base case harvest forecast, 2001.

Regeneration delay
The period of time between harvesting and the date at which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Figure 6 shows the distribution of forest stands by biogeoclimatic variant* on the productive forest land base and the division between the timber harvesting land base and the non-timber harvesting land base. A large portion of each variant is found in the non-timber harvesting land base that will contribute to seral requirements. The ESFFvw that encompasses 41% of stands in the productive forest land base is largely in the non-timber harvesting land base. A larger per cent of the ICHmc1 is present in the timber harvesting land base and contributes 61% of the timber harvesting land base.

For area labelled as AT (Alpine Tundra), a small portion of the contributing non-timber harvesting land base is documented as treed within the forest cover inventory. This treed AT was not combined into another biogeoclimatic variant for old-seral requirements. However, 73 hectares contribute towards visual quality objective (VQO)* management.

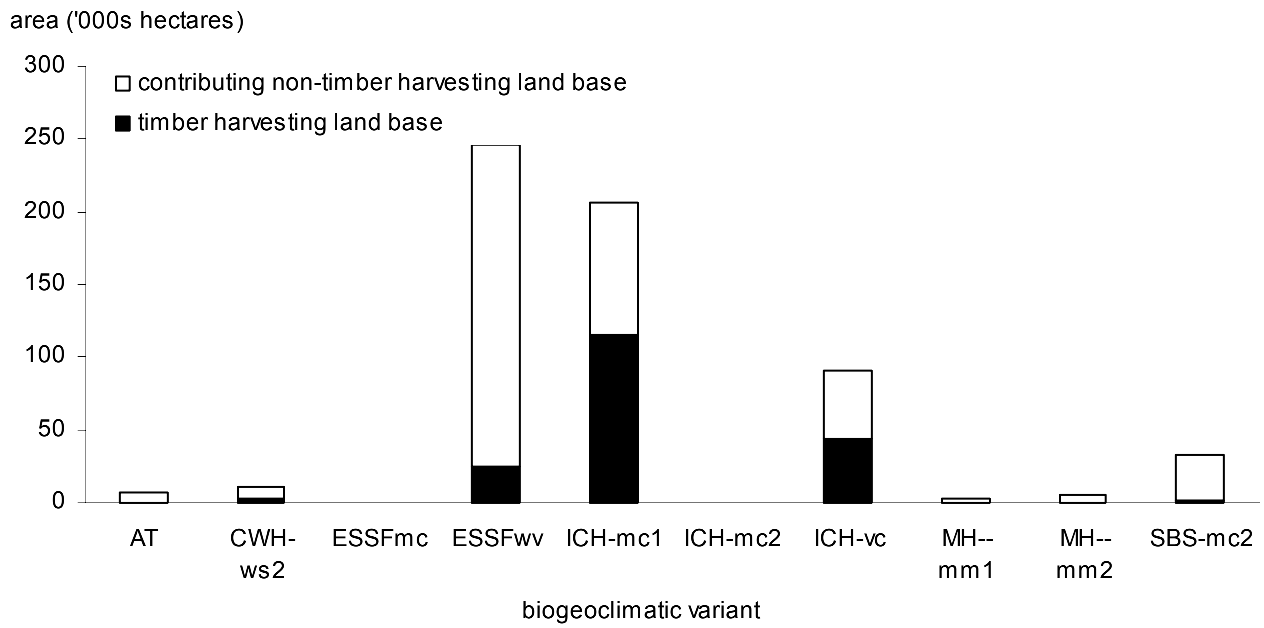

Figure 6. Distribution of biogeoclimatic units in productive forest land base — Nass TSA base case harvest forecast, 2001.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

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.

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, a key 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. All volumes reported in the timber supply analysis are the merchantable volumes based on the utilization standards.

Two growth and yield models were used to estimate timber volumes for the Nass TSA timber supply analysis. The variable density yield prediction (VDYP)* model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing natural stands. The table interpolation program for stand yields (TIPSY)*, developed by the B.C. Forest Service, Research Branch, was used to estimate yields for managed stands. Stands regenerated after harvesting over the last 20 years, and all stands harvested in the future, are assumed to grow according to managed stands yield estimates from TIPSY.

Volume estimation and prediction is subject to uncertainty due to uncertainty in inventories which form the basis for estimating site productivity, and to limited data for stands managed under current practices in British Columbia. To increase the efficiency of the timber supply analysis, volume estimates* have been grouped into "analysis units*" based on species, site productivity, age, and geographic region. Analysis units are further described in Appendix A. To address the possibility that actual timber volumes may be different from estimates used in this analysis sensitivity analyses around the volume forecasts are described in Section 5, "Timber Supply Sensitivity Analyses."

Based on timber volume estimates for existing stands, the current merchantable timber inventory on the timber harvesting land base is approximately 58 million cubic metres for the total Nass TSA. About 55 million cubic metres, or 95%, is currently found in stands older than the minimum harvestable age.

Variable Density Yield Prediction model
An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.
Table Interpolation Program for Stand Yields
A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.

Volume estimates (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.
Analysis unit
A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.

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 on the timber supply review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Kalum Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species.
- Unsalvaged losses* and forest health — unsalvaged timber losses on the timber harvesting land base. In the analysis, that excludes the Upper Nass zone, losses due to fire are expected to average 18 000 cubic metres per year, although this is expected to fluctuate annually. Hemlock looper attack in the Nass TSA has impacted hemlock stands in the Taylor River Zone and Kwinageese management zone. In the Kwinageese, hemlock stand volume projections were reduced by 20%. In the Taylor River Zone, hemlock stands in areas with a high attack were excluded from the timber harvesting land base and in areas of moderate or low attack a 20% volume reduction was applied. Forest District staff had estimated that approximately 50% of lodgepole stands older than 80 years were expected be lost to mountain pine beetle. As such all existing lodgepole pine-leading stand volumes are reduced by 50%. After the exclusion of the Nisga'a Treaty lands, only a small area of existing stands is present in the timber harvesting land base. No specific timber supply reduction due to pine pitch moth infections will be applied to lodgepole pine stands. In the Upper Nass, the impacts of balsam bark beetle attack on subalpine fir (balsam) are being investigated with satellite imagery. This information was unavailable for the timber supply analysis and the impacts were investigated within the critical issue analysis.
- Utilization levels — minimum size of trees to be removed during harvesting. Volume estimates are based on the utilization of all trees which meet or exceed the following standards: a minimum 10-centimetre top diameter; a maximum 30-centimetre high stump; and a minimum of 17.5 centimetres diameter at 1.3 metres above the ground.

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.

- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis are based on the age for each analysis unit at which a minimum harvestable volume of 300 cubic metres per hectare is obtained. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age in the model may be greater but not less than the minimum, and depend on ages of other stands, forest cover objectives* (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets.
- Deciduous stands — stands of predominately deciduous species are not currently considered merchantable in the Nass TSA. These stands are excluded from the timber harvesting land base under the "Problem Forest Type" classification but may contribute to management objectives such as landscape-level biodiversity and wildlife tree patch objectives. Mixed stands that are predominately coniferous* contribute to the timber harvesting land base but the deciduous component is removed from the volume tables.
- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits where the maintenance of scenic* landscapes is a priority for recreation and tourism management, particularly in areas that are adjacent to major travel corridors or are visible from major population centres. Visually sensitive areas in the Nass TSA are assigned a visual quality objective (VQO) of either preservation, retention*, partial retention or modification. Preservation VQOs* cover 4374 hectares (0.7%) of the Crown forested land base and are excluded from harvesting due to other exclusion criteria. Retention VQOs cover 757 hectares (0.4%) of the timber harvesting land base and 7883 hectares (1.3%) of the Crown productive forest land base. In retention VQO zones, at most 5% of the forested area within a landscape unit* may be covered by stands less than five metres tall (visually effective green-up*). Partial retention VQO* zones cover 11 347 hectares (6.0%) of the timber harvesting land base and 22 753 hectares (3.8%) of the Crown forested land. In partial retention VQO zones at most 15% of the forested area within a landscape unit may covered by stands less than five metres tall. Modification VQO* zones cover 13 576 hectares (7.2%) of the timber harvesting land base and 19 044 hectares (3.2%) of the Crown forested land base. In modification VQO zones at most 25% of the forested area within a landscape unit may be covered by stands less than five metres tall.

Forest cover objectives
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).

Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

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).

Preservation VQO
Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity. (see Visual quality objective).

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

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

Modification VQO
Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity (see Visual quality objective).

- Cutblock adjacency* and green-up — current forest management practices require that harvesting activities be approved based on previously harvested stands reaching a desired condition, or green-up before adjacent stands may be harvested. In the Nass TSA, this forest management objective is modelled as no more than 35% of the timber harvesting land base will be less than three metres tall at any time in the integrated resource management (IRM)* area. In VQO zones, the more stringent requirements noted above are modelled.
- 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 Nass TSA, within each biogeoclimatic variant, a proportion of the forested area must be covered by stands older than 140 or 250 years, depending on the biogeoclimatic variant.
- Stand-level biodiversity* — to maintain biological diversity in forest stands, wildlife trees* and wildlife tree patches (WTPs) are retained. The percentage retained for WTPs is based on the area that the timber harvesting land base occupies within a landscape unit and the percentage of area already harvested. Forest District staff indicate uncertainty about the percentage of the timber harvesting land base that would be reserved independent of forested land already excluded (e.g., riparian reserves, low sites). However, as at least double the WTP requirements are met in the contributing non-timber harvesting land base no deductions for WTP were applied in the base case harvest forecast. As a sensitivity analysis, removing the full requirements from the timber harvesting land base (i.e., other contributing non-timber harvesting land base is not used) and removing 50% of the requirements (i.e., as per *Provincial Wildlife Tree Management Recommendations,* February 2000) from the timber harvesting land base were modelled. It is assumed that wildlife tree patches will not be economical to harvest at a later date.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

- Management of identified wildlife — in the Nass TSA there are no wildlife habitat areas established, and no higher level plans* that identify other wildlife management practices. Environmentally sensitive areas for wildlife concerns are identified in the forest cover inventory and are excluded from the timber harvesting land base.
- Pine mushrooms — prime habitat for the pine mushroom (*Tricholoma magnivelare*) occurs in the Nass TSA. These habitats are within dry series of the ICHmc. These stands occupy about 4.5% of the ICHmc1. No specific forest management practices are in place and no specific consideration for pine mushroom is included with the base case analysis. A sensitivity analysis investigated restricting 4.5% of the ICHmc1 to a minimum harvestable age of 200 years.
- Kwinageese Integrated Resource Management Plan — management practices within the Kwinageese exceeds current *Forest Practices Code Guidelines* particularly for riparian retention. An additional reduction in the timber harvesting land base is applied to account for these management objectives.
- Harvest systems — clearcut* and clearcut with reserve* harvest systems are performed in the Nass TSA.

Further modelling assumptions for the above the management practices are described in Appendix A.

Higher level plans
Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Clearcut harvesting
A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Clearcutting with reserves
A variation of the clearcut silvicultural system in which trees are retained, either uniformly or in small groups, for purposes other than regeneration.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Nass 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 long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level 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 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. It is important to recognize that the representation (i.e., simplification) of forest practice guidelines in the timber supply model do not imply how these guidelines are to be applied operationally. Similarly, other simplifications of inventory (e.g., aggregation of similar stands, 10-year age classes) facilitate the analysis but are not to be construed as operational guidelines.

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 harvest levels 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.

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 practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Nass TSA. The base case harvest forecast* 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." 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" and Section 6, "Critical Issue Analysis." However, it is important to keep in mind that the base case harvest forecast provides only a part of the timber supply picture for the Nass TSA, and should not be viewed in isolation of the sensitivity and critical issue analyses.

Base case harvest forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

4 Results

4.1 Base case harvest forecast

The base case harvest forecast for the Nass TSA shown in Figure 7 represents current management as described in Section 2 and Appendix A. It excludes the Upper Nass zone. The base case harvest forecast starts at an initial harvest level of 820 000 cubic metres per year for one decade followed by a reduction of 10% for each of the next 6 decades prior to reaching the long-term harvest level* of 407 000 cubic metres per year. Due to the large timber harvesting land base changes (i.e., exclusion of Upper Nass zone) since 1996 when an AAC of 1 150 000 cubic metres per year for the Nass TSA was set, initiating a harvest forecast at a higher level is not possible without significant mid-term disruptions when harvesting switches from existing to second-growth forests (i.e., decades 14 and 15). The initial harvest level is 28% lower than the current AAC level which corresponds to the 28% reduction in the current timber harvesting land base.

There are many possible harvest flows, with different starting levels, decline rates, and potential trade-offs between short- and mid-term harvest levels (see Section 5.1, "Alternative harvest forecasts"). The harvest forecast illustrated in Figure 7 was defined using the following criteria: managing the rate of any changes in harvests, avoiding large and abrupt harvest shortfalls, and maintaining a reasonably constant total growing stock* level over the long term on the timber harvesting land base. 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 in timber supply from decade-to-decade and significant shortages in the future. As such the base case harvest forecast was chosen to maximize the initial harvest level and reach as soon as possible the maximum long-term harvest level with a maximum reduction of 10% in harvest per decade.

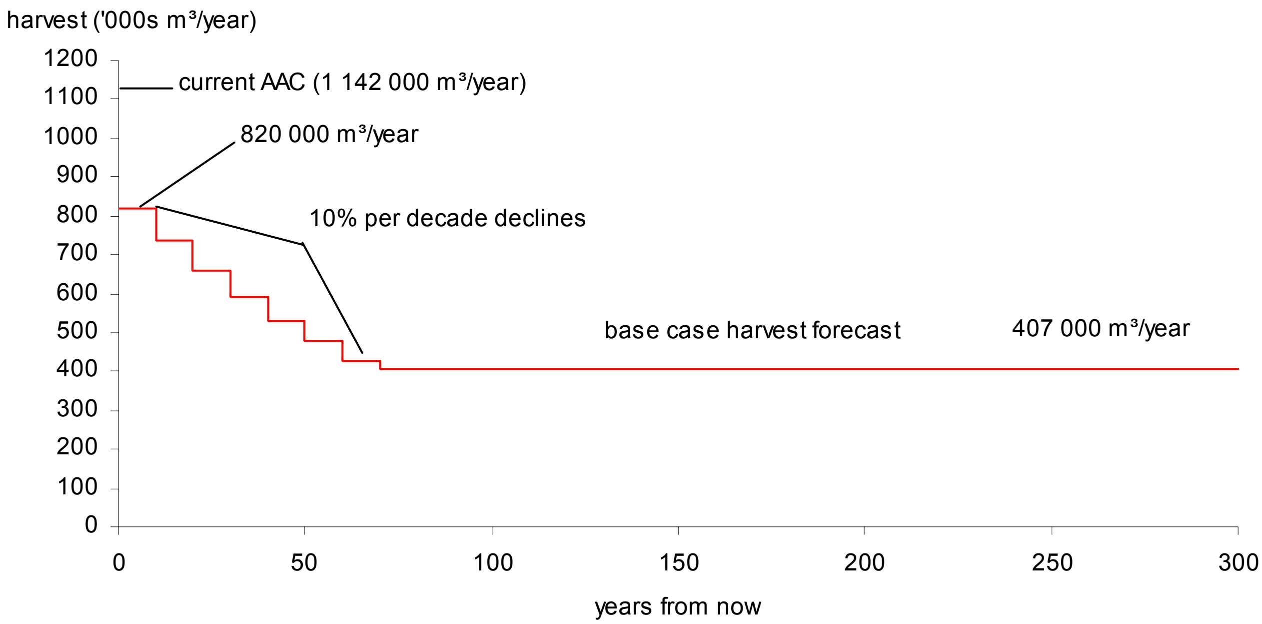

Figure 7. Harvest forecast — Nass TSA base case harvest forecast, 2001.

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 objectives and guidelines for non-timber values) and estimates of timber growth and yield.

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

4.2 Harvest characteristics of base case harvest forecast

Figure 8 shows that harvest in the base case forecast is achieved from existing stands for the first 11 decades before an abrupt transition to harvest from managed stands. This abruptness in part reflects the priority of harvesting relative oldest stands first as well as the minimum harvestable ages of managed stands. A small amount of existing stands (< 50 hectares per year) are harvested throughout the 400 year simulation (300 years shown) from the more constrained visual management zones.

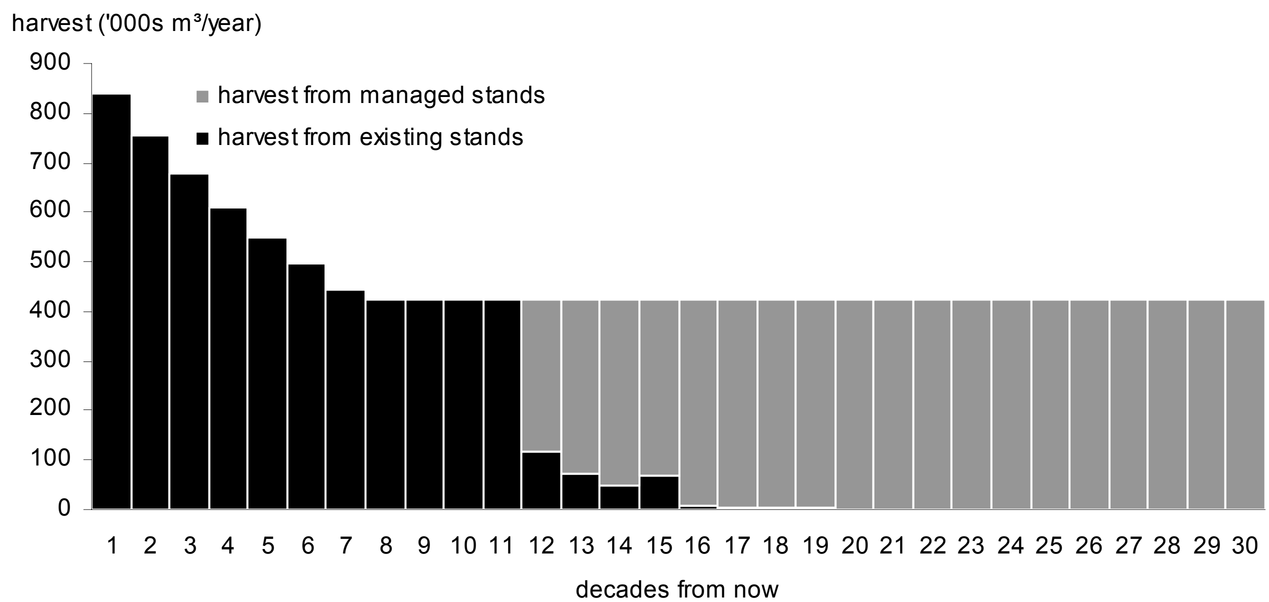

Figure 8. Harvest contributions from existing and managed stands — Nass TSA base case harvest forecast, 2001.

4 Results

Harvest volume is a function of the amount of area harvested and the volume of the stand harvested. In the base case harvest forecast, higher initial harvest levels for the first 5 decades are obtained by harvesting a larger area than is required to maintain the long-term harvest level (Figure 9). During this initial period average yields from the older existing stands are slightly higher than the yield of stands forecasted for the long-term harvest level. However, harvest ages of managed stands for the long-term harvest level are about half the age of the existing stands harvested in the initial 10 decades (i.e., 150 *versus* 300 years). The average harvest age initially increases as unmanaged stands age and then declines to reflect the harvest of managed stands. The harvest ages reflect a data simplification that stands above age 270 years were assigned to age 270 at period 0 but allowed to age over the analysis period.

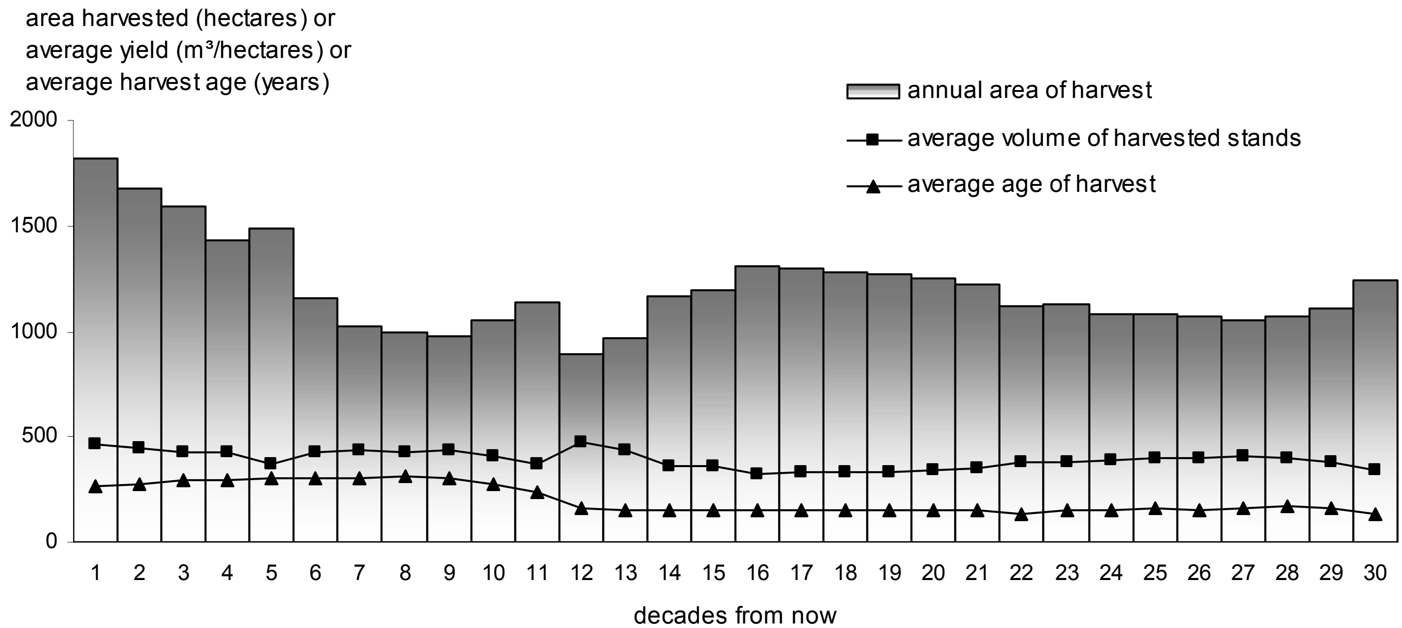

Figure 9. Average annual area harvested, the associated average volume yield, and the average age of the harvested stands on an area weighted basis — Nass TSA base case harvest forecast, 2001.

4 Results

The Kalum Forest District staff have expressed concerns about the harvest performance within cable operability zones of the Nass TSA. About 36% of the timber harvesting land base is classified as cable operability; 42% is considered conventional ground based operability and the remainder as mixed. Figure 10 shows the base case harvest forecast separated into the three operability zones defined in the timber harvesting land base: ground, cable, and mixed. A significant portion of the harvest forecast is obtained from the cable operability zone. This issue is further investigated as a sensitivity analysis in Section 5.10.

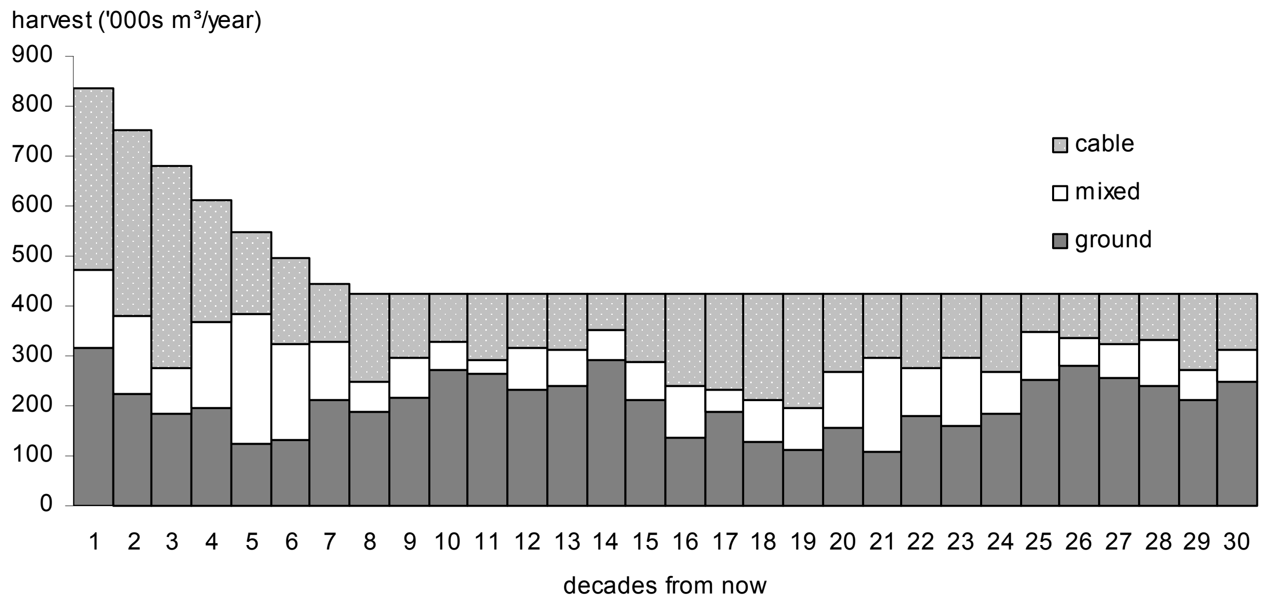

Figure 10. Volume harvested from the cable, ground, and mixed operability zones — Nass TSA base case harvest forecast, 2001.

4.3 Forest characteristics of base case harvest forecast

The base case harvest forecast was developed by first determining the maximum sustainable long-term harvest level. The sustainability of the long-term harvest level is reflected in a stable long-term growing stock on the timber harvesting land base. Figure 11 shows that the total growing stock volume remains constant over the long term after a managed reduction in the existing slower growing inventory.

Currently, most forest stands contain volume in excess of what Kalum Forest District considered the minimum volume desirable for a stand to be harvested (300 cubic metres per hectare). In the analysis, this minimum volume was translated to a minimum harvestable age. A low of 5.5 million cubic metres of inventory above minimum harvestable age is reached in decade 15.

