Resource and Timber Supply Analysis

Canadian Forest Products Ltd.
Alberta Region
Grande Prairie Operations

Revised April 2003

Approved November 3, 2003

Resource and Timber Supply Analysis

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Olympic Resource Management

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Executive Summary

Canfor has adopted public participation as an essential element in development of the Detailed Forest Management Plan (DFMP) and Sustainable Forest management Plan (SFMP). Without the considerable assistance and contribution of the Forest Management Advisory Committee (FMAC), these plans would not have been possible. Their commitment was crucial to the refinement of both plans and the quality of the final products. The Forest Ecosystem Management Task Force, a panel of scientific experts from government, academia and industry, provided technical input and guidance to ensure this Plan reflected a sound and practical approach to sustainable ecological management. A *Public Involvement Program* has been submitted to, and approved by, Alberta Sustainable Resource Development. The program ensures members of the public have opportunities to contribute their input about forest management.

As recommended by the *Alberta Forest Legacy* document, this plan generally uses a coarse-filter approach to ecosystem management on the premise that if representative areas of ecosystems are maintained, the species and ecological processes found within those areas will be maintained. A fine-filter approach has been applied to deal with 7 selected indicator species.

This DFMP reflects the cooperation of the 4 forest companies possessing timber rights within the FMA area - Canadian Forest Products Ltd. (Canfor), Tolko Industries Ltd. (Tolko), Ainsworth Lumber Company Ltd. (Ainsworth) and Grande Alberta Paper Ltd. (GAP). Through the *Resource and Timber Supply Analysis*, this document provides the annual allowable cuts (AAC) for both coniferous and deciduous species, specifically 670,0000 m^3 per year in the long-term (with a 640,000 m^3 20-year harvest level) and 453,712 m^3 per year allocation respectively. The *Resource And Timber Supply Analysis* was modelled for a 200-year period to ensure sustainability of the resource.

The ecosystem-based approach to forest management has been developed in response to a need to find solutions in resource management that are ecologically and economically sound, as well as being socially acceptable. A *Resource and Timber Supply Analysis* is a process that explores the interactions between these varying demands and the effects that the different management strategies eventually have on the values concerned.

Under the direction of Dwight Weeks (Forest Planner), Olympic Resource Management (ORM) has provided analytical and inventory services for the *Resource and Timber Supply Analysis*. ORM used the simulation model COMPLAN and the optimization model, WOODSTOCK, as tools for the analysis. The scenarios were run using both optimization and simulation models to gain further insight into the results of the forest planning decisions. The optimization results were used as a point of reference with which to compare the simulation results.

In 2000, a benchmark scenario conducted by ORM demonstrated that new inventory data and yield tables would have little effect on the Annual Allowable Cut (AAC) determined for the 1991 DFMP. This study concluded that changes in harvest levels would be the result of new management objectives and practices applied in subsequent analyses.

Canfor's Grande Prairie *Sustainable Forest Management Plan* achieved certification of its forestry operations to the Canadian Standards Association (CSA) Z809-96 standard in June 2000. The purpose of the CSA standard is to describe the components and performance objectives of a sustainable forest management system. Through a process of public participation, the CSA performance framework attains a local relevance in the form of locally determined values, goals, indicators and objectives. Such participation by the FMAC resulted in the development of the *Sustainable Forest Management Plan for Canfor's Alberta Region, Grande Prairie Operations* (June 2000).

The primary components of the *Sustainable Forest Management Plan* (SFMP), including values, goals, indicators and objectives, are contained in the DFMP.

Objectives are clear specific statements of expected quantifiable results that are to be achieved within a defined period of time. They are related to one or more goals. Goals are broad general statements describing a state or condition related to one or more forest values. Management alternatives that address the objectives are evaluated based on a series of COMPLAN and WOODSTOCK runs that use preliminary goals and constraints as established by the FEMTF, existing and newly compiled information. A final run was conducted so that the final management alternatives could be selected. Alberta Sustainable Resource Development, Land and Forest Division (LFD) was presented with the results at critical stages and has been kept informed as the analysis proceeded.

The resource management strategies examined were tested against the related objectives and compared to each other. The process involved extensive consultation with the public, other timber resource users, other stakeholders, and the government. Balancing the competing objectives of these groups is a very complex process. On the basis of this evaluation and consultation, the scenario that best met non-timber and timber objectives was selected as the preferred strategy (Scenario 4C described below). This strategy is "preferred" because it is the one that best meets all of the objectives (environmental and social, as well as economic).

The management objectives of the *Resource and Timber Supply Analysis* are:

- Wood flow including both coniferous and deciduous volumes, maintenance of current deciduous allocations and other allocations of deciduous volume;
- Watershed protection achieved by limiting the amount of vegetation cover removed within defined watershed;
- Maintenance of habitat conditions required for the identified selected indicator species; moose, American marten, pileated woodpecker, barred owl, bull trout, woodland caribou and trumpeter swan; and
- Maintenance of seral stages within a natural disturbance regime at present and at key points in time.

A series of seven scenarios were run using COMPLAN:

1. Scenario 1C is a benchmark run completed to determine the effect of new inventory data and yield tables on the AAC as compared to the previous timber supply analysis carried out in the 1991 DFMP. The results illustrate that little change can be expected in the harvest levels due to the new inputs. This indicates that any changes in harvest levels in subsequent analyses will be due to changes in management practices, assumptions or objectives and not due to changes in inventory data or yield table information. The report, *Supplementary Timber Supply Analysis: Benchmark Run Results and Amended Timber Supply Analysis Information*

Package details the results of this run;

2. Scenario 2C is an unconstrained aspatial run that is intended to provide the maximum sustainable coniferous timber harvest achievable in the absence of constraints;
3. Scenario 3C is a full spatial run with sub-compartment aggregation that is intended to determine the coniferous and deciduous harvest levels when green-up and caribou habitat requirements are implemented;
4. Scenario 4C is a full spatial run intended to include all the parameters from Scenario 3, but to modify them as necessary to meet acceptable levels of seral stage and patch size distribution in all landscape management units;
5. Scenario 5C is based on Scenario 4 and investigates the effect of a less aggressive regeneration strategy on the coniferous and deciduous levels;
6. Scenario 6C is a full spatial run that examines the risk associated with the regeneration strategy proposed ;and
7. Scenario 7C is a full spatial run intended to examine the effects of pursuing a strategy of reducing the level of risk present in the landscape due to fire.

The model inputs include information such as forest inventory that helps to describe the current forest status, growth and yield information for yield table assignment and management/operational information.

The preferred management strategy results in sustainable coniferous and deciduous wood flows. These harvest levels are achieved while assuring that non-timber resources are also maintained on a sustainable basis. These resources include natural biodiversity, wildlife habitat for numerous key species and water quality that is controlled on a watershed basis.

The results from the timber supply analysis show that a coniferous harvest (annual allowable cut) of 670,000 m^3/year is achievable in the long term. This level of coniferous harvest will support a deciduous annual allowable cut of 453,000 m^3/year. However, the model runs also indicate that a lower level of coniferous harvest is initially necessary; until 2018, only 640,000 m^3/year can be harvested, if 670,000 m^3/year is to be sustained for the long term.

The risk associated with the assumed volume gains from the regeneration strategy appears to be minimal based on the results of Scenario 5C and 6C. A coniferous non-declining even-flow harvest of 550,000 m^3/year was determined when all the benefits from enhanced silviculture were eliminated. Maintaining the coniferous and deciduous harvest at 640,000 m^3/year and 453,000 m^3/year respectively for the fist 20 years did not result in a reduction of the long-term sustainable harvest level identified in Scenario 5C.

1 INTRODUCTION TO *RESOURCE AND TIMBER SUPPLY ANALYSIS*

1.1 Introduction

Canfor has adopted public participation as an essential element in development of the DFMP and SFMP. Without the considerable assistance and contribution of the Forest Management Advisory Committee (FMAC), these plans would not have been possible. Their commitment was crucial to the refinement of both plans and the quality of the final products. The Forest Ecosystem Management Task Force, a panel of scientific experts from government, academia and industry, provided technical input and guidance to ensure this Plan reflected a sound and practical approach to sustainable ecological management. A *Public Involvement Program* has been submitted to, and approved by, Alberta Sustainable Resource Development. The program ensures members of the public have opportunities to contribute their input about forest management.

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The ecosystem-based approach to forest management has been developed in response to a need to find solutions in resource management that are ecologically and economically sound, as well as being socially acceptable. *A Resource and Timber Supply Analysis* is a process that explores the interactions between these varying demands and the effects that the different management strategies eventually have on the values concerned.

Resource and Timber Supply Analysis is the process of exploring the effects of forest management strategies and alternative timber harvesting levels on the forest. In the past, forest planners engaged in a timber supply analysis were specifically concerned with the flow of timber and fiber products from forests. Forests now need to satisfy a greater diversity of demands. The process that explores the interactions between these varying demands and the effects of different management strategies on all values concerned is more accurately termed a *Resource and Timber Supply Analysis*.

Canfor has adopted an ecological approach for developing the *Detailed Forest Management Plan* (DFMP) in order to address the innumerable challenges that arise from fragmented landscapes and diverse management strategies. Ecosystem management has been developed in response to a need to find solutions in resource management that are ecologically and economically sound, as well as being socially acceptable.

Due to their nature, the objectives and goals for resources such as wildlife habitat, old seral areas and reserves need to be set first. A management strategy that accounts for these objectives and achieves a certain harvest level is then developed. A computer model is employed in the process of *Resource and Timber Supply Analysis* to forecast the development of the forest over time given specific schedules of management activities.

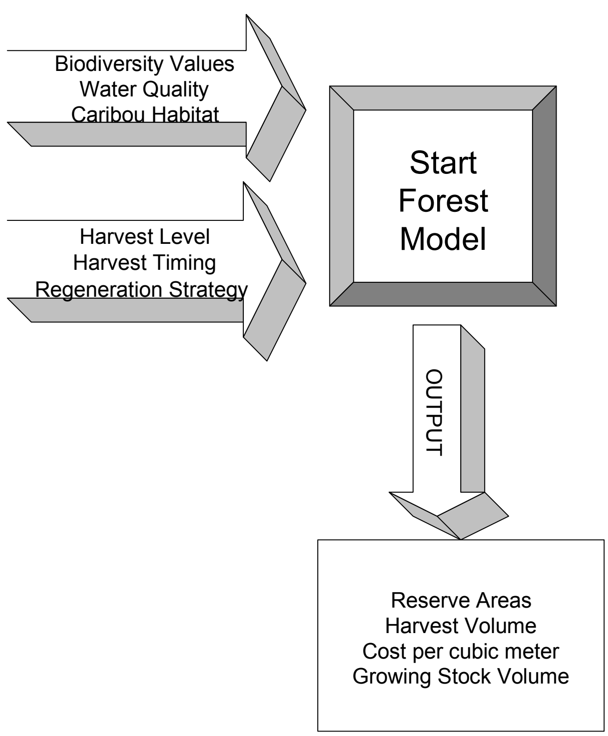
1.2 Why is *Resource and Timber Supply Analysis* Done?

Resource and Timber Supply Analysis is carried out to support landuse and forest management planning and to help in the determination of the annual cut for a specific area. It reveals to forest planners what the capability of the land to provide timber resources once non-timber value objectives have been met.

1.3 How is *Resource and Timber Supply Analysis* Done?

Resource and Timber Supply Analysis is accomplished using a computer model to forecast the development of the forest, given specific schedules of management (Figure 1). This analysis makes it possible to compare how alternative management strategies affect the structure of the forest and its resources over time.

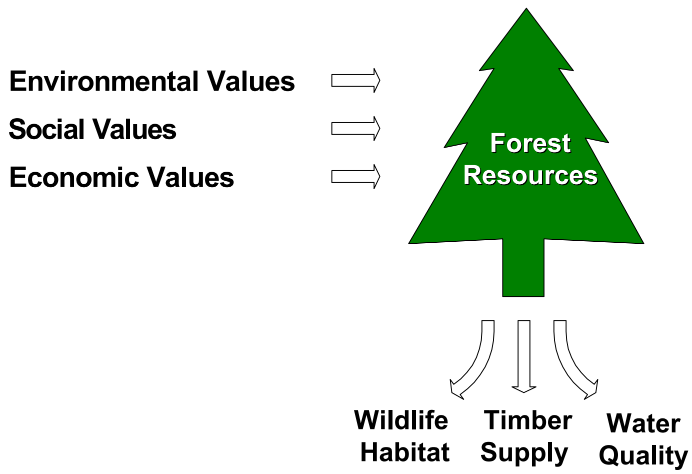
Figure 1. The Forest Model



1.4 *Resource and Timber Supply Analysis* and Forest Management Planning

Environmental, social, and economic factors influence resource supplies (Figure 2).

Figure 2. Key Influences on Resource and Timber Supply



Forest management has evolved as new information on forest resources becomes available. Over time, society's attitude towards the value of forests and the approach to forest management has evolved. Originally considered as an endless supply of fiber and an obstacle to settlement and development of the land, our forests now must satisfy numerous social, environmental and economic demands such as:

- The protection of water quality for human consumption;
- The desire for the specific products that we need to build our homes and that let us maintain the lifestyle that we desire;
- The ability to provide jobs, especially in remote rural communities;
- The protection of ecologically unique and sensitive areas, rivers, lakes and streams;
- The safeguarding of places of historical, cultural and/or archaeological value;
- The maintenance of wildlife habitat; and
- The maintenance of recreational sites, public use areas and research sites.

In addition, the biological characteristics of the forest have a direct affect on resource supply. These include:

- The species mix of trees in the forest stands;
- The ability of the land to grow trees which is affected by the nutrients and moisture available to trees;
- The ages of individual stands distributed across the land;

- The ruggedness of the terrain on which the forest grows;
- The remoteness of the forest; and
- The size of the forest.

Together these values and characteristics have individual and combined influences on the supply of timber. In some cases, a particular value or biological characteristic of the land may make it impossible for other values to be satisfied in a particular area. Some examples of this conflict include:

- Areas of low nutrient levels may not be considered for timber harvesting due to low economic return and the difficulty in getting the forest to regenerate after harvesting; and
- Areas where habitat is managed for one species may conflict with the management practices that conserve habitat for another species. For example, the Caribou Area management objectives are aimed at providing large patches of cover and browse However, in watersheds where Bull Trout are present, Equivalent Clearcut Area (ECA) objectives may limit the ability to generate large patches of browse.

1.4.1 How are Non-Timber Issues Identified?

Canfor has adopted public participation as an essential element in its forest management strategy. A Forest Management Advisory Committee (FMAC) has been formed to review plans and to identify issues of concern. This committee is comprised of local stakeholder groups who are directly affected by or who have an interest in the management of the forest resources.

1.4.2 Forest Management Planning

Once non-timber objectives are established, a *Resource and Timber Supply Analysis* can be very useful in determining the best management approach for a particular area. It allows managers to explore different combinations of treatments (e.g. spacing), the treatment extent (e.g. area spaced each year) and timing (e.g. the years or decades in which spacing should be done) to be employed in an overall plan.

1.5 Landuse Planning

Resource and Timber Supply Analysis is an essential tool of large-scale landuse planning.

1.6 Annual Allowable Cut Determination

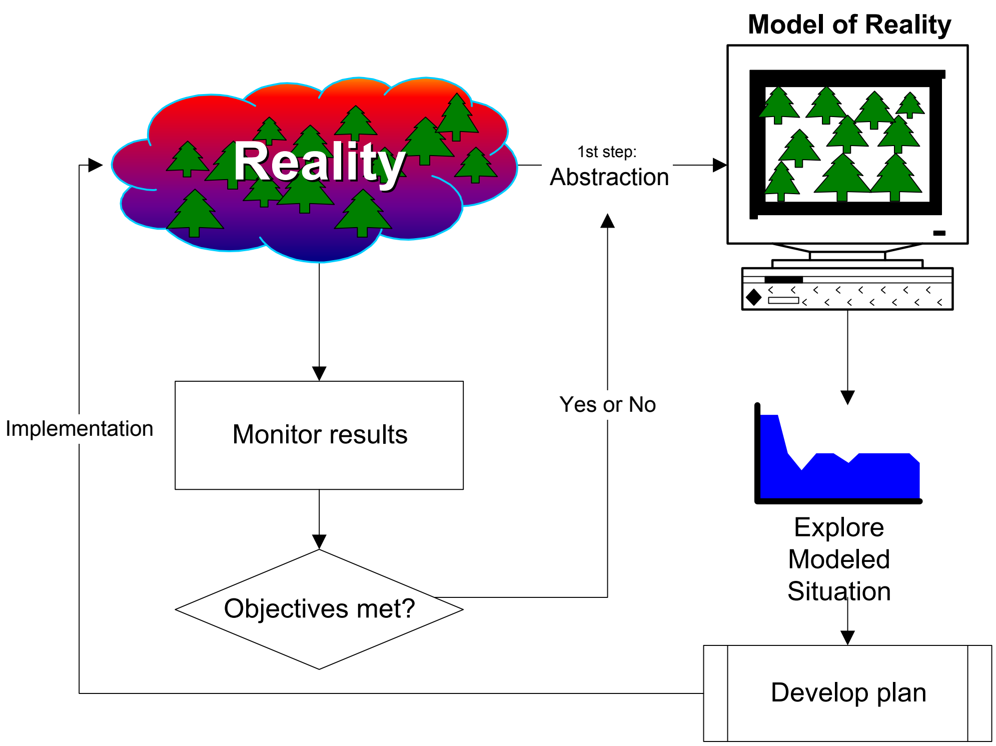
Resource and Timber Supply Analysis is an essential tool in the determination of the Annual Allowable Cut (AAC).

2 THE USE OF MODELS AS TOOLS FOR FOREST MANAGEMENT

2.1 What is a model?

Models are conceptual tools used to develop a better understanding of how natural systems interact and respond to different management plans (Figure 3).

Figure 3. Models are representations of reality



A model is a simplified version of reality, utilized to help us understand how reality works. A model helps to make complex decisions and to give some understanding of the implications of these decisions. Modelling is generally done in a controlled environment, for example, models are used in aircraft design to test flight characteristics without unnecessarily endangering people and equipment. An example of a model that has been an important tool that has been used in the field of forestry for a long time is a map. A map is a generalized view of specific aspects of the landscape. While there is very little physical correspondence between a map and the forest it represents, maps are essential tools in the planning of forestry activities.

2.2 Why We Need Models

Modelling helps to clarify the nature of the problem and the assumptions on which the predicted outcomes are based. It can also reveal vagueness and gaps in our understanding of the system. The objective of modelling is to compress the problem to make it more understandable, not to represent the real world in all its complexity. A very complex model is no easier to understand than the system being studied. Models should have only enough detail and complexity to represent the problem of interest. Too much detail obscures the important parts of the problem; too little detail renders the model “unrealistic”.

Modelling is an extremely critical tool for planning for large forested tracts of land with long rotations. The only way to determine the future timber supply on vast forest acreage is by using a model. The model helps to determine things like the optimal silvicultural investment in a forest, both in terms of prioritizing stands, timing and investment returns. It can help to show what harvest levels might be expected given the necessity of meeting non-timber objectives like caribou habitat targets, etc.

2.3 How Do Models Work?

In the field of forestry, modelling is done by using computer programs to imitate the natural processes occurring within a forest. Things like individual tree growth, forest stand growth, fire characteristics, insect infestation levels, forest ecosystem dynamics, log inventory distribution, forest land valuation and wildlife population dynamics can be modelled independently or can be integrated into a model of a whole landscape.

A forest planning model works - and there are many variations according to the design of the individual model - by growing individual stands of trees through to rotation, harvesting and then re-growing the stand. Models may or may not determine which areas or cutblocks are to be harvested. In some cases, the model defines the cutblocks, while in others, the forester must predefine the cutblocks. The model then calculates how much timber can be harvested each year sustainably over the planning period once non-timber objectives have been met. A model can "grow" a forest, infest a forest with "insects", or "burn" a forest under various conditions to predict volumes or damage. Forest modelling is used to simulate forest (as defined as a multiple of stands) growth and dynamics to undertake *Resource and Timber Supply Analysis*, prepare strategic level plans and calculate Annual Allowable Cut (AAC).

Where the forest management regime of a forest area is to harvest a regular and expected volume of timber on a sustainable basis, either yearly or multi-year, then an annual allowable cut must be determined. Planning of this type is done for on a long-term basis, usually over 2 or 3 rotations. Models are used to do this.

2.4 Modelling Resource Supply

To support integrated forest management and planning, and effectively model resource and timber supply, a model must include information about the forest and how it will be managed (e.g. landbase, species, site productivity, stand management regimes, and management objectives). It must also incorporate the way the forest changes with time, forest dynamics.

2.5 Types of Models

Different models use different techniques and problem-solving procedures to arrive at a solution. Each of these techniques has distinct advantages and disadvantages depending on the problem to be addressed. Two of these techniques; simulation and optimization are discussed in the next sections

2.5.1 Simulation Models

Simulation models project the development of the forest, decade by decade, given a specific set and schedule of management activities, constraints, and assumptions. The analyst defines a set of rules that the model follows, with a disregard for the way the forest will look at the end of the planning period. An example of a harvesting rule that an analyst might set is a maximum opening size of 500 ha, or that openings are not to be located closer than 400 m to another cutblock until the newly planted trees have grown to greater than 2 m in height. Rules are established to try and meet objectives, but their effect over a long-term planning horizon often cannot be properly visualized. The analyst inspects the model output (the indicators of forest development such as growing stock volume, harvest-level, age class distribution) to determine the extent to which that "run" meets the specified rule or management objective. This process is repeated again and again as the analyst uses the model to simulate forest development in a series of runs (varying parameters each run) to gain an understanding of how a particular parameter affects the outcome, or until a schedule that works is found.

Simulation models can either operate spatially or aspatially. Spatial models work with graphic forest information systems such as Geographic Information Systems (GIS), to not only help determine a sustainable Annual Allowable Cut (AAC), but also to show where that timber should be harvested from. Aspatial models will only give a calculated AAC, and it becomes the job of the forest manager to turn this strategic plan into an operational plan. Older aspatial models did not produce solutions that were as realistic as more recent spatially based models, because they were not capable of handling things like the actual location of wilderness reserves and parks. Considering the geographic location of such features has improved the accuracy of recent forest modelling scenarios.

The simulation model used in the *Resource and Timber Supply Analysis* undertaken for Canfor's FMA area is COMPLAN.

2.5.2 Optimization Models

Optimization models use a set of mathematical instructions and problem-solving procedures to find the "best" solution, given an objective, constraints (e.g. wildlife habitat requirements, operational limits on potential volume of timber that can be harvested in one year, limits on variation in harvest volume over planning period) and data. It can be considered a target-based approach. The look of the forest at the end of the planning horizon is determined in advance and the model works to create this effect in the shortest amount of time. Often long-term planning targets are defined by a percentage, like the percentage of old seral or the percentage of wildlife tree patches distributed throughout the planning area.

This type of model does not operate spatially. The model chooses the best combination of treatment, timing and location from all possible activities specified by the analyst. The "best" solution is the one that comes as close as possible to the objective by either maximizing something (e.g. profits, harvest volumes) or by minimizing something (e.g. costs, deviation from target harvest volumes).

The optimization model used in the *Resource and Timber Supply Analysis* undertaken for Canfor's FMA area is WOODSTOCK.

2.5.3 Using both Simulation and Optimization Models to arrive at a solution

Simulation and optimization models can be used together to model scenarios to gain further insight into the results of forest planning decisions. The results obtained from COMPLAN are as realistic as possible because the model is able to handle a very complicated data set and to consider the spatial aspects of the data. WOODSTOCK uses a complex process to come up with then optimum solution. This limits the complexity of the data that can be input. For example, WOODSTOCK may aggregate input data by lumping individual years into periods of ten, while COMPLAN is able to consider each year individually. Due to the process that it completes to search for an optimum solution, the WOODSTOCK results can be extremely valuable as a benchmark with which to compare the COMPLAN results. Using WOODSTOCK it is possible to determine how far removed the simulation solution is from the optimal solution.

3 APPROACH TO RESOURCE MODELLING FOR THE FMA AREA

3.1 Modelling Procedures

Modelling using computers follows a definitive process that requires inputs to be specified and any assumptions used by the modelers explained clearly.

The following 6 steps are followed to complete a modelling exercise:

1. Specify management objectives, constraints, and assumptions;
2. Prepare input data;
3. Establish rules and parameters;
4. Establish a base case forecast by repeatedly running the model and evaluating the results (amount of harvest and other treatments scheduled for each period, forest characteristics in each period);
5. Sensitivity analysis, more model runs and evaluation; and
6. Summarize and analyze results.

3.2 Input Data

A large amount of data that describes the forest is entered into the model in various formats. This information is kept up to date by regular surveys and studies carried out in the forest area to be modelled.

3.2.1 Spatial Data

The following list describes the type of information included in an analysis using the COMPLAN model. This data comes from spatial databases developed using a Geographic Information System (GIS).

- Updated forest inventory (AVI 2.1);
- Location of lakes, rivers, streams, and other wetlands;
- Location of watersheds;
- Location of seismic lines;
- Location of existing and planned roads;
- Existing and proposed cutblocks;
- Human-made clearings;
- Trumpeter swan sites;
- Stream and lake buffers;
- Caribou Area;
- Government landbase deletions;

- Grave sites and other rare physical environments;
- Natural subregion classification information which tells the forest planners about local climatic conditions and resulting moisture and nutrient levels which will effect the growing conditions for trees and other vegetation; and
- Management units that will be used to geographically subdivide the area being modelled so that specific management goals and objectives can be applied to individual areas.

3.2.2 Landbase Information

The landbase available for timber harvesting, called the Timber Harvesting Landbase, is determined in a stepwise procedure by first removing all non-forested and non-vegetated land from the total area calculated for the Forest Management Area (FMA area). Land in reserves and protected areas, buffer zones around streams, rivers and lakes, and areas containing special sites are all then removed.

3.2.3 Growth and yield

The model is driven by yield tables that display the expected yield of wood in terms of volume per ha for a series of stand ages. These tables are developed outside the model and are determined from long-term studies of natural and managed forest stands. These tables include any information on reductions in tree volume that might be expected due to losses caused by pathogens like fungi or wood that is lost to breakage that is an expected consequence of harvesting activities. These tables also include information that reflects methods used by forest planners to re-grow harvested stands.

3.2.3.1 Height-Age Validation

Yield curves were built using the two-stage modeling approach where stand volume is predicted first as the function of stand height then the height-age curves are validated against PSP height growth trajectories (Canfor 1999f). Combining the two sub-models will result in the traditional yield curve (stand volume over stand age).

The stand height validation by yield group was carried out using Canfor's fire-origin stand PSP data (Canfor 1999a). The validation of volume-age trajectories based on the PSP data was also assessed (Canfor 1999b). Stand decline functions were applied to avoid the non-declining nature of the individual tree based height-age curves.

3.2.3.2 Calculation of Site Index Seeds by Yield Group

Average site indices for each yield group were calculated from the Permanent Sample Plot (PSP) database using the provincial height-age curves with the exception of Lodgepole Pine in Natural Subregions UFH and LFH. In 1998 new parameters were calibrated for this exception using Canfor's stem analysis data (Canfor 1999g).

A site index seed was required to 'drive' the curves. The PSPs were used, since they were used in the validation process and were generally comparable to the Temporary Sample Plots (TSPs) based site index averages. The site index seed value for each Yield Group is set to the average of the site index values for all of the PSPs in the Natural subregion that has the largest number of PSPs for that Yield Group. Table 1 below shows the site index seeds that were used (Canfor 1999f).

1) The normal definition of site index[1] was used to come up with average site index seeds by yield group to drive the curves using the PSP data;
2) The applicability of the height-age curves to project top height (stand height) as the function of inventory Breast Height Age was validated;
3) The inventory Breast Height Age (stand age) and the site index seed were used to project top height and therefore volume. This is the reason why PSPs were used to derive the site index seed;
4) The resulting predicted volumes were compared to actual Temporary Sample Plots (TSP) and Permanent Sample Plots (PSP) volumes (Canfor 1999a) by yield group; and
5) The overall performance was validated using the area-weighted curves. (Canfor 2001).

Table 1. Average Site Index by Yield Group

Yield Group	Description	Site Index
1	AW + (S) - AB	18.5
2	AW + (S) - CD	17.7
3	AWSW/PBSW/BWSW	18.1
4	BW/BWAW + (S)	16.7
5	FB + OTH	12.0
6	H + (S)/S	17.0
7	PB + (S)	17.7
8	PL/PLFB + (H)	14.7
9	PLAW/AWPL	16.9
10	PLSB + OTH	11.0
11	PLSW/SWPL + (H)	16.4
12	SBLT/LTSB (G,M,F)	10.5
13	SBLT/LTSB (U)	7.8
14	SBPL/SBSW/SBFB	11.7
15	SW/SWFB + (H) - AB	13.8
16	SW/SWFB + (H) - CD	13.9
17	SWAW/SWAWPL	15.7

Source: Canfor 1999f

3.2.4 Management Parameters

Once wildlife and protected areas and other objectives have been set, the management of parameters affecting the harvestable areas are laid out.

Requirements for retention of forest cover for caribou habitat, old seral areas within harvested areas and the protection of the land with regard to hydrologic concerns will be input into the model. The priority of stands to be harvested is set in COMPLAN for the Canfor *Resource and Timber Supply Analysis* in the following manner:

- COMPLAN selects stands that have the slowest growth rates to be harvested first; and

[1] Site index is an expression of forest site quality based on the height, at a specified age, of dominant and codominant trees in a stand.

- COMPLAN selects the oldest stands to be harvested next.

The harvesting of certain areas is limited by the level of harvest occurring in adjacent areas. The model will be told what the desired species mix, minimum age and specific stand characteristics of the stands to be harvested should be set at.

Information on the strategy to be used to regenerate the harvested forests is entered here. Species and size of seedlings and other activities like spacing or fertilization influence the growth of the new forest and are accounted for in the planning process. Plans for areas that are not satisfactorily restocked will be detailed. A timeline of 200 years is also input into the model.

3.3 Output

Outputs are quantifiable levels of a resource attribute from each period of the planning horizon. These are expressed in units of volume harvested, area treated, costs incurred, etc. Outputs can be used as part of an internal calculation within the model or can be graphed. Graphs are visual tools that help display model outputs including:

- Success in meeting biodiversity objectives;
- Success in meeting wildlife habitat goals;
- Old seral targets;
- Characteristics of the forest in each period are described at different points along the modelling timeline. Things like the number of individual trees age class, growing stock inventory and of the harvested stands (e.g. average age of harvested stands); and
- Revenues and costs.

3.4 Sensitivity Analysis

Much of the work of modelling timber supply involves exploring the dynamics of the problem through a process called sensitivity analysis. This part of the analysis involves adjusting different parts of the input data to see how the treatment schedule and associated measures of timber supply change as a result. The difference in timber supply between the base case and the new case is the measure of the impact of the change in the constraint. A model is "sensitive" to a parameter if small changes in the variable or parameter result in large changes in the treatment schedule or timber supply.

Meaningful measures of timber supply must be selected as a basis for comparing different cases in sensitivity analysis. Measures typically used are:

- Harvest forecast;
- Amount of area contributing to targeted biodiversity goals;
- Amount of area contributing to targeted habitat goals;
- Amount of area contributing to targeted old seral goals;
- Growing stock inventory (available and total);
- Age-class distribution;

- Average area harvested;
- Average age of stands harvested; and
- Average yield, expressed as a volume of stands harvested.

A sensitivity analysis can reveal areas where relationships between values are easily misunderstood and where small decisions can have a very high impact on the outcome. A forest planner can choose to live with these uncertainties or to investigate them further through additional modelling and research.

4 SELECTION OF MANAGEMENT ALTERNATIVES DESIGNED TO ACHIEVE OBJECTIVES

Canadian Forest Products Ltd. (Canfor) is committed to managing the resources under the control of the Company in compliance with all national and provincial laws, legislation and regulations. The Company has also developed principles, policies and procedures that incorporate the strategic direction for sustainable forest management as outlined in the various national, provincial and industry initiatives. Canfor's documents define its commitments to sustainable forest management and include Canfor's *Mission Statement, Environment Policy and Forestry Principles* (Canfor. 1999a).

The values, goals, indicators and objectives for the *Detailed Forest Management Plan* (DFMP) include those derived for Canfor's *Sustainable Forest Management Plan* (SFMP) which was developed to obtain certification for the Company's forestry operations under the Canadian Standards Association (CSA). Systematic and formal input into these came from the Forest Management Advisory Committee (FMAC) which is comprised of local stakeholder groups who are directly affected by or have an interest in the management of the forest resources. The Forest Ecosystem Management Task Force (FEMTF) provided the advice of government and academic experts in the fields of ecology, forest management and wildlife biology.

Canfor has the right to manage, grow, harvest and reforest coniferous timber on the FMA area under its current agreement with the Crown. Three forest companies, Tolko Industries Ltd. (Tolko), Ainsworth Lumber Company Ltd. (ALC), and Grande Alberta Paper Ltd. (GAP) have been allocated deciduous timber within the FMA area. ALC and Tolko representatives act in an advisory capacity to the FMAC. Along with Grande Alberta Paper Ltd., they also provide technical input regarding strategic and operational plans, *Resource and Timber Supply Analysis*, growth and yield projections, and operational and harvest sequence plans for the DFMP.

The management alternatives evaluated within the *Resource and Timber Supply Analysis* are designed to meet objectives that are specific statements of expected quantifiable results related to one or more DFMP goals. The overall criteria, values and goals for the DFMP will be achieved when the objectives are met and constraints considered in the modelling process.

The management alternatives were evaluated in the *Resource and Timber Supply Analysis* by a series of COMPLAN and WOODSTOCK runs. A final run was eventually conducted and the final management alternatives selected. The resource management strategies examined were tested against the related objectives and against other targeted strategies. The selection of the preferred management strategy has been the result of an extensive cooperative effort between the public, other timber resource users, other stakeholders, government, Canfor personnel and consultants retained by Canfor. The preferred management strategy is comprised of compatible resource management strategies that best achieve the objectives contained within the SFMP.

4.1 Pertinent Government Legislation, Policies and Plans

Alberta Sustainable Resource Development developed the planning manual *Interim Forest Management Planning Manual - Guidelines to Plan Development, April 1998* to guide sustainable forest management planning in Alberta. The document outlines several key guiding principles for consideration when preparing forest management plans. Canfor has developed the DFMP and *Sustainable Forest Management Plan* (SFMP) in conformance with these principles.

The *Resource and Timber Supply Analysis* documentation and data file requirements that are to accompany the management plan submission are outlined by the *Interim Forest Management Planning Manual – Supplemental Guidelines – Timber Supply Analysis, 1998.*

4.2 Management Objectives

Objectives within the *Resource and Timber Supply Analysis* are designed so that overall DFMP goals and criteria are met. Section G of the DFMP describes these overall objectives in detail.

4.2.1 Long-term Wood Flow Objectives

The achievement of sustainable coniferous and deciduous harvest levels while meeting environmental, social and economic requirements across the FMA area is the long-term wood flow objective for the *Resource and Timber Supply Analysis.*

4.2.2 Short-term Wood Flow Objectives

Short-term objectives to be achieved in the *Resource and Timber Supply Analysis* are to ensure that the wood supply is sustainable in terms of access to volume within the area of the FMA area. A detailed, operationally realistic harvest sequence for the first 20 years of the Plan is incorporated into the *Resource and Timber Supply Analysis*. This ensures that timber and non-timber resource supply forecasts will be attainable with a high degree of certainty using the current operating rules, assumptions and input data. The harvest sequence and factors involved are described in Section 6.4 of this document.

4.2.3 Wildlife Habitat

Consultation with members from the Forest Management Advisory Committee (FMAC), Forest Ecosystem Management Task Force (FEMTF) and Canfor resulted in the selection of 7 selected indicator species. These 7 species represent a broad and variable range of habitat characteristics. If the habitat is maintained and available for these species, it is assumed that the FMA area will contain a wide range of habitat conditions suitable for many other species in the planning area. Conservation of biological diversity and ecosystem condition and productivity are addressed by these measures.

Four of the species were selected for HSI modelling and three are to be managed by means of habitat constraint modelling within this *Resource and Timber Supply Analysis*. The 3 species are as follows:

4.2.4 Woodland Caribou (*Rangifer tarandus caribou*)

Canfor is applying habitat cover constraints within the *Resource and Timber Supply Analysis* to forested stands identified within the Caribou Area as follows:

- No more than 25% of the area can be in pioneer or young seral condition;
- No less than 15% of the area can be in old seral stage.
- Maximum opening size of 1,000 ha; and
- 30 year green-up.

4.2.5 Bull Trout (*Salvelinus confluentus*)

The total bull trout area identified within the FMA area is 242,828 ha. This represents 37% of the total FMA area. There are a total of 163 watersheds in the Bull trout area. Bull trout habitat is dependent on the amount of vegetated cover within a watershed. Vegetated cover removal must be controlled to maintain adequate habitat. The absolute amount of Equivalent Clearcut Area (ECA) that can be supported without adverse impacts to bull trout is not well understood; it differs depending upon watershed sensitivity and characteristics. Given this lack of understanding, it is important to monitor the amount of ECA. Within a defined watershed, total vegetated cover removal will not exceed 35% ECA above the H60, where:

- ECA is a primary factor considered in an evaluation of the potential effect of past and proposed forest harvesting on water yield. ECA is usually expressed as a percent of watershed area;
- Total vegetated area includes the forested and non-forested vegetated covers; and
- H60 is the elevation above which 60% of the watershed lies. The watershed area above the H60 is considered as the source area for the major snowmelt peak flows.

4.2.6 Trumpeter Swan (*Cygnus buccinator*)

Two hundred meter “no harvest” buffers are maintained around identified trumpeter swan areas to protect nesting sites, unless changes are recommended or approved by the Alberta Sustainable Resource and Development, Land and Forest Division (LFD). There are 45 areas within the FMA area that have been identified by Alberta Sustainable Resource Development, Natural Resource Services (NRS) and which have been buffered to protect nesting sites. The nesting sites will be verified within the active Annual Operating Plan (AOP) areas with any “new” nest sites being incorporated into future plans.

4.2.7 Seral Stage

Seral stage distribution enables timber harvests to be planned in order to maintain a full range of successional habitats for wildlife and ecosystem types over the long-term. This contributes to the conservation of biological diversity throughout the landscape and addresses ecosystem condition and productivity and soil and water conservation.

A goal was established to maintain the range of seral stages on the FMA area. To achieve that goal the FMAC established an objective to ensure that each seral stage is represented on the landscape at key points in time. The target (natural) seral stage distribution is one that approximates the expected distribution created by natural disturbance regimes within the 2 Natural regions, Foothills and Boreal Forest.

4.2.8 Watershed

The protection of watersheds involves the protection of water yield and water quality. This contributes to the overall conservation of water resources within the FMA area. Water yield refers to streamflow quantity and timing which is a key determinant of the energy available for erosion, transport and deposition of sediment within channels. Streamflow is a key component in determining the morphology of channels, with implications for the quality and quantity of fish habitat. Water yield is an important component in determining the availability and suitability of water for beneficial uses including human consumption.

Water yield quantity and timing can be altered by compaction or disturbance of the ground surface, as with roads and skid trails. Water yield is also affected by vegetation growth or removal. Water yield generally increases after timber harvest through a reduction in transpiration and precipitation interception losses. Removal of forest canopy also affects snow accumulation and melt processes, often resulting in an increase in snowpack accumulation and melt rates, thereby increasing runoff rate and volume.

Water yield increases can be directly modelled, but Equivalent Clearcut Area (ECA) is often used as a surrogate. ECA is a primary factor considered in an evaluation of the potential effect of past and proposed forest harvesting on water yield. ECA is usually expressed as a percent of watershed area. The index (hydrological recovery) takes into account the initial percentage of crown removal and the recovery through regrowth of vegetation since the initial disturbance.

Within a defined watershed, total vegetated cover removal will not exceed 40% ECA above the H60. Total vegetated area includes the forested and non-forested vegetated covers.

4.3 Resource and Timber Supply Management Strategies Tested

The following sections describe the strategies tested for *the Resource and Timber Supply Analysis*.

4.3.1 Peace Block COMPLAN Pilot Study

The *Peace Block COMPLAN Pilot Project* was completed by Simons Reid Collins for Canadian Forest Products Ltd. in Grande Prairie, Alberta in 1996 to demonstrate the effectiveness of using COMPLAN to complete a *Resource and Timber Supply Analysis* with particular reference to modelling ecosystem management objectives.

4.3.2 Benchmark Run

The report, *Supplementary Timber Supply Analysis: Benchmark Run Results and Amended Timber Supply Analysis Information Package* (Appendix II) was prepared in February 2000 by R. Webb of Olympic Resource Management for Canadian Forest Products Ltd. in Grande Prairie, Alberta. The report describes the inputs, process and results obtained for Scenario #1 as described in Report #9 of the *Growth and Yield Information Package*.

The scenario described in this report was intended to determine the effect of new inventory data and yield tables on the AAC as compared to the previous timber supply analysis carried out in the 1991 DFMP. The results illustrate that little change can be expected in the harvest levels due to the new inputs. This indicates that any changes in harvest levels in subsequent analyses will be due to changes in management practices, assumptions or objectives and not due to changes in inventory data or yield table information.

The report outlines the data and procedures that were used in the COMPLAN analysis. Specific items that are addressed include:

- Spatial data coverages;
- Landbase;
- Growth and yield;
- Modelling parameters for non-timber resources and operational constraints;
- Proposed analysis framework; and
- Proposed scenarios.

There are some minor differences in the area summary information between the *Supplementary Timber Supply Analysis: Benchmark Run Results and Amended Timber Supply Analysis Information Package* and Report #9 of the *Growth and Yield Information Package* (Canfor 1999g) due to an error in GIS processing. Approximately 1,500 ha of forested land had been mistakenly classified as non-forest due to a problem with the road buffer coverage. This error has been corrected and the appropriate changes have been made.

5 SELECTION OF PREFERRED MANAGEMENT STRATEGY

The values, goals, indicators and objectives for the *Detailed Forest Management Plan* (DFMP) include those derived for Canfor's *Sustainable Forest Management Plan* (SFMP) which was developed to obtain certification for the Company's forestry operations under the Canadian Standards Association (CSA). Systematic and formal input into these came from the Forest Management Advisory Committee (FMAC) and the Forest Ecosystem Management Task Force (FEMTF). Tolko Industries Ltd. and Ainsworth Lumber Company Ltd., have been allocated deciduous timber within the FMA area, act in an advisory capacity to the FMAC. Along with Grande Alberta Paper Ltd., they also provide technical input regarding strategic and operational plans, *Resource and Timber Supply Analysis*, growth and yield projections, and operational and harvest sequence plans for the DFMP.

The total land base of the Forest Management Agreement (FMA) Area is determined using Alberta Vegetation Inventory (AVI ver 2.1) information. The AVI forms the basis for assigning yield tables and ages for use by the simulation model in the *Resource and Timber Supply Analysis*.

A stepwise net-down procedure was used to determine the net land base available for timber harvesting. Areas reserved from harvest, based on the net-down process, address objectives detailed in the SFMP and are removed from the Timber Harvesting Land Base (THLB). Areas of non-forest land are also removed. The resulting THLB is used in the modelling process to evaluate the management alternatives.

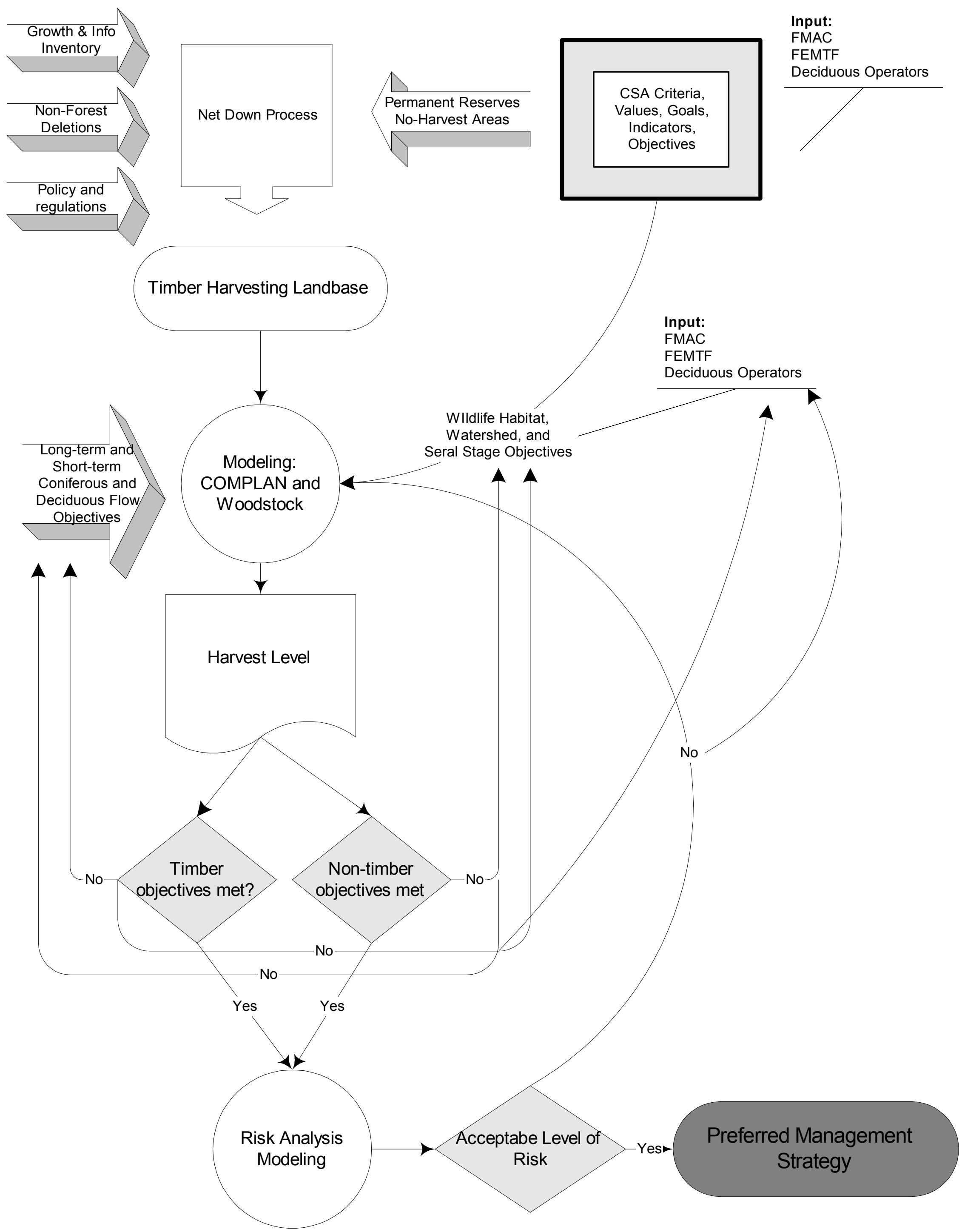
Wildlife habitat, seral stage and watershed objectives identified through the CSA sustainable forest management planning process and incorporated into the DFMP are applied as constraints and objectives within the modelling process. Long-term and short-term coniferous and deciduous wood flow objectives are set with input by the holders of deciduous allocations. It is attempted to satisfy these once the non-timber objectives have been met.

The Management alternatives are evaluated in the *Resource and Timber Supply Analysis* by a series of COMPLAN and WOODSTOCK runs. A non-declining even-flow (NDEF) harvest level is established for each of the management alternatives. Each run is evaluated in terms of its success in meeting the non-timber objectives. A final run will eventually be conducted and the final management alternatives will be selected. The preferred management strategy is comprised of compatible resource management strategies that best achieve the identified objectives (Figure 4).

A sensitivity analysis is completed to determine the level of risk implicit in the modelled solution. It can reveal areas where relationships between values are easily misunderstood and where small decisions have a high impact on the outcome. A decision on the acceptable level of risk is made. If the level of risk is unacceptable, then further runs must be completed and the timber and environmental objectives re-examined.

After evaluating numerous sensitivity analyses, the preferred management strategy was found to be Scenario 4C (Section 6.7). This scenario results in sustainable coniferous and deciduous wood flows. These harvest levels are achieved while assuring that non-timber resources are also maintained on a sustainable basis. These resources include natural biodiversity, wildlife habitat for numerous key species and water quality that is controlled on a watershed basis.

Figure 4. Evaluation of Preferred Management Strategy Flowchart.



6 RESOURCE AND TIMBER SUPPLY ANALYSIS

6.1 Description of Tools

The *Resource and Timber Supply Analysis* incorporated 2 modelling tools into the analysis, COMPLAN and WOODSTOCK.

6.1.1 COMPLAN

COMPLAN is a spatially based forest simulation model, developed by Olympic Resource Management (ORM) that has been used for timber supply analyses since 1994. COMPLAN uses an iterative approach to establish periodic harvest levels that can vary over time. Users are able to set harvest levels that the model will try to reach within the constraints established. COMPLAN schedules harvests at the individual cutblock or stand level subject to adjacency (green-up) and non-timber resource constraints (cover constraints). The model's built-in flexibility makes it possible to evaluate many different scenarios with a large degree of realism.

COMPLAN uses a hierarchical data structure that takes advantage of a compartmental management approach to spatial data organization. Advantages of this approach include easy integration with GIS systems, adaptation to a wide variety of tenure administration structures and integration of both strategic and operational planning.

Appendix III contains a more detailed description of COMPLAN's capabilities.

6.1.2 WOODSTOCK

WOODSTOCK is a forest level planning tool that is accomplishes optimization modelling more efficiently. Spatial concerns within WOODSTOCK are addressed through the monitoring and constraint of special management areas. WOODSTOCK searches for an optimum solution to a problem in a more complicated process than used in a simulation model like COMPLAN. For this reason, the database that is input is a simplified version of the one used in COMPLAN. The dataset is organized into distinct units that aggregate similar forest types and harvest-suitability areas so that the model can maximize either coniferous or deciduous volumes while maintaining a predetermined volume of resource values.

Appendix IV contains a more detailed description of WOODSTOCK's capabilities.

6.1.3 Modelling using both COMPLAN and WOODSTOCK

COMPLAN and WOODSTOCK can be used together to model scenarios and to gain further insight into the results of forest planning decisions. COMPLAN produces results that spatially illustrate yearly volume and area-based harvest levels. The amount of area that COMPLAN harvests each year can be used to manually limit the optimized harvest achieved by WOODSTOCK. This enables WOODSTOCK to consider the complicated spatial concerns modelled by COMPLAN when calculating an optimum solution. The optimized output is a benchmark for the more detailed simulation-based solution.

6.1.4 Description of Reports to describe COMPLAN Output

Text output files generated by COMPLAN are transferred into an ACCESS database for further analysis by COMPLAN Reporter. The output files can be loaded into a single database. Very complicated COMPLAN runs generate large output files that may have to be loaded into several databases.

6.2 Model Inputs

The following section describes the various data that was applied to *the Resource and Timber Supply Analysis*.

6.2.1 Landbase Summary

This section provides a land base summary for the inputs which will be used as part of the *Resource and Timber Supply Analysis*. As a result of the incorporation of the 2001 Annual Operating Plan (AOP), an area validation was performed to provide a comparison against the previous Benchmark Report (Appendix V).

6.2.1.1 Spatial Data Coverages

A number of Geographic Information System (GIS) data coverages were used in the preparation of the spatial dataset for the *Resource and Timber Supply Analysis*. These coverages were overlaid to generate a single coverage that contains all the information from all of the input coverages. The resultant dataset contains the attributes for each of the coverages. The individual roles of the coverages within the analysis are provided below.

6.2.1.1.1 Alberta Vegetation Inventory

Canfor completed an Alberta Vegetation Inventory (AVI 2.1) for the entire Forest Management Area. (FMA) in December 1996 using colour infrared photography taken during 1993-1995. This inventory has since been updated to reflect harvest areas up to April 30, 1997. Additional updates to the end of 2000 will be modelled within the COMPLAN simulations through use of the historical cutblock coverage.

The AVI forms the basis for assigning yield tables and ages for use by the simulation model in the Analysis.

6.2.1.1.2 Existing Cutblocks

A coverage consisting of cutblocks harvested prior to 1997 was used to assign yield tables and ages to areas identified as clearcut in the AVI. This additional information consisted of:

- Year harvested;
- Yield group assignment for regeneration; and
- A flag indicating where coniferous has been released by weeding with brush saws.

When assigning yield groups to the harvested areas, a strategy was used that considered whether weeding had occurred. Weeded areas are more coniferous dominated and untreated areas are more Mixedwood dominated. A random approach was used in applying this strategy and Canfor believes that the results favour

Mixedwood stands over pure coniferous. This means that the analysis will be somewhat conservative with respect to future coniferous volumes. Table 2 summarizes the assignment of yield groups for harvested areas.

Table 2. Yield Group Assignment for Harvested Areas

Yield Group	Description	Areas Assigned to Each Yield Group (ha)				
		Harvested Before 1991, Weeded	Harvested Before 1991, Not Weeded	Harvested 1991 and Later, Weeded	Harvested 1991 and Later Not Weeded	Total
3	AWSW/PBSW/BWSW	0.00	7,680.51	0.00	0.00	**7,680.52**
8	PL/PLFB+(H)	0.00	179.64	0.00	1,857.38	**2,037.03**
9	PLAW/AWPL	6,622.97	0.00	19.48	325.63	**6,968.08**
11	PLSW/SWPL+(H)	1,330.83	0.00	0.00	3,617.34	**4,948.19**
16	SW/SWFB+(H) – CD	494.17	2,630.73	0.00	6,106.39	**9,231.29**
17	SWAW/SWAWPL	431.25	18,431.56	0.00	3,996.88	**22,859.69**
Total		**8,879.23**	**28,922.44**	**19.48**	**15,903.64**	**53,724.79**

Source: ORM compiled data

6.2.1.1.3 Proposed Cutblocks

A coverage containing historical blocks was used to provide harvested updates to forest inventory for 1998. The 2001 Annual Operating Plan (AOP) submission blocks provided operational realism for the scheduled harvest up to 2003. Proposed cutblocks for both Canfor and Tolko were included in this coverage. It was necessary to use automated Geographic Information System (GIS) processing with manual intervention to rationalize this coverage with the stream and lake buffer coverage.