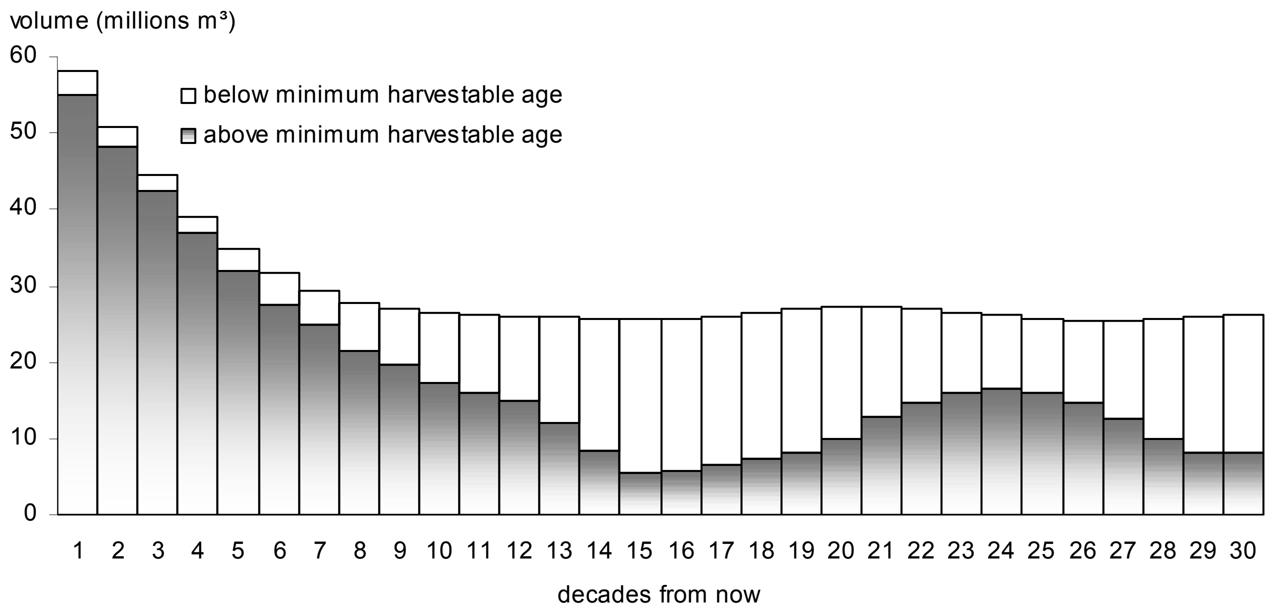

Figure 11. Growing stock volume on the timber harvesting land base — Nass TSA base case harvest forecast, 2001.

4 Results

The age class composition of the productive forest in the Nass TSA provides insight into the overall biodiversity characteristics. Figure 12 presents how the age class composition changes over the next 150 years under the base case harvest forecast.

Over time, the old forest in the timber harvesting land base is reduced through harvesting and the contributing non-timber harvesting land base supports most of the old forest in the timber supply area. Concern exists about forest in the non-timber harvesting land base aging continuously. Section 5.17, "Aging of non-timber harvesting land base" discusses this in greater detail.

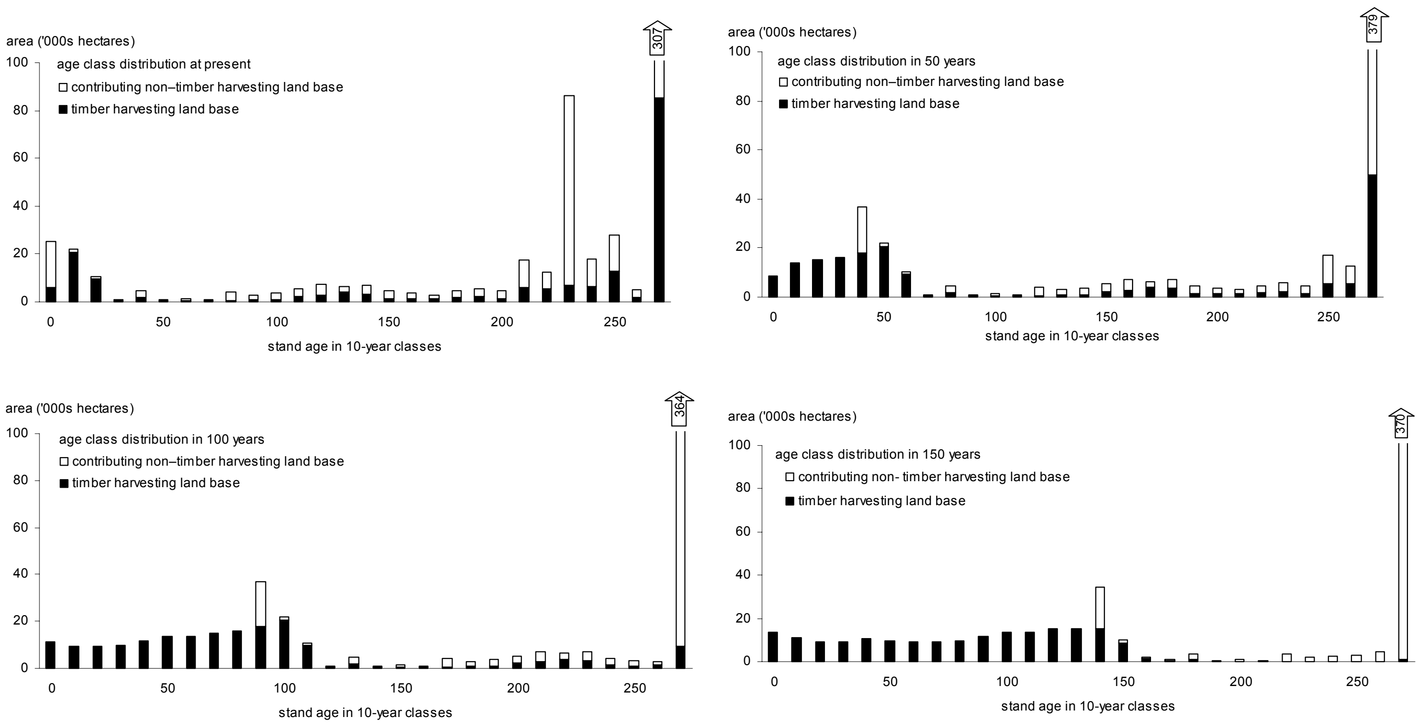

Figure 12. Age class distribution of timber harvesting land base and area that contributes to forest management objectives at 50 year intervals — Nass TSA base case harvest forecast, 2001.

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. An alternative 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 sensitivity analyses are relative to the base case (that shows current forest management assumptions*) and are for general modelling or management concerns. Concerns about the specific issue of the Upper Nass zone is discussed in Section 6, "Critical Issue Analysis." Harvest flows for sensitivity analyses used the following ordered criteria without causing harvest flow deficiencies: (a) maximize the long-term harvest level while maintaining a reasonable constant total growing stock level over the long term on the timber harvesting land base, (b) attempt to attain the base case initial harvest level, (c) harvest level declines will be in 10% steps, and (d) no mid-term harvest level drop below the long-term harvest level is desired but mid-term levels can decline to demonstrate impacts of using different information.

Sensitivity analysis
A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or 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 forecasts

There are many possible harvest forecasts with different initial levels, decline rates, and trade-offs between short-, mid-, and long-term harvests. The base case harvest forecast shown in Figure 7 was defined using criteria discussed in Section 4.1, "Base case harvest forecast." The criteria included managing the rate of decline in harvests from an initial level, avoiding large and abrupt harvest shortfalls, and maintaining a fairly constant growing stock level over the long term. Specifically, a harvest flow was selected of that obtained the highest initial harvest level with 10% reductions per decade to the long-term harvest level. The highest initial harvest level was desired in order to minimize the difference in initial harvest and the current AAC.

In this sensitivity analyses, two alternative harvest forecasts are presented. The first alternative enables the mid-term harvest level to decrease to a level no lower than that which equates to the long-term harvest level if existing stand yields (i.e., VDYP based) were assumed. The second alternative investigates the harvest forecast resulting from maintaining the recent (1996-1999) harvest level for the Nass TSA.

Figure 13 shows the two alternative forecasts. For Alternative 1 the initial harvest level could be elevated to 900 000 cubic metres per year but with stepped reductions each of the next 10 decades to a mid-term level that is 79% of the long-term harvest level. The second alternative illustrates that the actual 1997-2000 average harvest level of 553 000 cubic metres per year can be maintained for seven decades then stepped down to the long-term harvest level of 407 000 cubic metres per year. A third alternative forecast often illustrated is a non-declining forecast (i.e., often a flat line forecast). As the base case presented does not have harvest levels below the long-term harvest level, it is possible to harvest this long term level from initiation.

The harvest forecast in the base case was selected as the base case over alternative forecasts because (1) it illustrates an orderly transition to the long-term harvest level, (2) it provides slightly greater harvest over the 40 decade horizon than the alternative that lowers mid-term levels below the long-term harvest, and (3) it is an appropriate harvest flow to test sensitivities and dynamics.

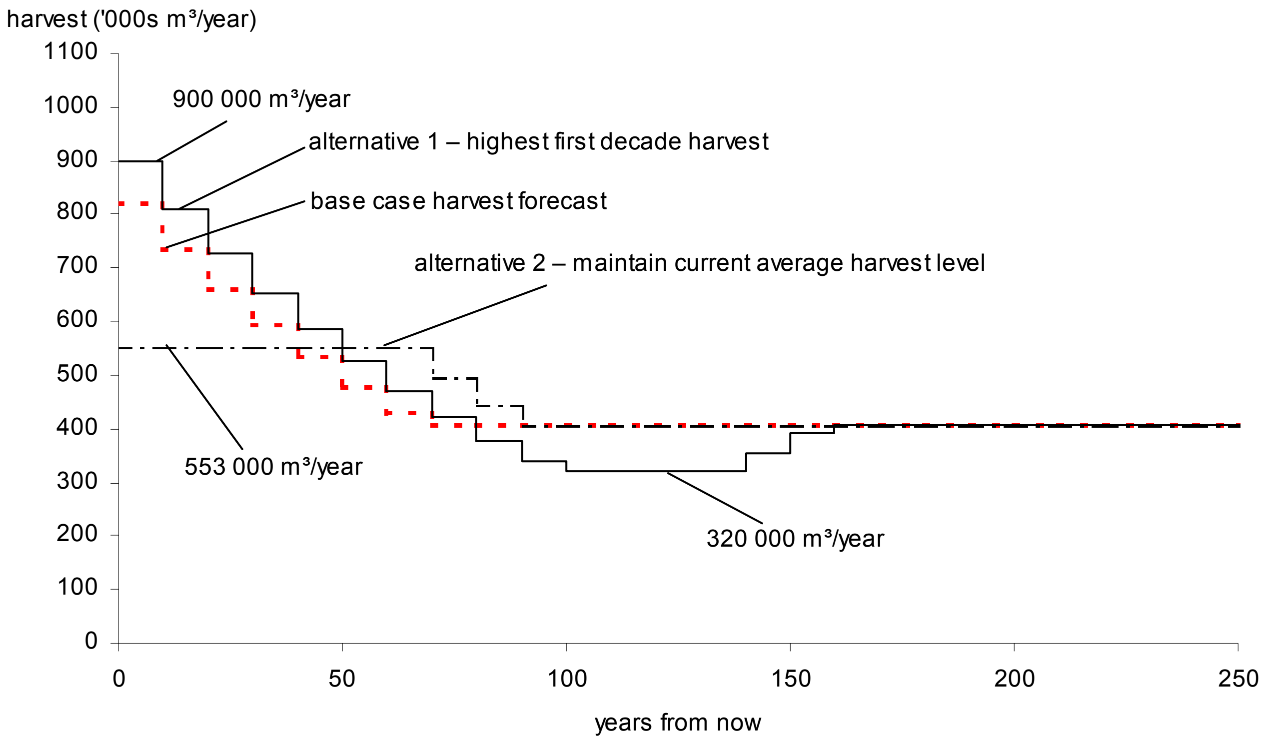

Figure 13. Alternative harvest forecasts — Nass TSA base case harvest forecast, 2001.

5.2 Uncertainty in harvesting priorities

The base case harvest forecast analysis placed a priority on harvesting stands that are the oldest relative to the minimum harvestable age. It is improbable that this harvesting priority rule can be fully applied operationally across the TSA. An alternative harvesting priority rule is random selection of stands above minimum harvestable age.

To investigate the impact on harvest flow if the random harvesting priority is followed, five FSSIM runs were conducted with differing random seeds. In all of the five cases, the base case harvest forecast was not obtainable in decades 14 and 15 and the long-term harvest level was not sustainable (i.e., decreasing merchantable inventory).

Figure 14 shows a representative forecast of the five runs using the random harvesting priority with an adjusted long-term harvest level. This alternative suggests that the short-term base case harvest forecast is insensitive to the harvesting priority rule as the starting target of 820 000 cubic metres per year can be met. However, the mid- and long-term harvest levels would be reduced 5% to 388 000 cubic metres per year at which the merchantable inventory is constant in the long term.

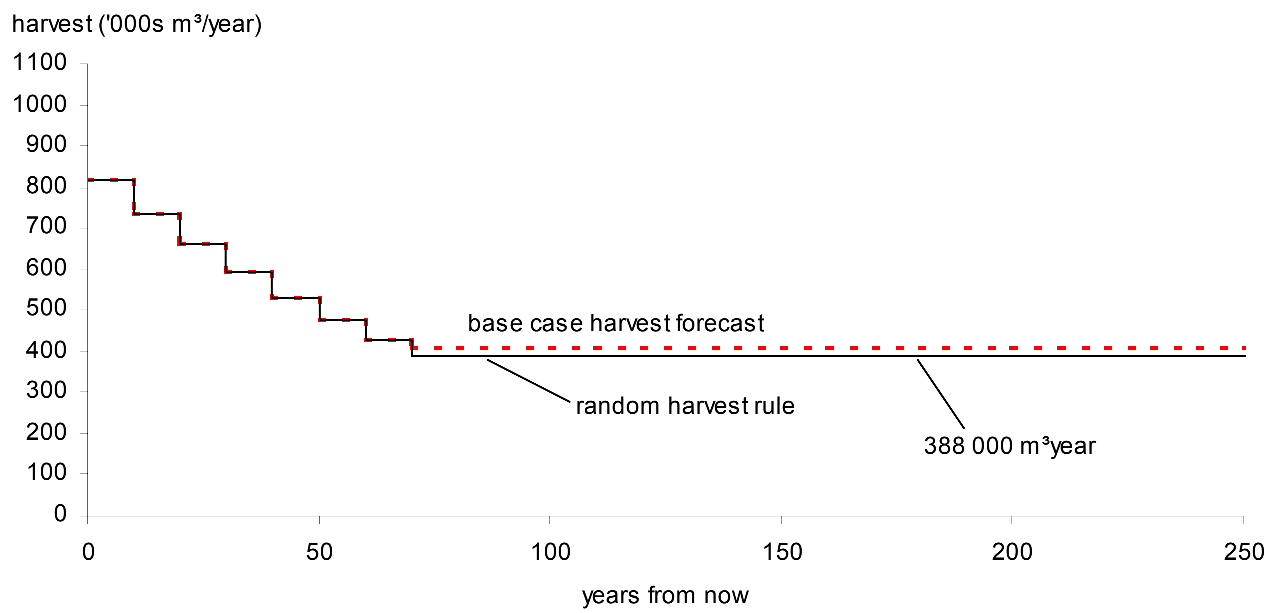

Figure 14. Example alternative harvest forecasts using a random harvest rule — Nass TSA base case harvest forecast, 2001.

5.3 Uncertainty in the existing unmanaged stand volumes

Timber volume estimates for existing unmanaged stands are subject to uncertainties. The uncertainties exist due to uncertainty inherent in the inventory methodology (e.g., photo estimated tree heights, stand ages, site indices) and the models used to derive current volumes and to predict future yield.

An inventory audit of the Nass TSA found no significant differences for mature forest between volumes calculated with VDYP using inventory information and volumes determined using field information. While no significant audit volume differences are present, sensitivity analysis on existing stand yields are useful for investigating the model constraint dynamics and for providing a sensitivity base for other uncertainties that effect unmanaged stand yields (e.g., pest damage effects).

This sensitivity analysis investigates the impacts of simply increasing and decreasing unmanaged stand yields by 10%. No other adjustments, such as minimum harvestable ages, were made.

Figure 15 shows that a 10% increase in existing stand yields enables the initial harvest level to increase a 13% increase to 925 000 cubic metres per year with 10% step downs to the long-term harvest level of 407 000 cubic metres per year. When a 10% decrease in yields is applied, to maintain the initial harvest level at 820 000 cubic metres per year requires that the harvest flow step down to a mid-term level of 307 000 cubic metres per year through decades 9-13 before increasing to the long-term harvest level. To avoid a mid-term dip below long-term harvest level requires that the initial harvest level be reduced 16% to 690 000 cubic metres per year (not shown).

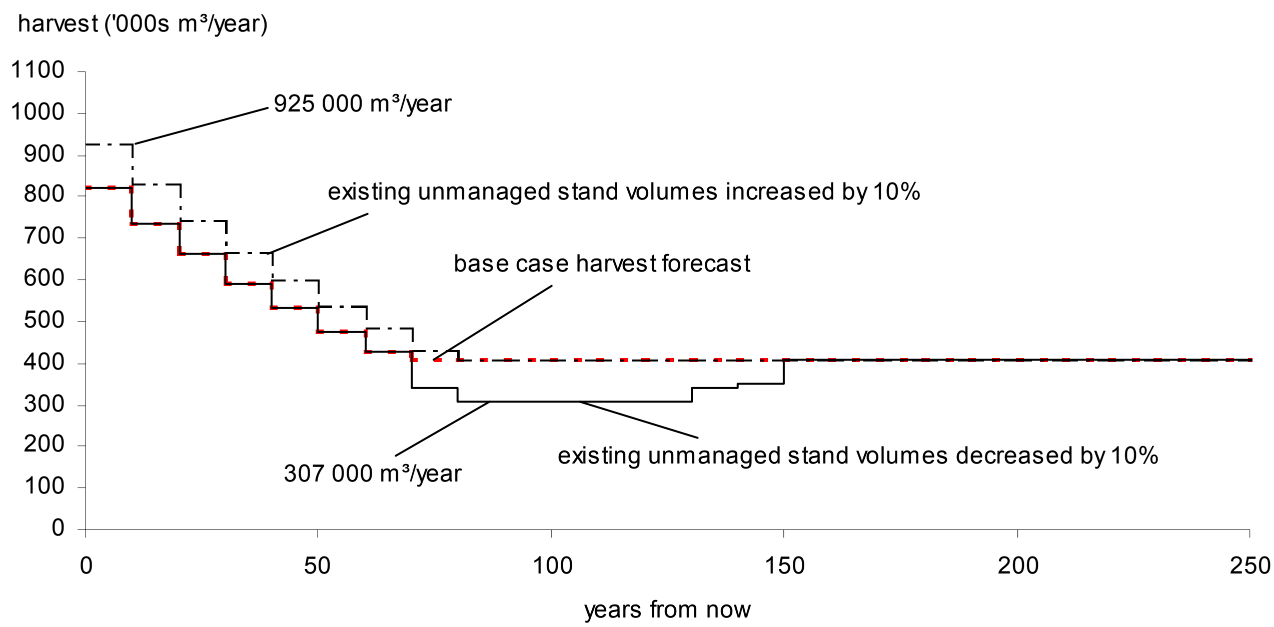

Figure 15. Effects of uncertainty in unmanaged stand volumes — Nass TSA base case harvest forecast, 2001.

5.4 Uncertainty in managed stand volumes

Timber volume estimates for managed stands are subject to uncertainties in inventory information of existing managed stands, site productivity estimates, genetic improvements, regeneration assumptions, and the equations used to predict future yield in the growth and yield model TIPSY.

The initial density, used as an input into the TIPSY growth and yield model is an example of this uncertainty. Initial density was estimated based on free-to-grow density estimates that included both planted trees and in-growth. As such, the appropriate initial density is unknown. However, analysis using TIPSY shows that an increase of 500 stems per hectares initial density results in a 2.7% increase in the long-run sustainable yield (i.e., the area weighted sum of the culmination mean annual increment*) as compared to the base case. A decrease of 500 stems per hectares initial density results in a 10.7% decrease.

This sensitivity analysis investigates the impacts of simply increasing and decreasing managed stand volume by 10%. No other adjustments, such as minimum harvestable ages, were made. Specific issues around the uncertainty for site productivity are also investigated in a sensitivity analysis in Section 5.

Figure 16 shows that to accommodate a 10% reduction in managed stand volumes the long-term harvest would be reduced 10% to 365 000 cubic metres per year. Alternatively, increasing the managed stand volumes by 10% results in a proportionate improvement in the long-term harvest level to 450 000 cubic metres per year. As expected, changes in managed stand volumes do not impact short-term harvest levels of these stands.

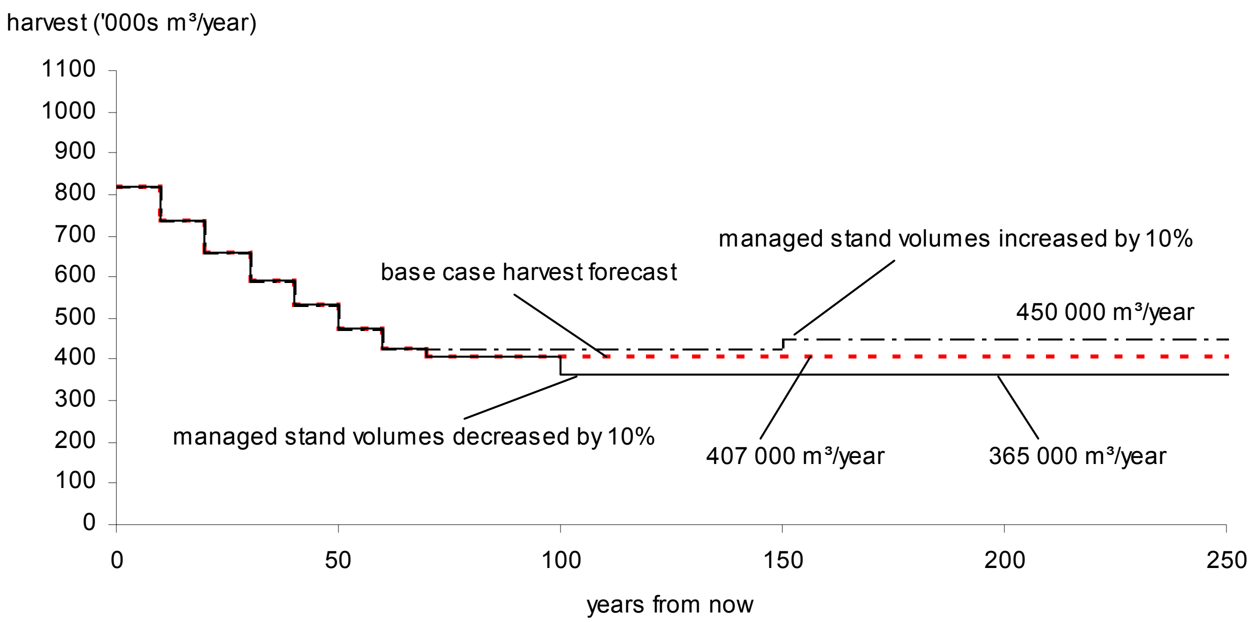

Figure 16. Effects of uncertainty in managed stand volumes — Nass TSA base case harvest forecast, 2001.

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

5.5 Uncertainty in the size of timber harvesting land base

Uncertainty in the size of the timber harvesting land base is due to factors such as changes in the economics defining operability, land-use decisions, and boundary changes. In the Nass TSA, boundary adjustments have occurred since the data file used in this analysis was prepared. These adjustments are noted in Appendix A.7.

In this sensitivity analysis 18 917 hectares (i.e., 10% of timber harvesting land base) of the land base is transferred from the timber harvesting land base to the contributing non-timber harvesting land base and vice versa. This transfer of land was done proportionately across all polygons in the data file. All other model parameters were held to the base case values (i.e., yields, age to green-up heights). For the transfer from non-timber harvesting land base to timber harvesting land base, the lower site index cutoff for poor/medium site in the analysis unit definition was removed (i.e., in the base case harvest forecast the limit was 9 metres).

For these general land base sensitivities a 10% proportional decrease in the timber harvesting land base results in a similar 10% decrease in the harvest forecast (Figure 17). However, a 10% increase in the land base results in a slightly smaller increase (6 to 8%) in the harvest forecast. This reflects the difference in the lower average site productivity in the contributing non-timber harvesting land base *versus* the timber harvesting land base.

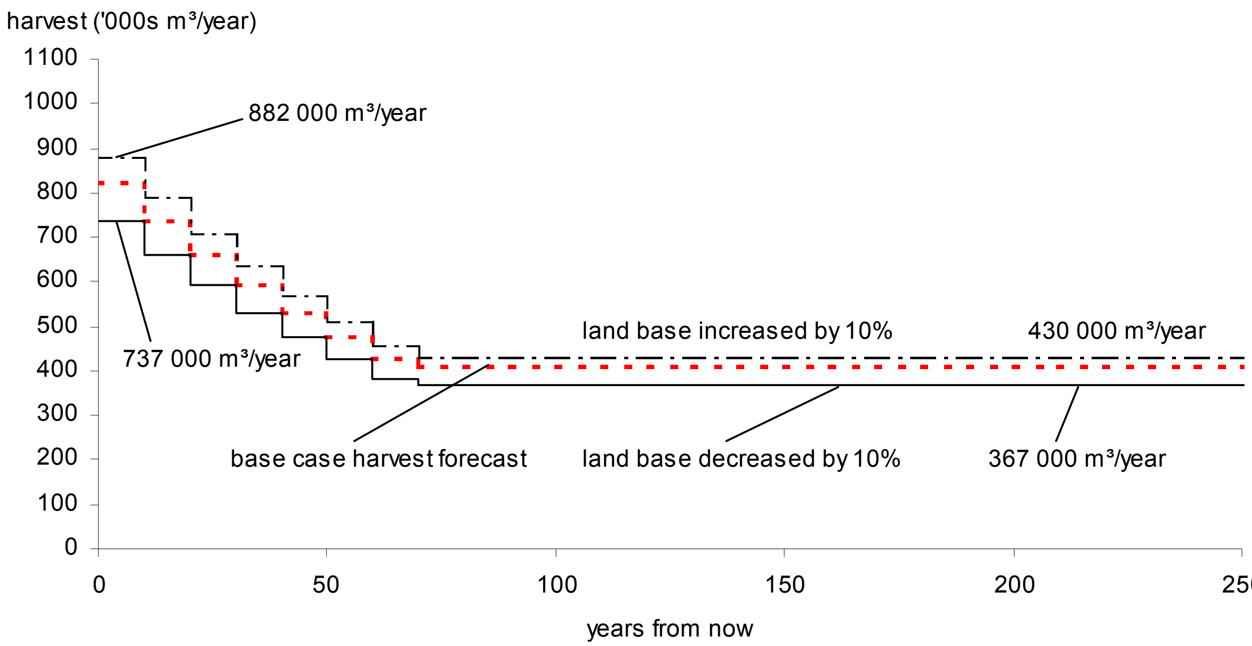

Figure 17. Effects of uncertainty in timber harvesting land base — Nass TSA base case harvest forecast, 2001.

5.6 Uncertainty in minimum harvestable age criteria

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. The time at which a stand becomes merchantable is subject to uncertainty. This is partly because of uncertainty about the growth of a stand, but mostly because we cannot foresee future conditions that will determine merchantability. Minimum harvestable ages are meant to approximate the timing of merchantability and are not legal or policy requirements.

For this analysis in the base case, a stand was considered merchantable when it reaches 300 cubic metres of merchantable volume per hectare. The minimum harvestable age was determined as the age at which the minimum volume is reached in the volume table of an analysis unit. To assess the impacts of the uncertainty sensitivity analyses were completed using minimum volumes of 250 cubic metres per hectare and 350 cubic metres per hectare to set the minimum harvestable age.

Increasing the minimum harvestable ages (i.e., minimum volume 350 cubic metres per hectare) restricts harvest flow (Figure 18). The initial harvest level can be met but a longer decline to a mid-term level below the long-term harvest level is required before stepping up to the long-term harvest level that is reduced slightly from the base case. To avoid a mid-term dip below the long-term harvest level requires that the initial harvest level be reduced 16% to 690 000 cubic metres per year (not shown).

Decreasing the minimum harvestable ages (i.e., minimum volume 250 cubic metres per hectare) results in a slightly higher initial harvest level (835 000 cubic metres per year) and long-term harvest level (412 000 cubic metres per year).

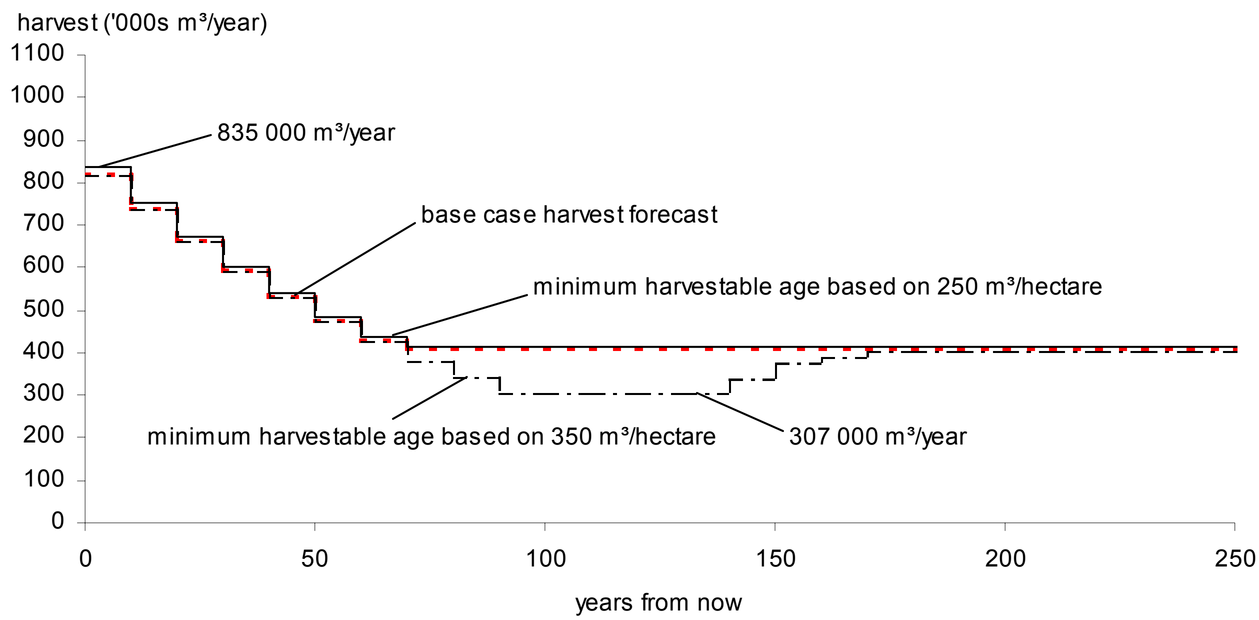

Figure 18. Effects of uncertainty in minimum harvestable age criteria — Nass TSA base case harvest forecast, 2001.

5.7 Uncertainty in the allowable disturbance in VQO zones

In the Nass TSA, the visual quality objectives (VQO) of scenic zones have been made known by the Forest District Manager. Visual quality objectives are established as a maximum percentage of disturbance that is allowed to be below visually effective green-up tree height. In this analysis we model this management limit as a maximum percentage of a VQO zone in a landscape unit being below a minimum age (the age to reach green-up height).

Uncertainty is present in the translation of the maximum perspective view disturbance percentage to the modelled maximum plan view disturbance level. The relationship between the perspective and plan view can vary depending on terrain, existing vegetation, and forest management. For timber supply analysis, a range of plan view disturbances is suggested within *Procedures for factoring visual resources into timber supply analyses*, Ministry of Forests 1998. For the base case harvest forecast, Kalum Forest District staff believe that within the Nass TSA, the upper limit of the range for each VQO is appropriate. Uncertainty is also present in determining the visually effective green-up tree height. This issue is discussed separately under Section 5.9, "Uncertainty in the time to green-up height."

For this sensitivity analysis, increasing and decreasing the maximum plan view percentages is investigated. The percentages are decreased to the mid-range maximum disturbance value of the provincial guidelines (3% for retention, 10% for partial retention, and 20% for modification) and increased an equivalent amount for each objective (7% for retention, 20% for partial retention, and 30% for modification).

Restricting the maximum plan view disturbance levels for zones with visual quality objectives to the mid-range results in a 150 000 cubic metres per year deficiency in decade 15 as compared to the base case harvest forecast (not shown). Figure 19 shows that this deficiency can be mitigated by reducing the mid-term harvest level to 6% below the long-term harvest level for 5 decades. Alternatively, the initial harvest level could be reduced 3% (795 000 cubic metres per year) with 10% per decade declines to the long-term harvest level (not shown). Relaxing the maximum plan view disturbance levels to above guideline levels results in a small increase in the initial harvest level (825 000 cubic metres per year) and the long-term harvest levels (412 000 cubic metres per year).

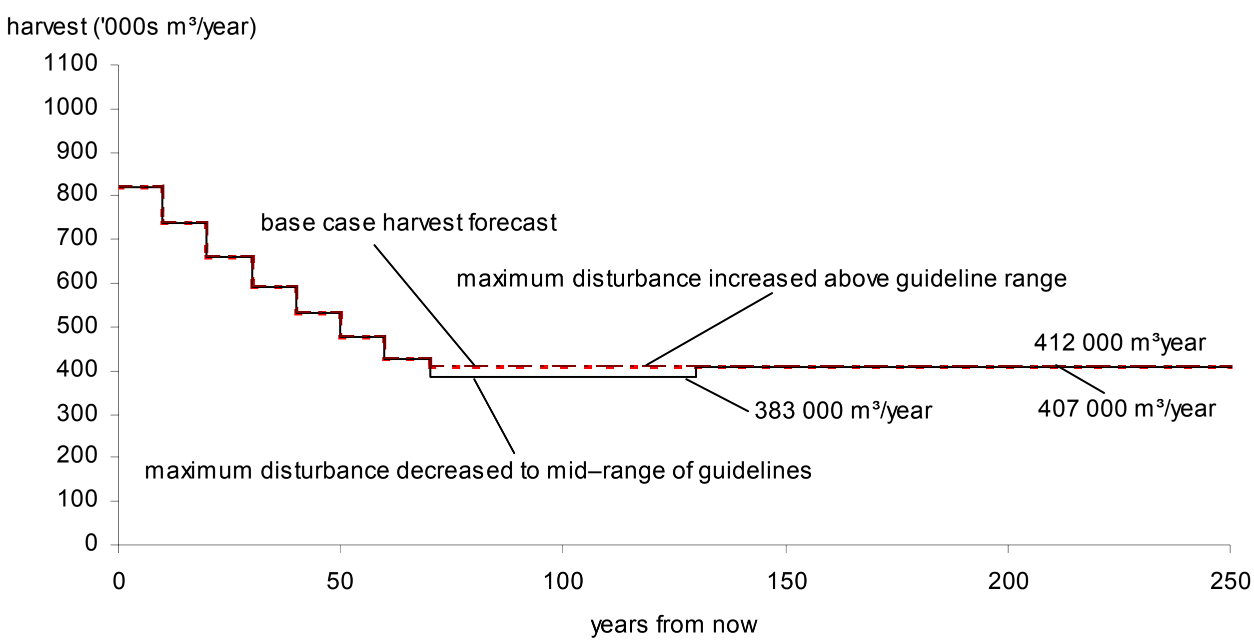

Figure 19. Effects of uncertainty in maximum disturbance levels for visual quality management — Nass TSA base case harvest forecast, 2001.

5.8 Uncertainty in allowable disturbance in the integrated resource management (IRM) zone

Within the integrated resource management (IRM) zones, the Kalum Forest District assumes a current management practice of a 3-pass harvest system. This is modelled by a maximum allowable disturbance of 35% of an IRM zone in a landscape unit being less than the age necessary to achieve green-up height. However, a 1999 study indicated for the SBFEP Arbor Lake Planning area that current harvesting operations was removing no more than 22% of the operable area, which is reflective of a 5-pass harvest system. This study thus raised some uncertainty about the maximum allowable disturbance percentage used.

To assess this uncertainty, a sensitivity analysis looked at increasing and decreasing the maximum allowable disturbance by 15 percentage points.

Figure 20 shows that the base case harvest forecast is insensitive to increases in the maximum allowable disturbance percentage in the IRM zones but very sensitive to a decrease by 15 percentage points (i.e., maximum allowable disturbance from 35% to 20%). The lower maximum allowable disturbance percentage results in a significant (38%) reduction in the initial harvest. The threshold for maximum allowable disturbance percentage above which the base case harvest forecast is not affected is 28% (not shown).

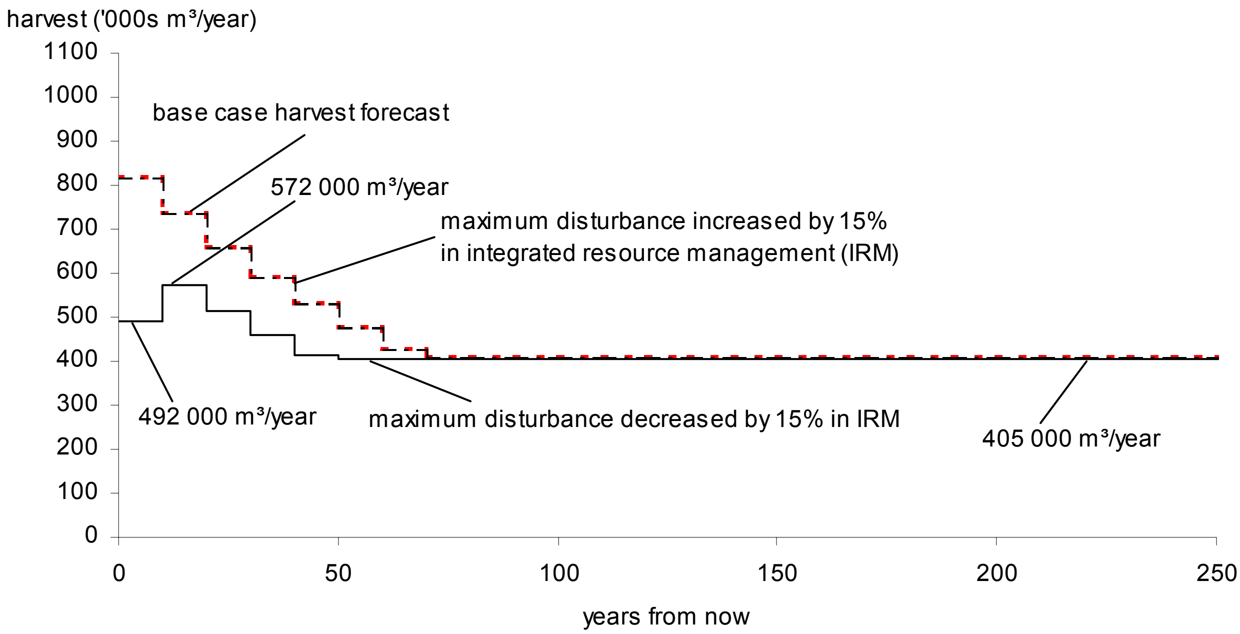

Figure 20. Effects of uncertainty in maximum disturbance levels for integrated resource management zones — Nass TSA base case harvest, 2001.

5.9 Uncertainty in the time to green-up height

Uncertainty around the time to green-up height exists due to both the sparse provincial data on early stand development and more specifically due to the limited data on the Nass TSA. The use of SiteTools, which derives top heights, may result in an under- or overestimation of the time to green-up given that management objectives are specified as silvicultural survey-based heights. However, a comparison of the predicted green-up ages to silvicultural records for the Prince Rupert Forest Region showed no apparent major discrepancies.

To assess this uncertainty, a sensitivity analysis looked at increasing and decreasing the time to reach green-up height by 10 years for all the analysis units. Figure 21 shows the impact of this sensitivity.

Reducing all green-up ages by 10 years enables a slight increase in the initial harvest level by relaxing the requirements. However, increasing all green-up ages by 10 years prevents the base case harvest forecast from being reached. Maximum disturbance constraints in decade 2 limit the initial harvest level.

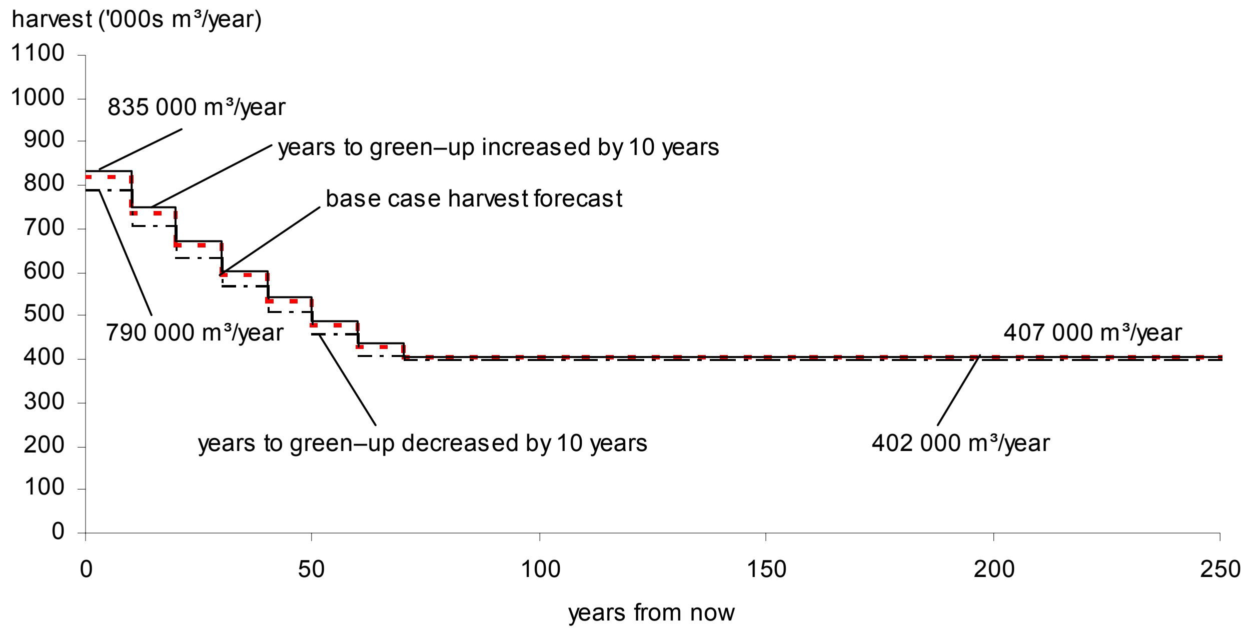

Figure 21. Effects of uncertainty in time to green-up height — Nass TSA base case harvest forecast, 2001.

5.10 Cable operability

Operability lines with the Nass TSA recognize cable harvesting systems on steep and broken terrain within portions of the Nass TSA. The base case indicates a significant portion of the harvest flow is from cable operability zones (see Figure 10). While full employment of cable harvesting has not yet occurred in some areas, 29% of the harvested area in the period 1991 to 1995 was from the cable operability zone. However, where harvesting has occurred in the cable zone, Kalum Forest District staff have observed that some harvesting practices have isolated patches of timber and staff believe that a combination of terrain stability, timber quality and high operating cost may make isolated cable areas uneconomic to harvest in the future. This issue is being further investigated.

Sensitivity analysis examined the impact of transferring 10%, 20% and 30% of all the area identified as cable operability from the operable land base to the inoperable land base. The analyses did not modify volume or constraint values (e.g., green-up ages). Additionally, the analysis looked at how long harvesting in cable areas could be deferred while still maintaining the base case harvest forecast.

The transfer of 20% (11 605 hectares) of cable operable area to inoperable reduces the long-term harvest level by 7% (Figure 22). To maintain the initial base case harvest forecast requires that the mid-term level drops 100 000 cubic metres per year below the level of the base case (Figure 22, Alternative 1). An alternative flow that steps down to the long-term harvest level requires that the initial harvest start at 760 000 cubic metres per year (Figure 22, Alternative 2). A transfer of 10% and 30% respectively drops the initial harvest level to 790 000 and 722 000 cubic metres per year and the long-term harvest level to 392 000 and 370 000 cubic metres per year (not shown).

Removal of all cable (67 531 hectares) from the timber harvesting land base reduces the long-term harvest level by 35% (Figure 22). A harvest flow that steps down to the long-term harvest level enables an initial harvest level of 499 000 cubic metres per year if no harvesting occurs in the cable operability zone.

Deferral of harvesting in cable areas is possible for five decades while maintaining the base case harvest forecast. However, for decades 6 to 10 all harvest would be required from the cable operability zone. This sharp transition is a function of both the need to harvest in the cable operability zone and the relative oldest harvesting rule.

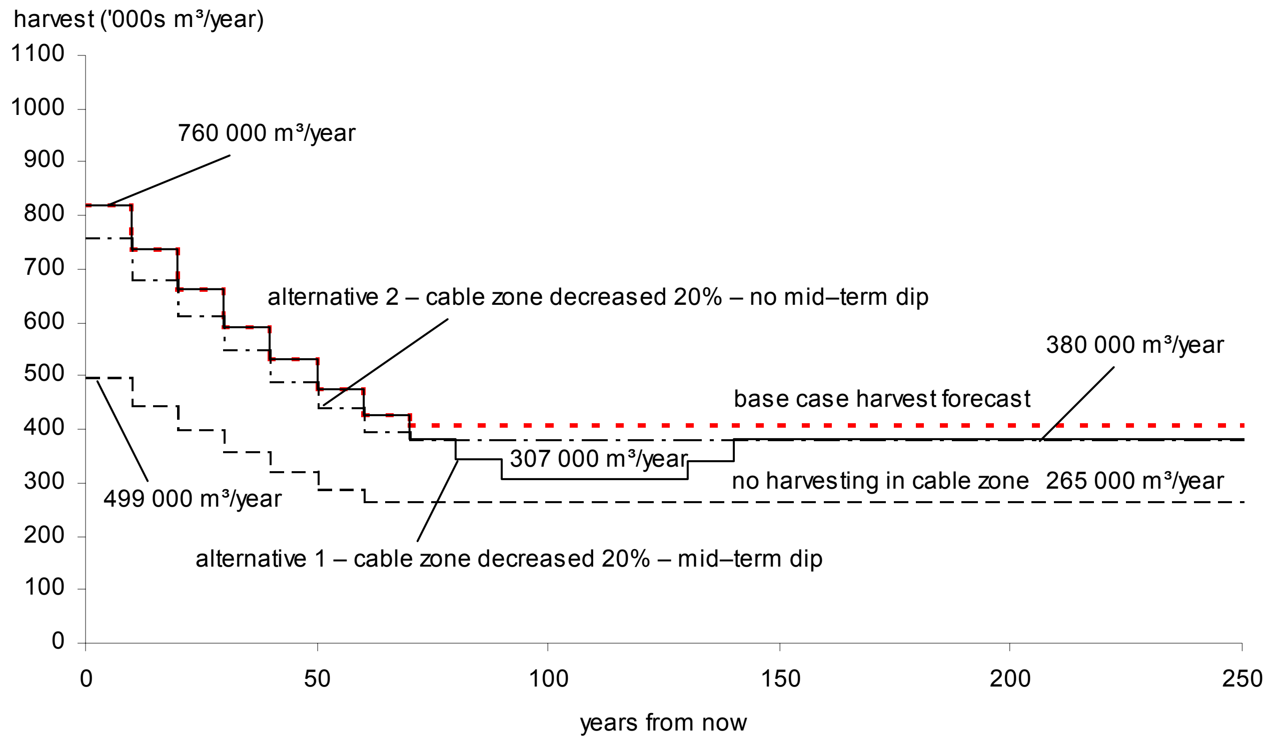

Figure 22. Effects of reduced cable operability areas — Nass TSA base case harvest forecast, 2001.

5.11 Old-growth site index (OGSI) estimation

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years, a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year will influence the estimated productivity for a stand that otherwise may be "averaged out" over a longer time period. At older ages, site productivity estimates may be incorrect because tree heights do not represent actual production — for example due to top breakage — and it is very difficult to determine ages of old trees accurately from aerial photo interpretation.

5 Timber Supply Sensitivity Analyses

The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two old-growth site index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged and regenerated stands of the same productivity. Site index was estimated for both and comparisons were made. Due to plot selection standards, few data in the low site index (0 to 15 metres) range were present in the data set. For these sensitivity analyses, adjustments for lodgepole pine and interior spruce were applied.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study. For these sensitivity analyses, adjustments for balsam, western hemlock, and western redcedar were applied.

Use of the results of the aforementioned studies is of interest to the Nass TSA, as stands older than 140 years comprise 71% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site index estimates, site indices of these older stands were adjusted using the applicable paired-plot results or veteran-tree results if no applicable paired-plot study is available. Timber supply analysis inputs affected by changes in estimated future productivity (managed stand volume estimates, green-up ages and minimum harvestable age) were recalculated based on the changed productivity.

Table 3 compares the average forest inventory-based site index for each old-growth analysis unit to those defined using the OGSI adjustments. This table shows area weighted averages regardless of species or age class. As a consequence of these changes, time to green-up height for visual and IRM zones decreased by 7.8 years and the average minimum harvestable age decreased by 49.9 years. The largest site index adjustments (approximately 6 metres increase) occurred in poor-medium analysis units with hemlock the most common leading species (analysis units 102 and 113). These two analysis units account for 74% of the timber harvesting land base. The decrease in minimum harvestable age in these analysis units decreased 70 and 60 years respectively.

Results of the OGSI sensitivity analysis, presented in Figure 23, show the long-term harvest level could be 57% higher than the base case and reached earlier at decade 4. This increased level consists of both an increase from the base case in volumes harvested and an increase in area harvested. The ability to harvest stands earlier (due to reduced minimum harvestable ages and time to green-up height) has relieved restrictions at decades 14 to 16 in the base case harvest forecast and allows greater harvest levels in the mid-term.

Site index adjustments are not included in the base case since there is little local site productivity data or long-term monitoring of regenerated stands to verify the adjustments. As indicated above, particularly for the study with veteran trees, these studies are based on limited data that are provincial in nature and may not reflect local conditions. However, the results of this analysis does provide insight into the possible impacts associated with underestimates of site productivity for the Nass TSA, and indicate that long-term timber supply is likely higher than currently estimated.

Table 3. Average analysis unit site index for forest cover inventory and OGSI adjusted information — Nass TSA base case harvest forecasts, 2001

Analysis unit (AU) #	Name of dominant original analysis unit (species, site quality, age)	Area (hectares)		Site index (m @ 50 years)	
		Total	> 140 years	Inventory	OGSI adjusted
101	Pure Hw/Hm — poor/med thrifty	7 759	0	12.2	12.2
102	Pure Hw/Hm — poor/med old	43 203	43 203	11.7	17.7
103	Pure Hw/Hm — good thrifty	1 912	0	19.0	19.0
104	Pure Hw/Hm — good old	918	918	17.6	20.8
105	Pure Ba/Bl — poor/med thrifty/old	10 205	9 188	12.4	15.6
107	Pure Ba/Bl — good thrifty/old	707	382	17.3	18.1
109	Pure pine — poor/med thrifty	1 417	0	11.5	11.6
111	Pure pine — good thrifty	4628	0	16.6	16.6
113	H/B/Cw — poor/med thrifty/old	95 340	77 908	12.0	16.6
115	H/B/Cw — good thrifty/old	10 812	2 392	18.4	19.0
117	Spruce mix — P/M/G thrifty/old	6 220	994	15.8	16.5
118	Spruce mix — P/M/G old	6 053	0	16.4	16.4

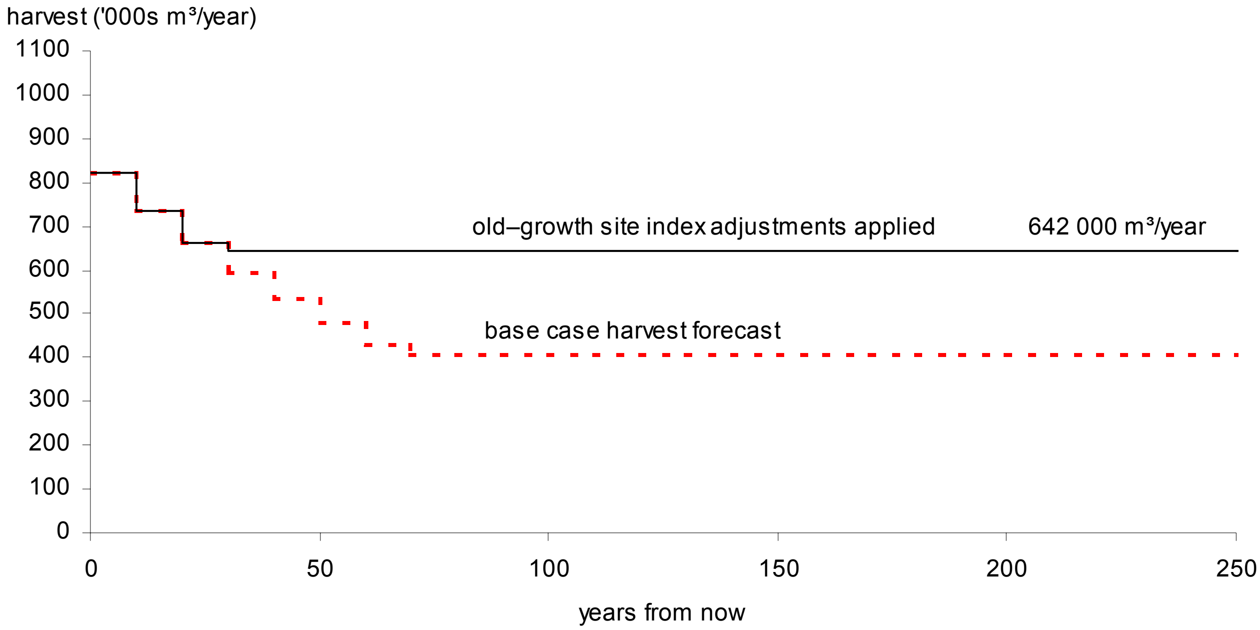

Figure 23. Harvest forecast that includes old-growth site index (OGSI) site index adjustments — Nass TSA base case harvest forecast, 2001.