6.2.1.1.4 Additional Road Clearings

Some but not all of the road right-of-ways were classified as clearings within the AVI (20 m tolerance). An additional coverage was created to account for road clearings not contained within the AVI. Areas within these buffers were assumed to be non-forest for purposes of the analysis.

6.2.1.1.5 Trumpeter Swan Sites

Alberta Sustainable Resource Development Fish and Wildlife supplied a map of the trumpeter swan nest sites. A 200 m buffer was created around these water bodies. Areas within these buffers were considered unavailable for harvest. The Trumpeter Swans sites are shown in Appendix VI, Map 1.

6.2.1.1.6 Stream and Lake Buffers

A coverage with buffer polygons (100%) around riparian features was created. Buffer widths correspond to the current operating ground rules and were:

- Major rivers – 60 m each side;
- Perennial streams – 30 m each side;
- Intermittent streams – 30 m each side;
- Lakes >= 4 ha and <= 16 ha – 100 m; and
- Lakes > 16 ha – 100 m.

Areas within these riparian buffers were considered unavailable for harvest.

6.2.1.1.7 Caribou

A coverage defining the limits of the Caribou Area. Forest cover constraints will be applied in a similar approach to that used by Weyerhaeuser (Grande Prairie and Grande Cache Operations). The Caribou Area is shown in Appendix VI, Map 2.

6.2.1.1.8 Government Landbase Deletions

A polygon coverage containing government landbase deletion sites was used. Specific types of deletions included:

- Base camps;
- Cabin sites;
- Fire towers;
- Permanent sample plots;
- Public pits;
- Recreation sites;
- Research sites;
- Reforestation projects;
- Sand and gravel pits;
- Staging areas;
- Stockpiles; and
- Weather stations.

Timbered areas within government landbase deleted areas were considered to be unavailable for harvest with the exception of sand and gravel pits, public pits and stockpiles. These exceptions were only available for harvest for the first cut, at which time they became non-forest land.

6.2.1.1.9 Grave Sites

Known archaeological gravesites were protected with a 100 m buffer. These buffers were considered to be unavailable for harvest.

6.2.1.1.10 Rare Physical Environments

The following rare physical environments were identified in a coverage and excluded from harvest:

- Cactus Hills;
- Peace Parkland;
- Peace River Dunvegan; and
- Parabolic Sand Dunes.

The rare physical environments are shown in Appendix VI, Map 3.

6.2.1.1.11 Eastern Slopes

Polygons from the East Slopes Higher Level Plan were included in the resultant overlay. Since the Major Valley Complex Landscape Management Unit overlaps with this area, it was not intended to constrain the analysis using this information. Polygons within this coverage include:

- Critical wildlife;
- General recreation; and
- Multiple use.

The Eastern Slopes are shown in Appendix VI, Map 4.

6.2.1.1.12 Natural Subregions

A Natural subregions (NSR) coverage was included in the resultant coverage and was used to provide information for development and assignment of the yield tables. NSRs present in the FMA area include:

- Central Mixedwood (CMW);
- Dry Mixedwood (DMW);
- Lower Foothills (LFH);
- Upper Foothills (UFH);
- Peace River Parkland (PRP); and
- Subalpine (SAL).

The Natural Subregions are shown in Appendix VI, Map 5.

6.2.1.1.13 Landscape Management Units

Fourteen Landscape Management Units (LMUs) were defined within the FMA. The LMUs are:

- Deep Valley Plateau;
- Losegun Plain;
- Kakwa Benchlands;
- Latornell Delta;
- Little Smoky Valley;
- Major Watercourse/Valley Complexes;
- Peace Parkland;
- Puskwaskau;
- Peace Slopes;
- Peace Upland;
- Simonette Benchlands;
- Smoky Plain;

- Simonette Uplands; and
- Simonette Uplands Slope.

6.2.1.1.14 Operational Unit and Operational Subunit Boundaries

A coverage with 10 operating units and 41 subunit boundaries was included in the overlay. These boundaries form logical operating units were used in the *Resource and Timber Supply Analysis* for geographic harvest prioritization. The operating units are:

- Deep North;
- Deep South;
- E8;
- Economy North;
- Economy South;
- Latronell;
- Peace;
- Puskwaskau;
- Simonette; and
- Smoky

The Operational Units and Operational Subunits are shown in Appendix VI, Maps 6 and 7 respectively.

6.2.1.2 Landbase

The following sections provide a description of the landbase used in the *Resource and Timber Supply Analysis*.

6.2.1.2.1 Timber Harvesting Landbase

The FMA area covers a total area of 649,160 hectares (ha). A stepwise net-down procedure was used to determine the net landbase available for timber harvesting. Table 3 provides a summary of the net-down process.

Table 3. Landbase Summary

Classification	Area (ha)	Area (ha)	% of Total Area	% of Forested Area
Total landbase		**649,159.89**	**100.00**	
Reductions for non-forest				
Natural non-vegetated	12,959.91		2.00	
Anthropogenic non-vegetated	4,939.35		0.76	
Anthropogenic vegetated	4,946.51		0.76	
Non-forest vegetated	32,884.48		5.06	
AVI Attribute MODCON1 = "sc"	0.18		0.00	
AVI Attribute MODCON1 = "cl"	0.68		0.00	
Roads not included in AVI	1,132.95		0.17	
Total non-forest reductions	56,864.06	56,864.06	8.76	
Total forested landbase		**592,295.83**	**91.24**	**100.00**
Reductions to forested landbase				
Steep slopes (from AVI)	10,522.07		1.62	1.78
Slumps (from AVI)	42.51		0.01	0.01
Gravesites	5.15		0.00	0.00
DRS	320.48		0.05	0.05
Peace Parkland Rare Physical Environment	303.82		0.05	0.05
Cactus Hills Rare Physical Environment	8.00		0.00	0.00
Peace River Dunvegan Rare Physical Environment	374.33		0.06	0.06
Parabolic Sand Dunes Rare Physical Environment	5,480.31		0.84	0.92
Swan buffers	2,247.56		0.35	0.38
Watercourse buffers	37,715.86		5.81	6.37
Low productive (Yield Group 13)	25,821.55 [1]		3.98	4.36
River buffers (Beaver)	3.79		0.00	0.00
Non-allocated deciduous areas	9,837.93 [2]		1.51	1.66
Height/Age Reduction areas	18,383.65 [3]		2.83	3.10
Non-allocated birch areas	6,903.09 [4]		1.06	1.16
AOP Reserve Areas	132.69 [5]		0.02	0.02
Total reductions to forested landbase	118,102.79	118,102.79	18.19	19.92
Timber harvesting landbase		**474,193.04**	**73.05**	**80.06**

The changes that have occurred to this present landbase summary as result of the integration of the 2001 Annual Operating

1. Low productive - Yield Group 13 (SBLT/LTSB-U)
Approximately 11 ha of yield group 13 in proposed cutblocks are not included in low productive. In addition, one of the GIS inputs into the timber supply is an AOP coverage containing stands to be harvested in the near term. One of the assumptions built into the process is that all timber within an AOP block is economically operable. The AOP coverage that was present at the time of the Benchmark Report contained a block that overlaid approximately 5 ha of a yield group 13 (SBLT/LTSB-U) type. Despite this, the 5 ha was assumed to be operable. Under the updated AOP coverage, this particular stand was either modified or removed. The 5 ha of yield group 13 reverted back to inoperable.

2. Non-Allocated Deciduous Areas
The addition of stands classified as non-allocated deciduous areas which were removed from the Timber Harvesting Landbase (THLB). These are hardwood stands within G8C and E8 that are not part of the hardwood quota allocation.

3. Height/Age Reductions Areas
The addition of stands classified as height/age reduction areas which were removed from the THLB. These are stands which
- Yield group 12 (SBLT/LTSB – G,M,F) stands with heights < 16 and ages > 80.
- All other coniferous stands with height < 13 and ages > 80.

4. Non-Allocated Birch Areas
The addition of stands classified as non-allocated birch areas which were removed from the THLB. These are birch stands which have not been allocated.

5. AOP Reserve Areas
The addition of stands classified as AOP reserve areas were removed from the THLB. These are polygons classified within the new AOP coverage as AOP blocks with a reserve status.

Source: ORM compiled data

6.2.1.2.2 Assignment of Coniferous Understorey to Deciduous Yield Groups

An understorey is composed of trees and other woody species growing under the canopies of larger adjacent trees and other woody growth (Dunster and Dunster 1996). Coniferous understories are very important to Canfor because they provide growing stock for future forests. Identification of deciduous priority stands with coniferous understorey is very important due to its substantial contribution to the coniferous annual allowable cut.

Stands with a deciduous overstorey and coniferous understorey have been identified through 2 methods:

1. Those that have been identified as part of the Alberta Vegetation Inventory standard through photo interpretation of 1:15,000 color infrared aerial photography. Stands with an interpreted coniferous understorey of 5 m in height and greater are classed as an understorey stand; and
2. Those that have been identified through an extensive understorey survey composed of Temporary Sample Plots (TSP). TSPs were classed as an understorey if the following conditions were met (Table 4):
   - A minimum density of 100 stems/ha for coniferous greater than 1.3 m in height; and
   - A minimum density of 400 stems/ha for conifers less than 5cm Diameter at Breast Height (DBH).

The TSPs were then used to determine what proportion, by yield group, of the deciduous priority stands had an understorey (Table 5). These proportions were then used to reassign stands from deciduous priority to coniferous priority.

Table 4. Minimum Required Coniferous Stocking Levels

Confierous Tree Size Class	Minimum Density (stems/ha)
confers 1.3 metres +	100
all confers < 5 cm DBH	400

Source: *Coniferous Understorey Stocking Study,* W.R. Dempster, in *Detailed Forest Management Plan 1991*, Appendix 8.

Table 5. Proportion of Deciduous Stands with Conifer Understory

Yield Group	Description	Proportion with Conifer Understorey
1	AW+(S) - AB	27%
2	AW+(S) - CD	11%
4	BW/BWAW+(S)	40%
7	PB+(S)	14%

Source: ORM Compiled Data

The FMA agreement Appendix B, 3(1) defines how stands will be managed:

"*Pure coniferous and Mixedwood stands (C, CD, and DC) and pure deciduous stands (D) with established coniferous understorey identified on Alberta Vegetation Inventory Standards (AVI) version 2.1 and which form part of the coniferous cut in the Detailed Forest Management Plan approved on December 3, 1991 or, when approved in the current Detailed Forest Management Plan, shall be managed for coniferous production." The Detailed Forest Management Plan shall provide for the sustainability of the volume of deciduous timber harvested from those stands managed for coniferous production.*

In 1997, Canfor commissioned a study to identify coniferous understories in the FMA area. Coniferous understories were identified in 2 ways:

1. From 1:15,000 Colour infrared (IR) (leaf-off). Due to the scale of the photography, interpretators were able to identify understories 5 m in height and greater; and
2. From temporary sample plots (TSPs). The details of this program follow.

An extensive understorey survey composed of temporary sample plots (TSP) was completed and Olympic Resource Management (Canfor 1999d) prepared a report. The report details the procedure used to identify information in the Alberta Vegetation Inventory (AVI) covertype "call" that can be used to partition stands, with or without sufficient coniferous understorey, in deciduous yield groups that are not photo-interpretable. The development of this procedure is a requirement of the *1999 Canfor Grande Prairie Forest Management Agreement* and is similar to the approach used in the approved 1991 *Detailed Forest Management Plan*. Refer to Section 5 in the *Resource and Timber Supply Analysis* document for further details of how this was applied.

The identification of deciduous stands with coniferous understorey is very important due to the substantial contribution to the coniferous annual allowable cut. Each forested polygon within the FMA area was initially classified into one of the yield groups using the methodology outlined in the document *Landbase Stratification in the Canfor FMA, Report #2*, (Canfor 1999c). Based on an analysis of temporary sample plots (please refer to *Coniferous Understorey Study in the Canfor FMA*, *Report # 3* (Canfor 1999d), it was determined that a proportion of stands in Yield Groups 1, 2, 4 and 7 contain coniferous understorey with sufficient stocking to be classified as coniferous landbase. Table 4 provides a summary of these proportions.

Because of the spatially explicit nature of the *Resource and Timber Supply Analysis*, it was necessary to assign the stands with understorey to specific polygons. Although this did not reflect operational reality, it provided consistency between scenarios and gives adequate information for strategic annual allowable cut determination.

Based on the conclusions from the *Coniferous Understorey Study in the Canfor FMA, Report # 3 June 1999*, the following generic methodology was used to assign the presence of understorey to specific stands:

- All stands were flagged as having understorey if they met specified criteria as outlined in the *Coniferous Understorey Study in the Canfor FMA, Report # 3* (Canfor

1999d). This was completed without reference to the timber harvesting landbase;

- Stands were added or subtracted as necessary to meet the specified percentage. The procedure used attempted to distribute the additions/subtractions across the FMA area in a random manner from within a subset of candidate stands. This process was completed without reference to the timber harvesting landbase;
- The proportion of stands flagged as having understorey within the net timber harvesting landbase were evaluated. Stands were added or subtracted as necessary to meet the targets within the net timber harvesting landbase in a procedure similar to that used in Step 2; and
- No attempt was made to adjust the percentages for stands that were not within the net timber harvesting landbase since there should be no effect on available harvest volumes.

Specific criteria for the 4 yield groups are described below.

1. Yield Group 1 - AW+(S)-AB

All stands with understorey indicated on the AVI classification were initially flagged as having understorey present. This resulted in a percentage greater than that indicated in Table 4. A procedure was used to adjust the number with understorey down to the target of 29%. This procedure selected stands without any coniferous species in the combined inventory label on a random basis from across the FMA area. A further reduction was required within the net timber harvesting landbase.

2. Yield Group 2 - AW+(S)-CD

All stands with understorey indicated on the AVI classification and within the Lower Foothills Natural subregion were initially flagged as having understorey present. To increase the resulting proportion up to the required 22%, a random procedure was used to select additional Yield Group 2 stands from across the FMA area. A reduction was required within the net timber harvesting landbase.

3. Yield Group 4 - BW/BWAW+(S)

All stands with understorey indicated on the AVI classification were initially flagged as having understorey present. To increase the resulting proportion up to the required 40%, a random procedure was used to select additional Yield Group 4 stands containing coniferous species in the combined inventory label from across the FMA area. A reduction was required within the net timber harvesting landbase.

4. Yield Group 7 - PB+(S)

All stands in Yield Group 7 and containing coniferous species in the combined inventory label were initially flagged as having understorey present. To reduce the resulting proportion to the required 14%, a random procedure was used to select stands from across the FMA area. Additional stands were required within the timber harvesting landbase.

Table 6 provides a summary of the area of deciduous stands classified as having coniferous understorey.

Table 6. Deciduous Stands with Coniferous Understorey

Yield Group	Description	Total Landbase (ha) (1) Total Area (ha)	(2) With Understorey (ha)	Timber Harvesting Landbase (ha) (3) Total Area (ha)	(4) With Understorey (ha)
1	AW+(S) – AB	19,382.95	5,268.45	16,196.63	4,672.69
2	AW+(S) – CD	107,353.21	12,042.43	88,957.75	11,016.59
4	BW/BWAW+(S)	15,449.12	6,156.16	6,977.34	5,694.52
7	PB+(S)	27,709.35	3,968.04	25,927.56	3,603.81
Total		**169,894.63**	**27,435.08**	**138,059.28**	**24,987.61**

Source: ORM compiled data

6.2.1.2.3 Summary of Landbase by Yield Group

Table 7 provides a summary of the area by yield group for the FMA area. The understorey classification breakdown is further described in Table 6

Table 7. Area by Yield Group

Yield Group	Description	Excluded From Timber Harvesting Landbase (ha)	Included In Timber Harvesting Landbase (ha)	Total (ha)
1	AW+(S) - AB	2,590.56	11,523.95	**14,114.51**
2	AW+(S) - CD	17,369.62	77,941.16	**95,310.78**
3	AWSW/PBSW/BWSW	3,002.97	29,049.70	**32,052.67**
4	BW/BWAW+(S)	8,010.14	1,282.82	**9,292.96**
5	FB+OTH	844.85	7,600.48	**8,445.33**
6	H+(S)/S	3,722.09	49,737.73	**53,459.82**
7	PB+(S)	1,417.56	22,323.75	**23,741.31**
8	PL/PLFB+(H)	4,793.12	48,294.40	**53,087.52**
9	PLAW/AWPL	1,350.65	18,251.67	**19,602.32**
10	PLSB+OTH	1,062.41	9,555.74	**10,618.15**
11	PLSW/SWPL+(H)	2,786.46	20,358.66	**23,145.12**
12	SBLT/LTSB(G,M,F)	22,738.59	34,448.90	**57,187.49**
13	SBLT/LTSB(U)	30,005.40	11.39	**30,016.79**
14	SBPL/SBSW/SBFB	2,217.45	16,686.44	**18,903.89**
15	SW/SWFB+(H) - AB	5,922.78	24,058.12	**29,980.90**
16	SW/SWFB+(H) - CD	3,576.36	32,909.22	**36,485.58**
17	SWAW/SWAWPL	4,244.30	45,171.29	**49,415.59**
US	Deciduous moved to Deciduous with Coniferous Understorey	2,447.48	24,987.62	**27,435.10**
Total		**118,102.79**	**474,193.04**	**592,295.83**

US refers to yield groups:
Yield Group 1 - AW+(S)-AB
Yield Group 2 - AW+(S)-CD
Yield Group 3 - BW/BWAW+(S)
Yield Group 4 - PB+(S)

Source: ORM compiled data

6.2.1.2.4 Reductions for Seismic Lines

Yield table reductions were used to account for seismic lines within the FMA area. The following procedure was used to determine the appropriate reduction for each yield group.

- The ARC/INFO seismic line coverage was buffered to a total width of 4 m;
- The seismic line buffers were overlaid on the resultant coverage;
- The proportion of area in seismic line buffers within each yield group was calculated for the net timber harvesting landbase (i.e. after application of net-downs); and
- The calculated reduction factor for each yield group was applied to the yield table for that yield group.

The yield group reduction factors are summarized in Table 8. An average of 1% was applied to all yield tables since COMPLAN restricts this factor to integer values.

Table 8. Seismic Line Reduction Factors

Yield Group	Description	Reduction Factor (%)
1	AW+(S) - AB	1.22
2	AW+(S) - CD	1.06
3	AWSW/PBSW/BWSW	1.12
4	BW/BWAW+(S)	1.13
5	FB+OTH	1.24
6	H+(S)/S	1.21
7	PB+(S)	0.93
8	PL/PLFB+(H)	1.09
9	PLAW/AWPL	1.31
10	PLSB+OTH	1.13
11	PLSW/SWPL+(H)	0.87
12	SBLT/LTSB(G,M,F)	1.19
13	SBLT/LTSB(U)	1.26
14	SBPL/SBSW/SBFB	1.26
15	SW/SWFB+(H) - AB	0.98
16	SW/SWFB+(H) - CD	0.96
17	SWAW/SWAWPL	1.03
Weighted Avg.		**1.10**

Source: ORM compiled data

6.2.1.2.5 Reduction for Future Roads

A yield table reduction of 2% was applied to regenerated yield tables to account for the area lost to future road construction.

6.2.2 Growth and Yield

The following section describes the growth and yield procedures applied to the *Resource and Timber Supply Analysis*.

6.2.2.1 Volume Sampling Program

Report #1 Inventory Program (Canfor 1999b) of the *Growth and Yield Information Package, Detailed forest Management Plan 1999, Volume 1* provides a summary of the methodology used to determine plot requirements for Canadian Forest Products Ltd. (Canfor), Alberta Vegetation Inventory (AVI) volume sampling program. The plot allocation method is also provided.

The following criteria were used as the basis for plot requirements:

- **Yield and attribute tables for each yield class** - predicting stand height, volume and density by species;
- **Volume, stock and stock tables for each volume sampling stratum** - estimating average volume and number of stems per ha by species, diameter class and AVI height and crown closure classes (volume sampling errors will be targeted not to exceed the lesser of ±33% or ±50 m^3/ha at the 95% probability level for any stratum exceeding 5% of the total standing volume for the Forest Management Area; however this sampling objective will be secondary to 3 below);
- **Total standing volume of coniferous and deciduous on the FMA area** - estimating to FMA area utilization standard, with a sampling error not exceeding ±10% at the 95% probability level for either the coniferous or deciduous component;
- **Understorey attributes** - stocking, density, age and height; and
- **Other stand attributes** - ecosystem indicators and biodiversity, snags, down woody debris and fuel loading.

In addition, this report details the field procedures, quality control, stand selection and plot allocation methods used in the volume sampling program.

6.2.2.2 Yield Curve and Volume Table Development

The following section describes the development of yield curves applied to the *Resource and Timber Supply Analysis*.

6.2.2.2.1 Stratification of Landbase

Report #2 Landbase Stratification in the Canfor FMA (Canfor 1999c) of the *Growth and Yield Information Package Detailed Forest Management Plan 1999, Volume 1* outlines the methodology that was used for the stratification of the landbase in the FMA area into yield classes. To aid in operational planning and analysis, the FMA area was stratified into 17 yield groups based on Alberta Vegetation Inventory (AVI) stand attributes of species composition, density, and height and timber productivity. The number of yield groups was decided based on practical considerations, the importance of certain timber types in the FMA area and the geographic significance of ecologically important strata.

The stratification methodology was designed with the following objectives in mind:

- The stratification must reflect growth characteristics of stands in the FMA area;
- The stratification must make operational sense;
- The stratification rules must be clearly defined;
- The stratification must be applied consistently to the landbase (AVI) and the subsequent grouping of temporary and permanent sample plots; and
- The stratification process must be repeatable.

To determine plot requirements, volume sampling error could not exceed the lesser of ± 33% or ± 50 m^3/ha at the 95% confidence level for any stratum exceeding 5% of the FMA standing volume. The sampling error for total standing volume of coniferous or deciduous on the FMA area could not exceed ± 10% at 95% confidence. Based on these objectives, 926 plots would meet sampling requirements. However, Canfor elected to establish additional plots to augment ecological data and the total number of Temporary Sample Plots (TSPs) identified for the 1997 sampling program was 1,395 plots.

The stratification rules were defined based on overstorey and understorey species and AVI height and crown closure classes. A total of seventeen yield groups were identified in this process. The number of yield groups was defined on the basis of practical combinations that reflected operational concerns and ecological and management constraints.

The stratification logic was applied consistently to both the landbase (AVI) and the sample plots. It was implemented in a repeatable database program within *Microsoft Access®*.

Report #3 of the *Growth and Yield Information Package* (Canfor 1999d) details the procedure used to identify information in the Alberta Vegetation Inventory (AVI) covertype call that can be used to partition stands, with or without sufficient coniferous understorey, in deciduous yield groups that are not photo-interpretable. The development of this procedure is a requirement of the 1999 Canfor Grande Prairie Forest Management Agreement and is similar to the approach used in the approved 1991 *Detailed Forest Management Plan* (DFMP). Identification of deciduous stands with coniferous understorey is very important due to its substantial contribution to the coniferous annual allowable cut.

An extensive understorey survey composed of Temporary Sample Plots (TSPs) was completed for the entire FMA area in 1997; this study is based on the data collected in those TSPs. The coniferous understorey distribution was evaluated based on the following parameters:

- Total number of coniferous understorey stems/ha < 5 cm DBH; and
- Total number of coniferous understorey stems/ha > 1.3 m.

The study consisted of 3 components:

1. Coniferous understorey stocking data was compiled by deciduous yield group;
2. The proportion of plots with sufficient coniferous understorey stocking was determined by deciduous yield group; and
3. Descriptive statistics (mean, standard deviation, range, etc.) were calculated by several AVI variables to determine whether partitioning can actually be carried out at the inventory level. Analysis of variance (ANOVA) was performed on the AVI (map) understorey variable for Yield Groups 1 and 4. A t-test comparing sample means with stocking requirements was also performed on Yield Group 7.

The objective of this study is to develop strategies that can be used to spatially allocate stands with sufficient understorey in the FMA area rather than relying on random selection. The proportion of selected stands within a yield group cannot exceed the proportion observed in the temporary sample plots (Table 3).

6.2.2.2.2 Permanent (PSP) and Temporary Sample Plot (TSP) Compilation

Report #4, Compilation of PSP and TSP Data in the Canfor FMA (Canfor 1999e) of the *Growth and Yield Information Package, Detailed Forest Management Plan 1999, Volume 1* summarizes the data compilation procedures that were applied prior to the development of the multiple utilization stand yield tables used for the calculation of the AAC for the Detailed Forest Management Plan.

This report details the compilation of inventory databases based on Temporary Sample Plot (TSP) and Permanent Sample Plot (PSP) data both used in the development and validation of Canfor's Multiple Utilization Yield Table System (MUYTS).

6.2.2.2.3 Multiple Utilization Yield Table System

Report #5, Development of a Multiple Utilization Stand Yield Table System (MUYTS) in the Canfor FMA (Canfor 1999f) of the *Growth and Yield Information Package* summarizes the work undertaken to develop a multiple utilization yield table system that is used in the calculation of the Annual Allowable Cut (AAC).

The MUYTS was designed to be used as the foundation of a sound and informed forest management plan. The key components of the system detailed in the report are as follows:

- Volume-Height model (VPH),
- Quadratic Mean Diameter-Height model (QMD),
- Volume Reduction Ratio model (VRR),
- Stems-QMD model (SPH), and
- Stem Reduction Ratio model (SRR).

The model forms for all key components, with exception of the volume-height model, were derived from Temporary Sample Plot (TSP) data. The form for volume-height model was based on work developed by the Alberta Forestry, Lands and Wildlife, Forest Service (1985).

In June of 1999 work was undertaken to improve the model fit of the MUYTS by re-examining the VRR. The objectives of this Project were to:

- Improve fit of the 15+/10 utilization model, without impacting negatively upon the other utilization models;
- Improve fit of the other utilization models;
- Maintain the biological and logic functional properties of the model; and
- Revisit stand decline for the deciduous component of the FMA area.

It was found that the volume predictions obtained from the 15+/10 utilization model in the earlier (June 1999) MUYTS were somewhat underestimated and conservative. The model was re-visited and enhancements were made to the model, improving its function. Deciduous stand decline was re-examined and new boundaries for maximum age, breakup age and terminal age were applied for yield table generation, as per the discussions with Ainsworth Lumber Co. Ltd. The results of this work were reported in *Amendment to Report#5 of the Growth and Yield Information Package* (Canfor 1999h).

6.2.2.3 Implementation of Growth and Yield in COMPLAN

The development of the base yield tables for the *Resource and Timber Supply Analysis* has been documented in a separate report called *Development of a Multiple Utilization Yield Table System in the Canfor FMA, Report #5,* (Canfor 1999f). The intent of this section is to describe the implementation of these yield tables within the *Resource and Timber Supply Analysis*.

6.2.2.3.1 Assignment of Breast Height Age for Existing Stands

The yield tables used in the analysis are referenced to breast height age. Therefore, it was necessary to convert AVI origin date to breast height age. Age adjustment factors for each yield group/Natural subregion combination were subtracted from AVI origin age. Table 9 summarizes the adjustment factors used.