5.12 Protected area strategy (PAS) study areas

Within the original data file for the Nass TSA, two protected area strategy (PAS) study areas are identified: Damadochax (50 054 hectares) and Hanna Ridge (11 676 hectares). As no decision on these areas had been made at the time of the analysis, these areas are included within the timber harvesting land base of the base case. However, if these areas do gain status as protected areas before the AAC determination, the impact of not including these areas in the timber harvesting land base must be considered. The Damadochax PAS study area is in the Upper Nass zone and is excluded from the timber harvesting land base. The Hanna Ridge PAS study area occupies 2467 hectares of the timber harvesting land base in the base case. Three other PAS study areas are present within the Nass TSA (Kwinageese Outlet, Tintina, Nass-Meziadin Junction), however, information on these areas was not included in the original data file.

This sensitivity analyses removes the Damadochax and Hanna Ridge PAS study areas completely from the timber harvesting land base but allows the areas to contribute to other forest objectives (e.g., landscape-level biodiversity). As the Damadochax PAS study area is within the Upper Nass zone, a further analysis for protected areas is found in Section 6.7 where the Upper Nass zone is included in the timber harvesting land base.

Figure 24 shows that the timber harvest forecasts differ only slightly from the base case harvest forecast and in proportion to the area removed. This reduction is required to address a shortfall of 117 000 cubic metres per year in decade 15 if the base case harvest forecast is followed (not shown).

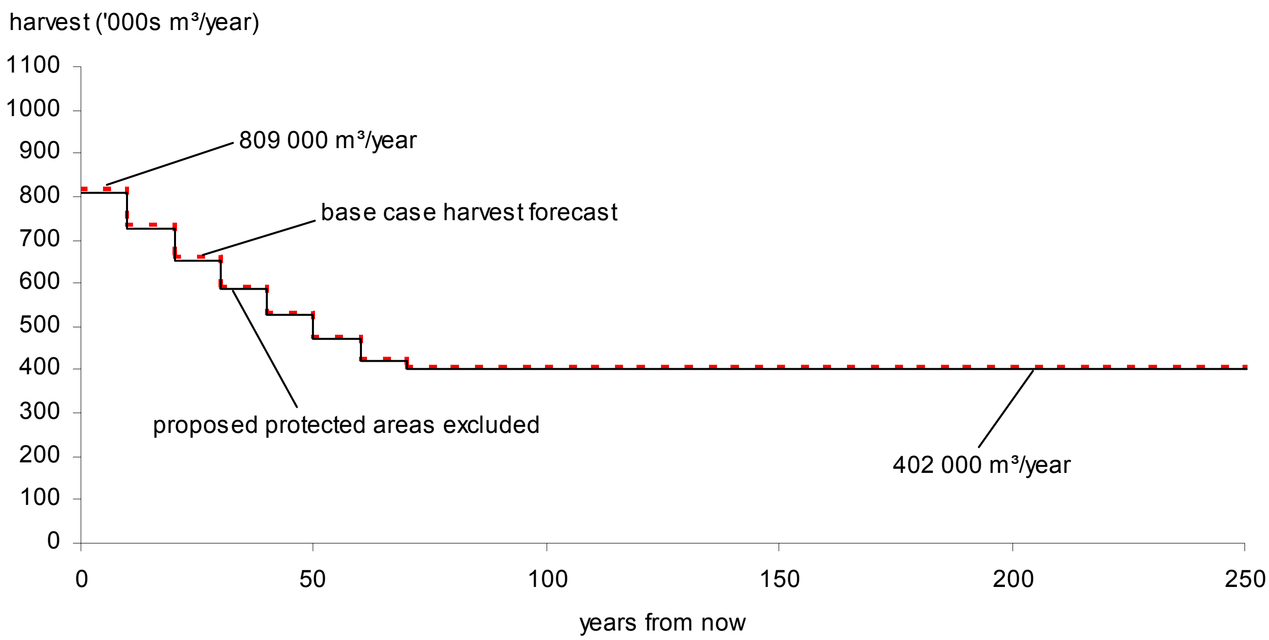

Figure 24. Harvest forecast based on removal of protected study areas — Nass TSA base case harvest forecast, 2001.

5.13 Uncertainty of landscape-level biodiversity methodology

The *Forest Practices Code Act of British Columbia (FPC)* describes the conservation of biological diversity as an essential component of the sustainable use of forests. Landscape-level biodiversity, as addressed in *The Landscape Unit Planning Guide,* has been modelled in this analysis through the use of forest cover requirements* for old-seral forest applied to biogeoclimatic zone/sub-zone/variant types within each landscape unit. The guideline defines the minimum retention percentage of productive forest required and the age of forests that qualify as old. The minimum retention requirements are dependent on an assigned biodiversity emphasis objective (BEO) of the landscape unit. *The Landscape Unit Planning Guide* addresses only old-seral objectives. In the *Biodiversity Guidebook* additional seral objectives were proposed that addressed ranges of early*-, mature*-, and old-seral stages*.

In the Nass TSA, while landscape units have been defined, the BEOs are not yet declared officially (but are expected to be declared this year). As such there is uncertainty about how the recommendations in the *Guidebook* should be interpreted and applied. In areas of the province without declared landscape units and emphasis options, a standard analysis approach has been to model average forest cover requirements, reflecting application of lower emphasis on 45% of the land base, intermediate emphasis on 45%, and higher emphasis on 10%. This approach was applied in the base case harvest forecast of the Nass TSA. Additionally for the base case, the requirements for the low emphasis objectives were allowed to be reduced to one-third with future step ups to the full requirements as per *Incorporating Biodiversity and Landscape Units in the Timber Supply Review*, Ministry of Forests, Timber Supply Branch, 1997.

Sensitivity analysis investigated the implications of applying (1) draft BEOs associated with the landscape units and (2) requirements of minimum retention for old and mature as per the *Biodiversity Guidebook*.

Neither analysis differed in harvest levels from the base case harvest forecast. Draft BEOs have an area weighted distribution of 47% lower emphasis, 49% intermediate emphasis, and 4% higher emphasis on the timber harvesting land base in the base case harvest forecast. The lack of sensitivity reflects both the amount of old forest available in the Nass TSA and, the amount of contributing non-timber harvesting land base. In the base case harvest forecast and this sensitivity analysis the non-timber harvesting land base continues to age without any intervention. Concerns exist that indefinite aging is inappropriate and is investigated in Section 5.17 as a sensitivity issue.

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****).*
Early seral
Stands are defined as early seral if they are younger than 40 years of age. An exception is deciduous-dominated stands in the Boreal White and Black Spruce biogeoclimatic zone, which are defined as early seral up to 20 years of age.

Mature seral
Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.
Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

5.14 Wildlife tree patches

The *Landscape Unit Planning Guide* describes forest practices for maintaining stand structure (e.g., wildlife trees) over time. Forest District staff indicated uncertainty about the percentage of the timber harvesting land base that would be reserved independent of forested land already excluded from harvest (e.g., riparian management zones, low sites, inoperable zones). In the preparation of the data package alternative opinions suggested either that all wildlife tree patch requirements were met from the contributing non-timber harvesting land base or that little is met from the non-timber harvesting land base.

Current practice in the district requires that wildlife tree patches be no more than 500 metres from existing mature forest (i.e., from another wildlife tree patch after the final harvest pass). Wildlife tree patches are also to be represented of the original forest on the cutblock*. Wildlife tree patches have typically been located on the side of a cutblock. However, current documentation of wildlife tree patches in the Nass TSA is limited.

In the base case harvest forecast, it was assumed that all wildlife tree patch requirements (8730 hectares) could be met from the contributing non-timber harvesting land base. Within all landscape units and subzones, the contributing non-timber harvesting land base was at least double the wildlife tree patch requirements.

In this sensitivity analysis, Forest District staff were interested in the impacts of applying (1) the full retention guidelines and (2) a 50% within cutblock retention policy as suggested in *Provincial Wildlife Tree Management Recommendations,* February 2000. The calculation of the percentage of a cutblock required in wildlife retention was based upon *Landscape Unit Planning Guide* Table A3.1 with input of area and harvesting information from the data file used in the timber supply analysis.

For the entire TSA 8730 hectares need to be reserved for wildlife tree patches. Requiring that this full amount be removed from the timber harvesting land base prevents the current base case harvest levels targets from being met. A harvest flow for this scenario results in a reduction of 5% in the long-term harvest level and an adjustment of the mid-term or short-term harvest levels to account for the loss of these lands (Figure 25). Alternatively, if a mid-term level below the long-term level is not desired, the initial harvest level needs to be reduced to 785 000 cubic metres per year with 10% reductions for each of the next six decades until the long-term harvest level is reached (not shown).

Cutblock
A specific area, with defined boundaries, authorized for harvest.

If only 50% of the required wildlife tree patch requirement must be met from the current timber harvesting land base, 4365 hectares need to be reserved. This loss of land base results in a proportionate loss (i.e., 2%) of long-term harvest (Figure 25). Alternatively, if a mid-term level below the long-term level is not desired, the initial harvest level could be reduced to 803 000 cubic metres per year with 10% reductions for each of the next six decades (not shown).

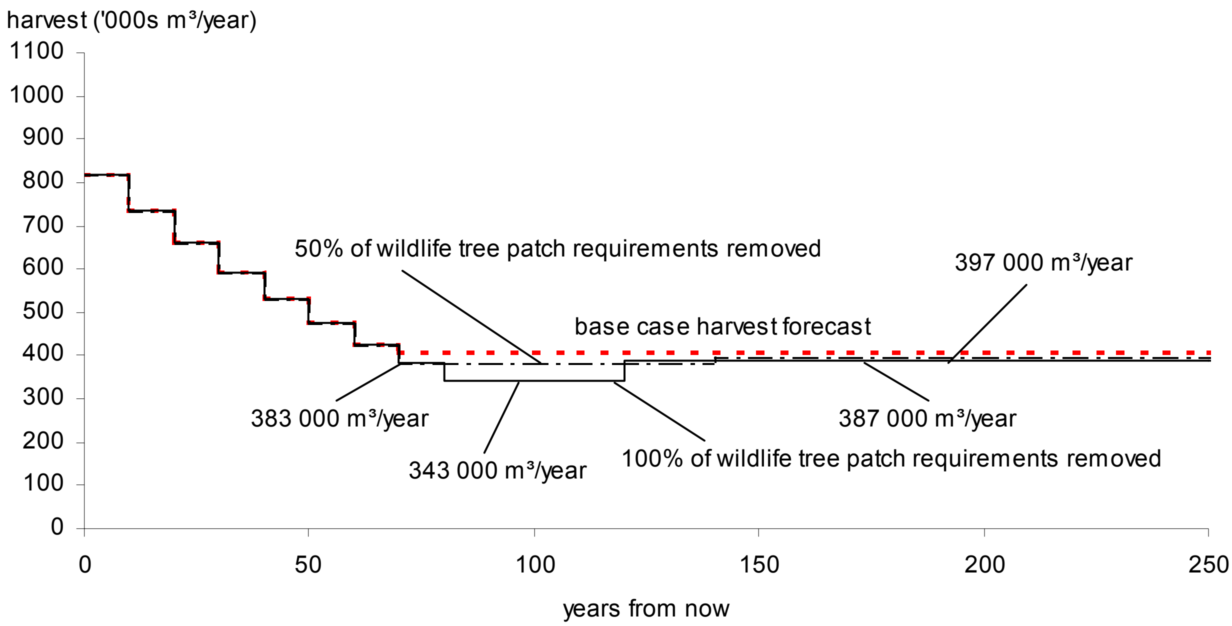

Figure 25. Effect of wildlife tree patch reductions from timber harvesting land base — Nass TSA base case harvest forecast, 2001.

5.15 Low productivity

Sites may have low productivity because of inherent site factors (nutrient availability, exposure, excessive moisture, etc). Forest District staff have concerns that the economic gains from harvesting these sites over the long term may not justify regeneration difficulties and potential environmental concerns. As such, in the base case harvest forecast, all forest stands with a forest cover inventory site index less than nine metres were not considered productive, and therefore were excluded from the timber harvesting land base. To understand the impact of the choice of a site index of nine metres on timber supply, a sensitivity analysis using a lower site index was investigated.

In this sensitivity analysis the site index cut-off was reduced to seven metres which increases the timber harvesting land base by 20 241 hectares (10.7%). The addition of this land base affects most of the model parameters (e.g., yield tables and green-up ages of analysis units). For this analysis, a recalculation was made of all model parameters affected by the addition of the lower site index polygons to the timber harvesting land base except the non-recoverable loss factor of 18 000 cubic metres per year.

Figure 26 shows the lowering of the productivity cut-off results in an increase in available timber flow. As expected the increases are proportionately less than the increase in land base due to the lower volume of stands being included.

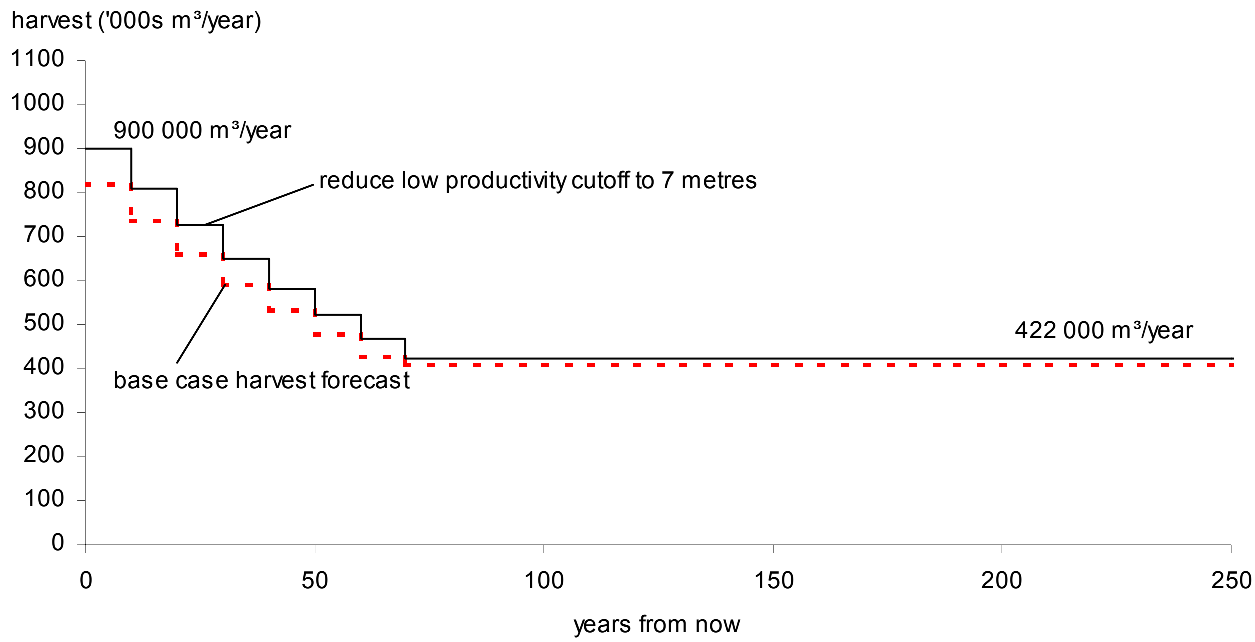

Figure 26. Harvest forecast based on low productivity as a site index of 7 metres rather than 9 metres — Nass TSA base case harvest forecast, 2001.

5.16 Pine mushroom

The pine mushroom (*Tricholoma magnivelare*) is considered the most economically significant mushroom species in the province. The pine mushroom habitat is associated with well-drained, coarse textured and nutrient poor soils under hemlock forests (Northwest Institute 1999). Pine mushroom production is likely best in mature stands, perhaps between 75 to 200 years old.

Within the Nass TSA, prime mushroom producing sites are thought to occur on terrain classified as submesic site series (01b Western Hemlock – Step Moss), in the Interior Cedar Hemlock Zone (ICHmc1). A study of the two primary mushroom producing landscape units estimated that 4.55% of the units (Kinskitch 5.06% and Brown Bear 2.92%) are classified as fully or marginally submesic sites (OESL 2000). For these sites, the regional pedologist requested analysis of a 200 year rotation.

For a this analysis, a 200 year minimum harvestable age was applied to 4.55% (5248 hectares) of the timber harvesting land base in the ICHmc1. All other assumptions about the analysis units associated with this separated area remained the same as the base harvest forecast.

This pine mushroom management objective results in an increase in the minimum harvestable age of all analysis units in the ICHmc1. Attempting to obtain the base case harvest forecasts results in a shortfall of 23 000 cubic metres per year in decade 15 and a slightly decreasing long-term inventory level (not shown). This shortfall can be accommodated by decreasing the initial harvest level by 3000 cubic metres per year and 10% decrease per decade until the long-term harvest level is reached at 404 000 cubic metres per year (Figure 27).

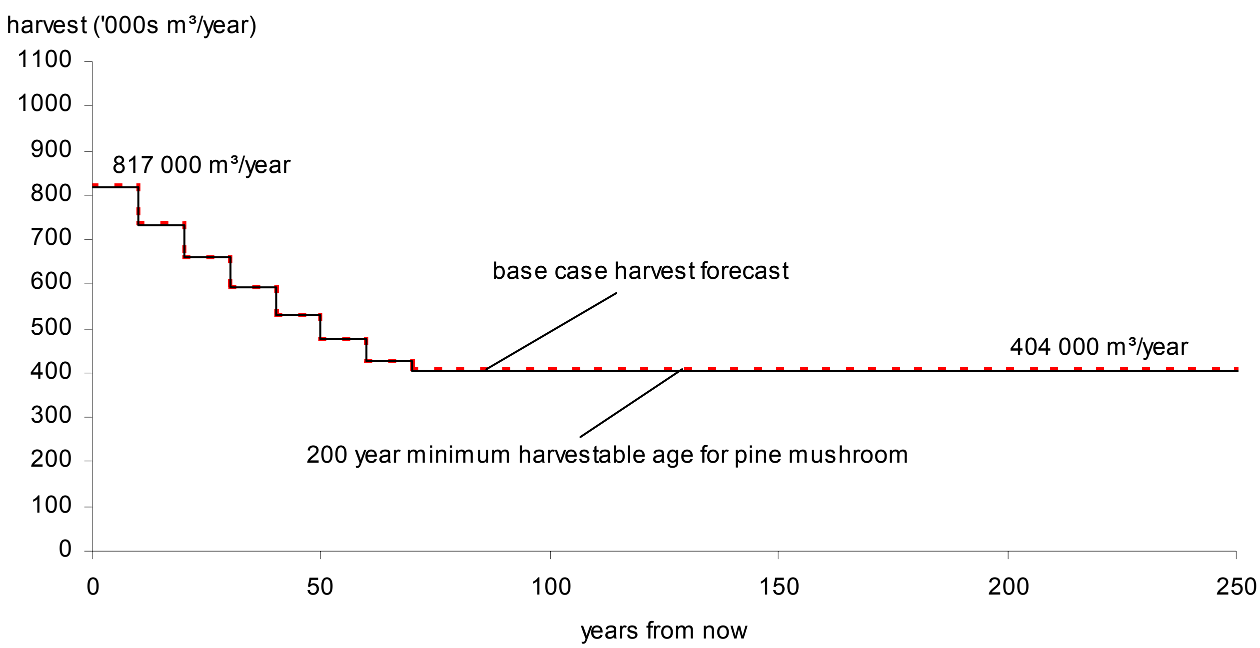

Figure 27. Effect of pine mushroom management — Nass TSA base case harvest forecast, 2001.

5.17 Aging of non-timber harvesting land base

Productive forest lands outside of the timber harvesting land base contribute to management objectives such as landscape-level biodiversity. In the base case, these lands are allowed to age continuously. As such, all contributing non-timber harvesting land base will eventually contribute to meeting management objectives requiring old-seral stands. However, concern exists that natural disturbance will prevent some of the forest from continuing to age.

To investigate the impact of not allowing all the non-timber harvesting land base to age, a sensitivity analysis to model natural disturbance within the non-timber harvesting land base was completed. This analysis involved setting a portion of each biogeoclimatic subzone to age 0 at each time step.

To determine the amount of area to set to age 0, it was assumed that the amount of old seral in each variant reflects the mean natural disturbance return interval of that variant. From the return intervals and the assumption that the cumulative age follows a negative exponential distribution, the rotation age to achieve the desired per cent of the land base in an old-seral stage can be determined (i.e., see *Forest Practices Code Biodiversity Guidebook*, Table A4.2). The area set to zero each year is equivalent to the total contributing non-timber harvesting land base in the variant divided by the rotation age. Table 4 shows the calculated "disturbance" areas used in this analysis.

Table 4. Annual area reverted to age zero in the contributing non-timber harvesting land base.

Variant	Rotation age	Disturbance area (hectares per year)
CWHws2	352	21
ICHmc1	352	256
ICHvc	490	115
SBSmc2	208	154
ESSFwv	397	450

Figure 28 shows that the continual aging of the timber harvesting land base influences the harvest forecast in the long term by 8.6%. The short-term harvest level can be maintained but requires a mid-term harvest level below the long-term harvest level. Alternatively a 16% drop in the initial harvest level is required if the short-term harvest level is to step down to the long-term harvest level.

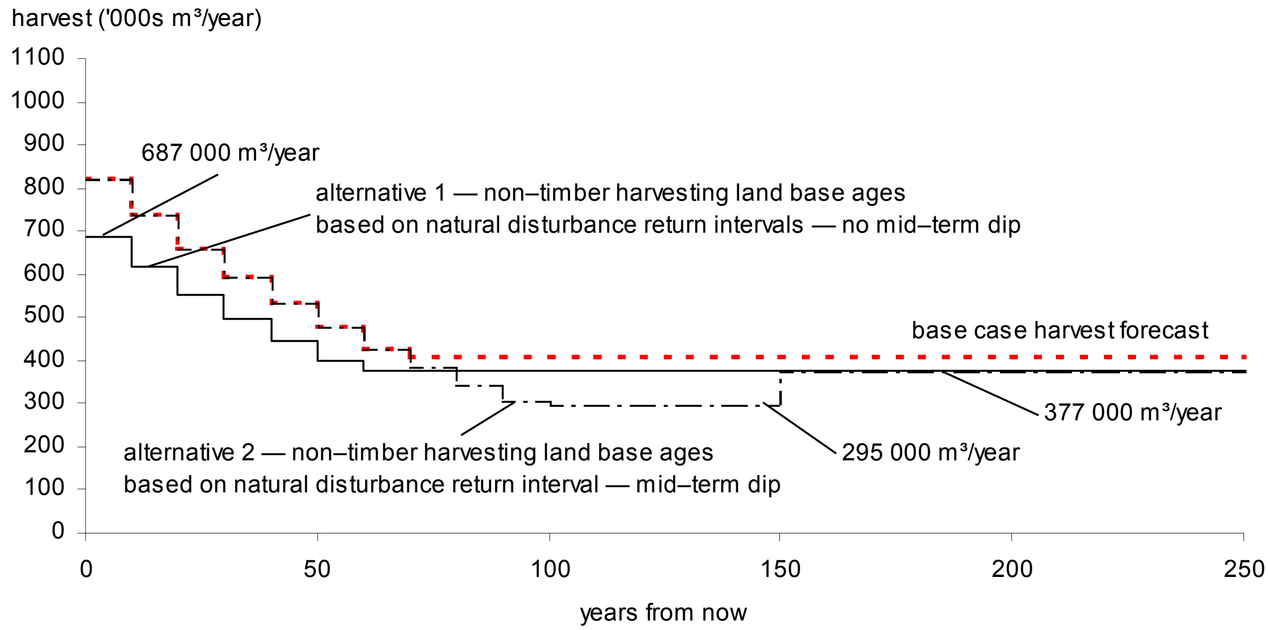

Figure 28. Effect of disturbance in the contributing non-timber harvesting land base — Nass TSA base case harvest forecast, 2001.

6 Critical Issue Analysis

Critical issue analysis is distinguished from sensitivity analysis to highlight the importance of the issue being examined. One critical issue exists for the Nass TSA — whether the Upper Nass zone will contribute to timber supply.

6.1 Upper Nass critical issue analysis

The economic viability of accessing and harvesting in the Upper Nass zone has been questioned. In the 1993 timber supply review of the Nass TSA, the Upper Nass zone was considered to be an operable area but deferred for three decades. In the current timber supply review, the entire Upper Nass zone was excluded from the base case scenario. However, to assess the timber supply impacts of including the Upper Nass zone a critical issue analysis was completed that considered accessing the Upper Nass zone in two decades. This critical issue analysis included investigating several issues related to the zone (i.e., deferral time frames, balsam bark beetle impacts, protected areas strategy proposals) and an abbreviated sensitivity analysis.

This critical issue analysis, that includes the Upper Nass zone, was not done incrementally to the base case analysis. The critical issue analysis involved a recalculation of yield input (volumes, minimum harvestable ages, green-up ages) of forest stands in the Upper Nass zone.

Inclusion of the Upper Nass zone results in an additional 60 117 hectares for a total timber harvesting land base of 249 291 hectares. The non-recoverable loss for fire was increased to 25 000 cubic metres per year to reflect the increased land base.

The criteria for harvest flow of this critical issue analysis was similar to the base case harvest forecast: managing the rate of any changes in harvests, avoiding large and abrupt harvest shortfalls, and maintaining a reasonably constant total growing-stock level over the long term. It was desired that the initial harvest level start as near as possible to the current AAC (1 142 000 cubic metres) with at most step reductions of 10% in harvest per decade and that the mid-term harvest level would not decrease below the long-term harvest level. Alternative harvest flows are presented in Section 6.2.

Figure 29 shows the harvest forecast with the Upper Nass zone included. By not allowing a mid-term dip, the initial harvest level is reduced 7% to 1 059 000 cubic metres per year from the current AAC. The long-term harvest level is 525 000 cubic metres per year. Within this scenario, the harvest forecast reflects the modelled harvest priority of relative oldest stands first after forest management objectives are met. In Sections 6.2 to Section 6.6 sensitivities are compared to this harvest forecast which is labelled as the "Upper Nass included base harvest forecast."