Table 9. Conversion of AVI Age to Breast Height Age

Yield Group	Description	Years to Breast Height
1	AW+(S) - AB	6
2	AW+(S) - CD	6
3	AWSW/PBSW/BWSW	15
4	BW/BWAW+(S)	6
5	FB+OTH	15
6	H+(S)/S	15
7	PB+(S)	6
8	PL/PLFB+(H)	10
9	PLAW/AWPL	10
10	PLSB+OTH	10
11	PLSW/SWPL+(H)	10
12	SBLT/LTSB(G,M,F)	20
13	SBLT/LTSB(U)	20
14	SBPL/SBSW/SBFB	20
15	SW/SWFB+(H) - AB	15
16	SW/SWFB+(H) - CD	15
17	SWAW/SWAWPL	15

Source: ORM compiled data

6.2.2.3.2 Assignment of Breast Height Age for Harvested Areas

Using performance survey results, a regeneration lag and years to breast height were assigned on the basis of yield group, weeding history and whether harvesting occurred prior to 1991. Table 10 summarizes the regeneration lags and breast height age adjustments used for this Analysis.

Table 10. Regeneration Lag and Years to Breast Height for Harvested Areas

Yield Group	Description	Natural Subregion	Weeded	Harvest Year	Regeneration Lag (years)	Zero to Breast Height (years)	Total to Breast Height (years)
3	AWSW/PBSW/BWSW	All	Y	Pre-1991	4	15	**19**
8	PL/PLFB+(H)	All	Y	Pre-1991	4	8	**12**
9	PLAW/AWPL	All	Y	Pre-1991	4	8	**12**
11	PLSW/SWPL+(H)	All	Y	Pre-1991	4	8	**12**
16	SW/SWFB+(H) - CD	All	Y	Pre-1991	4	8	**12**
17	SWAW/SWAWPL	All	Y	Pre-1991	4	8	**12**
3	AWSW/PBSW/BWSW	All	N	Pre-1991	9	15	**24**
8	PL/PLFB+(H)	All	N	Pre-1991	9	8	**17**
9	PLAW/AWPL	All	N	Pre-1991	9	8	**17**
11	PLSW/SWPL+(H)	All	N	Pre-1991	9	8	**17**
16	SW/SWFB+(H) - CD	All	N	Pre-1991	9	8	**17**
17	SWAW/SWAWPL	All	N	Pre-1991	9	8	**17**
9	PLAW/AWPL	CMW, DMW, LFH, PRP	Y	1991+	4	1	**5**
9	PLAW/AWPL	UFH, SAL	Y	1991+	4	4	**8**
3	AWSW/PBSW/BWSW	All except UFH	N	1991+	1	7	**8**
3	AWSW/PBSW/BWSW	UFH	N	1991+	1	10	**11**
8	PL/PLFB+(H)	CMW, DMW, LFH, PRP	N	1991+	1	4	**5**
8	PL/PLFB+(H)	UFH, SAL	N	1991+	1	7	**8**
9	PLAW/AWPL	CMW, DMW, LFH, PRP	N	1991+	1	4	**5**
9	PLAW/AWPL	UFH, SAL	N	1991+	1	7	**8**
11	PLSW/SWPL+(H)	CMW, DMW, LFH, PRP	N	1991+	1	4	**5**
11	PLSW/SWPL+(H)	UFH, SAL	N	1991+	1	7	**8**
16	SW/SWFB+(H) - CD	CMW, DMW, LFH, PRP	N	1991+	1	7	**8**
16	SW/SWFB+(H) - CD	UFH, SAL	N	1991+	1	10	**11**
17	SWAW/SWAWPL	CMW, DMW, LFH, PRP	N	1991+	1	7	**8**
17	SWAW/SWAWPL	UFH, SAL	N	1991+	1	10	**11**

Source: ORM compiled data

6.2.2.3.3 Assignment of Breast Height Age for Deciduous Stands with Coniferous Understorey

A proportion of deciduous stands was reassigned to reflect the presence of coniferous understorey. Information to assign breast height age to the understorey was derived from an analysis of the temporary sample plots.

- For those stands where the AVI indicated an understorey origin, this origin was converted to a breast height age by subtracting the years to breast height (indicated in Table 11) from the total age; and
- For those stands where the AVI did not indicate an understorey origin, the understorey was assigned the average breast height age of the understorey based on plot data. This is shown in Table 12.

Table 11. Years to Breast Height Age for Deciduous Stands with Coniferous Understorey

Yield Group	Description	Natural Subregion	Years To Breast Height (years)
1	AW+(S) - AB	CMW, PRP, SAL	15
1	AW+(S) - AB	DMW	15
1	AW+(S) - AB	LFH	15
1	AW+(S) - AB	UFH	15
2	AW+(S) - CD	CMW, UFH, PRP, SAL	15
2	AW+(S) - CD	DMW	15
2	AW+(S) - CD	LFH	15
4	BW/BWAW+(S)	CMW	15
4	BW/BWAW+(S)	DMW	15
4	BW/BWAW+(S)	LFH, UFH, PRP, SAL	15
7	PB+(S)	CMW, UFH, PRP, SAL	15
7	PB+(S)	DMW	15
7	PB+(S)	LFH	15

Source: ORM compiled data

Table 12. Average Breast Height Age for Deciduous Stands with Coniferous Understorey

Yield Group	Description	Natural Subregion	Years To Breast Height (years)
1	AW+(S) - AB	CMW, PRP, SAL	5
1	AW+(S) - AB	DMW	7
1	AW+(S) - AB	LFH	8
1	AW+(S) - AB	UFH	5
2	AW+(S) - CD	CMW, UFH, PRP, SAL	9
2	AW+(S) - CD	DMW	4
2	AW+(S) - CD	LFH	10
4	BW/BWAW+(S)	CMW	17
4	BW/BWAW+(S)	DMW	15
4	BW/BWAW+(S)	LFH, UFH, PRP, SAL	6
7	PB+(S)	CMW, UFH, PRP, SAL	11
7	PB+(S)	DMW	19
7	PB+(S)	LFH	2

Source: ORM compiled data

6.2.2.3.4 Modelling of Stands with Coniferous Understorey

All stands identified as having coniferous understorey (Yield Group 6 and those portions of Yield Groups 1, 2, 4 and 7 reassigned to have coniferous understorey) were modelled using the yield tables developed for Yield Group 3. These stands were modelled using the coniferous component to drive harvest scheduling.

6.2.2.3.5 Regeneration Strategy

The *Resource and Timber Supply Analysis* used a regeneration strategy that is based on current practice, results from field surveys, Northern Interior Vegetation Management

Association (NIVMA) Plots, Permanent Sample Plots, tree improvement programs and general observations. The implementation of this strategy within the *Resource and Timber Supply Analysis* consisted of yield table shifts, reduced years to breast height and volume multipliers for tree improvement (Table 13). The tree improvement multiplier shown in Table 13 is a volume multiplier based on the research of Dhir *et al* 1996.

Table 13. Regeneration Strategy

Yield Group	Description	Natural Subregion	Regenerated Yield Group	Primary Species Years to Breast Height*	Secondary Species Years to Breast Height**	Tree Improvement Multiplier***
1	AW+(S) - AB	All	2	4	16	0.5
2	AW+(S) - CD	All	2	4	15	0.5
3	AWSW/PBSW/BWSW	CMW, DMW, LFH, PRP	3	8	10	1
3	AWSW/PBSW/BWSW	UFH, SAL	3	11	12	1
4	BW/BWAW+(S)	All	4	5	15	0.5
5	FB+OTH	CMW, DMW, PRP	16	8	10	1
5	FB+OTH	UFH, LFH, SAL	5	0	4	1
6	H+(S)/S	CMW, DMW, LFH, PRP	17	8	10	1
6	H+(S)/S	UFH, SAL	17	11	15	1
7	PB+(S)	All	7	4	10	0.5
8	PL/PLFB+(H)	CMW, DMW, LFH, PRP	8	6	10	1.07
8	PL/PLFB+(H)	UFH, SAL	8	9	12	1
9	PLAW/AWPL	CMW, DMW, LFH, PRP	9	6	10	1.07
9	PLAW/AWPL	UFH, SAL	8	9	12	1
10	PLSB+OTH	CMW, DMW, LFH, PRP	8	6	10	1.07
10	PLSB+OTH	UFH, SAL	8	9	12	1
11	PLSW/SWPL+(H)	CMW, DMW, LFH, PRP	11	7	10	1.07
11	PLSW/SWPL+(H)	UFH, SAL	8	9	12	1
12	SBLT/LTSB(G,M,F)	All	12	15	6	1
13	SBLT/LTSB(U)	All	13	23	9	1
14	SBPL/SBSW/SBFB	CMW, DMW, LFH, PRP	14	7	10	1
14	SBPL/SBSW/SBFB	UFH, SAL	14	10	12	1
15	SW/SWFB+(H) - AB	DMW, PRP	15	9	10	1
15	SW/SWFB+(H) - AB	CMW, LFH	16	9	10	1
15	SW/SWFB+(H) - AB	UFH, SAL	16	12	12	1
16	SW/SWFB+(H) - CD	CMW, DMW, LFH, PRP	16	9	10	1
16	SW/SWFB+(H) - CD	UFH, SAL	16	12	12	1
17	SWAW/SWAWPL	CMW, DMW, LFH, PRP	17	9	10	1
17	SWAW/SWAWPL	UFH, SAL	16	11	12	1

* Includes an allowance for plantation failures; includes an allowance for regeneration delay; and an entry of 0 indicates understorey protection
** Values based on provincial averages obtained from the Alberta Vegetation Inventory Standards Manual (v 2.1, 1991).
*** Tree improvement multiplier includes an allowance for non-treated areas.

Source: ORM compiled data

6.2.2.3.6 Minimum Harvest Ages

Minimum harvest ages by yield group and Natural subregion are provided in Table 14. The *Resource and Timber Supply Analysis* used the breast height age value since all ages in the yield tables and simulations are referenced to breast height age. However, the estimated age at breast height and total stand age for existing stands are also provided for information purposes. Since the time to reach breast height is less for regenerated stands as a result of the regeneration strategy, the total stand age and years from harvest is less for regenerated stands for a given minimum harvest age expressed in breast height age.

Table 14. Minimum Harvest Ages

Yield Group	Description	Natural Subregion	Estimated Age at Breast Height* (years)	Minimum Breast Height Age (years)	Estimated Minimum Total Age* (years)
1	AW+(S) - AB	CMW, PRP, SAL	6	44	50
1	AW+(S) - AB	DMW, LFH, UFH	5	45	50
2	AW+(S) - CD	CMW, DMW, UFH, PRP, SAL	5	45	50
2	AW+(S) - CD	LFH	6	44	50
3	AWSW/PBSW/BWSW	All	15	80	95
4	BW/BWAW+(S)	CMW, LFH, UFH, PRP, SAL	7	43	50
4	BW/BWAW+(S)	DMW	6	44	50
5	FB+OTH	All	22	80	102
6	H+(S)/S	All	15	80	95
7	PB+(S)	All	5	45	50
8	PL/PLFB+(H)	CMW, DMW	8	80	88
8	PL/PLFB+(H)	LFH	10	80	90
8	PL/PLFB+(H)	UFH, PRP, SAL	11	80	91
9	PLAW/AWPL	CMW, DMW	8	80	88
9	PLAW/AWPL	LFH, PRP, SAL	9	80	89
9	PLAW/AWPL	UFH	10	80	90
10	PLSB+OTH	LFH	10	80	90
10	PLSB+OTH	SAL	12	80	92
10	PLSB+OTH	CMW, DMW, UFH, PRP	11	80	91
11	PLSW/SWPL+(H)	LFH	10	80	90
11	PLSW/SWPL+(H)	CMW, DMW, UFH, PRP, SAL	11	80	91
12	SBLT/LTSB(G,M,F)	CMW, UFH, LFH, PRP, SAL	19	90	109
12	SBLT/LTSB(G,M,F)	DMW	18	90	108
13	SBLT/LTSB(U)	CMW, LFH, PRP, SAL	21	Never Merch	Never Merch
13	SBLT/LTSB(U)	DMW	20	Never Merch	Never Merch
13	SBLT/LTSB(U)	UFH	19	Never Merch	Never Merch
14	SBPL/SBSW/SBFB	CMW, UFH	17	90	107
14	SBPL/SBSW/SBFB	DMW, LFH, PRP	16	90	106
14	SBPL/SBSW/SBFB	SAL	18	90	108
15	SW/SWFB+(H) - AB	CMW, DMW	16	80	96
15	SW/SWFB+(H) - AB	LFH, PRP, SAL	15	80	95
15	SW/SWFB+(H) - AB	UFH	18	80	98
16	SW/SWFB+(H) - CD	CMW, DMW	16	80	96
16	SW/SWFB+(H) - CD	LFH, PRP, SAL	15	80	95
16	SW/SWFB+(H) - CD	UFH	17	80	96
17	SWAW/SWAWPL	CMW, DMW	16	80	96
17	SWAW/SWAWPL	LFH, PRP, SAL	15	80	95
17	SWAW/SWAWPL	UFH	17	80	97

* For existing stands only. Regenerated stands will be less as a result of reduced time to reach breast height.

Source: ORM compiled data

6.2.2.3.7 Cull Factors

The yield tables developed for this analysis do not include allowances for cull. Therefore, cull factors based on analysis of waste surveys, check scale percentages and bush bucking practices were developed for both coniferous and deciduous volumes. The cull factors applied in the *Resource and Timber Supply Analysis* are summarized in Table 15. For additional information regarding cull factors refer to Report #9 Timber Supply Analysis Information Package (Canfor 1999b).

Table 15. Cull Factors

Yield Group	Coniferous (%)	Deciduous (%)
1,2,4,7	5	10
5	9	15
3,6,8-17	5	15

Source: ORM compiled data

6.2.2.3.8 Growing Stock Adjustments

COMPLAN allows for initial volumes and other stand parameters to be assigned to individual stands. These values are then trended using the yield tables to forecast future stand parameters. The growing stock adjustments discussed in the *Development of a Multiple Utilization Yield Table System in the Canfor FMA Agreement,* Report # 5, (Canfor 1999f) document will be implemented in the *Resource and Timber Supply Analysis*.

6.2.2.4 Data Transformation of Landbase and Growth and Yield Data from COMPLAN to the WOODSTOCK Model

COMPLAN and WOODSTOCK are two different models that run from the same data set. The data does not change between the two models but must be formatted specifically for each model. The data set used within COMPLAN was reformatted to comply with WOODSTOCK requirements.

6.2.2.4.1 Aggregation Methodology

The WOODSTOCK model is large and complex. The speed at which WOODSTOCK is able to arrive at a solution is highly influenced by the number of different aggregation groups used within the model. This in turn affects the size of the area file used to describe the starting land-base. Past experience has shown that the area file should not contain more than 3,500 records. Beyond this size the model will be unable to come to a meaningful solution.

Linear Programming (LP) based models are not able to handle the same complexity as spatial simulation models. Modelling with unique data at the stand level is not feasible. instead, the data must be simplified and grouped according to themes selected for in the WOODSTOCK model.

The following is a general overview of the process used to convert the Canfor COMPLAN data into a WOODSTOCK model.

- Yield tables were aggregated by combining yield tables from the same natural subregion that displayed similar yields, minimum harvest ages and regeneration strategies;

- COMPLAN compartments were aggregated according to block location and the period available for harvesting; and

- Harvest Status, Wildlife and Seral Cover Constraints for caribou and Foothills/Boreal area were combined under one unique name for each combination.

All of this was performed with look-up tables in Microsoft Access®. This process reduced the number of records in the area file to 3,500.

6.2.2.4.2 Testing Standing Inventory

The WOODSTOCK initial standing inventory data was compared with COMPLAN's initial standing inventory to determine if the volume represented by each yield table group was the same for both models. This confirmed that both models started from the same point and validated the data used in WOODSTOCK.

6.2.2.4.3 Testing Model Growth and Yield

After testing the initial standing inventory, the data was also validated in terms of growth and yield. The WOODSTOCK data was imported into COMPLAN and modelled aspatially. The volume results produced by COMPLAN were compared to WOODSTOCK volume results to confirm that both models produced approximately the same results. This process validated the WOODSTOCK data and further modelling with WOODSTOCK proceeded (Table 16).

Table 16. COMPLAN and WOODSTOCK Area Comparison

Landscape Attribute	Complan Area	Woodstock Area	Percent Difference
Normal	474,084.00	473,204.00	100%
Reserve	118,103.00	113,092.00	96%
Special	108.00	77.00	71%
Non-caribou	525,537.00	520,200.00	99%
Caribou	66,758.00	66,174.00	99%
Boreal	296,004.00	294,046.00	99%
Foothills	296,184.00	292,251.00	99%
Other	177.00	77.00	44%

Source: ORM compiled data

6.2.3 COMPLAN Scenarios

The following 7 scenarios were modelled in COMPLAN to identify and validate the proposed management strategy. Due to the complex nature of modelling an integrated coniferous and deciduous wood supply in a full-spatial modelling environment, a series of scenarios were also modelled using WOODSTOCK as a linear programming model. The purpose of these scenarios was to support the results from COMPLAN and identify areas where the simulation algorithm in COMPLAN may be pursuing an undesirable solution. The results from the WOODSTOCK scenarios will not be discussed in detail but only as they relate to the COMPLAN spatial results.

6.2.3.1 Scenario 1C

The objective of Scenario 1 is to validate the model inputs against those from the previous Detailed Forest Management Plan (DFMP). The inputs and results from this run are discussed in detail in Appendix II.

6.2.3.2 Scenario 2C

The objective of this Scenario is to provide the maximum sustainable coniferous timber harvest achievable in the absence of constraints or any other objectives. The purpose of this Scenario is to identify the costs associated with regulations, operational factors and objectives for non-timber resource values. This information will be used to help identify issues where the development of mitigation strategies is required and where the timber supply model needs to be constrained.

Specifics concerning this scenario are:

- Aspatial analysis;
- No block size or green-up requirements;
- No caribou management requirements;
- No seral stage requirements;
- No hydrological recovery requirements;
- No requirement for deciduous AAC sustainability; and
- No 20-year operational sequencing.

6.2.3.3 Scenario 3C

The objective of this Scenario is to determine the sustainable coniferous and deciduous harvest levels when green-up requirements and caribou habitat requirements are implemented. Seral stage distribution and hydrological recovery are tracked but the harvest level is not constrained to meet those objectives.

Specifics concerning this scenario are:

- Full-spatial analysis;
- Application of cover constraints within the Caribou Area;
- Maximum aggregated sub-compartment size of 1,000 ha in the Caribou Area;
- Maximum aggregated sub-compartment size of 500 ha outside of the Caribou Area;
- Two meter coniferous green-up and 3 m deciduous green-up required between aggregated sub-compartments;
- Implementation of Canfor operating unit sequencing protocol;
- Deciduous AAC sustainability;
- 20-year harvest sequencing; and
- No seral stage constraints.

6.2.3.4 Scenario 4C

It is recognized that the results from the previous scenario may produce future forest conditions that do not meet acceptable levels of issues related to the Canfor's *Sustainable Forest Management Plan*. Parameters that may be modified include:

- Seral stage objectives;
- Hydrological recovery objectives; and

- Modification of the maximum aggregated sub-compartment size in one or more landscape management units.

This Scenario is the Preferred Management Strategy.

6.2.3.5 Scenario 5C

This full-spatial Scenario will be based on Scenario 4, and will investigate the effect of a regeneration strategy based on natural yield tables on coniferous and deciduous harvest levels. The purpose of this strategy is to identify the benefits that are achieved from intensive silviculture program.

Scenario 4 parameters that will be modified are:

- Removal of yield table shifts at regeneration; and
- More conservative regeneration delays.

6.2.3.6 Scenario 6C

This full-spatial scenario will examine the risk associated with the regeneration strategy proposed by Canfor. It will use the regeneration strategy outlined in Scenario 5. However, the harvest level from Scenario 4 will be used for the first 20 years, after which an even-flow level will be determined for the remaining periods.

6.2.3.7 Scenario 7C

This full-spatial scenario will examine the effects of pursuing a strategy of reducing the level of risk present in the landscape due to fire risk. This will be done by targeting high risk stands for harvest and comparing those results against the results from Scenario 4. Results will be compared in terms of harvest levels and fire risk. The questions being investigated in this analysis are:

- Is it possible to prioritize timber based on fire risk and not affect the long-term harvest level?
- Do non-timber resource objectives limit the ability to successfully execute a strategy of prioritizing timber based on fire risk?

6.2.4 WOODSTOCK Scenarios

WOODSTOCK scenarios were developed in response to modelling issues and results that were identified during COMPLAN modelling. It should be noted that due to limitations within WOODSTOCK and other Linear Program (LP) models, the input dataset for WOODSTOCK had to be significantly simplified and some constraints were not incorporated in to the inputs.

Linear program based optimization models can not handle the level of complexity common to current forest management plans in western Canada. Therefore, some management constraints, such as hydrological recovery periods, are left out of the modelling process. Other issues, like harvest compartment priorities and sequencing, are simplified to produce a solvable model.

6.2.4.1 Scenario 1W

This run tests the sustainability of the even-flow deciduous harvest level given an even-flow coniferous harvest level of 640,000 m^3 per year and a deciduous harvest level of 312,977 m^3 per year from the entire FMA area for the first five years and 111,537 m^3 per year from Forest Management Unit (FMU) G2C area for the first 5 years followed by a harvest level of at least 60,500 m^3 per year. Results will show the years when deciduous harvest levels will deviate from the even-flow objective and will quantify the reduction in volume. For this run, all seral and caribou constraints are activated.

6.2.4.2 Scenario 2W

This run tests the implications of not performing any enhanced silviculture strategies on the sustainable harvest level for deciduous species. All curves regenerate back to the original yield curve instead of regenerating to the enhanced yield curves. The coniferous volume is maintained at an even-flow level of 550,000 m^3 per year with a deciduous harvest level of 312,977 m^3 per year from the entire FMA area for the first 5 years and with a FMU G2C deciduous volume of 111,537 m^3 per year for the first 5 years followed by a harvest level between 55,000 m^3 per year and 93,000 m^3 per year. Results will show the even-flow deciduous harvest volume given these assumptions.

6.2.4.3 Scenario 3W

This run contains the same assumptions as Run 2W except the coniferous harvest level is 640,000 m^3 per year for the first 20 years followed by a reduction to 550,000 m^3 per year for the rest of the planning horizon. Results will show the even-flow deciduous volume for years 20 to 200 given these assumptions.

6.2.5 Modelling Parameters for Non-timber Resources and Operational Constraints

There are a number of model parameters that can be set in COMPLAN to address non-timber resource requirements or other operational constraints. Specific parameters to be addressed in the *Resource and Timber Supply Analysis* include seral stage distribution, caribou habitat, green-up requirements, maximum aggregated sub-compartment size and habitat modelling.

6.2.5.1 Seral Stage Distribution

Five seral stages are defined for use in this analysis. Table 17 outlines the breast height age by yield group that was used to define these seral stages. Seral stage distribution targets were defined at the following levels:

- FMA area;
- Forest Management Unit G2C;
- Forest Management Unit G8C;
- Forest Management Units G5C/E8C combined;
- Foothills natural region including the Peace Parkland Natural region; and
- Boreal Forest natural region including the Rocky Mountain Natural region.

Table 17. Breast Height Age Ranges for Seral Stages

Yield Group	Description	Pioneer	Young	Mature	O.Mature	Old	Species	Years to BH
1	AW+(S) - AB	0	1-20	21-70	71-110	110+	AW	6
2	AW+(S) - CD	0	1-20	21-70	71-110	110+	AW	6
3	AWSW/PBSW/BWSW	0	1-40	41-80	81-120	120+	SW	15
4	BW/BWAW+(S)	0	1-20	21-70	71-110	110+	BW	6
5	FB+OTH	0	1-40	41-100	101-120	120+	FB	15
6	H+(S)/S	0	1-40	41-80	81-120	120+	SW	15
7	PB+(S)	0	1-20	21-80	81-110	110+	PB	6
8	PL/PLFB+(H)	0	1-40	41-80	81-120	120+	PL	10
9	PLAW/AWPL	0	1-30	31-70	71-120	120+	PL	10
10	PLSB+OTH	0	1-40	41-90	91-120	120+	PL	10
11	PLSW/SWPL+(H)	0	1-40	41-90	91-120	120+	PL	10
12	SBLT/LTSB(G,M,F)	0	1-50	51-130	131-150	150+	SB	20
13	SBLT/LTSB(U)	0	1-50	51-140	141-160	160+	SB	20
14	SBPL/SBSW/SBFB	0	1-40	41-100	101-130	130+	SB	20
15	SW/SWFB+(H) - AB	0	1-40	41-90	91-120	120+	SW	15
16	SW/SWFB+(H) - CD	0	1-40	41-90	91-120	120+	SW	15
17	SWAW/SWAWPL	0	1-40	41-90	91-120	120+	SW	15
Note: Ages are breast height ages								

Source: ORM compiled data

6.2.5.2 Caribou Habitat

Cover constraints were applied to the forested stands identified as being within the Caribou Area identified by the West Central Alberta Caribou Standing Committee. Seral stage was used to formulate the caribou constraints. The cover constraint formulation is:

- No more than 25% of the area can be in a pioneer or young seral condition (this falls within the 5% threshold for the 20% requirement);
- Maximum opening size of 1,000 ha; and
- 30 year green-up

Although the amount of land in old seral within the Caribou Area is currently below the 20% level specified in the SFMP, no constraint was applied to these stands. Early model runs indicated, and subsequent analysis confirmed, that the old seral class could support some harvesting without delaying the time that it takes to recover to the lower limit of the SFMP-prescribed range (15%). By 2021, the 20% old seral requirement will be met.

Canfor continues to provide support for research on caribou habitat. Until this research provides better information about actual habitat usage by caribou, the SFMP targets, within the 5% will be used as guidelines. During this period, particular attention will be paid to managing caribou habitat at the operational level through such measures as:

- Access control using gates;
- The use of existing roads and linear structures rather than the construction of new roads;
- Habitat evaluation during pre-harvest assessments; and
- The judicious selection of old seral stands for harvest so as to defragment the land base with respect to age class.

Canfor is committed to the development of a Caribou Management Strategy based on the results of research efforts that are currently underway.

6.2.5.3 Green-up Requirements

- A required green-up height of 2 m for coniferous stands and 3 m for deciduous priority stands between adjacent aggregated sub-compartments was used for simulations completed with a full spatial analysis.
- A green-up requirement of 30 years was used in the caribou habitat area.

6.2.5.4 Maximum Aggregated Sub-compartment Size

For the full spatial simulations, COMPLAN allows aggregation of sub-compartments to a pre-determined maximum size. The maximum aggregated sub-compartment sizes used in the *Resource and Timber Supply Analysis* are as follows:

- 1,000 ha in the Caribou Area; and
- 500 ha in the remainder of the Forest Management Agreement (FMA area).

Although this is a maximum, a distribution of sizes ranging from very small (i.e. less than 10 has) up to the maximum was obtained because of the effect of timber maturity and other constraints.

6.2.5.5 Habitat Modelling

It was not intended to constrain the simulations to reflect habitat requirements other than for caribou. However, habitat suitability indices have been generated and reported for the results of selected scenarios for the following species:

- Moose;
- American marten;
- Pileated woodpecker; and
- Barred owl.

6.3 Deciduous AAC Sustainability

The deciduous operators for the FMA area operate under a series of volume allocations that have been established outside of this Detailed Forest Management Plan (DFMP). Given that there is no information regarding the assumptions that were used in establishing these allocations, there is considerable uncertainty as to whether these volume targets can be achieved under the current planning environments which must be in alignment with the objectives identified in the Canfor *Sustainable Forest Management Plan*. However, these allocations will form a key element in identifying sustainable deciduous harvest levels from an integrated coniferous and deciduous timber supply. Table 18 shows the allocations and how they are applied in the *Resource and Timber Supply Analysis*, which takes into account the actual harvested volumes during 1999 and 2000. It should be noted that due to the nature of spatial simulation modelling, final deciduous harvest volumes will be close to any final target levels but will not match them exactly.

Table 18. Timber Allocations Within The FMA Area

DFMP		FMU G2C	FMU G5C			Total			Quadrant Totals		
Quadrant	Year	Tolko	Tolko	Ainsworth	GAP	G2C	G5C	FMA Area	G02C	G05C	FMA Area
1	1999										
	2000		**134,563**				134,563	134,563			
	2001	**436,686**	54,212	170,000		436,686	224,212	660,898			
	2002	60,500	54,212	170,000		60,500	224,212	284,712			
	2003	60,500	54,212	170,000		60,500	224,212	284,712	557,686	807,199	1,364,885
2 - 4	2004	60,500	54,212	170,000	169,000	60,500	393,212	453,712			
	2005	60,500	54,212	170,000	169,000	60,500	393,212	453,712			
	2006	60,500	54,212	170,000	169,000	60,500	393,212	453,712			
	2007	60,500	54,212	170,000	169,000	60,500	393,212	453,712			
	2008	60,500	54,212	170,000	169,000	60,500	393,212	453,712	302,500	1,966,060	2,268,560
Blue numbers were derived from actual production numbers harvested minus the total Quadrant allocation											

Source: Canfor compiled data

It was determined that the deciduous volumes from FMU G2C should meet or exceed the 60,500 m^3/year limit as an average but that some flexibility from period to period would be permitted. Deciduous flows from FMU G2C were to range between approximately 45,000 and 85,000 m^3/year through the planning horizon.

6.4 Harvest Sequencing

A key element of this *Resource and Timber Supply Analysis* is the incorporation of a detailed, operationally realistic harvest sequence for the first 20 years of the Detailed Forest Management Plan (DFMP). This ensures that timber and non-timber resource supply forecasts will be attainable with a reasonable degree of certainty with the current operating rules, assumptions and input data in place. The following factors were incorporated into the harvest sequencing:

- All non-timber resource objectives (seral stage, caribou habitat management and hydrological recovery) are met;
- The current 2001 Annual Operating Plan (AOP) submission runs from 1999 to 2003 which corresponds with the first 5-year planning period within *the Resource and Timber Supply Analysis*;
- Harvesting for 1999 and 2000 is based on harvested blocks; and
- Harvesting for 2001, 2002 and 2003 is limited to the planned AOP blocks for those years.

Access was controlled on the basis of the operational subunits and the anticipated focus of coniferous and deciduous operations through the FMA area for the first 20 years as shown in the following matrix (Table 19). This matrix served as a starting point and was modified on an iterative basis to produce the final sequencing results as shown in the results discussion.

The resulting harvest pattern that is developed from the *Resource and Timber Supply Analysis* is not and should not be construed as a replacement for the AOP or future AOPs. It will provide guidance but new AOPs will be formulated based on new data and other factors including market conditions, fire salvage and insect and disease. However, there is a regulatory process and DFMP / AOP validation process (refer to DFMP Section F 2.4.1 under development to ensure that any changes in sequence are consistent with the approved Annual Allowable Cut (AAC) and the Sustainable Forest Management Plan (SFMP).

Table 19. Operational Subunits

Operational Subunit	Operations Quadrant			
	1999-2003	2004-2008	2009-2013	2014-2018
DN-1	Coniferous		Both	Both
DN-2	Coniferous		Deciduous	
DN-3	Coniferous		Deciduous	Deciduous
DN-4	Coniferous		Deciduous	Both
DN-5	Coniferous			Both
DS-2	Coniferous	Coniferous		
DS-3		Coniferous	Coniferous	Coniferous
E8-1	Coniferous	Coniferous	Coniferous	
E8-2			Coniferous	Coniferous
E8-4	Coniferous			
EN-1		Deciduous	Both	Deciduous
EN-3		Coniferous		
EN-4	Both		Deciduous	Deciduous
EN-5	Both	Both	Deciduous	Deciduous
ES-1	Both	Both	Deciduous	Deciduous
ES-2		Coniferous	Both	Both
ES-3			Deciduous	Both
LAT-1	Coniferous		Deciduous	Deciduous
LAT-2		Both	Both	Deciduous
LAT-3		Both	Both	
PEACE-2		Coniferous	Coniferous	Coniferous
PEACE-3				Coniferous
PUSK-1	Deciduous	Deciduous	Both	Both
PUSK-2	Both	Deciduous	Deciduous	Deciduous
PUSK-3	Both	Both	Both	Both
PUSK-4	Both	Both	Deciduous	Deciduous
SIM-1			Both	Deciduous
SIM-2	Both	Deciduous	Deciduous	Deciduous
SIM-3	Both	Coniferous		Deciduous
SIM-4	Deciduous		Deciduous	Coniferous
SMOKY-1	Coniferous	Both		Deciduous
SMOKY-2		Both		
SMOKY-3		Both		
SMOKY-4		Deciduous	Both	
SMOKY-5			Coniferous	
SMOKY-6		Deciduous	Both	Both

Source: ORM compiled data

6.5 Results

6.5.1.1 Scenario 1C

Results for Scenario 1C are discussed in Appendix II in the document entitled *Supplementary Timber Supply Analysis: Benchmark Run Results and Amended Timber Supply Analysis Information Package*.

6.5.1.2 Scenario 2C

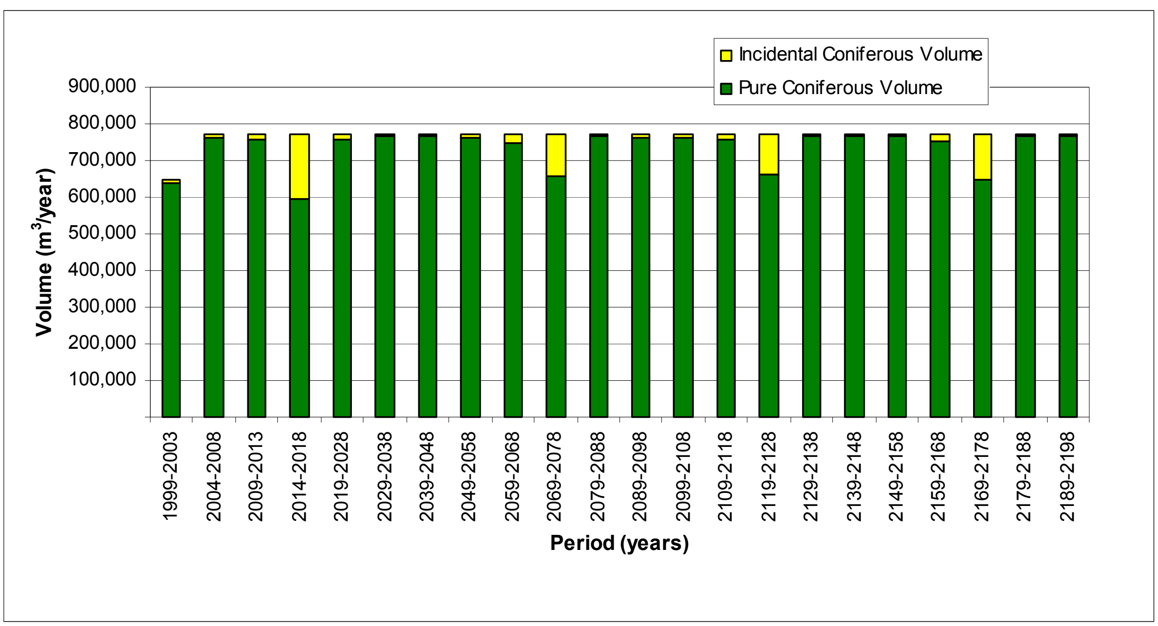
Results for Scenario 2C are discussed in the following sections.

6.5.2 Timber Harvest

In the absence of any constraints other than minimum harvest age and any requirement for deciduous sustainability, a coniferous even-flow harvest of 770,000 m^3/year can be maintained for the entire planning horizon as shown in Figure 5 and Table 20. The reduced harvest in the first period is to account for the harvesting that has taken place in 1999 and 2000. In this run, all stands are being harvested for their coniferous volume with no concern for the deciduous volume that is being generated. The resulting deciduous flow is extremely variable as shown in Figure 6 and Table 21, ranging from 197,516 m^3/year to 4,763,109 m^3/year with an average of 616,780 m^3/year. The wide variation in deciduous flow presents sustainability problems from several perspectives including:

- Forest operations;
- Economics; and
- Markets.

Figure 5. Scenario 2C: Coniferous Harvest Flow



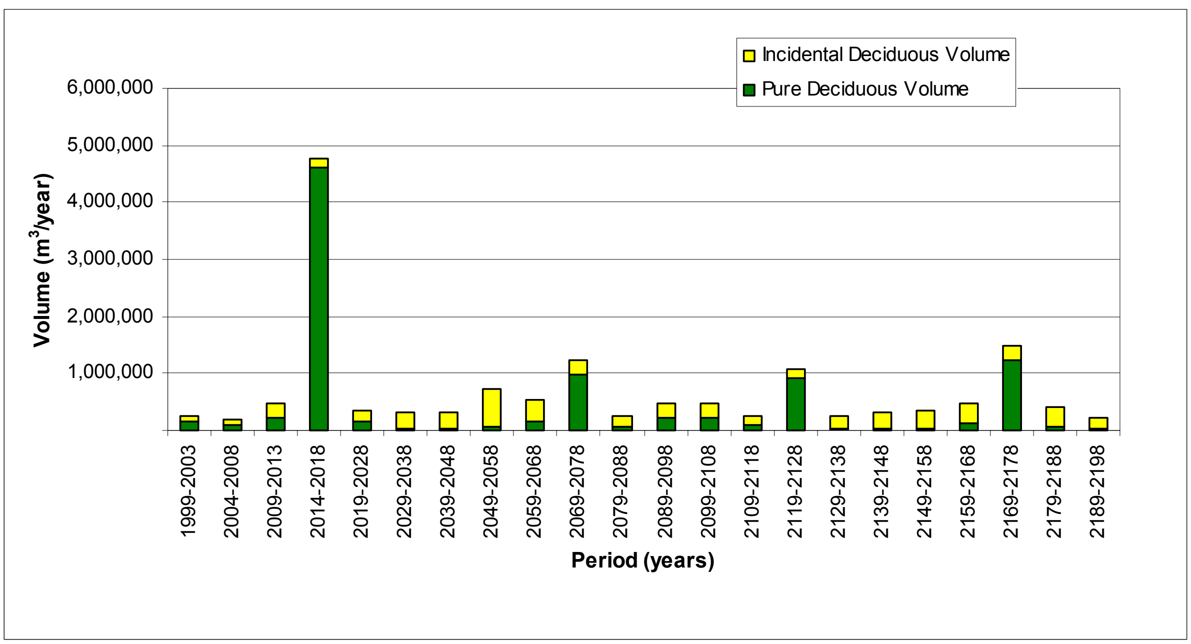
Source: ORM compiled data

Table 20. Scenario 2C: Coniferous Harvest Flow

Period	Coniferous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	636,248	12,567	**648,815**
2004-2008	761,244	8,756	**770,000**
2009-2013	756,970	13,030	**770,000**
2014-2018	597,565	172,435	**770,000**
2019-2028	759,320	10,680	**770,000**
2029-2038	765,745	4,255	**770,000**
2039-2048	765,882	4,118	**770,000**
2049-2058	759,765	10,235	**770,000**
2059-2068	748,493	21,507	**770,000**
2069-2078	658,619	111,381	**770,000**
2079-2088	764,551	5,449	**770,000**
2089-2098	760,568	9,432	**770,000**
2099-2108	759,994	10,006	**770,000**
2109-2118	758,083	11,917	**770,000**
2119-2128	659,859	110,141	**770,000**
2129-2138	765,550	4,450	**770,000**
2139-2148	766,081	3,919	**770,000**
2149-2158	764,458	5,542	**770,000**
2159-2168	753,549	16,451	**770,000**
2169-2178	646,320	123,680	**770,000**
2179-2188	764,831	5,169	**770,000**
2189-2198	766,482	3,518	**770,000**

Source: ORM compiled data

Figure 6. Scenario 2C: Deciduous Harvest Flow



Source: ORM compiled data

Table 21. Scenario 2C: Deciduous Harvest Flow

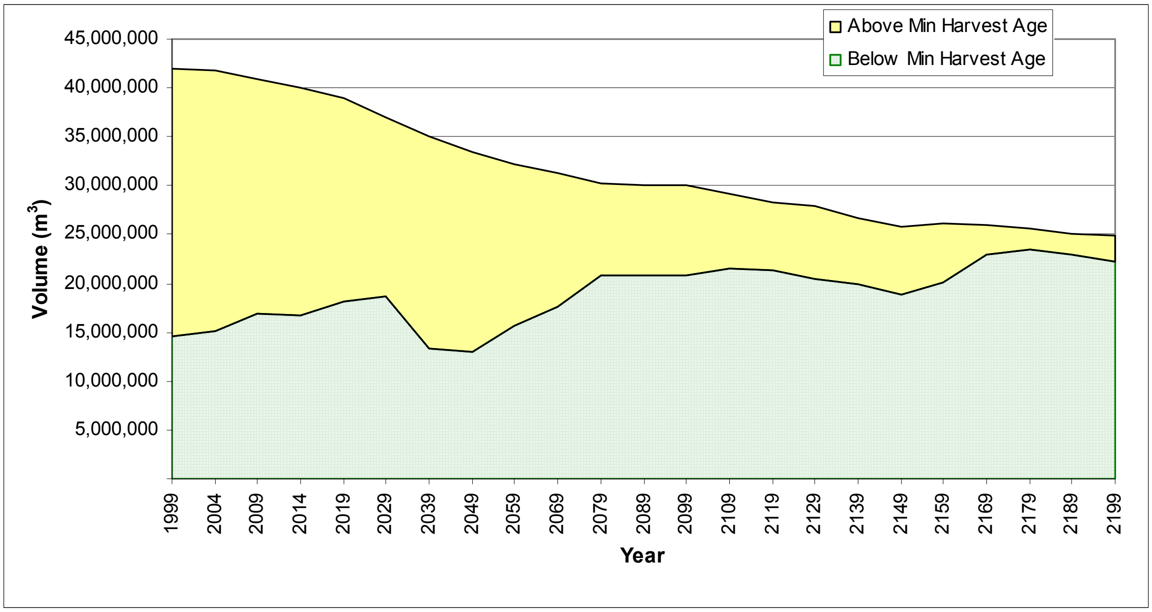
Period	Deciduous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	147,635	111,824	**259,459**
2004-2008	109,754	87,762	**197,516**
2009-2013	236,810	239,161	**475,971**
2014-2018	4,606,022	157,087	**4,763,109**
2019-2028	156,829	181,143	**337,971**
2029-2038	35,275	295,211	**330,486**
2039-2048	29,198	297,211	**326,409**
2049-2058	54,309	666,708	**721,016**
2059-2068	150,296	398,835	**549,131**
2069-2078	974,881	268,045	**1,242,926**
2079-2088	49,004	211,202	**260,206**
2089-2098	213,169	256,690	**469,859**
2099-2108	219,816	240,336	**460,152**
2109-2118	103,724	149,243	**252,968**
2119-2128	901,788	163,534	**1,065,322**
2129-2138	32,089	228,694	**260,783**
2139-2148	26,868	281,578	**308,446**
2149-2158	43,381	292,828	**336,210**
2159-2168	122,820	351,129	**473,949**
2169-2178	1,218,800	251,271	**1,470,072**
2179-2188	69,476	326,005	**395,481**
2189-2198	29,784	196,408	**226,192**

Source: ORM compiled data

6.5.3 Inventory

The standing inventory for both coniferous and deciduous shows a rapid decline with the maximized harvest levels as shown in Figures 7 and 8 and Tables 22 and 23. The inventories also do not show any signs of stabilization, which may indicate that these harvest levels are not sustainable over a period of time longer than the 200-year planning horizon used in this analysis.

Figure 7. Scenario 2C: Coniferous Standing Inventory Volume



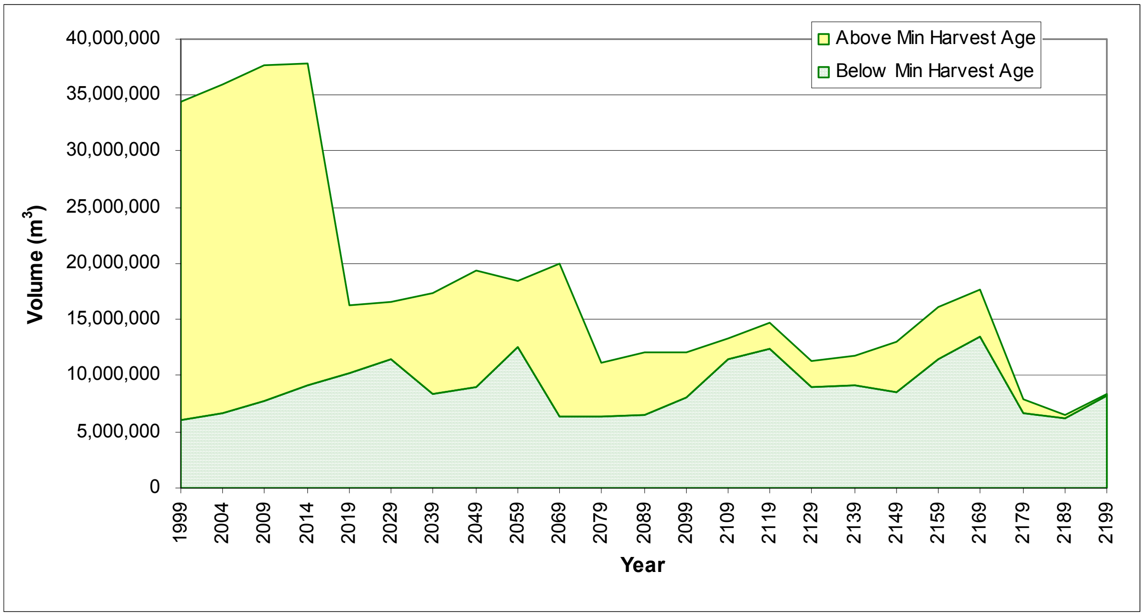
Source: ORM compiled data

Table 22. Scenario 2C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,157
2004	26,603,766	15,205,728
2009	24,041,494	16,870,605
2014	23,279,003	16,718,201
2019	20,799,396	18,195,002
2029	18,375,873	18,616,481
2039	21,807,880	13,297,319
2049	20,534,805	12,960,315
2059	16,571,761	15,703,724
2069	13,688,497	17,536,938
2079	9,369,386	20,799,051
2089	9,308,951	20,777,328
2099	9,248,964	20,850,019
2109	7,554,981	21,609,708
2119	6,958,254	21,330,212
2129	7,470,386	20,494,328
2139	6,781,189	19,951,190
2149	7,054,996	18,777,262
2159	6,016,595	20,153,928
2169	2,932,115	22,982,156
2179	2,017,279	23,516,834
2189	2,236,135	22,886,959
2199	2,716,969	22,268,350

Source: ORM compiled data

Figure 8. Scenario 2C: Deciduous Standing Inventory Volume



Source: ORM compiled data

Table 23. Scenario 2C: Deciduous Standing Inventory Volume

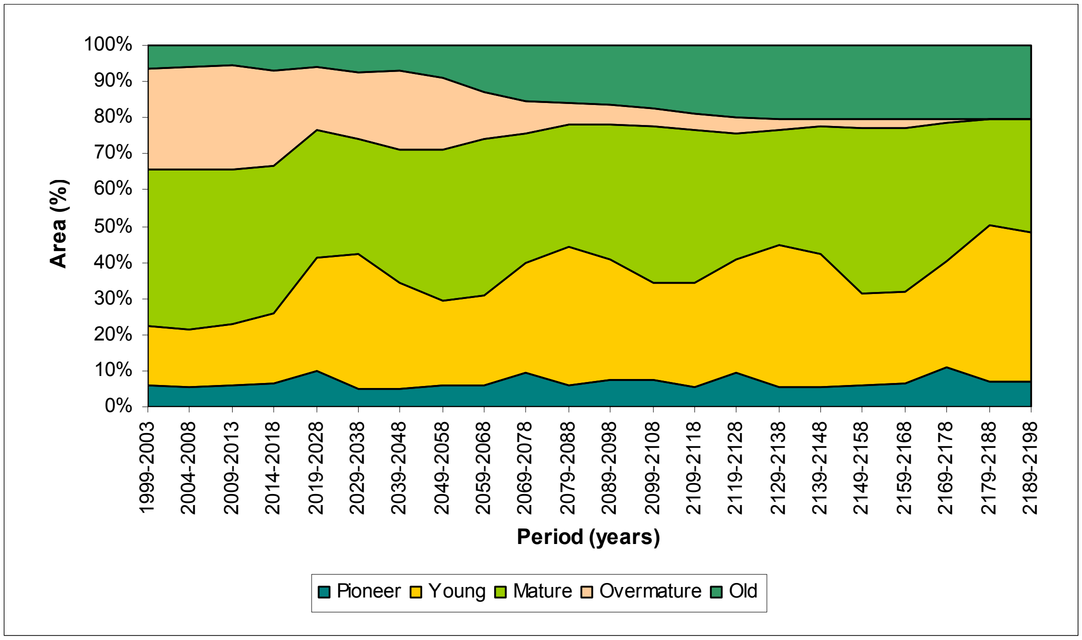
Year	Deciduous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,301
2004	29,321,673	6,705,243
2009	29,900,640	7,782,435
2014	28,693,452	9,194,773
2019	6,139,601	10,158,646
2029	5,008,849	11,550,031
2039	8,971,877	8,401,725
2049	10,386,780	9,035,032
2059	5,922,916	12,548,302
2069	13,594,011	6,347,511
2079	4,790,403	6,396,833
2089	5,545,052	6,569,603
2099	4,055,938	8,082,998
2109	1,947,976	11,461,351
2119	2,340,647	12,398,928
2129	2,208,673	9,046,869
2139	2,542,674	9,174,894
2149	4,505,174	8,460,670
2159	4,626,797	11,461,824
2169	4,144,594	13,558,426
2179	1,200,192	6,667,036
2189	282,192	6,229,526
2199	199,516	8,154,751

Source: ORM compiled data

6.5.4 Non-timber Resources

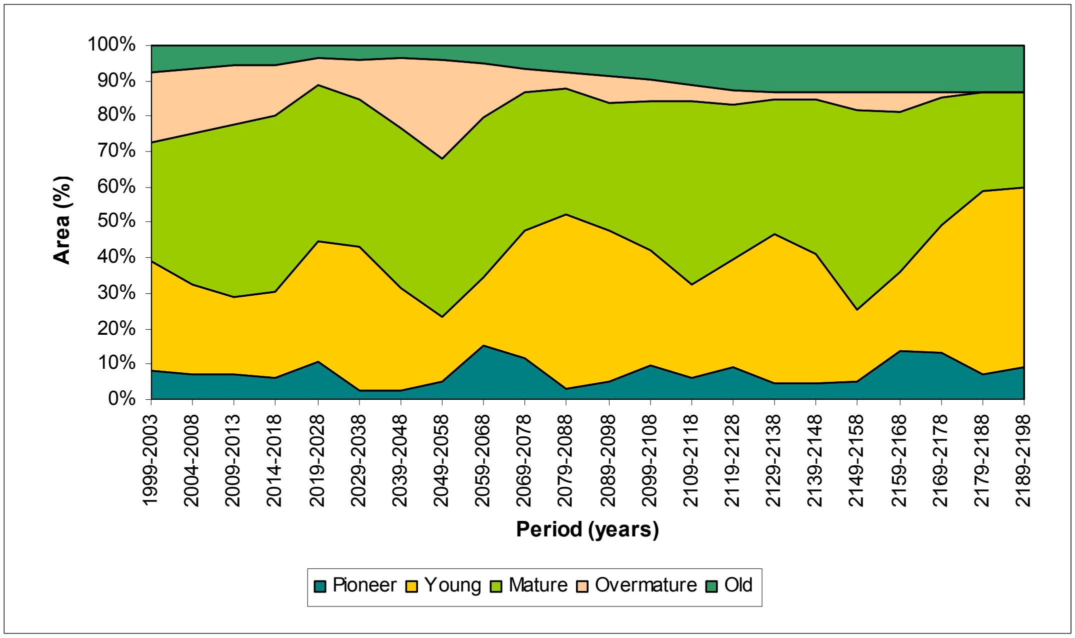
The seral stage distributions shown in Figures 9 through 15 are indicative of a situation where there are no constraints imposed on timber harvesting. The old seral stage remains intact because they are contained in reserve areas, which age over time. The overmature seral stage disappears completely by the end of the planning horizon due to harvesting and by the end all of the harvesting is done within mature timber types.