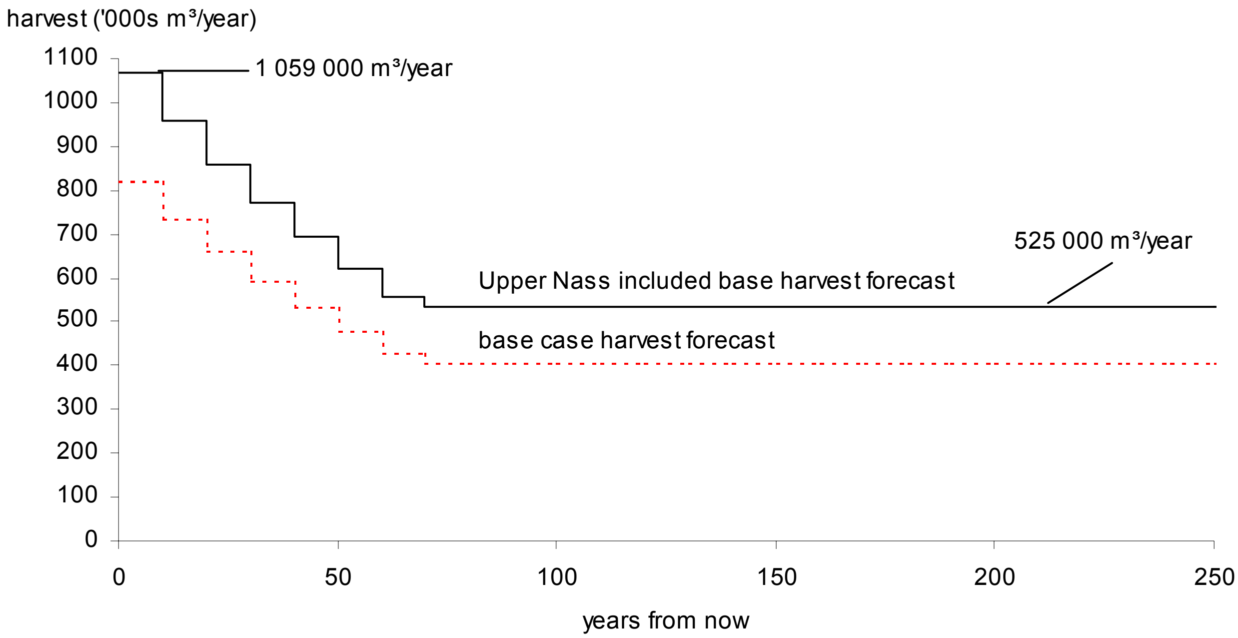

Figure 29. Effect of a 20 year entry deferral for the Upper Nass — Nass TSA Upper Nass included base harvest forecast, 2001.

6.2 Upper Nass — alternatives in harvest flows

The harvest forecast that includes the Upper Nass shown in Figure 29 was defined using criteria that included 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. However, there are many possible harvest flows, with different decline rates, starting harvest levels, and potential trade-offs between short- and long-term harvests.

Figure 30 shows two alternative harvest flows. If a mid-term drop is considered, the current AAC level with subsequent 10% drops to the long-term level could be met. The mid-term dip is 42 000 cubic metres per year above the long-term harvest level forecasted in the timber supply analysis provided for the 1996 AAC determination. Alternatively, the base case harvest forecast initial level of 820 000 cubic metres per year could be maintained for four decades prior to stepping down to the long-term harvest level.

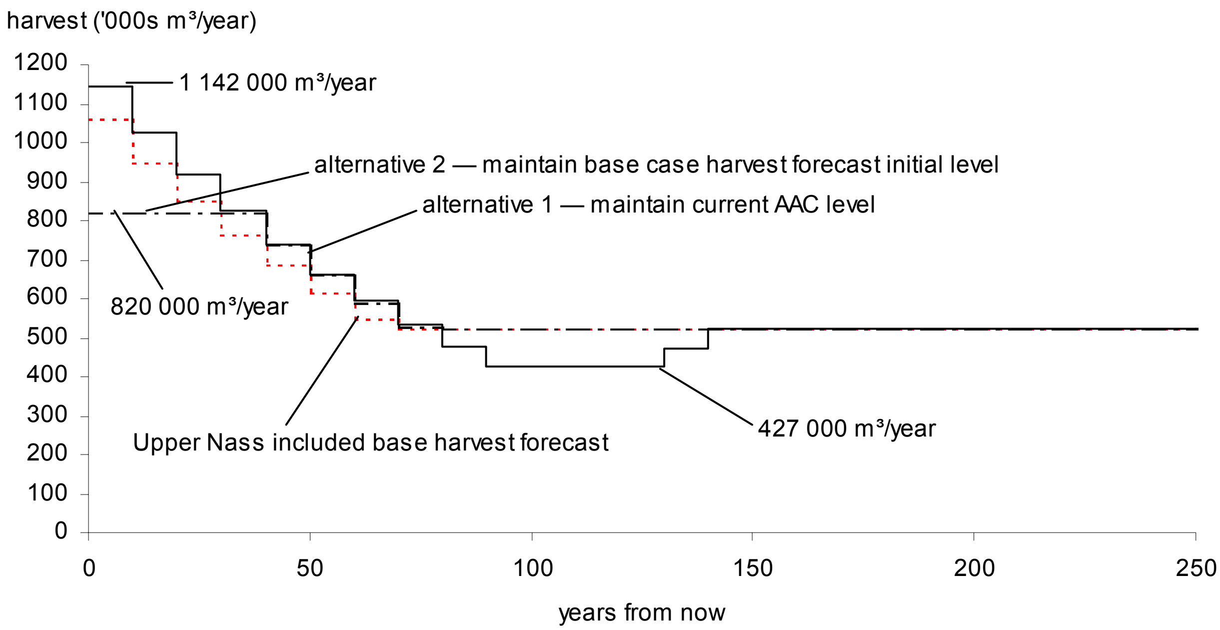

Figure 30. Effect of alternative harvest flows — Nass TSA Upper Nass included base harvest forecast, 2001.

6.3 Upper Nass — uncertainty in deferral time frames

Road access to the Upper Nass zone is not present at this time and timing of access to the Upper Nass zone is unknown. In the 1993 timber supply analysis, access to the Upper Nass was assumed to occur after three decades. In the current Upper Nass critical issue analysis, access was assumed to occur after two decades.

To understand the implications of the timing of access, a sensitivity analysis was completed. In this analysis, the deferral length was increased until an impact on the Upper Nass base harvest forecast was observed.

The analysis found that removing the deferral or increasing the deferral up to four decades is possible with no impact on the overall timber supply forecast. However, if access is delayed, more harvest is concentrated in the Upper Nass zone once access is available.

Growth and yield values were modified for Upper Nass critical issue analysis (i.e., different weighted averages for volumes and ages to green-up height). To determine if the use of these modified values would result in a different harvest forecast than that in the base case, an analysis was completed where no access to the Upper Nass zone was allowed (i.e., harvest was deferred 1000 years). No significant difference in harvest forecast was found in the Upper Nass critical issue analysis with the base case harvest forecast.

6.4 Upper Nass — uncertainty in existing unmanaged stand volumes

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the aerial photo interpretation, derived inventory measurements (e.g., estimated tree heights, stand ages, site indices) and the equations used to predicted forest growth and yield. An audit of the Nass TSA found no significant differences for mature forest between volumes calculated with the VDYP growth and yield model using inventory information and volumes determined with sampled information. While no significant audit volume differences are present, sensitivity analysis on existing stand yields are useful for investigating the constraint dynamics and providing a sensitivity base for other uncertainties that effect existing stand yields (e.g., pest damage effects).

A sensitivity analysis that increased and decreased the volume estimates by 10% for unmanaged stand analysis units was investigated.

Figure 31 shows that the Upper Nass base harvest forecast is sensitive to changes in existing unmanaged stand yields. The harvest forecast in the short term is about 14% higher for a 10% increase in existing unmanaged stand yields and 17% lower for a 10% decrease.

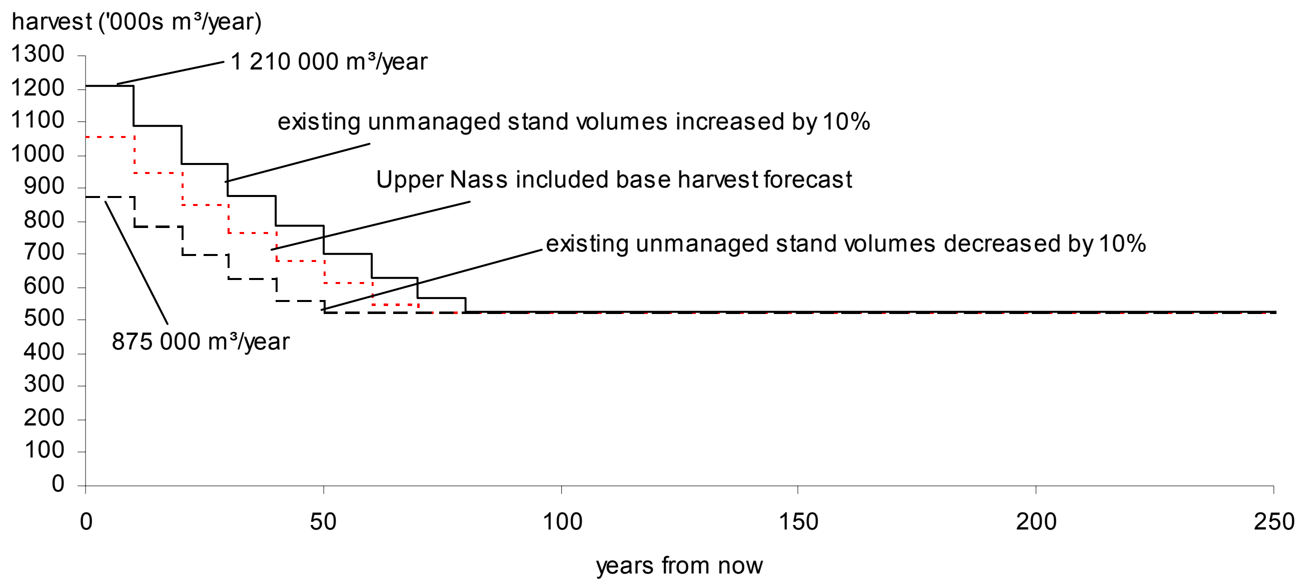

Figure 31. Effect of increasing and decreasing volume estimates for existing stand volumes by 10%— Nass TSA Upper Nass included base harvest forecast, 2001.

6.5 Upper Nass — uncertainty in managed stand volumes

Timber volume estimates for managed stands are subject to uncertainties in inventory information for existing managed stands, site productivity estimates, and the equations used to predict forest growth and yield. Uncertainty exists around site productivity estimates and regeneration assumptions used as input into the TIPSY growth and yield model.

To assess this uncertainty, a sensitivity analysis looked at increasing and decreasing the managed stand volumes by 10%. No other changes to model parameters (e.g., minimum harvestable ages) were considered.

Figure 32 shows that changing managed stand (both existing and future) volumes results in proportionate reduction to the long-term harvest levels while being able to maintain the short-term initial harvest levels.

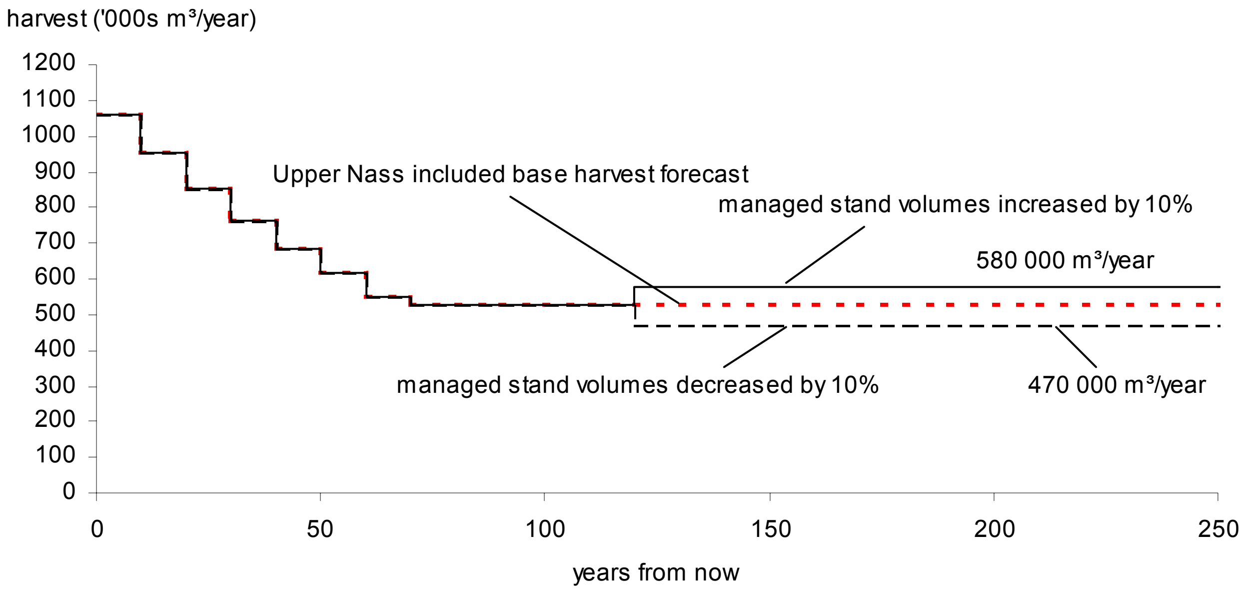

Figure 32. Effect of uncertainty in managed stand volume table estimates — Nass TSA Upper Nass included base harvest forecast, 2001.

6.6 Upper Nass — uncertainty in balsam leading stand volumes

Forests within the Upper Nass zone are dominated by subalpine fir (balsam), which is susceptible to balsam bark beetle attack. Historically, the attack levels have been low. In 1996 satellite imagery indicated that increased balsam mortality was occurring. A January 1998 report estimated that 11% of the subalpine fir were dead or about to die. Overview monitoring flights in 1999 observed that the balsam bark beetle attack was continuing.

In the Upper Nass base harvest forecast, yield estimates and non-recoverable losses were not adjusted for losses due to the balsam bark beetle. In this critical issue analysis the yield estimates were reduced by 20% for those analysis units dominated by balsam in the Upper Nass zone.

Figure 33 shows that the 20% volume reduction impacts the short- and mid-term harvest forecasts. As seen with other sensitivity analysis, a reduction in volume can be accommodated either by lowering the initial harvest level and maintaining the base mid-term level (Alternative 1) or by reducing harvest from the mid-term while maintaining the initial harvest level (Alternative 2).

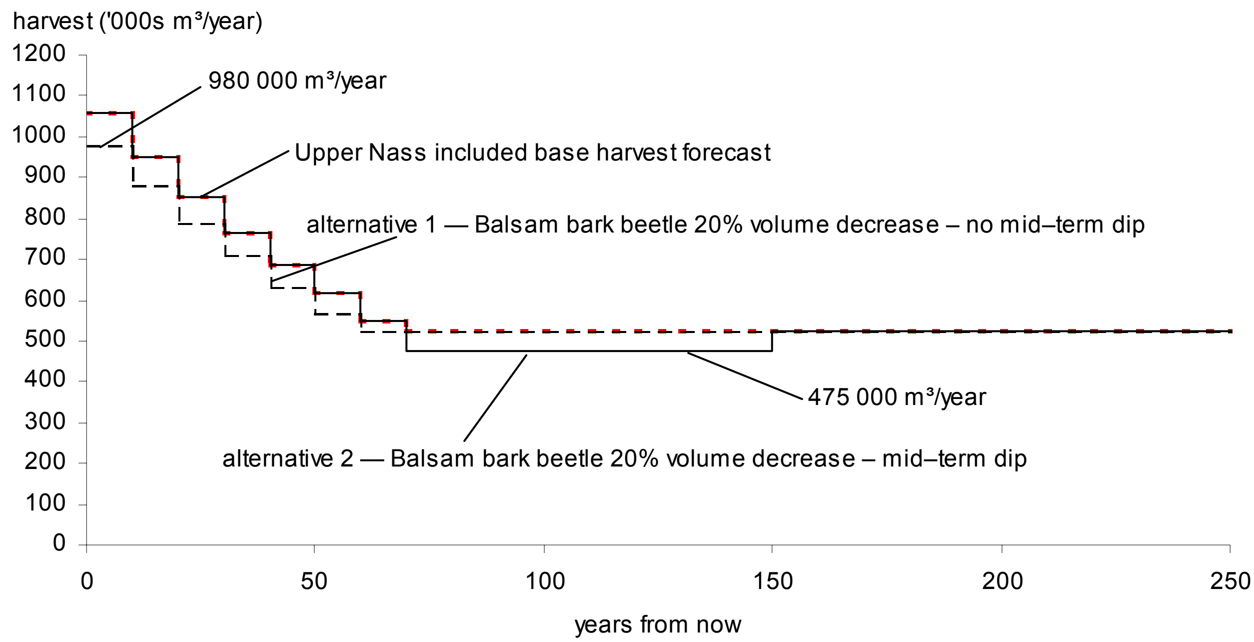

Figure 33. Effect of a 20% reduction in existing unmanaged stand volumes due to balsam bark beetle loses in Upper Nass zone — Nass TSA Upper Nass included base harvest forecast, 2001.

6.7 Upper Nass — protected area strategy (PAS) study areas

Within the Nass TSA, five protected area strategy (PAS) areas are present. The Damadochax PAS study area is predominately found in the Upper Nass of which 13 316 hectares is considered to be in the timber harvesting land base. The Hanna Ridge PAS study area**,** outside of the Upper Nass, has 2467 hectares in the timber harvesting land base. Three other PAS study areas are present within the Nass TSA (Kwinageese Outlet, Tintina, Nass-Meziadin Junction), however, information on these areas was not included in the original data file. As no government decision on these areas had been made at the time of the analysis, these areas are included within the timber harvesting land base. However, if these areas do gain status as protected areas before the AAC determination, the impact of not including these areas in the timber harvesting land base must be considered.

This critical issue analysis removes these protected areas completely from the timber harvesting land base but allows the areas to contribute to other forest objectives (e.g., landscape-level biodiversity). A similar sensitivity analysis was conducted on the base case harvest forecast in Section 5.12.

Transferring these PAS study areas, which are 6.3% of the total timber harvesting land base, to the non-timber harvesting land base, results in an inability to meet the Upper Nass base harvest forecast in decades 14 and 15. Following a harvest flow criteria of not harvesting below the long-term harvest level, results in an initial harvest forecast reduction of 6.3%, proportionate to the area reduction (Figure 34).

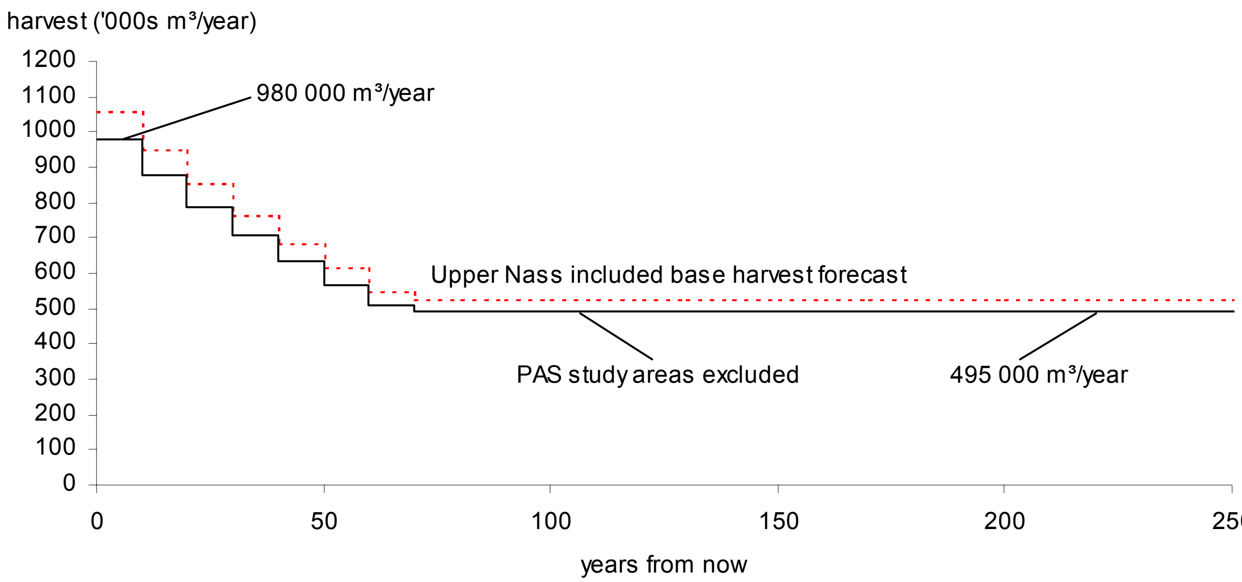

Figure 34. Effect of excluding PAS study areas — Nass TSA Upper Nass included base harvest forecast, 2001.

7 Summary and Conclusions of the Timber Supply Analysis

The results of this timber supply analysis based on current inventory, growth and yield, and forest management information suggests that the current allowable annual cut in the Nass TSA of 1 142 000 cubic metres per year cannot be obtained. Even if the Upper Nass zone is included, the current AAC can only be obtained if the mid-term is allowed to fall below the long-term harvest level. The analysis indicates an initial harvest level of 820 000 cubic metres per year is obtainable for the first decade with subsequent reductions of 10% per decade until a long-term harvest level of 407 000 cubic metres per year is reached. Alternatively, the average 1997 to 2000 actual harvest from the Nass TSA of 553 000 cubic metres per year could be maintained for seven decades before stepping down to the long-term harvest level.

The timber harvest forecast is driven by several factors related to the current inventory, forest management, and modelling assumptions. Table 5 presents a summary of sensitivity and critical issue analyses of the base case harvest forecasts.

In the short- and mid-term the abundance of stands above minimum harvestable age and the large portion of the land base in the integrated resource management zone provides flexibility and stability in the harvest forecasts. This flexibility is shown in the range of alternative harvest flows that balance the initial harvest level and the mid-term harvest levels. If the short- and mid-term are not balanced appropriately the analysis is particularly sensitive around decades 14 and 15 where the harvest is in transition from existing stands to younger previously harvested stands. Harvest forecasts are also greatly influenced by decisions about the land base (especially the Upper Nass zone, and cable operability zone) and are less sensitive in the short term around forest management objectives, such as VQO and wildlife tree patches.

In the long term, the analysis suggests a higher harvesting level than was forecast during the timber supply analysis in 1996. This optimism is primarily the result of improved estimates for managed stand volumes. Further optimism is suggested by studies of site indices of older forests. As with the short- and mid-term, the long-term harvest level is influenced by decisions about land base inclusions.

The analysis suggests that a significant component of the harvest should be from the cable operability zone. In the period 1991 to 1995 harvest records suggest that this was occurring. However, current performance in these cable operability zones is believed to be lower. It is possible to maintain higher harvest levels within non-cable operability zones in the short term but this places greater emphasis on the cable operability zones in the mid term.

Modelling assumptions also influence the harvest forecasts. In particular, the aging of non-timber harvesting land base has an impact on harvest forecasts as does the harvesting rule that harvesting occurs first in available stands that are the oldest relative to their minimum harvestable ages. Both of these uncertainties result in reduced harvest forecasts.

The Upper Nass zone was considered to be excluded from the timber harvesting land base due to the uncertainty in the economics of accessing this zone. This exclusion greatly influences harvest forecasts. Higher short-term harvest levels are possible in zones outside of the Upper Nass if the Upper Nass zone is accessed within four decades and current forest management objectives are assumed. With the Upper Nass included, the current AAC harvest level can be maintained for one decade with stepped reductions down to a mid-term level below the long-term level.

In conclusion, this analysis indicates, based on current inventory, growth and yield, and forest management information, that the current allowable annual cut level is not obtainable. In general, the current abundance of forest above minimum harvestable age enables flexibility of harvest level decisions within the short term. However, the analysis indicates several factors, both from a management and modelling perspective, that have large positive or negative influence on the timber harvest forecasts.

7 Summary and Conclusions of the Timber Supply Analysis

Table 5. Summary of sensitivity and critical issue analyses, Nass TSA, 2001.

	Impact on harvest forecast relative to the base case		
Issue	**Initial level**	**Long term**	**Mid-term level to mitigate initial level decrease**
Random harvest priority	None	5% decrease	
Existing stand volumes increase 10%	12% increase	None	
Existing stand volumes decrease 10%	16% decrease	None	25% lower
Managed stand volumes increased 10%	None	10% increase	
Managed stand volumes decreased 10%	None	10% decrease	
Land base increased 10%	8% increase	6% increase	
Land base decreased 10%	10% decrease	10% decrease	33% lower
Minimum harvestable volume decreased by 50 cubic metres	2% increase	1% increase	
Minimum harvestable volume increased by 50 cubic metres	16% decrease	< 1% decrease	25% lower
Visual quality objective (VQO) maximum disturbance increased above guideline range	1% increase	1% increase	
VQO maximum disturbance decreased to mid-guideline range	3% decrease	None	6% lower
Integrated resource management (IRM) maximum disturbance decreased 15%	38% decrease	< 1% decrease	Not feasible
IRM maximum disturbance increased 15%	None	None	
Time to green-up height decreased 10 years	2% increase	None	
Time to green-up height increased 10 years	4% decrease	1% decrease	Not feasible

(continued)

Note: Only harvest forecasts that step down to the long-term harvest level are reported. For issues where an initial harvest level decrease is reported but the initial base case harvest forecast could be obtained under an alternative harvest forecast, the low point of an alternative mid-term in harvest forecast is reported.

Table 5. Summary of sensitivity and critical issue analyses, Nass TSA, 2001 (concluded)

	Impact on harvest forecast relative to the base case		
Issue	**Initial level**	**Long term**	**Mid-term level to mitigate initial level decrease**
Cable operability zone decreased 20%	7% decrease	7% decrease	25% lower
No harvesting in cable operability zone	39% decrease	35% decrease	Not feasible
Old-growth site index adjustment	None	58% increase	
Protected area strategy	1% decrease	1% decrease	6% lower
Draft biodiversity emphasis options (BEO) applied	None	None	
Mature- and old-seral requirements applied	None	None	
Wildlife tree patch 50% of requirements met on timber harvesting land base	2% decrease	4% decrease	7% lower
Wildlife tree patch 100% of requirements met on timber harvesting land base	5% decrease	6% decrease	16% lower
Low productivity stands cut-off at site index of seven metres	10% increase	4% increase	
Pine mushroom management	< 1% decrease	1% decrease	< 1% lower
Aging of contributing non-timber harvesting land base set to natural disturbance rate	16% decrease	7% decrease	28% lower
Upper Nass zone included in timber harvesting land base	28% increase	28% increase	

8 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the Timber Supply Review. This socio-economic analysis compares the level of forestry activity currently supported by the timber harvested from the Nass TSA to the level of activity that could be supported according to the forecasts presented in the timber supply analysis.

The socio-economic analysis examines the base case harvest forecast, which best represents current forest management practices; consequently, the socio-economic analysis does not evaluate alternative management scenarios.

The socio-economic analysis includes:

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

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Nass TSA within the context of regional timber supplies and production capacity. The profile of the regional and local forest industry is described, and employment and income impacts associated with three main sectors — harvesting and other woodlands-related, processing, and silviculture — are estimated. Employment is measured in terms of 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 figures were calculated using the Nass 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 the indirect and induced impacts.

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

> ***Person-year(s)***
> *One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.*
> ***Employment multiplier***
> *An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.*

8.1 Current socio-economic setting

8.1.1 Overview

The socio-economic analysis focuses on the timber supply from the Nass TSA, a relatively remote area in the north-west portion of the province. The TSA is part of the larger Kalum Forest District which also contains the Kalum TSA and Tree Farm Licences 1 (Skeena Cellulose Inc.) and 41 (West Fraser Mills Ltd.). The Nass TSA comprises approximately 1.6 million hectares.

8.1.2 Population and demographic trends

Apart from logging camps, the Nass TSA is sparsely populated. The total permanent population of the TSA is about 2,000 people.

A local feature of the Nass TSA is the highway junction of Highway 37 and 37A at Meziadin Lake. Stewart, located about 60 kilometres west of the junction, is the closest commercial, administrative and retail centre for the area. Highway 37 and 37A, which were constructed in the 1960s, provide access to tidewater at Stewart for the Cassiar asbestos mine and an important link between central B.C. and Alaska.

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

8 Socio-Economic Analysis

Through a special partnership with the "Nisga'a House of Learning," Northwest Community College provides opportunities for post-secondary education to the people in the Nass Valley. Various programs are offered including career and college preparation in Lax Galts'ap (Greenville) in the adjoining Kalum TSA.

8.1.3 Economic profile

The Nass TSA is not well diversified and is heavily dependent on the forest industry. Figure 35 illustrates the shares of total employment by industry sector for the Nass portion of the Kalum Forest District. Total employment is only about 400 positions. Commercial harvesting of pine mushrooms is an important "underground" economy in the area. Pine mushrooms are generally harvested in the fall. The mushrooms are most often found growing in old western hemlock and lodgepole pine forests in the area's river valleys. In 1994, about 160 000 kilograms of pine mushrooms worth an estimated $4.2 million were harvested in the area. Employment opportunities also arise from the area's Meziadin fishway, one of the Northwest's major sockeye producers, and a number of gold and copper properties and mineral processing in and around Stewart.

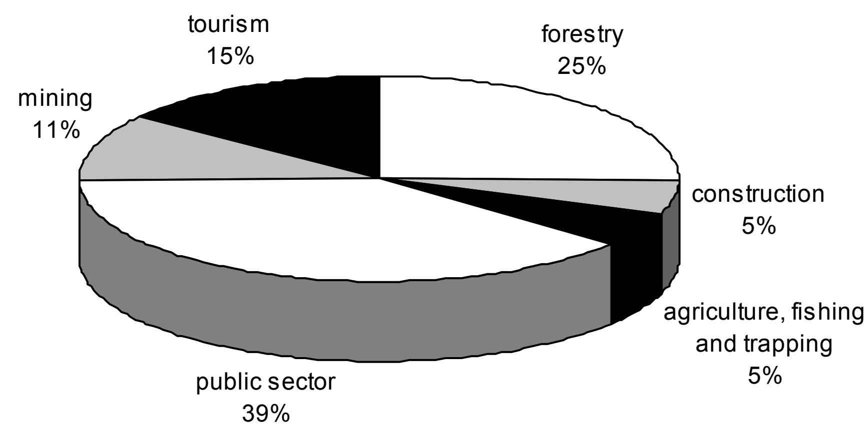

Figure 35. Total employment by industry sector, 1996.

Note: The figures are for the Nass portion of the Kalum Forest District. Percentages reflect direct, indirect, and induced employment supported by the basic sector*. "Other" (basic sectors) consist of some manufacturing, and transportation.

Source: The 1996 Forest District Tables, B.C. Ministry of Finance and Corporate Relations.

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

In addition to direct forestry sector employment, the forest sector also supports numerous other jobs in the region through companies and employees purchasing goods and services from local businesses. This spending is another indicator of the role forestry has in the economy. Each 100 direct forestry jobs in the Nass TSA are estimated to support a further 20 to 30 indirect and induced jobs*[1], depending on the type of forestry activity (logging or processing) and the associated level of income. In comparison, each 100 tourism jobs support only 10 to 15 additional positions.

8.2 Nass TSA forest industry

8.2.1 Current allowable annual cut

The current allowable annual cut (AAC) for the Nass TSA is 1 142 400 cubic metres, a decline of 9% from the previous level of 1.25 million cubic metres. The AAC is apportioned into a number of licence types as outlined in Table 6. There are four replaceable forest licences in the TSA, which account for about 78% of the total AAC. The remainder is apportioned among smaller forest licences and other forms of tenure including the Small Business Forest Enterprise Program (SBFEP).

Table 6. Allowable annual cut apportionment, Nass TSA

Licence types	Volume (m^3/year)	Per cent (%)
Forest licences — replaceable	892 031	77.6
Forest licences — non-replaceable	62 469	5.4
Small Business Forest Enterprise Program (SBFEP)	184 000	16.0
Forest Service Reserve	11 500	1.0
Total	1 150 000	100.0

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

Note: This apportionment has not yet been updated to reflect the current AAC of 1 142 400 cubic metres.

8.2.2 Recent harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity in the area. If actual annual harvest levels are consistently less than the AAC, then economic activity is less than the TSAs full potential. A persistent gap between actual and allowable harvest activity will influence the potential short-term impacts of changes to the AAC.

Table 7 summarizes the volume of timber harvested in the Nass TSA from 1997 to 2000. It indicates a fairly steady profile over the last three years, taking into account provisions for cut control[2] that allow licensees to vary their harvest levels based on operating and market conditions.

(1) Ibid.

(2) A licensee's harvest may differ from the AAC by up to 50% on an annual basis, although the average harvest must be within 10% of the AAC over each five-year period.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Over the last four years, about 553 000 cubic metres of Crown timber were harvested annually from the Nass TSA. Additional (non-TSA) sources of timber include private lands, Indian Reserves, TFL 41 (West Fraser Mills Ltd.), and TFL 1 (Skeena Cellulose Inc.). During the year 2000, the Nass TSA harvest contributed about 8% to the total volume harvested in the Prince Rupert Forest Region (7.9 million cubic metres) while the region in turn, accounted for about 11% of the total provincial crown harvest (68.9 million cubic metres).

Table 7. AAC and volumes billed by licence type, Nass TSA, 1997-2000

	(Cubic metres per year)				
Type of licence	**1997**	**1998**	**1999**	**2000**	**Average 1997-2000**
Forest licences	198 141	173 612	363 731	429 411	291 224
Small Business Forest Enterprise Program (SBFEP)	184 668	374 449	322 147	152 791	258 514
Other[a]	4 112	1 047	4 015	5 344	3 630
Total	386 921	549 108	689 893	587 546	553 367
AAC for Nass TSA	1 150 000	1 150 000	1 150 000	1 142 400	

Source: Ministry of Forests.

(a) Other consists of cutting permits such as right-of-way and road permits.

8.2.3 Nass TSA major licensees

West Fraser Mills Ltd.

West Fraser Mills Ltd. (West Fraser) has a replaceable forest licence to harvest 232 484 cubic metres per year in the Nass TSA. West Fraser has numerous other tenures throughout the province and is British Columbia's fourth largest licence holder at 4.0 million cubic metres per year. Table 8 outlines West Fraser's recent harvest activity in the TSA and the year 2000 direct employment statistics.

West Fraser has interests in 10 sawmills in the province that produce dimension lumber and by-product wood chips: Quesnel, Williams Lake, Smithers, Chetwynd, Fraser Lake, Terrace, Prince Rupert, Blue Ridge, Houston and Burns Lake.

8 Socio-Economic Analysis

West Fraser's Terrace mill employs about 250 people. Economic conditions are difficult for the mill due to the predominance of poor quality logs, which are often located in areas with high logging costs due to difficult terrain. While West Fraser's operations in the Nass TSA have the potential to contribute to Terrace facilities' requirements, the volume has not been significant in the last four to five years.

Table 8. West Fraser's harvest and direct employment statistics

Licence AAC	232 484 cubic metres
2000 harvest	116 543 cubic metres
1997-2000 average harvest	116 304 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	36

Note: The employment figures relate to the volumes harvested from the Nass TSA land base only.

Orenda Logging Ltd.

Orenda Logging Ltd. (Orenda) a wholly owned subsidiary of Skeena Cellulose Inc. has been involved in logging operations in northwestern British Columbia since 1986. The company holds a replaceable forest licence to harvest 298 908 cubic metres per year in the Nass TSA. Stewart is the major coastal shipping point for most of this timber, which is destined for coastal markets and other provincial processors. Table 9 outlines the company's recent harvest activity and year 2000 direct employment statistics.

Table 9. Orenda's harvest and direct employment statistics

Licence AAC	298 908 cubic metres
2000 harvest	116 141 cubic metres
1997-2000 average harvest	46 499 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	36

Note: The employment figures relate to the volumes harvested from the Nass TSA land base only.

Buffalo Head Forest Products Ltd.

Buffalo Head Forest Products Ltd. (Buffalo Head), a wholly owned subsidiary of Skeena Cellulose Inc., has a replaceable forest licence to harvest 314 640 cubic metres per year in the Nass TSA. Over the past few years, Buffalo Head has harvested considerably less than this level. As with Orenda, a significant portion of the Buffalo Head harvest is destined for coastal markets, and/or the Skeena Cellulose facility in Prince Rupert. Table 10 outlines Buffalo Head's recent harvest activity and year 2000 employment levels in the Nass TSA.

Table 10. Buffalo Head's harvest and direct employment statistics

Licence AAC	314 640 cubic metres
2000 harvest	196 727 cubic metres
1997-2000 average harvest	98 759 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	59

Note: The employment figures relate to the volumes harvested from the Nass TSA land base only.

Sim Gan Forest Corporation

Sim Gan Forest Corporation (Sim Gan) manages a replaceable forest licence allowing the harvest of 45 999 cubic metres per year in the Nass TSA. Sim Gan, a First Nations and Interpac Forest Products Ltd. joint venture, operates a logging camp, an office and a dryland sort in the TSA. Table 11 summarizes the harvest activity and employment associated with Sim Gan's operations in the TSA.

Table 11. Sim Gan's harvest and direct employment statistics

Licence AAC	45 999 cubic metres
2000 harvest	0 cubic metres
1997-2000 average harvest	29 661 cubic metres
Direct employment (person-years) in 2000	
Harvesting, silviculture and administration	0

Note: The employment figures relate to the volumes harvested from the Nass TSA land base only.

Other licensees

Other licensees in the Nass TSA are mainly comprised of Small Business Forest Enterprise Program participants with a total AAC apportionment of 184 000 cubic metres. From 1997 to 2000, these licensees harvested an average of 258 000 cubic metres per year, which support about 215 direct harvesting, silviculture and processing person-years.

Table 12. SBFEP harvest and direct employment statistics

Licence AAC	184 000 cubic metres
2000 harvest	152 791cubic metres
1997-2000 average harvest	258 514 cubic metres
Direct employment (person-years)	
Harvesting, silviculture and administration	94

Note: The employment figures relate to the volumes harvested from the Nass TSA land base only.

8.2.4 Forest sector employment summary

In this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forest sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log salvage and log scaling, and planning;
- silviculture activity including all planting and other basic and intensive operations; and,
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and in close to the same proportions.The silviculture sub-sector is also linked to the current level of harvest, however since silviculture activities occur up to six years after harvesting the link is less immediate. Silviculture activity is divided into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced, or intensive silviculture includes spacing, fertilizing, and pruning*. In the Nass TSA, licensees are responsible for basic silviculture on areas harvested under forest licences.

Primary timber processing employment

There are no timber processing facilities located within the TSA. All timber harvested in the area is shipped to sawmills or pulp mills in the Terrace, Prince Rupert and Hazelton, or exported to U.S. or Asian markets.

Forest Service employment

The Nass TSA is administered by the Kalum Forest District office in Terrace. Currently, about 65 people work in the district office, which oversees the management of the Nass TSA, Kalum TSA, TFL 1, and TFL 41. Since Forest Service activities are related more to the administration and enforcement of government policy than to the timber harvest level, these jobs are not included in the analysis of forestry sector impacts. Ministry employees are, nevertheless, an important part of total employment in the TSA and are accounted for in the public services component of the TSA's economic base.

> ***Pruning***
> *The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.*

8 Socio-Economic Analysis

Forestry employment and employment coefficient

Table 13 summarizes employment supported by the 1997-2000 average harvest in the Nass TSA, and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

- TSA employment and employment coefficients, which comprises residents of the Nass TSA who are employed as a result of the Nass TSA harvest, and
- Provincial employment and employment coefficients, which comprise all forest sector employment in the province that relies on the Nass timber supply; including both residents of the Nass TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forest sector within the Nass TSA and to highlight the contribution that the Nass TSA's forest sector makes to the provincial economy.

The average annual harvest from the timber supply area from 1997-2000 was 553 000 cubic metres, 48% of the current AAC of 1 142 400 cubic metres.

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

Table 13. Employment and employment coefficients, Nass TSA

	Within TSA		Provincial	
Forest sector activity	**Employment (person-years)**	**Coefficients (person-years per '000s m³)**	**Employment (person-years**	**Coefficients (person-years per '000s m³)**
Harvesting and silviculture	50	0.09	201	0.36
Processing	26	0.05	260	0.47
Total direct	76	0.14	461	0.83
Indirect + induced	21	0.04	549	0.99
Total employment	97	0.18	1,010	1.82

Note: Employment estimates are person-years based on average 1997-2000 employment levels and the average 1997-2000 harvest of 553 000 cubic metres. Person-years do not indicate individual jobs. Wood products transport, and road building and maintenance are included in indirect estimates.

8.2.5 Forest sector employment income

During the period 1997 to 1999, the average annual income for direct forest sector employees was approximately $48,100 and for indirect and induced employees was $30,700 (in 1999 dollars). Based on these averages, current harvesting, silviculture, and processing of timber from the Nass TSA generates an estimated $22.6 million in direct wages and salaries and $14.1 million in indirect and induced wages and salaries, annually throughout the province (see Table 14).

Table 14. Average annual total employment income, Nass TSA 1997-2000

	Average annual income (1999 dollar value)	**Total annual income ($ millions)**	**Total income ($ per '000s m³)**
Direct	48,100	22.6	40,850
Indirect / induced	30,700	14.1	25,500
Total income		36.7	66,350

Source: Statistics Canada, Survey of Employment Payrolls and Hours, 1997-2000 data.

8.2.6 Provincial government revenues

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

Between 1997 and 2000, average stumpage and rent payments for Crown timber in the Nass TSA were approximately $3.7 million per year. Forest and corporate taxes and revenues generated $4.1 million, while employment supported by the Nass timber harvest accounted for $3.4 million in provincial income taxes (see Table 15).

Table 15. Average annual provincial government revenues, 1997-2000

	Average annual revenue 1997-2000 ($1999 thousands)	**Average annual revenue 1997-2000 ($ per '000s m³)**
Stumpage, rents and royalties[a]	3,675	6,650
Forest industry taxes[b]	4,100	7,400
Provincial income tax[c]	3,375	6,100
Total government revenues	11,150	20,150

(a) Ministry of Forests, Revenue Branch.

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

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

8.3 Socio-economic implications of the base case harvest forecast

The base case harvest forecast shows a potential decline from the current AAC to 820 000 cubic metres per year, and then further declines of 10% per decade until the long-term harvest level of 407 000 cubic metres is reached in about six decades. The socio-economic analysis on the base case harvest level considers:

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

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing, and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the magnitude of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture, and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

Table 16 presents estimates of the range of impacts the base case harvest forecast may have on employment and income. Ranges are utilized to reflect the availability of employment insurance and social assistance payments, and their mitigating effects on labour mobility in the shorter term. The lower end of the range reflects induced impacts which are diminished in the short term, because employment insurance and social assistance provide income support to displaced workers who might otherwise enter or leave the region. The upper end of the range represents long-term impacts when new workers do enter or leave the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers accessing social assistance payments, some finding temporary employment in the region and some leaving or moving to the area permanently — is more likely to occur.

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

Nass TSA employment and income impacts

For accounting purposes, TSA employment and income includes only that of workers who are supported by the TSA harvest and who reside within the TSA. The Nass TSA has very few permanent residents. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Nass TSA timber processed at mills outside the TSA. Table 16 indicates the employment and income that could be supported within the Nass TSA by the base case harvest forecast. If fully harvested and processed, the base case harvest level of 820 000 cubic metres would support 144 person-years of direct employment and another 31 indirect and induced person-years of employment within the timber supply area. About $5.3 million (1999 dollar value) of total local after-tax annual income would be supported by the Nass timber supply. There are no timber processing facilities within the Nass TSA.

Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Nass TSA. Assuming the base case harvest level of 820 000 cubic metres per year is fully harvested and processed, the Nass TSA can support at least 683 person-years of direct forestry employment and a further 815 person-years of indirect and induced employment across the province. These levels of employment would be an increase of approximately 490 person-years over the employment levels supported by the average 1997-2000 harvest activity.

Provincial government revenue impacts

Based on current tax and stumpage rates, a fully utilized harvest level of 820 000 cubic metres per year has the potential to provide approximately $16.5 million annually to the provincial government (1999 dollar value), an increase of $5.3 million annually from recent levels (assuming current taxation and stumpage rates do not change).

Table 16. Socio-economic impacts of the Nass TSA base case forecast

			Base case harvest forecast	
	Current AAC	Actual harvest (average 1997-2000)	Initial forecast 0-10 years	Mid term 41-50 years
Timber supply ('000s m³)				
Annual harvest levels	1 142 400	553 000	820 000	538 000
Change from actual levels			+ 267 000	– 15 000
Nass Timber Supply Area				
Employment		(person-years)		
Direct	157	76	113	74
Indirect/induced	43	21	31	20
Total	200	97	144	94
Cumulative change in total person-years			41 – 52	(6) – 1
Employment income		($ 1999 millions)		
Direct	5.3	2.6	3.8	2.5
Indirect/induced	1.0	0.5	0.7	0.5
Total	6.4	3.1	4.6	3/0
Cumulative change in total income			1.4 – 1.6	(0.2) – 0.0
Province (includes Nass TSA)				
Employment		(person-years)		
Direct	953	461	683	448
Indirect/induced	1,138	550	815	535
Total	2,091	1,011	1,498	983
Cumulative change in total person-years			353 – 621	(116) – 60
Employment income		($ 1999 millions)		
Direct	33.6	16.3	24.1	15.8
Indirect/induced	26.9	13.0	19.3	12.6
Total	60.5	29.3	43.3	28.4
Cumulative change in total income			10.9 – 17.3	(2.9) – 1.3
Provincial government revenues		($ 1999 millions)		
Provincial income tax	7.0	3.4	5.0	3.3
Stumpage and rent	7.6	3.7	5.4	3.6
Other B.C. revenues	8.5	4.1	6.1	4.0
Total B.C. revenues	23.1	11.2	16.5	10.8
Cumulative change in total revenue			5.1 – 5.7	(0.5) – (0.1)

Notes: Provincial employment includes both Nass TSA employment and employment supported outside the TSA by Nass TSA harvested timber.

Income figures in Table 14 are gross income.

The ranges for employment and income changes take into consideration employment insurance and other social assistance programs. The range's upper limit is based on the assumption that all those who are unemployed are instantly mobile. The lower limit is based on the assumption that employment insurance and other social assistance payments will reduce the induced impacts of a change in harvest level.

8.3.2 Community level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region the less effect changes in any one sector will have on the regional economy. Centres that rely on Nass' timber supply include Stewart, Terrace, Hazelton, Kitwanga (Kitwangak), and Kitwancool (Gitanyow).

Given that the Nass timber supply provides about 25% of the basic employment in the TSA, and over 25% of the regional timber supply (Nass, Kalum and Kispiox TSAs, and TFLs 1 and 41), changes to the AAC would be expected to have an impact on the overall economic trends of the region. However, it is anticipated that in the short term at least, the Nass TSA base case forecast which reflects a 28% reduction (1.142 million cubic metres to 820 000 cubic metres per year) will not have a significant impact. Recent actual harvest levels in the TSA have been considerably lower (48%) than the current AAC. Over the longer term it seems likely that spin-off activities relying on primary forestry, although remaining significant, will become less dominant as timber supplies decline.

8.3.3 Nature, production capabilities, and timber requirements of processing facilities

The potential decline in the Nass TSA timber supply from 1.142 million cubic metres to 820 000 cubic metres should not have a significant effect on regional processing activity. Hazelton, Prince Rupert and Terrace mills secure timber supply from throughout the Prince Rupert Forest Region (TSAs include Nass, Kalum, Kispiox, North Coast, Bulkley, and Morice). The impact on regional mills is dependent on all of these TSAs, as well as adjacent TFLs.

8.3.4 Regional timber supply implications

In the Prince Rupert Forest Region, the previous timber supply review led to a reduction in the coniferous AAC of 6.8%, or about 600 000 cubic metres. In two to three decades, the annual timber supply from the region may fall by another 5.0% or about 400 000 cubic metres per year. However, this outlook may change as each successive timber supply review will re-examine the timber supply in the region.

Mill level impacts in the region will occur both as a result of changes in the volume of timber harvested from the Nass TSA as well as from harvest changes that occur in other regional TSAs and TFLs. It is impossible to predict however which mills and TSAs will be most affected, or if new "value-added" operations will enhance and/or mitigate regional timber supply changes.

The only trend that seems clear is that over the long term, economies that rely on primary forestry, although remaining significant, will become less dominant as timber supplies decline, local economies diversify and in the face of mounting environmental pressures.

8.4 Summary

The forestry sector is an important source of employment and income for the Nass TSA. The current AAC for the Nass TSA is 1 142 400 cubic metres. If the AAC is fully harvested and processed, it can support approximately 953 person-years of direct employment across the province and a further 1,138 indirect and induced jobs.

The initial base case harvest forecast for the Nass TSA indicates that the timber supply could decline to 820 000 cubic metres per year. This level could decrease the total employment potential by about 593 person-years; of which about 45% would be direct forestry jobs. Even at this lower projected level, the resulting employment (1,498 person-years) would still be about 50% above the average levels experienced during 1997 to 2000.

In about five decades, the base case harvest level is projected to decline to about 538 000 cubic metres per year. At this level, the resulting potential employment should be approximately 983 person-years; similar to the levels experienced during 1997 to 2000.

9 References

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10 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest — for example, by species, site productivity, silvicultural treatment, age, and or location — done to simplify analysis and generation of timber yield tables.
Base case harvest forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Basic sector	Sectors of the economy, such as forestry, tourism and mining, that create flows of income into the region and are assumed to be drivers of the local economy. Non-basic sectors, such as retail outlets, are supported by basic sectors.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic subzone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Clearcut harvesting	A harvesting method in which all trees are removed from an area of land in a single harvest. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding. Note that retention of some live trees and snags for purposes of biodiversity now occurs on most clearcuts.
Clearcutting with reserves	A variation of the clearcut silvicultural system in which trees are retained, either uniformly or in small groups, for purposes other than regeneration.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cultural heritage resource	An object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to the province, a community or an aboriginal people.

10 Glossary

Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees shed their leaves annually and commonly have broad-leaves.
Drainage	The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.
Early seral	Stands are defined as early seral if they are younger than 40 years of age. An exception is deciduous-dominated stands in the Boreal White and Black Spruce biogeoclimatic zone, which are defined as early seral up to 20 years of age.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Employment multiplier	An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, impediments to establishing a new tree crop, or high risk of avalanches.

10 Glossary

Forest cover objectives	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**).
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**).
Forest inventory	An 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 other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
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 (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. 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.

10 Glossary

Higher level plans | Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Higher level plans	Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed 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 objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Mature seral	Forest stands with trees between 80 and 120 years old, depending on species, site conditions and biogeoclimatic zone.

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

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

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Modification VQO
Visible alterations may dominate the landscape, but should blend with natural features. Up to 25% of the visible area can be altered by harvesting activity (see **Visual quality objective**).

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas subject to less frequent stand-initiating disturbances usually have more older forests.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

Old seral
Old seral refers to forests with appropriate old forest characteristics. Ages vary depending on forest type and biogeoclimatic variant.

Operability
Classification of an area considered available 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 may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).

Person-year(s) — One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Preservation VQO — Alterations are generally not visible. Up to 1% of the visible landscape can be visibly changed by harvesting activity. (see **Visual quality objective**).

Protected area — A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Pruning — The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Regeneration delay — The period of time between harvesting and the date at 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.

Scenic area — Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

Sensitivity analysis — A process used to examine how uncertainties about data and management practices could affect timber supply. Inputs to an analysis are changed, and the results are compared to a baseline or base case.

Seral stages — Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

10 Glossary

Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
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.
Table Interpolation Program for Stand Yields	A B.C. Forest Service computer program used to generate yield projections for managed stands based on interpolating from yield tables of a model (TASS) that simulates the growth of individual trees based on internal growth processes, crown competition, environmental factors and silvicultural practices.
Timber harvesting land base	Crown forest land within the timber supply area where timber harvesting is considered both acceptable and economically feasible, given objectives for all relevant forest values, existing timber quality, market values and applicable technology.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	An empirical yield prediction system supported by the B.C. Forest Service, designed to predict average yields and provide forest inventory updates over large areas (i.e., Timber Supply Areas). It is intended for use in unmanaged natural stands of pure or mixed composition.

10 Glossary

Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (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.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

This appendix describes inventory and forest management information and the interpretation of that information to construct the base case harvest forecast for the Nass TSA timber supply analysis.

The base case harvest forecast represents current forest management and available inventory knowledge in the Nass TSA. Current forest management is defined as set of land-use decisions, forest legislation, and forestry practices currently implemented and enforced. In the absence of clear definition of certain practices (e.g., assignment of biodiversity emphasis objectives) provincial policy as related to timber supply modelling may be applied. Future management objectives or practices not yet implemented and enforced at the time of the analysis are not included in the base case harvest forecast.

Uncertainty about some of the inventory and forest management information and its interpretation exists. To understand the effects of this uncertainty, sensitivity analysis (i.e., looks at change in specific information) are conducted. The Kalum Forest District also wished to explore specific inventory and forest management issues, these issues are addressed as separate sensitivity analyses.

Further detail on the determination of the timber harvesting land base, forest management assumptions, and the modelling approach is available in the May 2000, *Nass Timber Supply Area Timber Supply Review Data Package*. Information in the data package may be superceded by information in this appendix.