Figure 9. Scenario 2C: Seral Stage Distribution – FMA



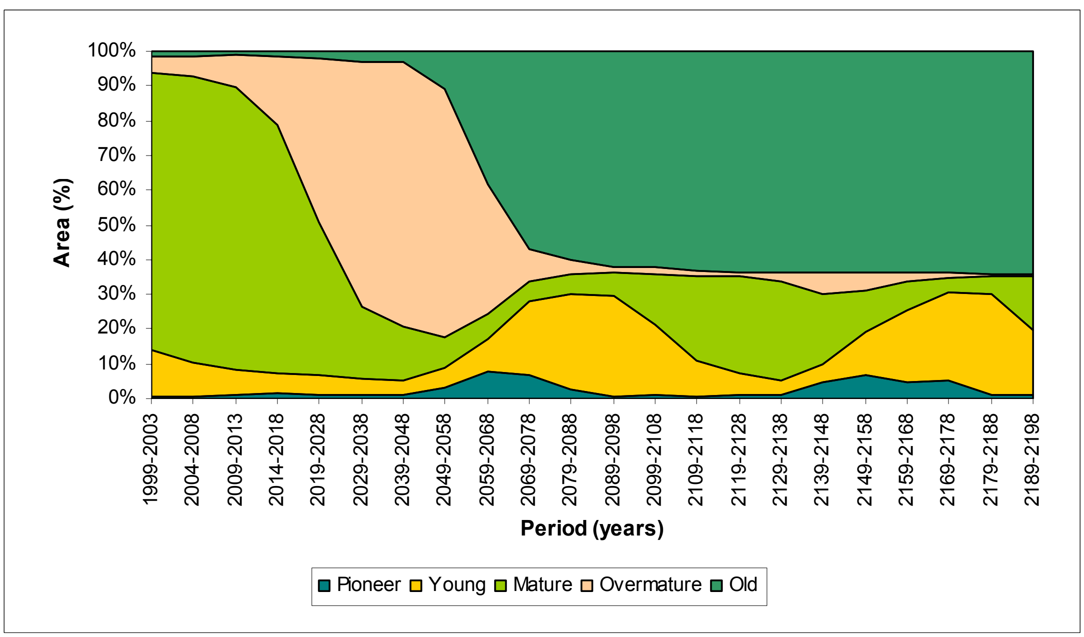
Source: ORM compiled data

Figure 10. Scenario 2C: Seral Stage Distribution – FMU G2C



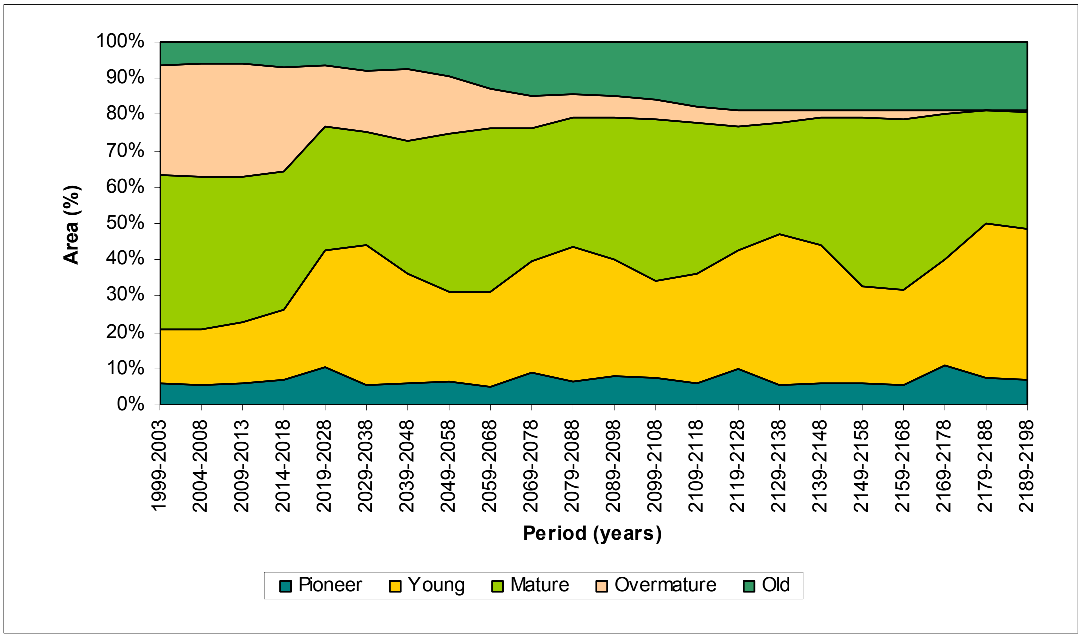
Source: ORM compiled data

Figure 11. Scenario 2C: Seral Stage Distribution – FMU G8C



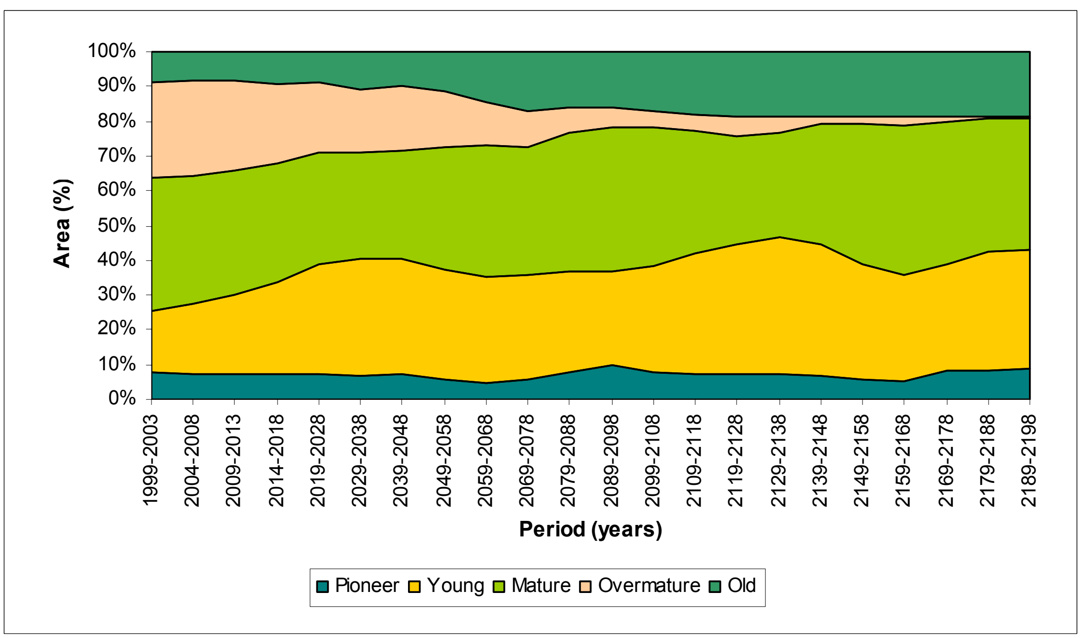
Source: ORM compiled data

Figure 12. Scenario 2C: Seral Stage Distribution – FMUs G5C and E8C



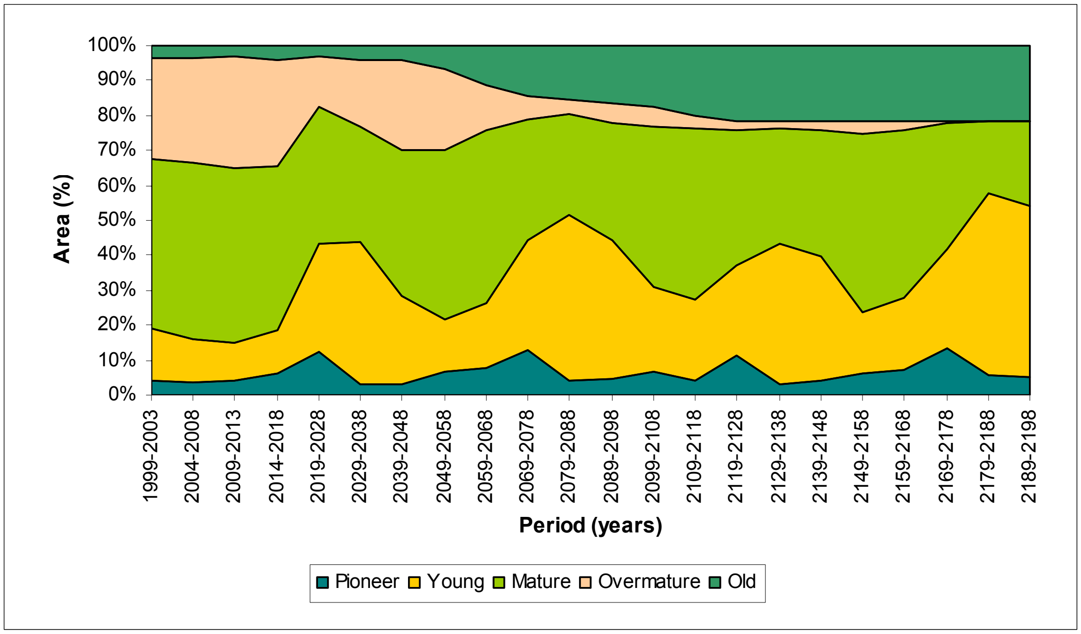
Source: ORM compiled data

Figure 13. Scenario 2C: Seral Stage Distribution – Foothills Natural Region



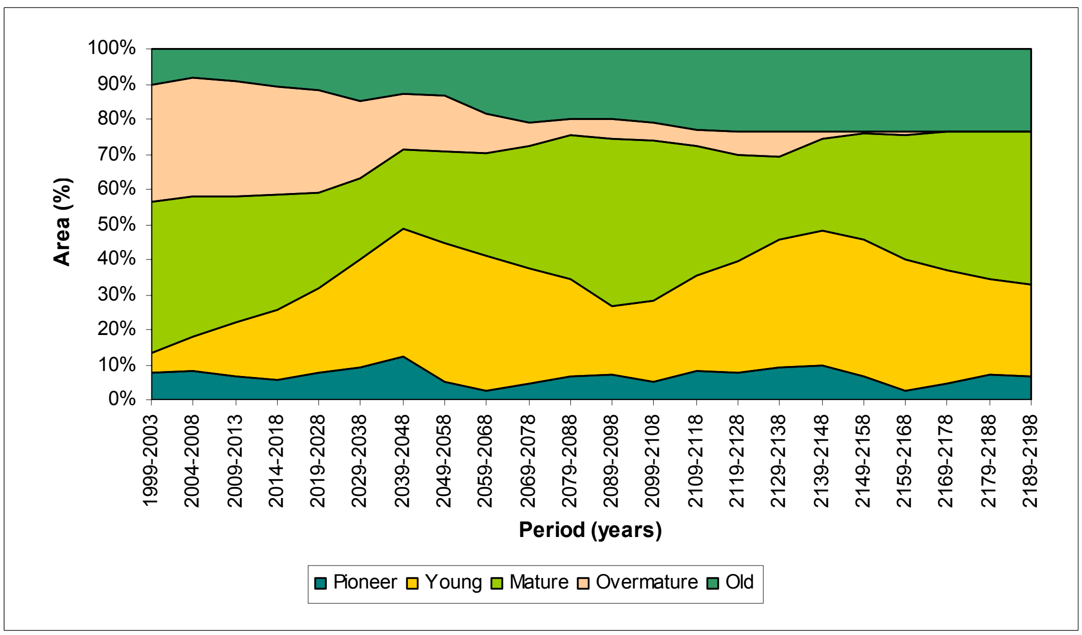
Source: ORM compiled data

Figure 14. Scenario 2C: Seral Stage Distribution – Boreal Forest Natural Region



Source: ORM compiled data

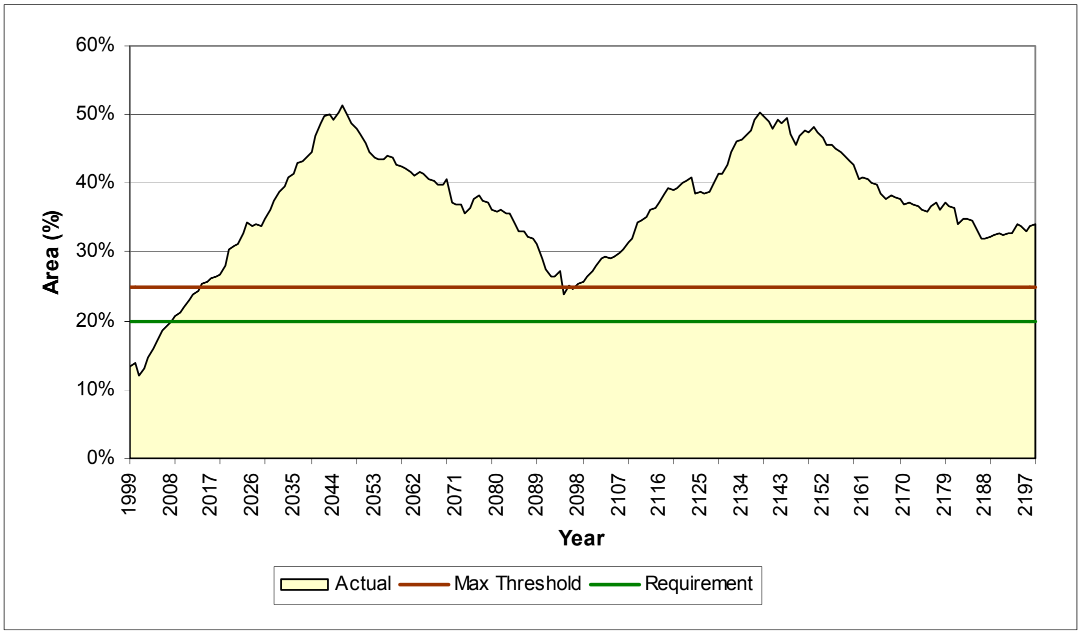
Figure 15. Scenario 2C: Seral Stage Distribution – Caribou Area



Source: ORM compiled data

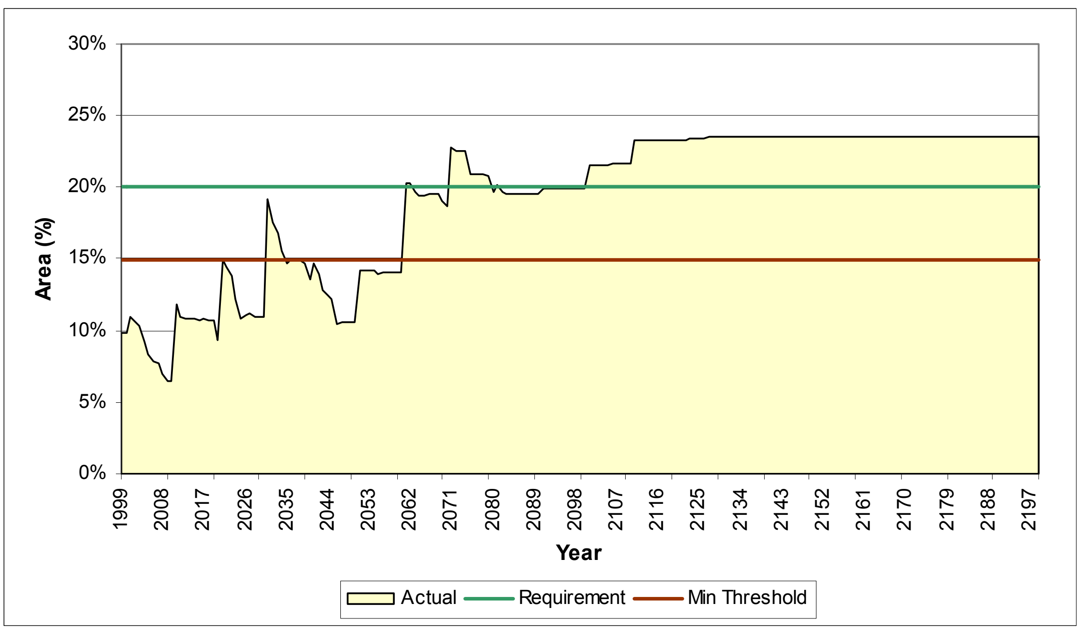
The amount of caribou habitat follows the same trend as that seen in the seral stage distributions with an overabundance of the pioneer and young seral stage habitat (Figure 16). While, there is enough old seral stage habitat in the reserve areas, this would tend to be fragmented and not found in large enough patches to provide the complete habitat requirements (Figure 17).

Figure 16. Scenario 2C: Pioneer and Young Seral Stage Habitat in the Caribou Area



Source: ORM compiled data

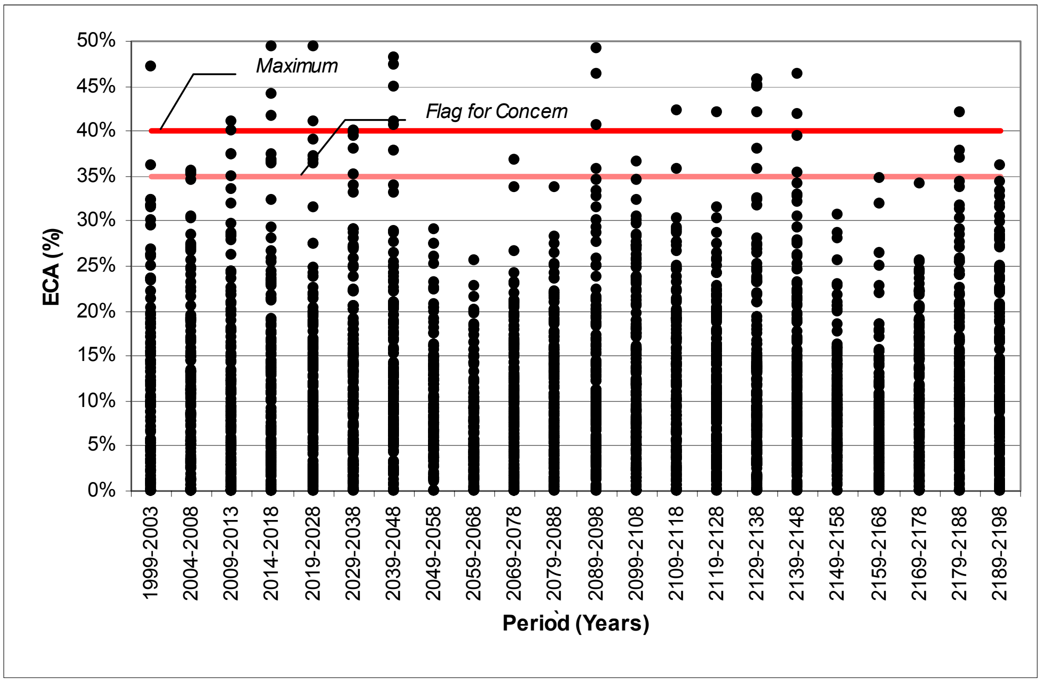
Figure 17. Scenario 2C: Old Seral Stage Habitat in the Caribou Area



Source: ORM compiled data

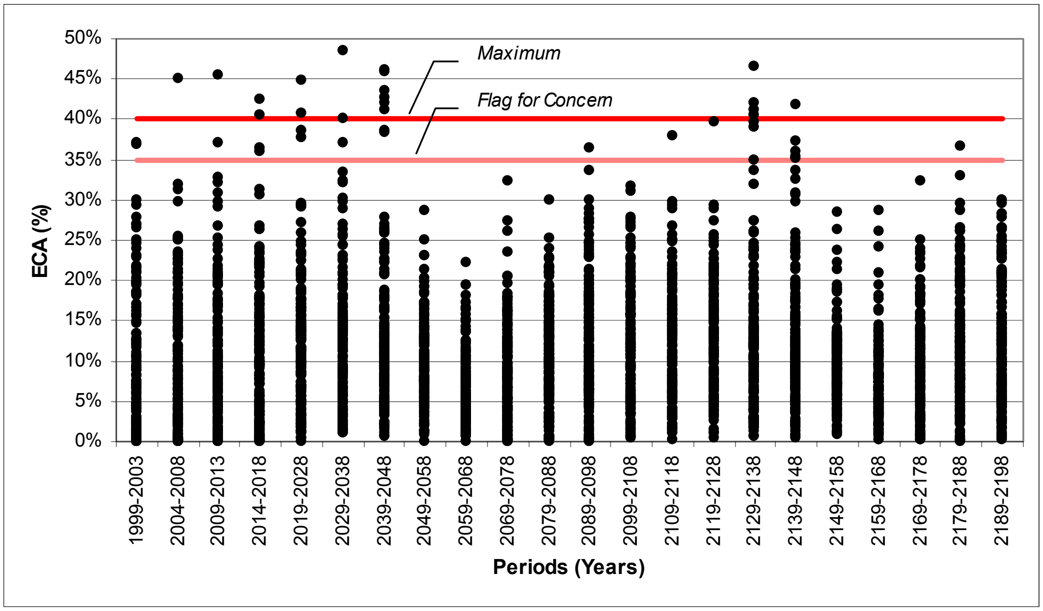
The majority of watersheds are still below the Equivalent Clearcut Area (ECA) limit of 40% mainly due to the requirement for an even-flow harvest. However, there are still many that exceed the 40% limit and the 35% threshold level in watersheds that are identified as providing bull trout habitat. Figures 18 and 20 show the ECA levels in the H60 portion of the watersheds, defined as 60% of the area of the watershed that is at the highest elevation. Figures 19 and 21 show the ECA for the entire watershed. Each point in these graphs correlates to the average ECA in a period for an individual watershed.

Figure 18. Scenario 2C: Hydrological Recovery in Watersheds with Bull Trout – H60 Portion



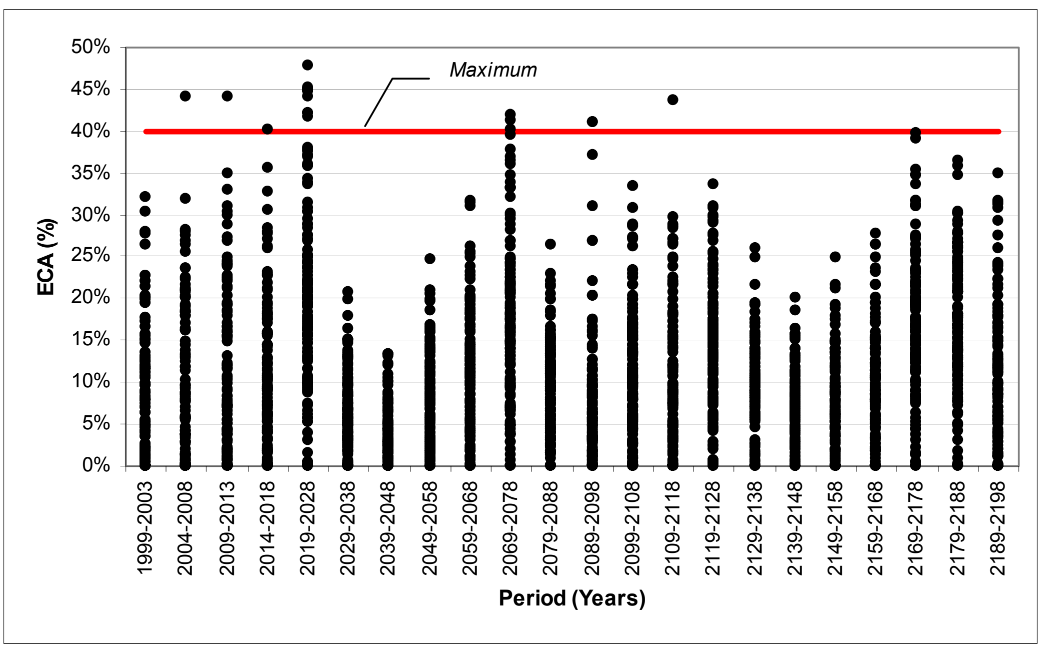
Source: ORM compiled data

Figure 19. Scenario 2C: Hydrological Recovery in Watersheds with Bull Trout – Entire Area



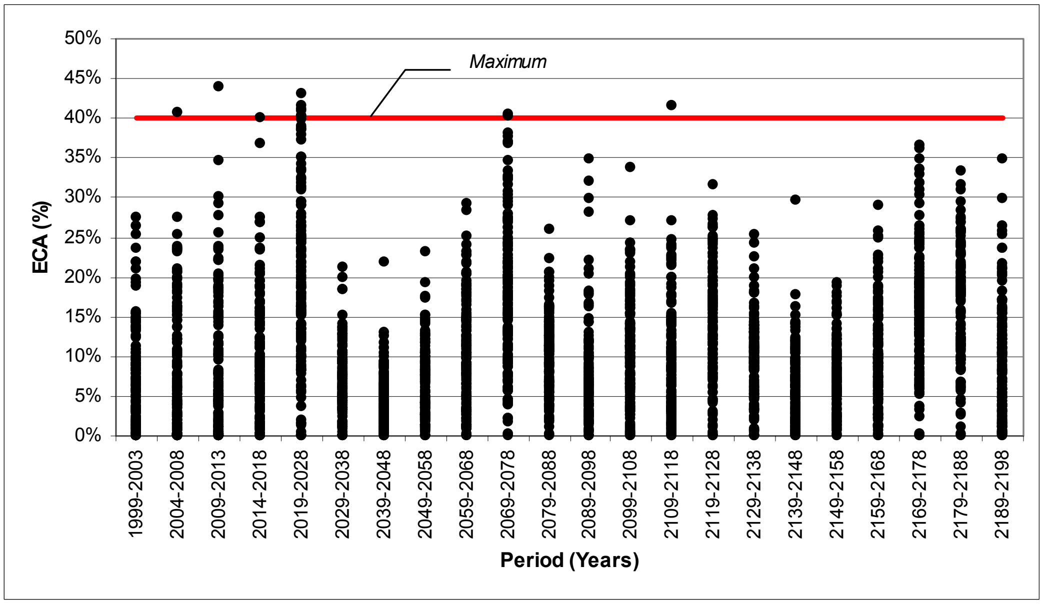
Source: ORM compiled data

Figure 20. Scenario 2C: Hydrological Recovery in Watersheds without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 21. Scenario 2C: Hydrological Recovery in Watersheds without Bull Trout – Entire Area



Source: ORM compiled data

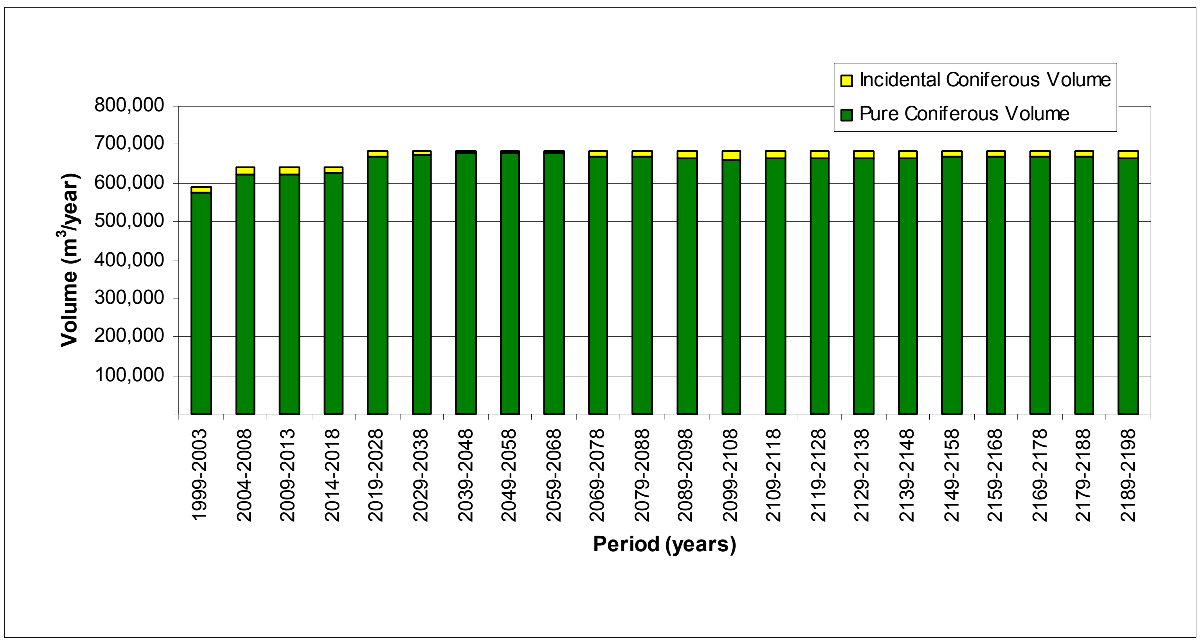
6.6 Scenario 3C

Results for Scenario 3C are discussed in the following sections.

6.6.1 Timber Harvest

Application of non-timber resource objectives, operational constraints and the requirement for deciduous sustainability results in a decrease of the long-term sustainable coniferous harvest to 685,000 m^3/year as shown in Figure 22 and Table 24. One of the side effects of the requirement for deciduous sustainability is that the flow of incidental coniferous volume from deciduous priority stands is stable. A comparison with the flow of incidental coniferous volume from Scenario 2C indicates that this is one of the primary factors in reducing the harvest from the unconstrained 770,000 m^3/year level. This is supported by the seral stage and hydrological recovery graphs (Figures 26–32 and Figures 35-38) which also show significant improvement even though harvesting was not explicitly limited to address these objectives in this scenario.

Figure 22. Scenario 3C: Coniferous Harvest Flow



Source: ORM compiled data

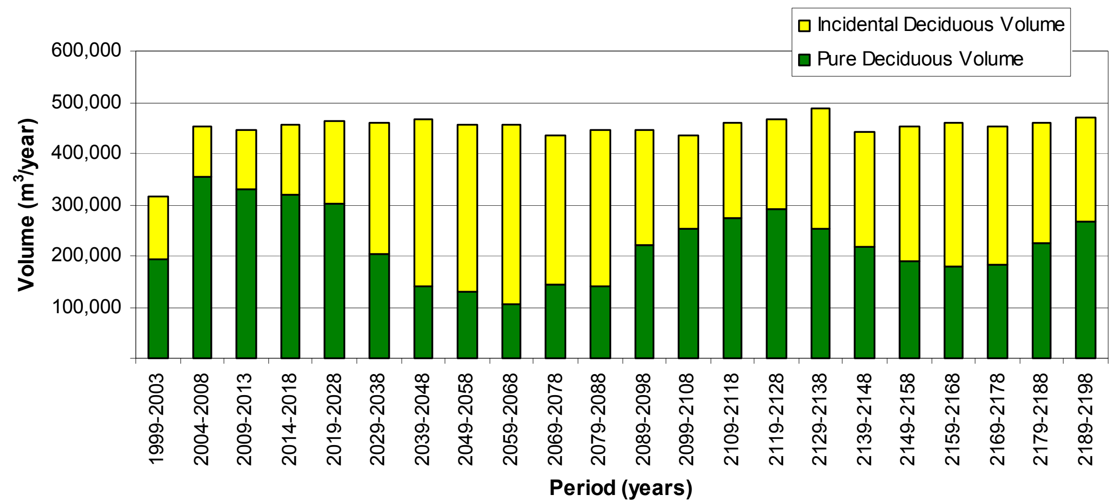
Table 24. Scenario 3C: Coniferous Harvest Flow

Period	Coniferous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	575,636	11,979	**587,615**
2004-2008	622,618	17,382	**640,000**
2009-2013	622,910	17,090	**640,000**
2014-2018	624,563	15,437	**640,000**
2019-2028	668,248	16,752	**685,000**
2029-2038	674,199	10,801	**685,000**
2039-2048	677,393	7,607	**685,000**
2049-2058	676,969	8,031	**685,000**
2059-2068	677,176	7,824	**685,000**
2069-2078	670,647	14,353	**685,000**
2079-2088	670,734	14,266	**685,000**
2089-2098	665,502	19,498	**685,000**
2099-2108	661,054	23,946	**685,000**
2109-2118	663,988	21,012	**685,000**
2119-2128	664,043	20,957	**685,000**
2129-2138	663,672	21,328	**685,000**
2139-2148	665,171	19,829	**685,000**
2149-2158	669,533	15,467	**685,000**
2159-2168	669,282	15,718	**685,000**
2169-2178	671,003	13,997	**685,000**
2179-2188	667,642	17,358	**685,000**
2189-2198	664,872	20,128	**685,000**

Source: ORM compiled data

Deciduous flows are maintained at or near the deciduous allocation levels for the entire planning horizon as shown in Figure 23 and Table 25. There are several small dips and one minor spike but these could be eliminated with further iterations of the simulation model.

Figure 23. Scenario 3C: Deciduous Harvest Flow



Source: ORM compiled data

Table 25. Scenario 3C: Deciduous Harvest Flow

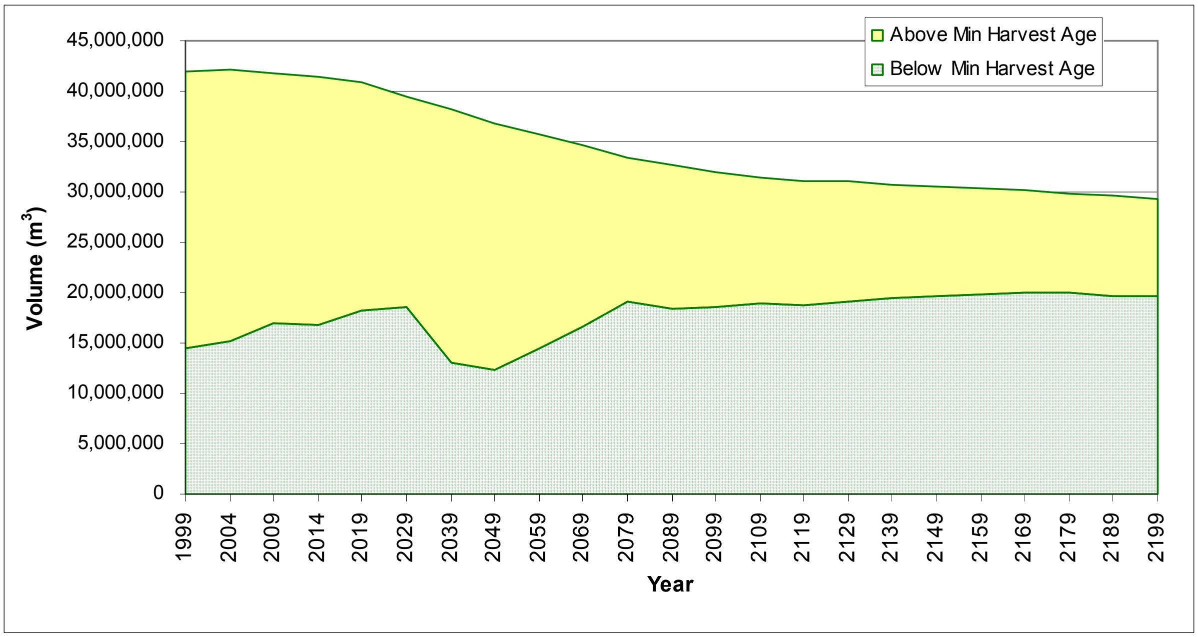
Period	Deciduous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	193,678	121,271	**314,949**
2004-2008	355,074	97,326	**452,401**
2009-2013	328,350	118,985	**447,335**
2014-2018	320,371	136,394	**456,766**
2019-2028	303,261	158,280	**461,541**
2029-2038	201,865	259,391	**461,255**
2039-2048	139,170	327,920	**467,090**
2049-2058	131,182	326,667	**457,849**
2059-2068	105,786	351,695	**457,481**
2069-2078	143,127	292,172	**435,299**
2079-2088	139,558	307,787	**447,345**
2089-2098	220,980	225,753	**446,732**
2099-2108	251,341	184,645	**435,986**
2109-2118	272,349	187,112	**459,461**
2119-2128	289,792	177,005	**466,798**
2129-2138	252,489	235,747	**488,235**
2139-2148	216,412	226,787	**443,198**
2149-2158	190,236	261,214	**451,450**
2159-2168	178,021	282,260	**460,281**
2169-2178	183,320	269,967	**453,286**
2179-2188	224,614	235,360	**459,973**
2189-2198	265,862	205,173	**471,035**

Source: ORM compiled data

6.6.2 Inventory

The application of constraints on the timber harvests result in a standing inventory that stabilizes within the 200-year planning horizon (Figures 24 and 25 and Tables 26 and Table 27). The stabilization in both coniferous and deciduous standing inventory volume is indicative of stable long-term supplies for both types and also indicates that the supply of deciduous volume has been maximized within the objectives and constraints of this analysis. The rapid decline in the deciduous standing inventory volume is exaggerated by the loss of volume in deciduous stands because of the decline portion of the curve.

Figure 24. Scenario 3C: Coniferous Standing Inventory Volume



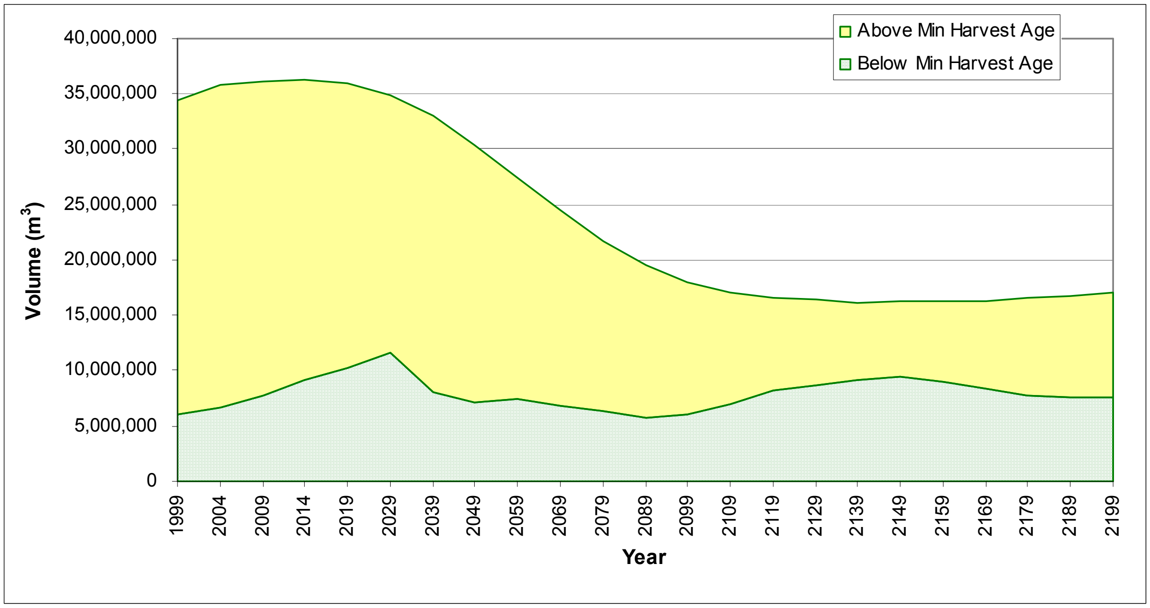
Source: ORM compiled data

Table 26. Scenario 3C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,157
2004	26,897,141	15,222,512
2009	24,922,489	16,891,068
2014	24,686,301	16,740,343
2019	22,744,111	18,212,095
2029	20,991,941	18,561,441
2039	25,066,968	13,063,847
2049	24,427,830	12,351,957
2059	21,182,378	14,487,220
2069	17,945,917	16,682,163
2079	14,267,748	19,173,031
2089	14,300,966	18,388,300
2099	13,382,602	18,548,769
2109	12,627,910	18,857,861
2119	12,212,418	18,802,634
2129	12,000,043	19,022,093
2139	11,328,702	19,393,203
2149	10,894,703	19,647,833
2159	10,495,891	19,878,097
2169	10,138,551	20,072,064
2179	9,874,963	19,934,489
2189	9,905,042	19,676,431
2199	9,736,222	19,573,865

Source: ORM compiled data

Figure 25. Scenario 3C: Deciduous Standing Inventory Volume



Source: ORM compiled data

Table 27. Scenario 3C: Deciduous Standing Inventory Volume

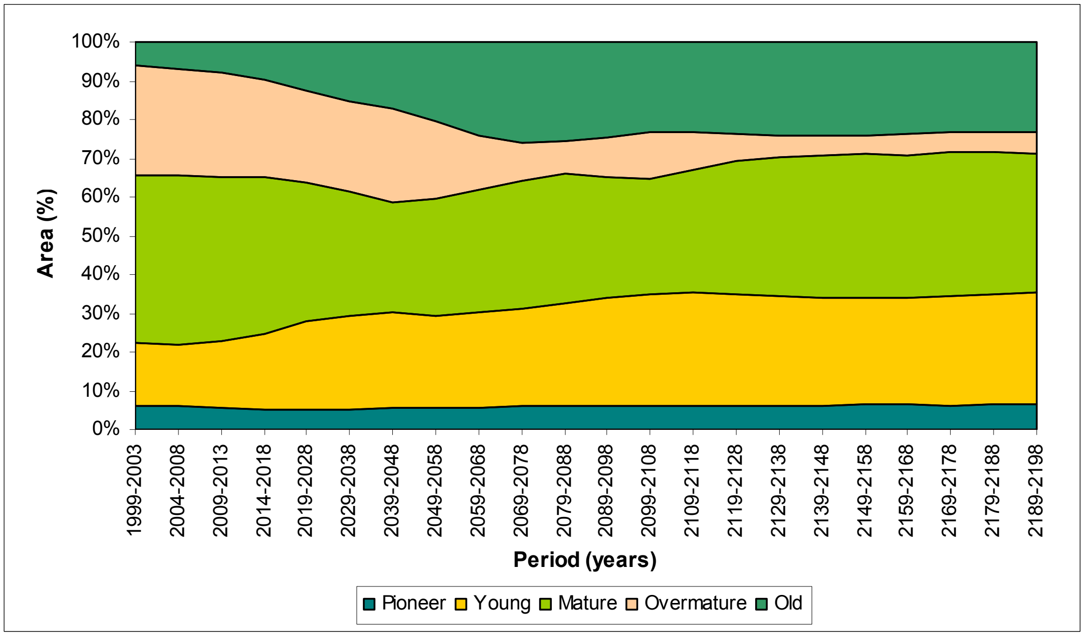
Year	Deciduous Volume (m³)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,301
2004	29,033,070	6,718,415
2009	28,296,759	7,799,777
2014	27,077,959	9,218,282
2019	25,847,402	10,181,614
2029	23,285,830	11,558,668
2039	25,026,207	7,995,467
2049	23,343,468	7,113,369
2059	20,032,288	7,451,454
2069	17,654,456	6,782,240
2079	15,348,264	6,368,307
2089	13,735,860	5,747,464
2099	11,839,735	6,070,935
2109	10,106,292	7,007,761
2119	8,330,936	8,212,427
2129	7,649,881	8,707,583
2139	6,872,853	9,185,083
2149	6,750,670	9,461,120
2159	7,230,745	9,052,247
2169	7,888,308	8,407,989
2179	8,845,657	7,756,029
2189	9,220,348	7,530,252
2199	9,317,921	7,670,605

Source: ORM compiled data

6.6.3 Non-timber Resources

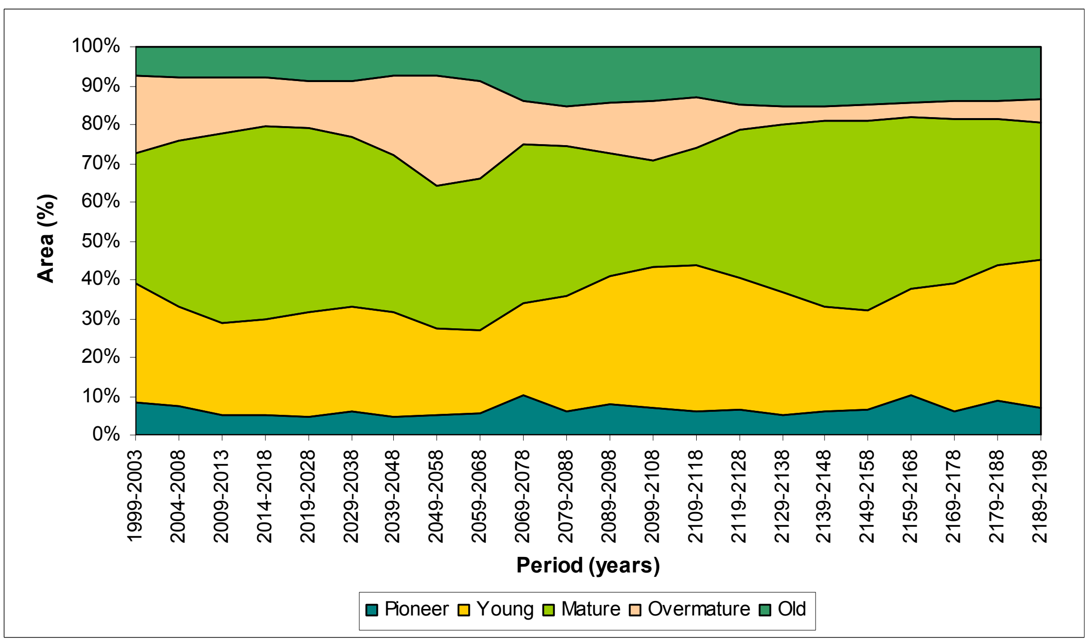
The most noticeable effect of the reduced harvest level on the seral stage distribution is the fact that the overmature seral stage remains present throughout the planning horizon (Figures 26-32). This is a very clear indicator of the fact that the real impact of constraints is to extend the effective rotation length for a stand. The overmature seral stage still disappears in Forest Management Unit (FMU) G2C but this is because so much of the area is reserved from harvesting. The other noticeable change is the tendency for a more stable seral stage distribution across the time horizon. Besides the reduced harvest levels, one of the factors affecting the seral stage distribution is the use of a spatial model which builds aggregated cut units which are more operational in nature. A non-spatial model would tend to harvest the oldest stands first so that harvesting would tend to always occur in the oldest available stands. With cut unit aggregation, a younger stand may be harvested because it is next to an old stand and the opening size hasn't reached the desired maximum. Under this scenario, more harvesting tends to take place in the mature and overmature seral stages.

Figure 26. Scenario 3C: Seral Stage Distribution – FMA



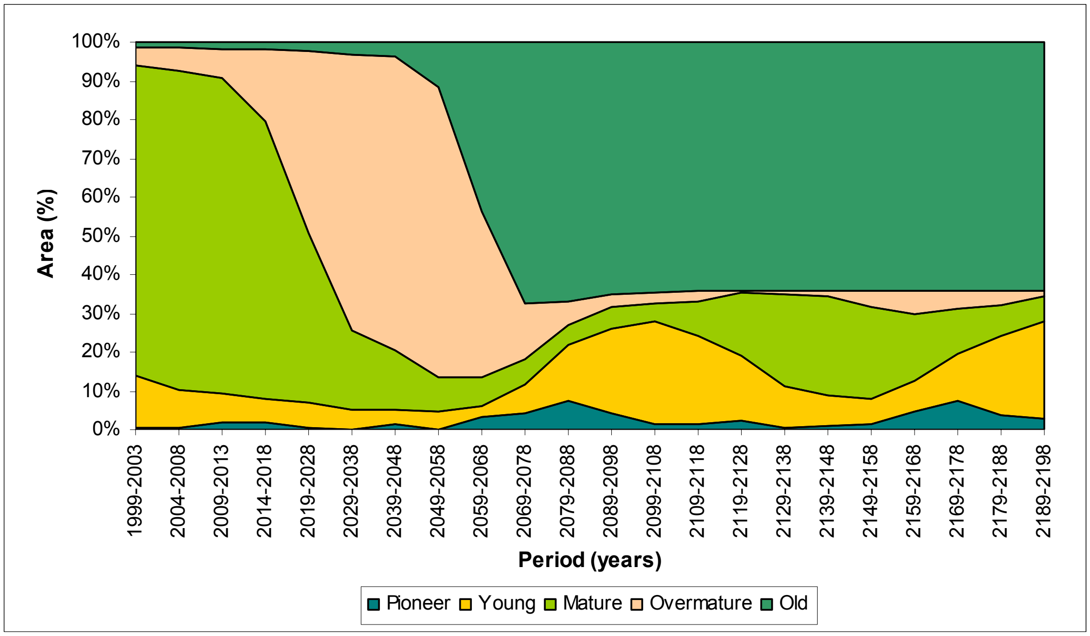
Source: ORM compiled data

Figure 27. Scenario 3C: Seral Stage Distribution – FMU G2C



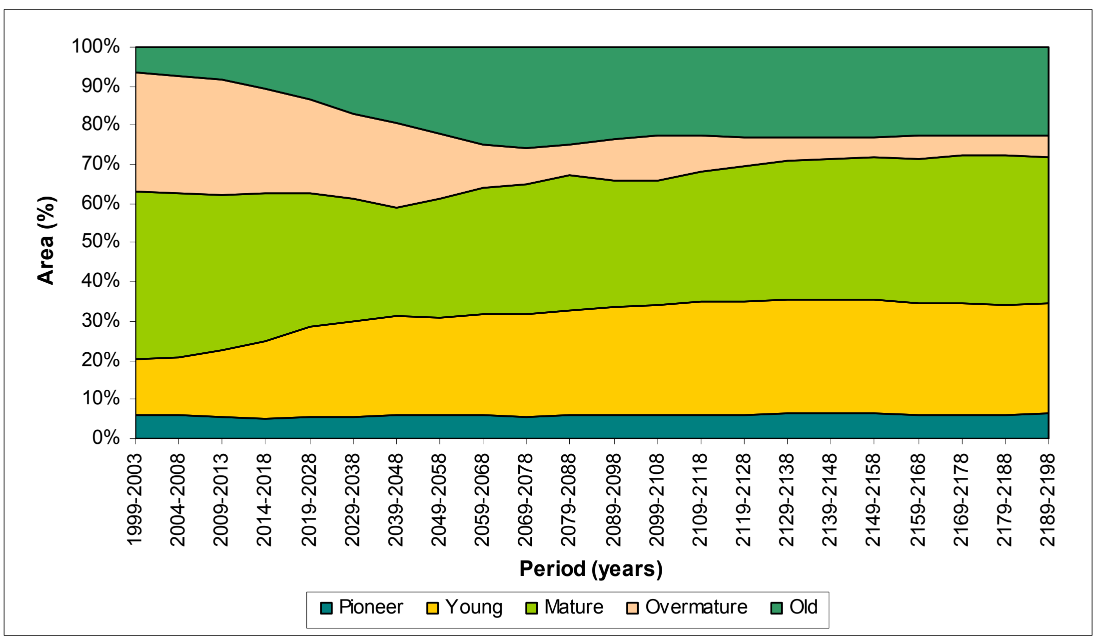
Source: ORM compiled data

Figure 28. Scenario 3C: Seral Stage Distribution – FMU G8C



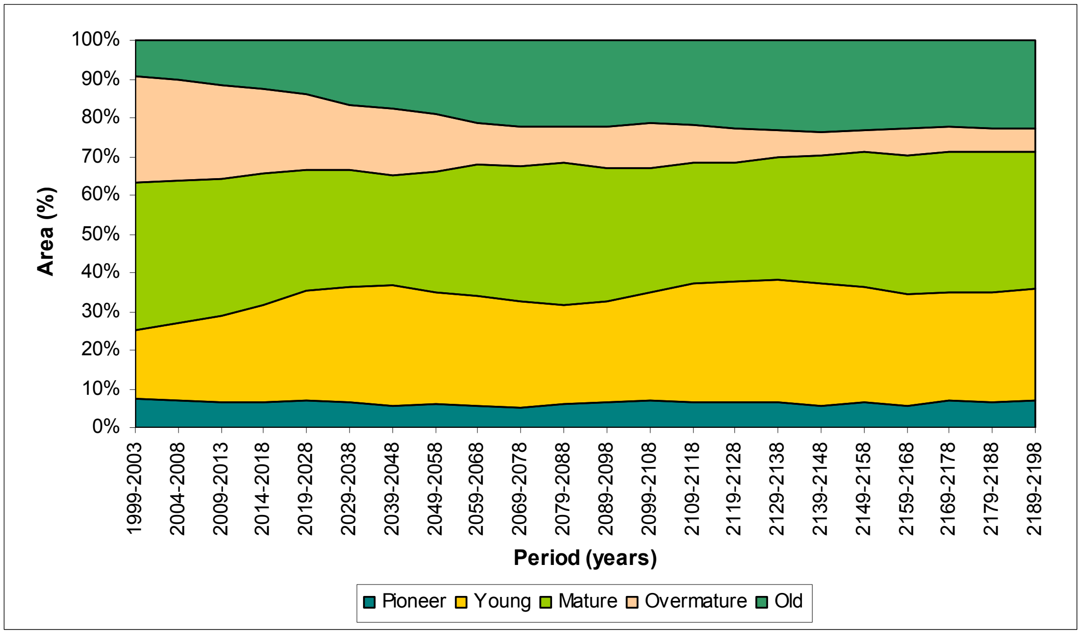
Source: ORM compiled data

Figure 29. Scenario 3C: Seral Stage Distribution – FMUs G5C and E8C



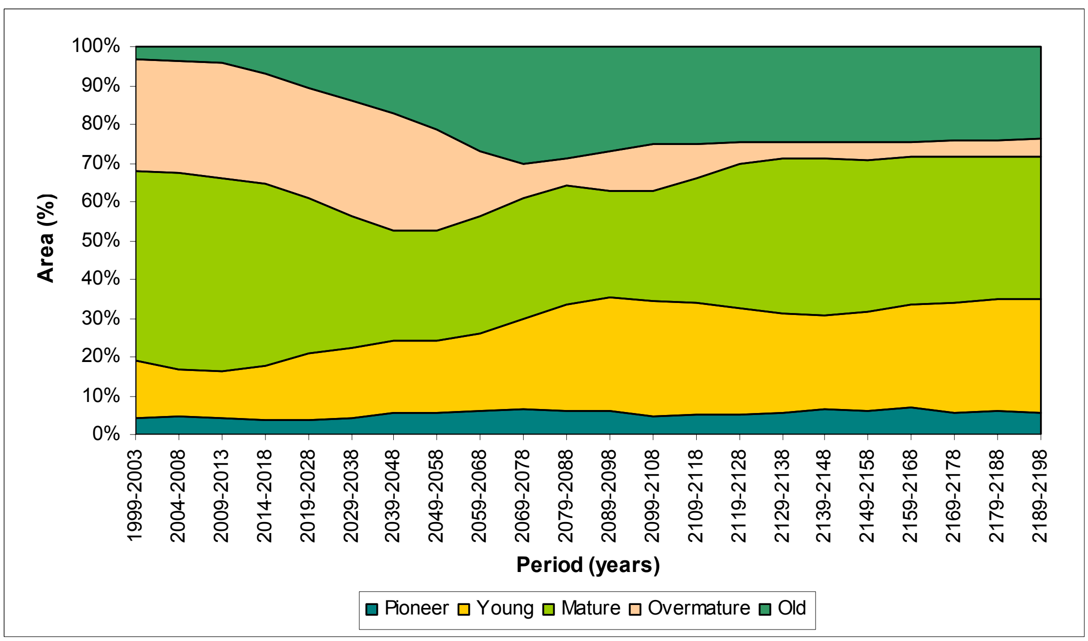
Source: ORM compiled data

Figure 30. Scenario 3C: Seral Stage Distribution – Foothills Natural Region



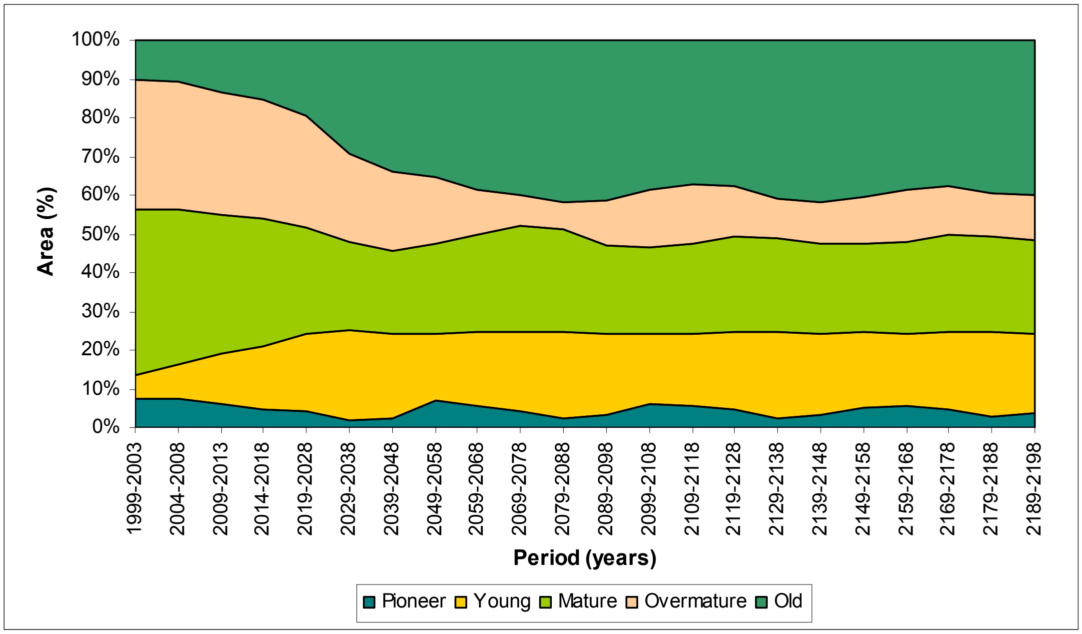
Source: ORM compiled data

Figure 31. Scenario 3C: Seral Stage Distribution – Boreal Forest Natural Region



Source: ORM compiled data

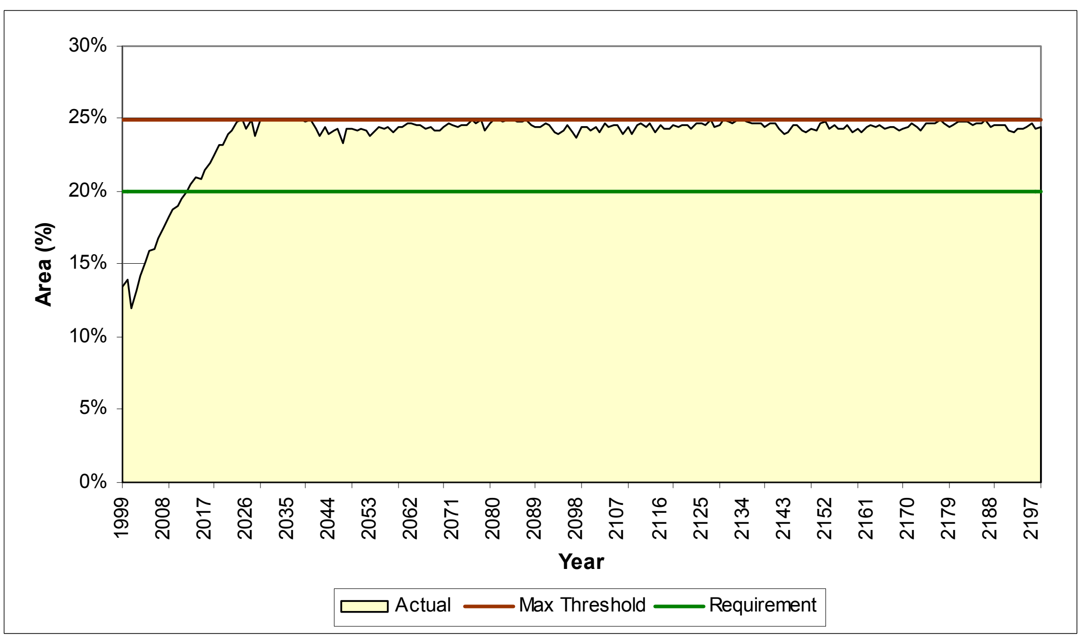
Figure 32. Scenario 3C: Seral Stage Distribution – Caribou Area