A.1 Inventory Information

Table A-1. Inventory and related research information

Data	Source	Vintage	Update	Scale
Forest cover	Ministry of Forests (MoF) standard inventory file			
Original inventory		1973	N/A	1:20 000
Re-inventory		1990	Continuous from 1990 to 1997	1:20 000
Environmentally sensitive areas	MoF standard inventory file	1973 and 1989	N/A	1:20 000
Operability				
Upper Nass	MoF standard inventory file	1997	N/A	1:20 000
Nass/Bell Irving area		1989	N/A	1:20 000
Biogeoclimatic ecosystem classification (BEC)	MoF standard inventory file	1988	N/A	1:50 000
Recreation inventory	MoF standard inventory file	1995	1998	1:50 000
Visual quality objectives	MoF standard inventory file	1995	1998	1:50 000
The following inventories are all Nass TSA non-standard inventory files:				
Nisga'a Lands, as identified by Nisga'a Final Agreement map	MoF Aboriginal Affairs Branch	1998	N/A	1:20 000
Riparian buffer mapping	MoF District	1999	N/A	1:20 000
Draft landscape unit boundaries	MoF District	1999	N/A	1:20 000
Hemlock looper zones	MoF District	1997	1999	1:50 000
Pine mushroom site analysis	MoF Region	1999	N/A	1:15 000

Inventory and related research information used to develop the base case timber supply model for the Nass TSA timber supply review that was presented in May 2000, *Nass Timber Supply Area Timber Supply Review Data Package* is repeated in Table A-1. Data associated with these inventories were combined by the Kalum Forest District into a single data file (dated 27-September-1999) for timber supply analysis. Modifications of information in this data file and qualifications of the descriptions for these inventories are discussed below.

A.1 Inventory Information

Forest cover

The first inventory of the Nass TSA was conducted in 1973. In 1990, a re-inventory was conducted within the Nass and Bell Irving River systems, which is the area of current harvesting. The only portion of the 1973 inventory that still applies is in the Upper Nass and inoperable areas west of Meziadin and Bowser Lakes.

The inventory is updated for documented changes such as harvesting and fires. However, the forest cover inventory had not been updated for much of the harvest information in 1997 and 1998. Harvested lands (4136 hectares) were identified through silvicultural records, however, original forest polygon numbers for these harvested lands were not available. To account for this harvest an equivalent area of the oldest stands corresponding to mapsheet number and biogeoclimatic ecosystem classification (BEC) variant were reassigned to managed stand analysis units with the appropriate regeneration delay.

A timber supply area boundary adjustment occurred after the creation of the 1999 data file. Neither the data file nor the timber harvesting land base were corrected to account for these adjustments. Separate information summaries on these changes (see Section A.7), in addition to land base sensitivity analyses, will be presented to the chief forester for the determination of the allowable annual cut.

Operability

For further information, see Section A.2.6.

Biogeoclimatic ecosystem classification (BEC)

The biogeoclimatic ecosystem classification is used to describe many forest management objectives. Biogeoclimatic ecosystem classification to the variant level is available for the Nass TSA. However, the 1999 data file did not include biogeoclimatic ecosystem classification information for mapsheet number 104A005. This information was obtained from Ministry of Forests, Research Branch and merged into the data file.

The Ministry of Forests' regional forest ecologist identifies that the biogeoclimatic ecosystem classification in the Nass TSA requires revision. It was identified that more CWH and MH are present than on existing maps. As no revised mapping was available, existing mapping was applied as the best available information.

Recreation inventory

The Nass TSA recreation inventory has three components: (1) the recreation feature inventory; (2) the visual landscape inventory; and (3) the recreation opportunity spectrum. The recreation inventory was completed in 1995, with a minor update in 1998. The Forest District recently discovered that some of the recreation inventory has been deleted from digital files. The magnitude of the problem is small, as the problem maps are located adjacent to district boundaries in remote areas with little recreation or VQO objectives.

Visual quality objectives (VQO)

For further information see Section A.3.3.1.

A.1 Inventory Information

Nisga'a lands

The effective date of the Nisga'a Treaty was 11 May 2000. Lands identified in the Nisga'a Final Agreement as present in the 1999 data file were excluded from the timber harvesting land base. These lands are no longer Crown forest land managed by the Ministry of Forests.

Riparian buffer mapping

Riparian reserves and management zones are implemented to protect riparian resources in the Nass TSA. Current mapping of these zones is not available. For timber supply analysis, the amount of area in riparian reserve and management zones was determined based on a sample of representative mapsheets. Map information from these sample mapsheets was not directly incorporated into the 1999 data file. See Section A.2.11 for details on how forest management objectives for riparian areas were incorporated into the timber supply analysis.

Draft landscape unit boundaries

The 1999 data file had incomplete landscape unit designation information. Where the landscape unit designation was missing, it was assigned only for stands within the productive land base. The designation was based on the following rule set: (1) if the resultant polygon is on a mapsheet with only one landscape unit identified, all resultants were assigned the landscape unit; (2) if more than one landscape unit is on a mapsheet and if a landscape unit can be identified for another resultant polygon with the same forest cover polygon, the resultant polygon with missing information was assigned that landscape unit; and (3) if there are more than one landscape units on a mapsheet and no similar forest cover polygon identification with landscape unit, then the landscape unit with the closest sequential forest cover polygon identification was assigned.

Hemlock looper zones

Information on Hemlock looper impacts from satellite imagery were incorporated into the data file as an overlay of the impacted zones (Kwinageese River area, Taylor River area high attack area, Taylor River area moderate/low attack areas).

Pine mushroom site analysis

No specific inventory information on pine mushroom habitat suitability was incorporated into the data file. Information on pine mushroom forest management was incorporated as sensitivity analysis.

A.2 Definition of the Timber Harvesting Land Base

The timber harvesting land base for the Nass TSA is determined by separating out categories of land that do not contribute to timber harvesting. This section outlines the steps used to identify the timber harvesting land base (the productive forest expected to support timber harvesting) within the Nass TSA. Land may be unavailable for timber harvesting for three principle reasons:

- it is not administered by the British Columbia Forest Service for timber supply (e.g., Nisga'a Lands, other private land, parks);
- it is not currently suitable for timber production; and
- it is required for other forest values.

Any area in which some timber harvesting will occur remains in the timber harvesting land base, even if the area will be subject to stringent constraints. Any such constraints are reflected in the analysis. Nevertheless, area may be removed from the timber harvesting land base for modelling purposes to reflect forest management objectives that are best modelled as a land base removal.

After all areas that do not contribute to the timber harvesting land base have been excluded, the resulting productive forest land base is defined as the "current timber harvesting land base" for the Nass TSA. Areas that are not within the current timber harvesting land base but contribute to meeting other management objectives (e.g., old-seral requirements) are classified as "contributing non-timber harvesting land base."

In the following descriptions of the timber harvesting land base, specific reference is made to variables defined within the 1999 timber supply analysis data file. Variables are described in detail on the Ministry of Forests Resources Inventory Branch forest cover relational data dictionary at ***http://www.for.gov.bc.ca/resinv/reports/Rdd/search/rddseaan.htm*.**

A.2.1 Land not administered by the B.C.F.S. for timber supply

Ownership codes within the Ministry of Forests forest cover inventory identify whether the land can be considered to contribute to timber supply. In the Nass TSA, only lands with ownership codes that indicate Crown land in a forest management unit (owner= 62C, 69C) are included in the timber harvesting land base. All areas with other ownership codes were removed from the timber harvesting land base.

The Nisga'a Treaty, effective date 11 May 2000, resulted in 28 754 hectares of land that are not Ministry of Forest managed Crown lands. This area identified by the Nisga'a Agreement-in-Principle (AIP) boundaries (AIP="IN") in the data file (i.e., area may differ slightly in other summaries) are excluded from the timber harvesting land base.

The above excluded areas are also excluded from the contributing non-timber harvesting land base.

A.2.2 Land classified as non-forest

Lands that fall under the categories of alpine areas, rock and ice, lakes, swamps and rivers do not contribute to timber supply and are excluded from the timber harvesting land base. These excluded areas were identified within the Ministry of Forests forest cover inventory as non-forested (typid_pr=6). Areas where no typing is available (typid_pr=8) were also excluded.

The above excluded areas are also excluded from the contributing non-timber harvesting land base.

A.2 Definition of the Timber Harvesting Land Base

A.2.3 Non-commercial cover

Areas occupied by non-commercial brush species are considered to be unlikely sites for timber production and are excluded from the timber harvesting land base. These areas are identified within the Ministry of Forests forest cover inventory file as N.C (non-commercial) (typid_pr=5).

In the base case timber supply model area labelled as non-commercial cover was also excluded from the contributing non-timber harvesting land base. Uncertainty exists in forest management objectives for seral stage distribution whether this land should be excluded from the contributing non-timber harvesting land base.

A.2.4 Roads, trails and landings

The Forest District determined that there were 1343 hectares of existing roads within the productive land base of the Nass TSA. As this information is not location specific, an equivalent amount of area was proportionately removed from all polygons identified as logged (activity="L" or activ2="L" or active3="L") in the productive (typid_pr={6,8} excluded) Crown lands and those areas that were later assigned to a logged status to account for an incomplete updating of logged stands in 1996-1998. This translated to a 2.9% area reduction for each resultant in the logged areas. A further 4% of harvested lands was believed made unproductive due to landings. As such 4% was assigned to these areas for landings. Thus, the total reduction to the lands identified as logged was 6.9% which results in an area reduction of 2962 hectares in the current timber harvesting land base when applied to those areas identified as assigned as logged.

Existing roads removed at this step do not include roads that were identified as separate polygons and removed as non-productive forest. The 1343 hectares of existing roads also included Nisga'a Treaty Lands on which the 2.9% calculation was based. It is assumed that the removal of the Nisga'a Treaty Land from the timber supply area does not affect this general road per cent (i.e., the density of roads on Nisga'a Treaty Lands was not significantly different than other roaded areas).

The method used for road allocation biases the reduction to previously logged lands and does not distribute any of the road reduction to other polygons through which roads may have occurred for access.

For future roads, trails, and landings, 7% of the land base is estimated to be lost for each cutblock of an existing stand at the time in which those blocks are initially harvested. The land base reduction occurs throughout the modelling time frame in which existing forest is harvested.

A.2.5 Not satisfactorily restocked (NSR) lands

The Ministry of Forests forest cover inventory identify areas that are not satisfactorily restocked (NSR). These lands, identified below, include both areas that are expected to be restocked and those that are not expected to be restocked. Lands that are not expected to be sufficiently restocked are excluded from the timber harvesting land base.

Lands that were excluded are as follows:

1. Area identified as old burn is excluded from the timber harvesting land base. These are polygons labelled as NSR (typid_pr=4 or 9) with a history record of fire (activity="B") that occurred over 30 years ago (50<actyear<70).
2. Area that has not been restocked for 30 years is excluded from the timber harvesting land base. These are polygons labelled as NSR (typid_pr=4 or 9) that occurred over 30 years ago (50<actyear<70).
3. NSR area (typid_pr=4) that had no history information was to be removed from the timber harvesting land base. However, the Forest District was able to provide supplementary information on all these polygons and no such area was removed.
4. In the file there are 2891 hectares of NSR land (typid_pr=4) that has no date information available. These lands were removed from the timber harvesting land base. For future analysis it is recommended that the Forest District update the history information on these polygons. Of these lands 824 hectares would have be included in the timber harvesting land base other than for their designation as NSR.

All area excluded above were included in the contributing non-timber harvesting land base. These areas were assigned a stand age of zero. As age is a criteria for non-timber forest management objectives (e.g., old-seral requirements), the influence of these lands should be monitored.

A.2.6 Areas considered inoperable

Operability is based on the presence or absence of physical barriers or limitations to harvesting, applicable logging methods (e.g., cable), and the merchantability of stands. Two operability inventories will be applied: (1) a 1997 operability study for the Upper Nass; (2) a 1989 operability study for the entire Nass TSA except the Upper Nass. Table A-2. lists the codes used to identify area excluded from the timber harvesting land base due to operability considerations.

Table A-2. Description of inoperable areas

Inventory description	Code	Reduction per cent (%)
Operability label inoperable	I	100
Operability label not reported	N	100

A.2.7 Sites with low timber growing potential

Sites may have low productivity 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. Forest District staff have concerns about the benefits of harvesting these stands given other forest management objectives (e.g., environmental values). All forest cover inventory stands with an indicated site index (height @ 50 years) less than 9 metres (site_idx<=9) were removed from the timber harvesting land base.

A.2.8 Environmentally sensitive areas (ESA)

Some forest land is environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory as environmentally sensitive areas (ESAs). The ESA system uses the following classification: sensitive soils (Es); forest regeneration problems (Ep); snow avalanche risk (Ea); recreation value (Er); wildlife habitat (Ew); watershed concerns (Eh); and fisheries (fisheries symbols). With the exception of avalanche and fisheries, two ESA categories are recognized: high and moderately sensitive. For abbreviation purposes these are coded as 1 and 2 respectively and appended to the ESA class (e.g., Es1 is a highly sensitive soil ESA).

ESAs may result in a reduction in the harvesting opportunities. As such in the timber supply analysis, per cent area reductions were applied to account for such opportunity loss. Operationally, the strategy for management of an area identified as environmentally sensitive might involve an onsite evaluation for harvesting opportunities.

Table A-3. identifies the proportion of areas in each ESA category where harvesting is not expected to occur. For ESA soil classifications, the Prince Rupert Forest Region research geomorphologist reviewed the ESA soil classifications on 10 randomly selected Nass TSA forest cover mapsheets. For highly sensitive Es terrain a 100% reduction factor was recommended whereas for moderately sensitive Es a 50% reduction was recommended to account for the observed terrain features which may preclude harvesting.

A.2 Definition of the Timber Harvesting Land Base

Table A-3. Description of environmentally sensitive areas and associated timber harvesting land base reduction

ESA category	ESA description	Reduction per cent (%)
Es1	Extreme soil sensitivity	100
Es2	Moderate soil sensitivity	50
Ew1	High wildlife importance	100
Ew2	Moderate wildlife importance	50
Er1	High recreation value	100
Er2	Moderate recreation value	50
Ep1	Severe regeneration problem	100
Ep2	Moderate regeneration problem	50
Ea	High avalanche problems	100
Ec	High management difficulties	100
Eh1	High water quality values	100

A.2.9 Problem forest types (PFT)

Problem forest types are stands that are physically operable and exceed low site criteria yet are not currently utilized, have marginal merchantability, or are avoided due to regeneration difficulties. In the Nass TSA the problem forest types that are excluded from the timber harvesting land base are listed in Table A-4.

Table A-4. Problem forest types criteria

Category	Inventory type group itg	Age class agecl_pr	New stocking class stkcl_pr	Crown closure class crncl_cl	Reduction per cent (%)
Small stems	9-26		2		100
Open stands		> = 4		00, 01, 02, 03	100
Deciduous	35-42				100
Pine	28-31		3, 4		100

A.2.10 Looper – 100% reduction

In the Taylor zone (identified by zone='B'), hemlock leading ITG={12,13,14,15,16,17} stands in mapsheet "104A027") are assumed to be unsalvageable given current access (May 2000*, Nass Timber Supply Area Timber Supply Review Data Package*) and an expected regeneration strategy was not available. These stands were excluded from the timber harvesting land base.

A.2.11 Riparian areas

The Nass TSA does not have a completed stream inventory and classification. In order to consider riparian areas appropriately, the riparian reserve and management areas (*Forest Practices Code Riparian Management Area Guidebook*) were determined for a sample of 12 representative forest cover mapsheets from three geographic zones. For each variant in a geographic zone the percentage that the riparian management zone occupies was excluded from the timber harvesting land base (Table A-5.). This reduction was proportionate to the area of each resultant polygon. The three geographic zones were identified due to differing amounts of streams, wetlands and lakes within each geographic zone: southwest lower Nass zone (loc=SW); southeast lower Nass zone (loc=SE); north Bell Irving zone (loc=UP).

Table A-5. Riparian reserve and management zone reductions

Data file identifiers		
Zone	**BEC variant**	**Reduction per cent (%)**
Southeast lower Nass	EssFwv	2.8
	ICHmc1	3.8
	AT, ESSFmc, MHmm1	2.8
Southwest lower Nass	ESSFwv	0.4
	ICHmc1	1.6
	ICHvc	2.4
	AT, ESSFmc, MHmm1	0.4
Bell Irving	ESSFwv	1.4
	ICHvc	2.7
	SBSmc	4.9
	AT, ESSFmc, MHmm1	1.4

A.2 Definition of the Timber Harvesting Land Base

A.2.12 Exclusion of specific, geographically defined areas

Four areas in the Nass TSA received special consideration with respect to timber harvesting land base reductions.

- Meziadin and Bowser Lake — Most of the area west of Meziadin and Bowser Lakes is excluded from the timber harvesting land base due to inoperability, environmental sensitivity and presence of unmerchantable forest types. Only a small scatter amount of area remains in the timber harvesting land base. However, given the small size and accessibility, the remaining area is uneconomical to harvest, and was excluded from the timber harvesting land base. All area that was present in mapsheets within the area west of Meziadin and Bowser Lakes were excluded from the timber harvesting land base (map_no ='103P081', '103P082', '103P083', '103P091', '103P092', '104A001', '104A002', '104A011', '104A012', '104A021', '104A022', '104A031,', '104A041', '104B019', '104B020', '104B029', '104B030', '104B039', '104B040', '104B050', '104B060', '104B070', '104B080', '103O090', '103O100', '104B010', '104B049', '104B059', '104B079').
- UREP — One UREP (Use, Recreation, Enjoyment of the Public) map notation (owner=61C) occurs within the Nass TSA. This UREP surrounds Bear Glacier and Strohn Lake. A portion of the UREP area may become a Class A Provincial Park, as outlined in the Nisga'a Final Agreement. The UREP area is dominated by ice fields and alpine forests. There are no current or proposed logging operations within the UREP area. As such, the Kalum Forest District believe that if any productive forest existed within the UREP, it would not be desirable to harvest. Thus, the UREP area was excluded from the timber harvesting land base.
- Upper Nass — The economic viability of harvesting the Upper Nass zone has not been proven. As such the Kalum Forest District has decided to exclude the Upper Nass zone from timber harvesting land base of the base case harvest forecast (zone="A").
- Kwinageese integrated resource management (IRM) — Forest practices in the Kwinageese IRM zone exceeds the requirements of the *Forest Practices Code*. Specific information to include in the current analysis was unavailable. However, Forest District staff believed that the area netted out during the 1993 timber supply analysis for the Kwinageese IRM zone (February 1993*, Kalum North Timber Supply Analysis*) reflects the current management practices. The amount of area removed from the timber harvesting land base (e.g., for riparian) in the current timber supply analysis totalled less than the amount of area removed in the 1993 timber supply analysis. As such, to meet the 1993 expectations an extra 372 hectares was removed from the timber harvesting land base in the Kwinageese management zone. To obtain this amount 2.3% was removed from each polygon in the timber harvesting land base of the Kwinageese zone after all other land base deductions had been made.

A.2.13 Wildlife tree patches (WTP)

The *Landscape Unit Planning Guide* describes forest practices for maintaining stand structure (e.g., wildlife trees) over time. Forest District staff indicated uncertainty about the percentage of the timber harvesting land base that would be reserved independent of land already excluded from harvest (e.g., riparian management zones, low sites, inoperable zones). In the preparation of the data package alternative opinions suggested either that all wildlife tree patch requirements were met from the contributing non-timber harvesting land base or that little is met.

In the base case, it was assumed that all wildlife tree patch requirements could be met from the contributing non-timber harvesting land base. In all landscape units and subzones, the contributing non-timber harvesting land base was at least double the wildlife tree patch requirements.

A.2.14 Cultural heritage resources

Cultural heritage assessments, including an archaeological overview inventory and traditional use studies on defined geographic areas, are used for operational forest planning. Operational forest plans have thus far avoided archaeological site conflicts without any timber supply impacts. No reductions of the timber harvesting land base were applied for cultural heritage resource reductions.

A.3 Forest Management Assumptions

A.3.1 Harvesting

A.3.1.1 Utilization levels

Utilization levels define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species (Table A-6.) used to calculate merchantable volume tables as described in Sections A.5 and A.6.

Table A-6. Utilization levels

Species	Utilization levels		
	Minimum dbh (cm)	**Maximum stump height (cm)**	**Minimum top dib (cm)**
All	17.5	30	10

A.3.1.2 Volume exclusions for mixed species stands

Deciduous species in predominantly coniferous stands are unmerchantable and are not harvested in the Nass TSA. This unharvested portion was removed from the estimated merchantable volume tables as described in Sections A.5 and A.6.

Table A-7. Volume exclusions for mixed species types

Inventory type group	Species	Volume exclusion (%)
All coniferous leading	Deciduous	100

A.3.1.3 Minimum harvestable age derivation

The minimum harvestable age is the time required for a stand to grow to a harvestable size. Minimum harvestable ages are minimum criteria required within the timber supply model FSSIM. While harvesting may occur in stands at the minimum age to meet forest level objectives (e.g., maintaining overall harvest levels for a short period of time, or avoiding large changes in harvest levels), most stands will not be harvested until past their minimum age.

In the Nass TSA minimum harvestable ages were determined by setting a minimum harvest volume requirement. Forest District staff believe the minimum net merchantable harvest volume within the Nass TSA is 300 cubic metres per hectare. Minimum harvestable age for each analysis unit based on 300 cubic metres per hectare is reported in the yield tables of Sections A.5 and A.6. As the timber supply analysis was conducted in 10-year steps and volumes reported as such, the minimum harvestable ages are reported at 10-year intervals.

A.3.1.4 Harvest scheduling priorities

Harvest profile restrictions were not be applied. Local mills are adapted to utilize the Nass TSA forest species profile which is dominated by hemlock/balsam stands.

A.3.1.5 Silviculture systems

Clearcuts and clearcuts with reserves are the most frequent silviculture systems used in the Nass TSA. The timber supply analysis assumed that all harvesting was by clearcut.

A.3.1.6 Unsalvaged losses

Timber that is killed through catastrophic events such as fire, insect and disease epidemics or other damaging agents is salvaged where possible. However, due to many reasons (e.g., accessibility, merchantability of damaged wood, timing) the volume salvaged is less than the merchantable volume predicted from yield tables. This lost volume is considered within the timber supply analysis by: (1) a general average annual non-salvaged loss estimated for a specific mortality source or (2) a volume reduction applied to a specified stand type. Both methods are used and described in Table A-8.

Loss due to fire was based on 10-year fire record estimates of 25 000 cubic metres per year loss as used during the 1995 Timber Supply Review of the Nass (Kalum North) TSA. The timber harvesting land base in the current base case, that excludes the Upper Nass zone, is 28% lower than the 1995 timber harvesting land base. The unsalvaged estimate due to fire loss has been proportionately reduced to 18 000 cubic metres per year. In the analysis this amount of loss is removed from potential harvest flow regardless of the level of harvest.

Volume loss due to catastrophic insect damage of specific species was accounted by volume reduction if the effect was less than 100% of the stand volume. For high intensity Hemlock looper damage in the Taylor River zone, the estimated volume loss was modelled by a timber harvesting land base reduction. Balsam bark beetle losses in the Upper Nass zone are not considered in the base case harvest forecast as the Upper Nass zone was excluded from the timber harvesting land base.

Table A-8. Unsalvaged losses

Cause of loss	Location	Analysis units	Unsalvaged losses removed from total timber supply forecast (m^3)	Volume table reduction (%)
Fire	Nass TSA	All	18 000	
Hemlock looper	Taylor River Zone	H leading (high attack) (moderate/low attack)		 100% 20%
	Kwinageese	H leading		20%
Mountain pine beetle	All	P leading >100 years		50%
Total			18 000	

A.3 Forest Management Assumptions

A.3.2 Silviculture

A.3.2.1 Site productivity estimates for managed stands

Site index estimates used to calculate yield tables for managed stands are the area weighted averages of site index from the forest cover inventory which are based upon leading species of the inventory type group. Determining the managed stand site index is complicated as existing stand analysis units may be composed of inventory type groups with varied leading species (e.g. analysis unit 13) or the leading species of the managed stand may differ from the existing stand leading species (e.g., analysis unit 219).

To adjust for these differences, prior to area-weighting, site indices were determined for each species in the managed stand analysis unit based on conversion equations. Conversions documented in the model SiteTools (Batch for Windows version 3.1, Ministry of Forests based upon Nigh 1995a, 1995b) were used. Where no direct conversion is documented, a multi-step conversion (i.e., species A to species B to species C) was used.

The reliability of forest cover inventory estimates of site index for polygons less than 30 years of age has been questioned. These stands were excluded from estimates of site index for future managed stand analysis units. Existing managed stand analysis units used the reported forest cover inventory site indices.

A provincial study on the determination of site index for sites occupied by old-growth stands (OGSI) has been completed. The results of this provincial study show that some adjustment of site productivity estimates from forest cover inventory should be made when stands currently greater that 140 years of age are harvested and replaced with managed stands. No specific studies have been conducted on the Nass TSA. As such, no adjustment of site productivity estimates from forest cover inventory were made in the base case.

A.3.3.2 Regeneration activities in managed stands

The silviculture program reflects a mix of treatments expected to be carried out on the Nass TSA. This level of activity assumes basic silviculture on all sites. Table A-9. shows the regeneration assumptions by existing-stand analysis unit.

In the May 2000 data package, regenerated pine stands were to be divided into two categories: (1) stands less than 20 years of age resulting from harvesting and subsequent reforestation density control; and (2) stands less than 20 years of age resulting from fire with natural regeneration and no density control. However, little of timber harvesting land base was identified in the latter condition. As such, all existing regenerated pine stands were placed into managed stand yield tables.

A.3 Forest Management Assumptions

Table A-9. Regeneration assumptions for existing stand analysis unit

Existing analysis units	Existing analysis unit name	Regen delay (years)	OAFs[a] (%)		Regen method		Regeneration results		Free-growing density and [assumed initial density] (sph)	Regen analysis unit
			1	2	Type	%	Species	%		
1, 201	Pure Hemlock Poor/Med Thrifty	3	15	5	Plant	100	H Pl	50/50	900 1100	101
2	Pure Hemlock Poor/Med Old	3	15	5	Plant	100	H B S Pl	40/40/ 10/10	900 1100	102
3, 203	Pure Hemlock Good Thrifty	3	15	5	Plant	100	H B S Pl	40/40/ 10/10	900 1100	103
4	Pure Hemlock Good Old	3	15	5	Plant	100	H Pl	50/50	900 1100	104
5, 21, 205	Pure Balsam Poor/Med Thrifty	3	15	5	Plant	100	B H S	40/40/ 20	850 1000	105
6, 22	Pure Balsam Poor/Med Old	3	15	5	Plant	100	B H S	40/40/ 20	850 1000	105
7, 23, 207	Pure Balsam Good Thrifty	3	15	5	Plant	100	B S H	40/40/ 20	850 1000	107
8, 24	Pure Balsam Good Old	3	15	5	Plant	100	B S H	40/40/ 20	850 1000	107
9, 209	Pure Pine Poor/Med Thrifty	3	15	5	Plant	100	Pl S	50/50	1000 1200	109
10	Pure Pine Poor/Med Old	3	15	5	Plant	100	Pl	100	1000 1200	110
11, 211	Pure Pine Good Thrifty	3	15	5	Plant	100	Pl H S	40/40/ 20	1000 1200	111
12	Pure Pine Good Old	3	15	5	Plant	100	Pl H S	40/40/ 20	1000 1200	111
13, 25, 213	H/B/Cw Poor/Med Thrifty	3	15	5	Plant	100	H B	50/50	900 1100	113
14, 26	H/B/Cw Poor/Med Old	3	15	5	Plant	100	H B	50/50	900 1100	113
15, 27, 215	H/B/Cw Good Thrifty	3	15	5	Plant	100	H B S	40/40/ 20	900 1000	115
16, 28	H/B/Cw Good Old	3	15	5	Plant	100	H B S	40/40/ 20	900 1000	115
17, 217	Spruce mix P/M/G Thrifty	3	15	5	Plant	100	S B	50/50	900 1000	117
18	Spruce mix P/M/G Old	3	15	5	Plant	100	S B	50/50	900 1000	117
19, 219	Pine mix P/M/G Thrifty	3	15	5	Plant	100	S B H	40/40/ 20	900 1000	119
20	Pine mix P/M/G Old	3	15	5	Plant	100	S B	50/50	900 1000	117

(a) Operational adjustment factors (OAFs) are used to adjust timber yield estimates to account for operational factors. OAF1 is a constant percentage reduction to account for small unproductive areas within stands, uneven stem distribution and endemic losses that do not increase with age. OAF2 accounts for losses that increase with stand age, for example decay due to disease. In this case OAF2 increases from zero at stand establishment and passes through 5% at 100 years of age.

A.3.2.3 Tree improvement

Through selection breeding procedures, improvements on current tree growth, and insect and disease resistance are expected. Currently in the Nass TSA only planted pine seedlings are considered to demonstrate a genetic improvement by the Ministry of Forests, Tree Improvement Branch. In the base case a 2% genetic worth was assigned to the pine component of managed stand yield tables.

A.3.3 Integrated resource management

Forest cover requirements may be applied for many forest management objectives including wildlife habitat and visual quality areas. Forest cover requirements modelled in the base case timber supply analysis represent the current management practices of the Kalum Forest District.

A.3.3.1 Visual quality and general integrated resource management (IRM) objectives

Harvesting in areas with visual quality objectives is subject to constraints on the maximum area that is allowed to be disturbed (i.e., harvested). Land is considered to be free from visible disturbance after it reaches a pre-determined green-up height. In the Nass TSA, the Kalum Forest District Manager has made scenic areas known and established visual quality objectives (VQOs). These areas are identified as an overlay variable (VQO) within the 1999 data file.

Three VQOs are considered in the timber harvesting land base of the Nass TSA: retention (R); partial retention (PR); and modification (M) in which harvesting may occur subject to constraints. A fourth VQO class, preservation, is present but no harvesting is allowed. Area outside of these four classes of visually sensitive areas is required to meet general integrated resource management (IRM) objectives.

Disturbance percentages for VQOs are described differently depending on their use. In this timber supply analysis, plan view percentages are reported and used while for operational harvesting plans perspective view percentages may be used. Provincial guidelines for timber supply analysis provide a range of plan view disturbance values "typical" of management practices in British Columbia. For use in the base case harvest forecast, the forest district believe that the maximum of these disturbance ranges for retention, partial retention, and modification VQO zones represents current practice in the Nass TSA. For the IRM zone, a 35% disturbance level is believed to reflect current practice and is used in the base case harvest forecast.

Green-up of a harvested stand was considered to be the age at which site height reaches a desired green-up height. To determine age, height-age relationships in SiteTools (Batch for Windows version 3.1, Ministry of Forests) were used to calculate ages based required site heights and on the average site index of the leading species in a VQO zone of a landscape unit. The forest cover requirements are described in Table A-10. Green-up ages by landscape unit and VQO are shown in Table A-11.

Table A-10. Forest cover requirements

	Green-up height (metres)	Green-up maximum allowable disturbance (% area)	Application
IRM areas	3	35	Timber harvesting land base
VQO = R	5	5	Productive forest
VQO = PR	5	15	Productive forest
VQO = M	5	25	Productive forest

Table A-11. Time to green-up height for the timber harvesting land base by landscape unit and VQO/IRM zone in base case harvest forecast

	Time to green-up height (years)			
Landscape unit	**Retention**	**Partial retention**	**Modification**	**IRM**
1	32	34	35	26
4	33	32	33	24
5	N/A	N/A	N/A	25
6	36	31	31	23
7	N/A	N/A	N/A	27
8	36	34	31	23
9	N/A	30	33	24
10	39	31	32	24
13	N/A	29	32	24
14	N/A	N/A	44	24
15	N/A	33	32	23
16	N/A	N/A	N/A	22
17	N/A	N/A	N/A	23
18	N/A	32	N/A	23

Note: N/A = not applicable.

A.3.3.2 Kwinageese integrated resource management plan

Management practices of Kwinageese IRM plan that exceed current *Forest Practices Code* requirements are discussed above under timber harvesting land base exclusions in Section A.2.12.

A.3.3.3 Forest cover requirements for landscape-level biodiversity

In the base case harvest forecast, forest cover requirements for landscape-level biodiversity consist of the application of constraints on the amount of productive land base in old forest only. Current policy requires a 45/45/10 distribution of low-, intermediate- and high-biodiversity emphasis if biodiversity emphasis objectives have not been declared officially by the Forest District Manager. Additionally, current policy allows that the lower BEO can be reduced to one third of the recommended value and phased in over three rotations. Requirements are specified by biogeoclimatic variant within each landscape unit. The old-seral requirements listed in Table A-12. are based on the *Landscape Unit Planning Guide*, and are weighted according to the 45/45/10 distribution, and the phase-in policy applicable to lower biodiversity emphasis areas.

Table A-12. Old-seral requirements by biogeoclimatic variant for productive forest

Biogeoclimatic variant	Natural disturbance type	Old-seral requirement (%) starting in year			Minimum age (years)
		1	70	140	
ESSFwv	1	14.2	17.1	19.9	250
ICHvc	1	9.7	11.7	13.6	250
MHmm1	1	14.2	17.1	19.9	250
MHmm2	1	14.2	17.1	19.9	250
CWHws2	2	6.7	8.1	9.4	250
ESSFmc	2	6.7	8.1	9.4	250
ICHmc1	2	6.7	8.1	9.4	250
ICHmc2	2	6.7	8.1	9.4	250
SBSmc2	3	8.2	9.9	11.5	140

A.3.3.4 Riparian management zones

Riparian management is discussed above in Section A.2.11.

A.3.3.5 Wildlife trees and wildlife tree patches

Wildlife tree patch management is discussed above in Section A.2.13 under defining the timber harvesting land base.

A.3.3.6 Identified wildlife management strategy

Habitat for certain wildlife species will be managed through implementation of the Identified Wildlife Management Strategy (IWMS). Currently, there are no wildlife habitat areas established under the IWMS within the Nass TSA and no higher level plans that identify other wildlife management practices. Therefore in the base case harvest forecast, IWMS wildlife habitat areas were not considered.

A.3.3.7 Pine mushrooms

The pine mushroom (*Tricholoma magnivelare*) is considered the most economically significant mushroom species in the province. Currently there are no specific pine mushroom forest management practice requirements in the *Code* nor practiced in the TSA. As such, pine mushroom management is not considered in the base case harvest forecast.

A.4 Definition of Zone and Analysis Unit Definition

Analysis units as identified in the data package were used in the base case harvest forecast. These analysis units for the Nass TSA were primarily developed during a November 1999 meeting of Forest District staff and the timber supply analyst. Analysis units group stands according to species, site index, and age (Tables A-13. and A-14.).

Species were separated out by inventory type groups (ITG) with "pure" analysis units for hemlock, balsam, and pine. Mixed analysis units were created for hemlock/balsam/cedar-leading, pine-leading, and all spruce-leading stands (pure and mixed).

Site indices were combined into two groups: poor/medium (site index 9 to 15 metres @ 50 years) and good (site index >15 metres @ 50 years). For spruce and pine mixed analysis units, due to limited area of these stands, site index differences were not separated.

Ages were lumped into 3 groups: <=20 years, 21 to 140 years, and >140 years. Stands <=20 years are separated as it is believed that these represent managed stands and should be projected with the growth and yield model TIPSY. Stands were separated at 140 years to enable the application of old-growth site index adjustments to stands >140 years in a sensitivity analysis.

Pest damaged analysis units were included to account for yield reductions for pest damage in specific zones of the TSA.

The analysis units reported in the data package were used in the base case timber supply model. However, in the base harvest forecast not all analysis units are applicable (i.e., no area in the timber harvesting land base). These analysis units are reported in the following tables for the base case harvest forecast and in the yield tables (as nil volume) for consistency with sensitivity and critical issue analyses where such analysis units were used.

A.4 Definition of Zone and Analysis Unit Definition

Table A-13. Definition of analysis units for existing natural stands

Analysis unit #	Name (species, site quality, age group)	Criteria		
		Inventory type groups	Site index range (m @ 50 years)	Age (years)
	General analysis units			
1	Pure Hw/Hm – poor/med thrifty	12	9-15	21 to 140
2	Pure Hw/Hm – poor/med old	12	9-15	> 140
3	Pure Hw/Hm – good thrifty	12	16+	21 to 140
4	Pure Hw/Hm – good old	12	16+	> 140
5	Pure Ba/Bl – poor/med thrifty	18	9-15	21 to 140
6	Pure Ba/Bl – poor/med old	18	9-15	> 140
7	Pure Ba/Bl – good thrifty	18	16+	21 to 140
8	Pure Ba/Bl – good old	18	16+	> 140
9	Pure Pine – poor/med thrifty	28	9-15	21 to 140
10	Pure Pine – poor/med old	28	9-15	> 140
11	Pure Pine – good thrifty	28	16+	21 to 140
12	Pure Pine – good old	28	16+	> 140
13	H/B/Cw – poor/med thrifty	9,10,11,13-17,19,20	9-15	21 to 140
14	H/B/Cw – poor/med old	9,10,11,13-17,19,20	9-15	> 140
15	H/B/Cw – good thrifty	9,10,11,13-17,19,20	16+	21 to 140
16	H/B/Cw – good old	9,10,11,13-17,19,20	16+	> 140
17	Spruce mix – P/M/G thrifty	21,22,23,24,26	All	21 to 140
18	Spruce mix – P/M/G old	21,22,23,24,26	All	> 140
19	Pine mix – P/M/G thrifty	5,25,30,31	All	21 to 140
20	Pine mix – P/M/G old	5,25,30,31	All	> 140
	Pest damaged analysis units			
21	Beetle zone A poor/med thrifty	18,19	9-15	21 to 140
22	Beetle zone A poor/med old	18,19	9-15	> 140
23	Beetle zone A good thrifty	18,19	16+	21 to 140
24	Beetle zone A good old	18,19	16+	> 140
25	Looper zone B/C poor/med thrifty	12-17	9-15	21 to 140
26	Looper zone B/C poor/med old	12-17	9-15	> 140
27	Looper zone B/C good thrifty	12-17	16+	21 to 140
28	Looper zone B/C good old	12-17	16+	> 140

A.4 Definition of Zone and Analysis Unit Definition

Table A-14. Definition of analysis units for existing managed stands

Analysis unit #	Name (species, site quality, age group)	Criteria		
		Inventory type groups	Site index range (m @ 50 years)	Age (years)
201	Pure Hw/Hm – poor/med managed	12	9-15	< = 20
203	Pure Hw/Hm – good managed	12	16+	< = 20
205	Pure Ba/Bl – poor/med managed	18	9-15	< = 20
207	Pure Ba/Bl – good managed	18	16+	< = 20
209	Pure Pine – poor/med managed	28	9-15	< = 20
211	Pure Pine – good managed	28	16+	< = 20
213	H/B/Cw – poor/med managed	9,10,11,13-17,19,20	9-15	< = 20
215	H/B/Cw – good managed	9,10,11,13-17,19,20	16+	< = 20
217	Spruce mix – P/M/G managed	21,22,23,24,26	All	< = 20
219	Pine mix – P/M/G managed	5,25,30,31	All	< = 20

A.5 Volume Estimates for Unmanaged Stands

The variable density yield projection model (VDYP version 6.5a), developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate merchantable timber volumes for existing unmanaged stands. Table A-15. shows the area-weighted volume estimates by stand age for existing unmanaged stands within the timber harvesting land base as identified in the base case harvest forecast. As some analysis units do not have any area within the timber harvesting land base of the base case harvest forecast no volume is shown. Volume estimates for analysis units used for specific sensitivity and critical issue analyses will differ from the tables.

Table A-15. Merchantable timber volume tables for existing unmanaged stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years

	Analysis unit									
Age (years)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10[a]**
10	0	0	0	0	0	0	0	0	0	.
20	0	0	0	0	0	0	0	0	0	.
30	0	0	0	1	0	0	12	10	0	.
40	0	0	27	25	14	8	48	47	2	.
50	4	5	101	100	42	29	86	86	34	.
60	19	27	166	165	72	55	122	122	66	.
70	65	68	223	222	105	84	158	158	97	.
80	110	112	273	271	132	107	189	189	126	.
90	147	149	307	305	156	129	218	217	155	.
100	176	178	333	329	179	149	244	244	182	.
110	200	202	351	347	200	167	268	268	209	.
120	219	220	364	358	220	185	291	291	234	.
130	243	244	388	380	240	203	315	314	259	.
140	264	265	407	399	260	220	337	336	276	.
150	282	284	424	416	279	237	358	358	289	.
160	299	301	439	431	296	253	377	378	298	.
170	314	316	451	443	313	268	396	398	303	.
180	326	328	461	453	329	283	413	416	304	.
190	337	339	469	461	345	297	430	433	303	.
200	348	350	478	470	359	311	446	449	305	.
210	359	360	486	479	373	324	461	465	307	.
220	369	370	492	486	387	337	476	480	310	.
230	379	380	498	492	400	349	490	494	312	.
240	388	389	503	497	413	361	503	508	314	.
250	396	397	507	502	425	372	516	522	316	.
260	404	404	511	505	426	373	516	522	318	.
270	412	411	515	508	428	373	517	522	320	.
280	419	417	518	511	429	374	517	523	322	.
290	425	422	522	514	430	375	517	523	323	.
300	431	426	524	516	431	375	518	523	325	.
310	436	430	527	518	432	376	518	523	326	.
320	440	434	530	520	433	377	518	523	326	.
330	444	437	532	522	434	377	519	524	325	.
340	448	440	534	524	435	378	519	524	324	.
350	451	443	536	525	436	378	519	524	324	.
MHA	170	160	90	90	170	200	130	130	170	

(continued)

(a) Volumes are not shown for analysis units which will not be harvested (e.g., no area in the timber harvesting land base).

A.5 Volume Estimates for Unmanaged Stands

Table A-15. *Merchantable timber volume tables for existing unmanaged stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years*

	Analysis unit									
Age (years)	**11**	**12[a]**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
10	0	.	0	0	0	0	0	0	0	0
20	0	.	0	0	0	0	0	0	0	0
30	3	.	0	0	6	3	0	0	2	2
40	34	.	3	2	35	34	16	9	26	21
50	77	.	19	12	81	105	47	40	66	59
60	117	.	54	40	122	168	92	79	103	98
70	155	.	96	81	161	224	134	118	137	134
80	191	.	135	123	193	272	169	154	168	167
90	225	.	167	160	220	308	199	184	195	197
100	258	.	194	191	242	336	225	211	219	224
110	289	.	217	217	261	359	246	233	242	249
120	319	.	236	238	278	377	264	252	262	273
130	347	.	258	263	296	401	281	270	283	296
140	363	.	277	286	312	422	296	286	298	311
150	375	.	293	306	327	441	309	300	309	323
160	384	.	308	325	339	458	319	313	317	333
170	388	.	320	341	350	473	328	324	322	339
180	390	.	330	356	360	486	336	334	325	343
190	388	.	339	369	369	497	343	343	326	344
200	390	.	348	382	377	509	350	351	329	348
210	393	.	357	395	386	519	355	358	332	353
220	396	.	365	407	393	529	361	365	336	357
230	399	.	373	418	400	537	365	371	339	361
240	402	.	381	428	407	545	370	377	342	365
250	404	.	388	438	413	552	373	382	345	368
260	407	.	393	445	415	556	376	385	348	371
270	409	.	397	450	417	559	378	387	350	374
280	411	.	401	456	418	562	380	390	352	376
290	413	.	404	461	420	565	382	391	354	379
300	415	.	407	465	421	568	383	393	356	381
310	416	.	410	469	423	570	385	395	358	383
320	418	.	413	473	424	572	386	396	359	384
330	419	.	415	476	425	574	387	397	360	385
340	420	.	418	479	426	576	388	398	361	387
350	421	.	420	482	427	578	388	399	361	388
MHA	120		160	150	140	90	150	150	150	140

(continued)

(a) Volumes are not shown for analysis units which will not be harvested (e.g., no area in the timber harvesting land base).

A.5 Volume Estimates for Unmanaged Stands

Table A-15. Merchantable timber volume tables for existing unmanaged stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years (concluded)

Age (years)	Analysis unit 21[a]	22[a]	23[a]	24[a]	25	26	27	28
10	.	.	.	.	0	0	0	0
20	.	.	.	.	0	0	0	0
30	.	.	.	.	0	0	0	4
40	.	.	.	.	0	0	37	48
50	.	.	.	.	7	2	114	119
60	.	.	.	.	27	14	181	182
70	.	.	.	.	64	43	239	237
80	.	.	.	.	105	85	289	285
90	.	.	.	.	138	122	323	319
100	.	.	.	.	167	153	349	345
110	.	.	.	.	192	179	368	365
120	.	.	.	.	213	201	382	379
130	.	.	.	.	236	226	404	401
140	.	.	.	.	256	248	423	421
150	.	.	.	.	274	268	440	438
160	.	.	.	.	290	285	455	452
170	.	.	.	.	303	301	467	464
180	.	.	.	.	314	315	476	474
190	.	.	.	.	323	326	484	482
200	.	.	.	.	333	338	493	490
210	.	.	.	.	343	350	501	497
220	.	.	.	.	352	361	507	504
230	.	.	.	.	360	371	512	509
240	.	.	.	.	368	381	516	514
250	.	.	.	.	376	390	520	518
260	.	.	.	.	382	398	523	521
270	.	.	.	.	388	405	526	523
280	.	.	.	.	394	412	529	525
290	.	.	.	.	399	418	532	527
300	.	.	.	.	403	423	534	529
310	.	.	.	.	407	428	536	530
320	.	.	.	.	411	432	537	532
330	.	.	.	.	414	436	539	533
340	.	.	.	.	417	439	540	534
350	.	.	.	.	420	443	541	535
MHA					170	170	90	90

(a) Volumes are not shown for analysis units which will not be harvested (e.g., no area in the timber harvesting land base).

A.6 Volume Estimates for Managed Stands

The yield projection system, BatchTIPSY version 3.0a, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate the yield of existing and future managed stands. The area-weighted site index for each analysis unit along with the regeneration assumptions as noted in Tables A-13. and A-14. (for existing) and A-9. (for future) were used. Table A-16. displays the volume tables for the managed stands. Where the projection estimate limits for TIPSY are less than 350 years, the last TIPSY estimate is held constant until 350 years.

Table A-16. *Merchantable timber volume tables for existing managed stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years*

	Analysis unit									
Age (years)	**201**	**203**	**205**	**207**	**209**	**211**	**213**	**215**	**217**	**219**
10	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
30	0	7	0	2	0	2	0	9	0	1
40	0	84	0	54	0	36	2	68	3	12
50	1	176	11	139	3	93	15	152	30	44
60	9	264	43	222	18	148	55	233	85	88
70	40	340	93	304	42	190	107	305	149	136
80	85	411	141	374	66	227	156	371	202	179
90	129	471	183	423	93	257	202	427	254	217
100	170	523	223	465	115	283	243	471	307	253
110	205	573	266	502	135	302	281	509	346	284
120	239	613	307	534	152	317	316	539	379	311
130	270	650	341	545	168	331	351	539	405	333
140	299	682	370	549	181	342	381	539	426	349
150	322	710	393	550	192	352	403	539	444	364
160	346	738	413	546	202	363	427	539	460	377
170	370	738	431	546	213	369	445	539	473	388
180	390	738	448	546	220	375	460	539	484	400
190	407	738	464	546	226	380	477	539	494	407
200	423	738	479	546	232	385	490	539	504	417
210	438	738	490	546	236	387	502	539	505	424
220	451	738	502	546	241	389	516	539	505	430
230	465	738	508	546	247	391	521	539	507	433
240	473	738	509	546	251	393	531	539	505	433
250	484	738	510	546	252	394	536	539	505	436
260	494	738	511	546	255	397	541	539	503	436
270	501	738	510	546	259	397	544	539	500	436
280	510	738	508	546	260	398	547	539	498	438
290	517	738	507	546	263	399	549	539	498	437
300	517	738	507	546	263	399	549	539	498	437
310	517	738	507	546	263	399	549	539	498	437
320	517	738	507	546	263	399	549	539	498	437
330	517	738	507	546	263	399	549	539	498	437
340	517	738	507	546	263	399	549	539	498	437
350	517	738	507	546	263	399	549	539	498	437
MHA	150	70	120	70	999	110	120	70	100	120

(continued)

A.6 Volume Estimates for Managed Stands

Table A-16. Merchantable timber volume tables for future managed stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years

	Analysis unit						
Age (years)	101	102	103	104	105	107	109
10	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
30	1	0	6	27	0	1	1
40	11	2	37	87	0	30	15
50	34	8	105	164	5	94	51
60	65	24	178	232	30	169	103
70	102	58	245	288	73	237	156
80	142	99	304	340	115	300	202
90	177	137	359	382	158	361	242
100	208	174	408	424	198	411	281
110	238	209	446	454	234	453	313
120	262	240	476	482	269	490	340
130	284	267	505	506	303	524	358
140	302	293	530	527	334	547	373
150	319	317	530	527	362	575	386
160	335	341	530	527	385	596	397
170	349	359	530	527	407	615	407
180	361	379	530	527	425	626	414
190	372	394	530	527	440	634	422
200	385	409	530	527	454	643	431
210	393	421	530	527	470	649	435
220	402	432	530	527	479	654	436
230	407	440	530	527	490	660	436
240	415	448	530	527	499	660	437
250	420	458	530	527	509	660	435
260	428	464	530	527	518	660	434
270	430	470	530	527	523	660	434
280	431	476	530	527	532	660	433
290	432	481	530	527	535	660	433
300	432	481	530	527	535	660	433
310	432	481	530	527	535	660	433
320	432	481	530	527	535	660	433
330	432	481	530	527	535	660	433
340	432	481	530	527	535	660	433
350	432	481	530	527	535	660	433
MHA	140	150	80	80	130	80	110

(continued)

A.6 Volume Estimates for Managed Stands

Table A-16. Merchantable timber volume tables for future managed stands (cubic metres per hectare) and minimum harvestable ages (MHA) in years (concluded)

	Analysis unit					
Age (years)	**110[a]**	**111**	**113**	**115**	**117**	**119**
10	.	0	0	0	0	0
20	.	0	0	0	0	0
30	.	7	0	1	0	0
40	.	42	0	39	7	7
50	.	103	1	113	50	48
60	.	169	14	190	116	115
70	.	227	50	265	183	181
80	.	278	90	328	242	240
90	.	322	131	389	302	297
100	.	359	170	437	353	346
110	.	392	204	475	390	385
120	.	420	236	510	422	417
130	.	442	265	541	446	442
140	.	462	291	566	466	466
150	.	480	323	586	486	485
160	.	497	349	601	502	502
170	.	505	370	613	516	517
180	.	515	391	623	522	524
190	.	523	408	629	522	529
200	.	529	424	636	522	532
210	.	537	437	642	521	533
220	.	541	448	642	520	532
230	.	548	461	642	515	534
240	.	554	471	642	515	532
250	.	554	479	642	512	532
260	.	554	488	642	512	532
270	.	554	497	642	512	532
280	.	554	502	642	512	532
290	.	554	508	642	512	532
300	.	554	508	642	512	532
310	.	554	508	642	512	532
320	.	554	508	642	512	532
330	.	554	508	642	512	532
340	.	554	508	642	512	532
350	.	554	508	642	512	532

(a) Volumes are not shown for analysis units which will not be harvested (e.g., no area in the timber harvesting land base).

A.7 Land Base Changes after Analysis

Boundary adjustments were made to the Nass TSA by an order-in-council on 28 January, 2000. These adjustments include both additions and subtraction of land base.

The most significant change is an estimate of 8416 cubic metres per year of timber forecast gain from the North Coast TSA for the transfer of the Bear River landscape unit (LU) to the Nass TSA. This estimate was determined during the North Coast TSA timber supply analysis (November 1999).

Table A-17. Boundary realignments not considered in the Nass Timber Supply Analysis, 2001

Name	From TSA	To TSA	Timber harvesting land base (hectares)	Estimated initial timber supply (m^3/year)
Bear River LU	North Coast	Nass	1 667	8 416

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

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

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

B.2 Economic Impact Analysis Methodology

Data sources

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

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

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

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

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests' stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

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

Two estimates of direct employment in harvesting were calculated:

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

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

B.2 Economic Impact Analysis Methodology

Employment — silviculture

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

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

Employment — timber processing

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

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

Indirect and induced employment estimates

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

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

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Nass TSA analysis are shown in Table B-1.

Table B-1. Employment multipliers, Nass TSA

Forestry sub-sector	Nass TSA migration multiplier	Nass TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.23	1.33	2.14	1.80
Solid wood processing	N/A	N/A	2.29	1.93
Pulp and paper	N/A	N/A	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers during the period 1997 to 1999 (in 1999 dollars) was:

$47,400 for those working in logging and forestry services;

$46,700 for those working in solid wood manufacturing; and

$56,500 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,700. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

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

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B-2.).

Table B-2. Estimates of provincial government revenues, Nass TSA

	Average annual revenue 1997–2000 ($ millions)	Revenue ($ per '000s m^3)
Stumpage and related payments[a]	3,675	6,650
Forest industry taxes[b]	4,100	7,400
Employee income tax[c]	3 375	6,100
Total	11,150	20,150

(a) Source: Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

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