Source: ORM compiled data

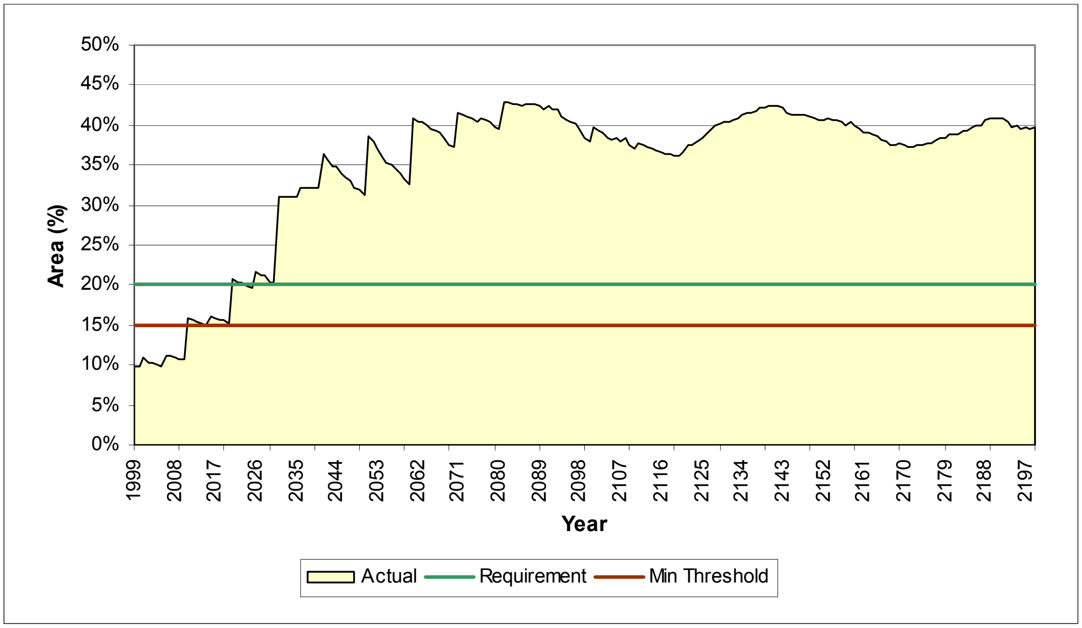
In Scenario 3C, controls were placed explicitly to meet the Caribou Area habitat objectives and this is verified in Figures 33 and 34. The amount of pioneer and young seral stage habitat never exceeds 25% while the amount of old seral stage habitat is always greater than 20%.

Figure 33. Scenario 3C: Pioneer and Young Seral Stage Habitat in the Caribou Area



Source: ORM compiled data

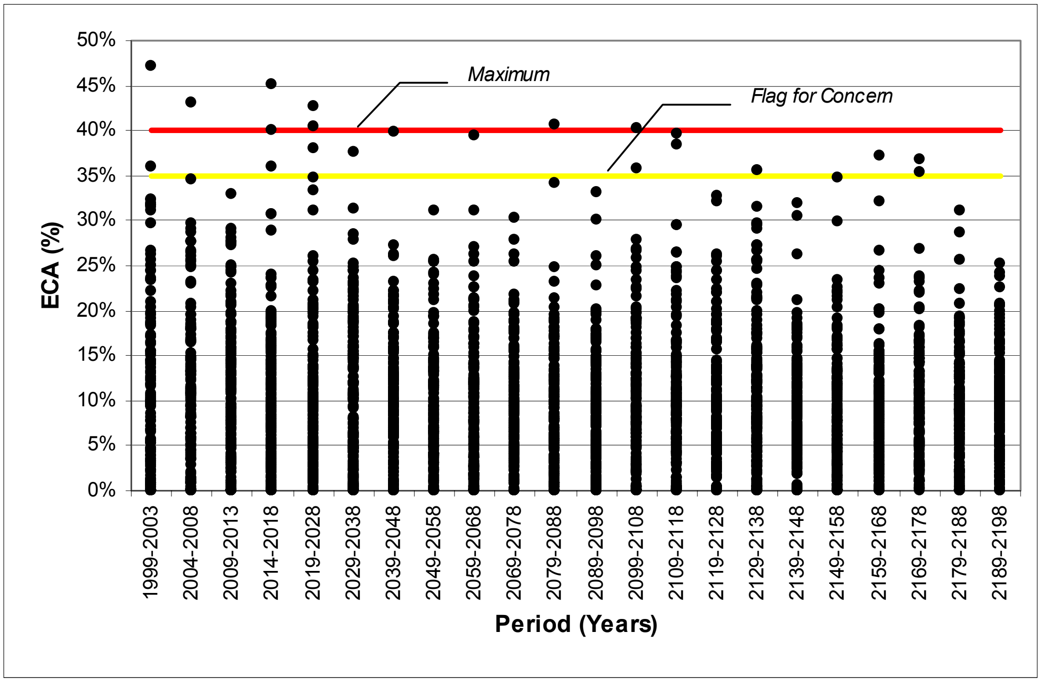
Figure 34. Scenario 3C: Old Seral Stage Habitat in the Caribou Area



Source: ORM compiled data

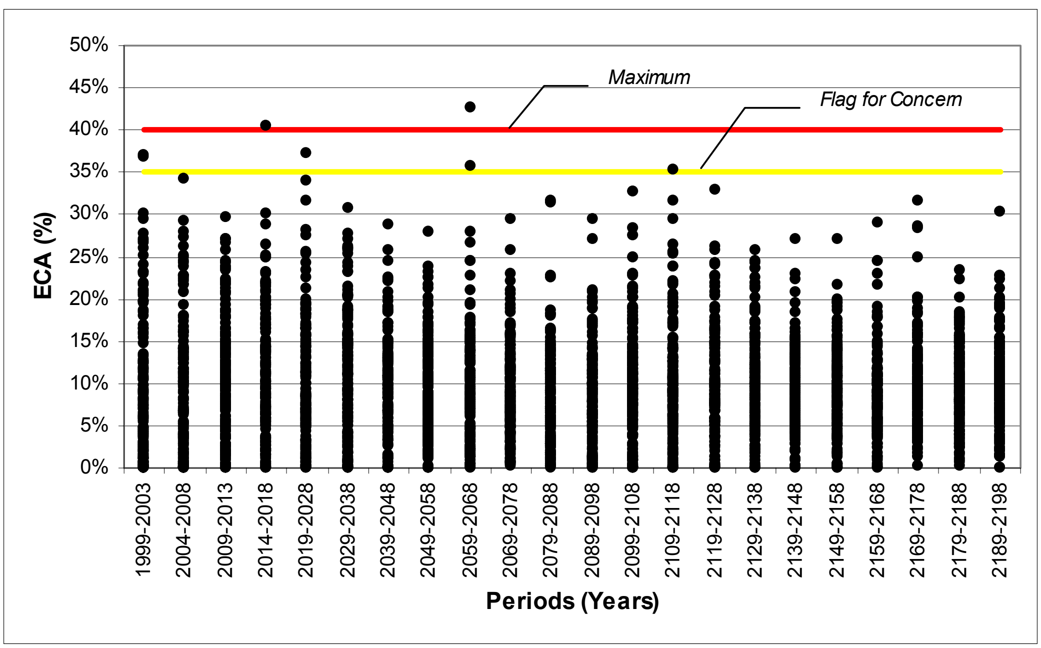
Equivalent Clearcut Area (ECA) was not controlled and still presents a problem for some watersheds although significantly less than was seen in Scenario 2C. However, the problems are found in the H60 portions of watersheds that do provide bull trout habitat as shown in Figure 35. Figures 36 through 38 indicate there are no significant problems in the remaining portion of the bull trout watersheds and in the other watersheds as a whole.

Figure 35. Scenario 3C: Hydrological Recovery in Watersheds with Bull Trout – H60 Portion



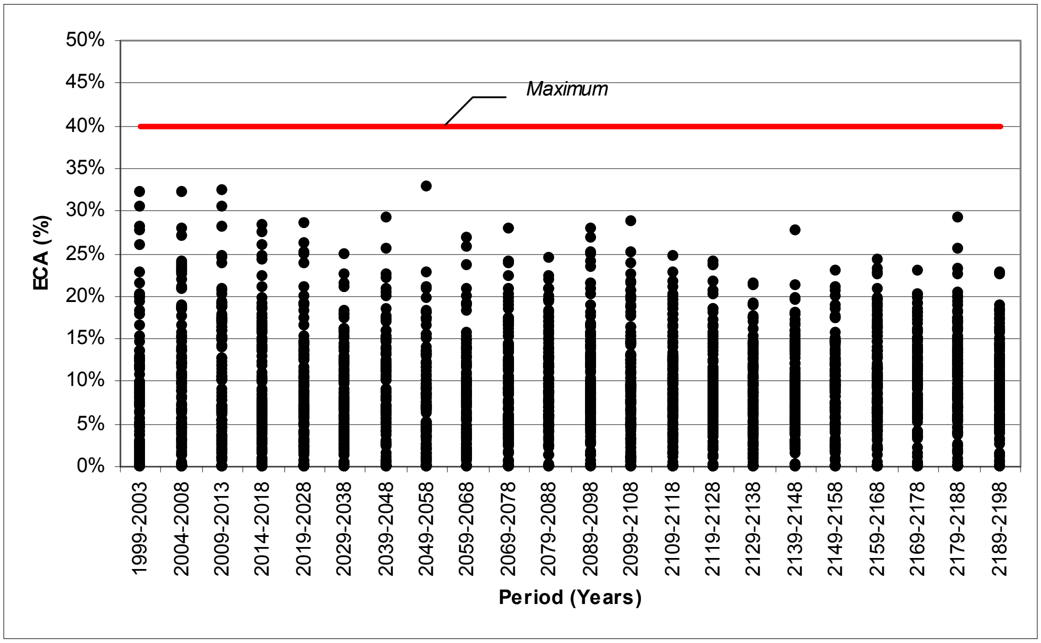
Source: ORM compiled data

Figure 36. Scenario 3C: Hydrological Recovery in Watersheds with Bull Trout – Entire Area



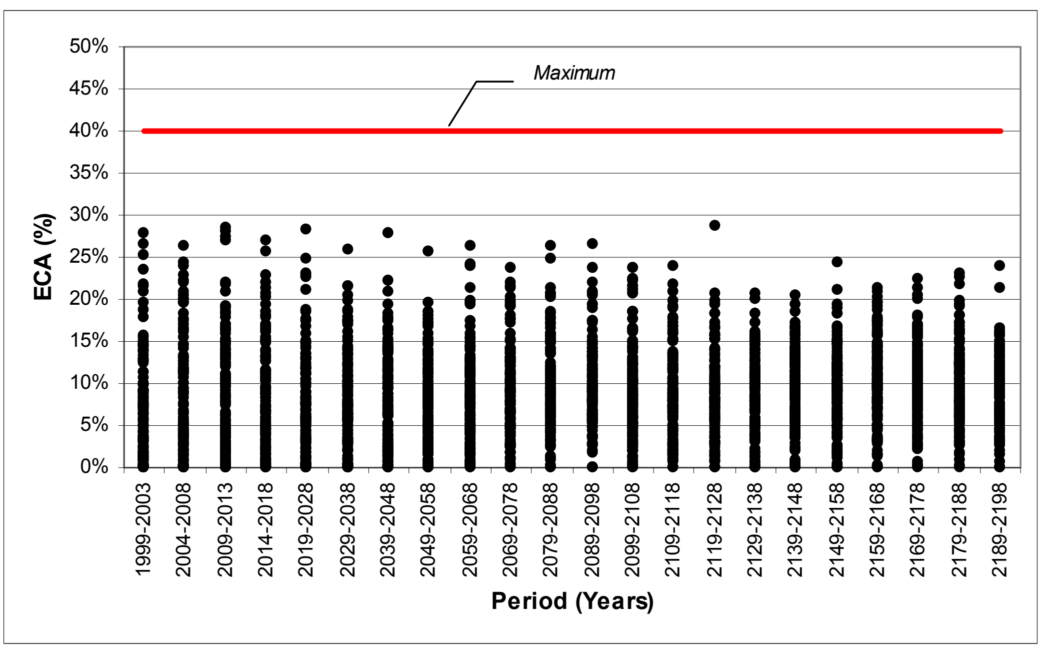
Source: ORM compiled data

Figure 37. Scenario 3C: Hydrological Recovery in Watersheds without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 38. Scenario 3C: Hydrological Recovery in Watersheds without Bull Trout – Entire Area



Source: ORM compiled data

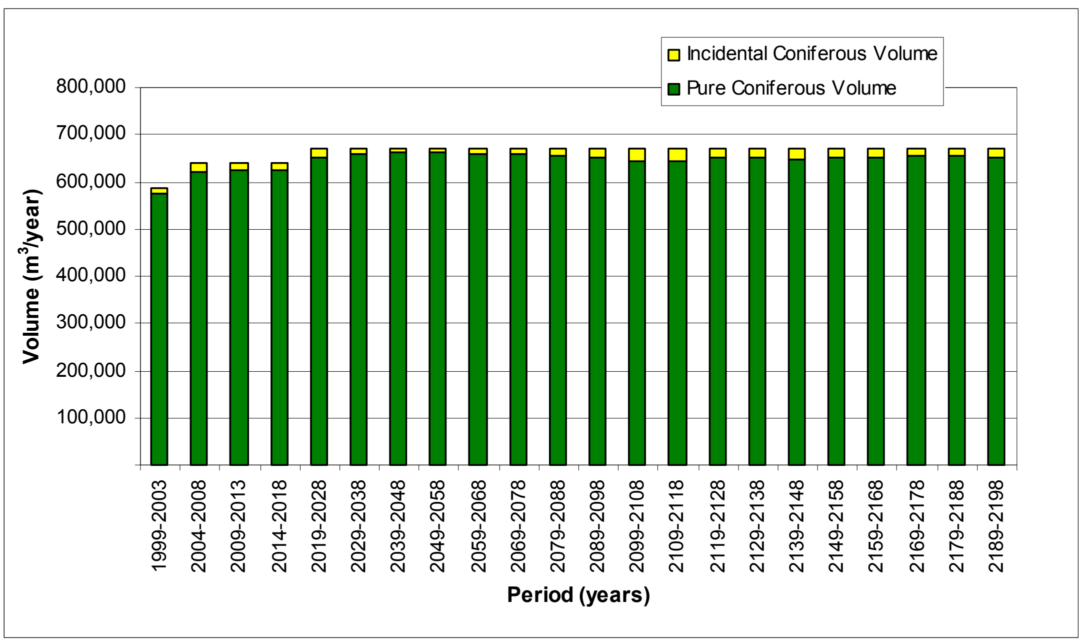
6.7 Scenario 4C

Results for Scenario 4C are discussed in the following sections.

6.7.1 Timber Harvest

Within Scenario 4C, a coniferous harvest level of 587,615 m^3/year was attained for the period 1999-2003 to reflect the actual harvested area in 1999 and 2000. After this point. a harvest level of 640,000 m^3/year was maintained for the first 20 years and then increased by approximately 4.6% to 670,000 m^3/year as shown in Figure 39 and Table 28. This higher coniferous harvest level was required to meet allocated deciduous volumes of 453,712 m^3/year. A non-declining even-flow harvest level of 670,000 m^3/year is attainable for the entire 200-year planning horizon but only if the operational harvest sequencing that is implemented in the first 20 years is not taken into account. Incidental coniferous volume is relatively small with less than 25,000 m^3/year being generated from deciduous priority stands.

Figure 39. Scenario 4C: Coniferous Harvest Flow



Source: ORM compiled data

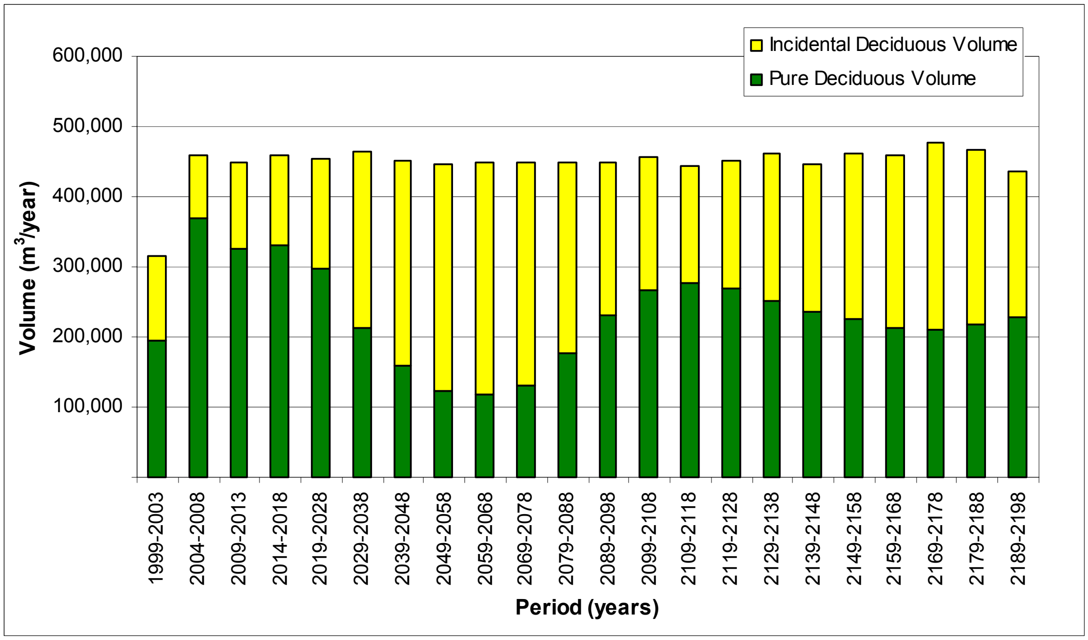
Table 28. Scenario 4C: Coniferous Harvest Flow

Period	Coniferous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	575,636	11,979	**587,615**
2004-2008	622,502	17,498	**640,000**
2009-2013	622,976	17,024	**640,000**
2014-2018	623,006	16,994	**640,000**
2019-2028	652,709	17,291	**670,000**
2029-2038	657,914	12,086	**670,000**
2039-2048	661,928	8,072	**670,000**
2049-2058	664,298	5,702	**670,000**
2059-2068	660,309	9,691	**670,000**
2069-2078	657,633	12,367	**670,000**
2079-2088	654,620	15,380	**670,000**
2089-2098	650,878	19,122	**670,000**
2099-2108	645,241	24,759	**670,000**
2109-2118	645,381	24,619	**670,000**
2119-2128	651,660	18,340	**670,000**
2129-2138	649,976	20,024	**670,000**
2139-2148	648,866	21,134	**670,000**
2149-2158	651,422	18,578	**670,000**
2159-2168	652,417	17,583	**670,000**
2169-2178	654,689	15,311	**670,000**
2179-2188	653,932	16,068	**670,000**
2189-2198	651,908	18,092	**670,000**

Source: ORM compiled data

Deciduous harvest levels are maintained at or near the prescribed deciduous allocation level of 453,712 m^3/year with little variation as shown in Figure 40 and Table 29. However, the deciduous harvest level is much more reliant on incidental volume generated from the harvesting of coniferous priority stands. Attempting to maintain an even-flow of the incidental deciduous volume from the coniferous priority stands would result in reduced levels for both coniferous and deciduous wood flows. However, while the incidental volume change is significant over the entire planning horizon the transition from period to period appears to be graduated thus allowing for operations to adapt at a reasonable rate.

Figure 40. Scenario 4C: Deciduous Harvest Flow



Source: ORM compiled data

Table 29. Scenario 4C: Deciduous Harvest Flow

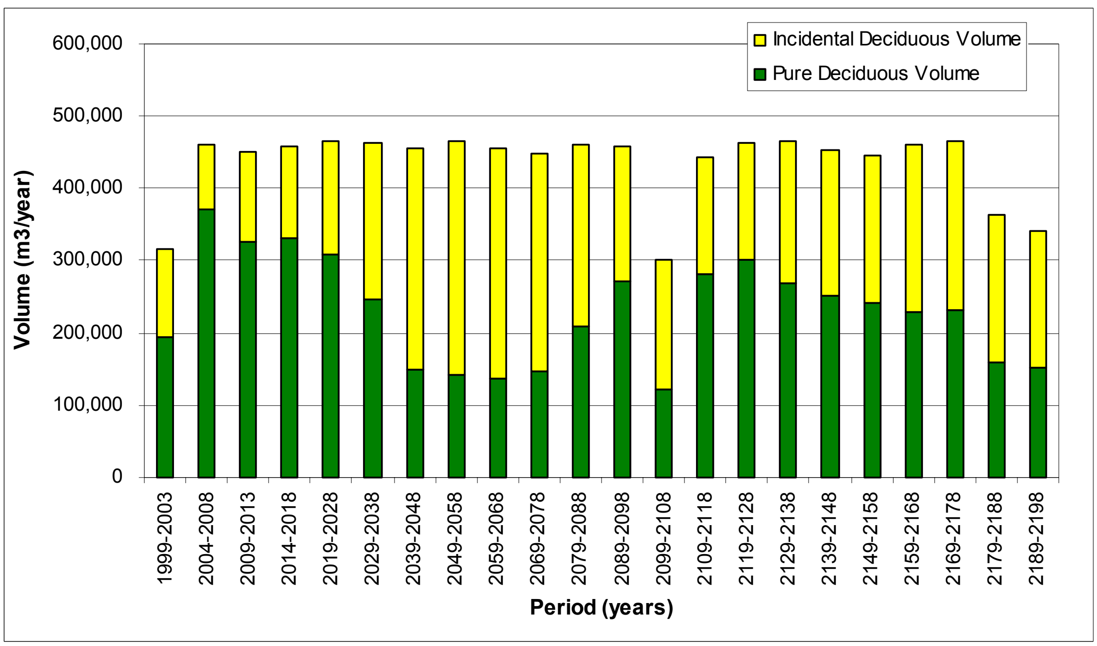
Period	Deciduous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	193,678	121,271	**314,949**
2004-2008	370,381	89,038	**459,419**
2009-2013	325,160	124,694	**449,854**
2014-2018	331,673	127,660	**459,333**
2019-2028	297,836	156,972	**454,808**
2029-2038	212,713	250,224	**462,937**
2039-2048	158,046	293,140	**451,186**
2049-2058	122,205	323,051	**445,256**
2059-2068	119,182	330,129	**449,311**
2069-2078	130,133	319,400	**449,533**
2079-2088	175,812	273,570	**449,382**
2089-2098	231,785	217,063	**448,848**
2099-2108	267,744	189,341	**457,085**
2109-2118	276,466	167,703	**444,169**
2119-2128	269,623	181,866	**451,489**
2129-2138	252,367	209,521	**461,888**
2139-2148	236,072	209,100	**445,172**
2149-2158	224,412	236,307	**460,719**
2159-2168	211,670	246,312	**457,982**
2169-2178	209,293	267,581	**476,874**
2179-2188	217,419	249,725	**467,144**
2189-2198	227,175	209,225	**436,400**

Source: ORM compiled data

Initially, Scenario 4C was implemented with an even-flow coniferous harvest level of 640,000 m^3/year for the entire 20-year planning horizon. However, under this coniferous harvest level there were significant drops in the deciduous harvest level in the 2099-2108 period and at the end of the planning horizon as shown in Figure 41 and Table 30. One risk around the increased coniferous harvest level of 670,000 m^3/year revolves around the assumption that by establishing the harvest pattern over the first 20-years, harvest sequencing will become less of an issue beyond the 20-year time period for two main reasons:

- The 20-year harvest sequence covers a large portion of the Forest Management Agreement area (FMA area) and therefore is establishing a harvest pattern that will tend to also guide future harvests; and
- It is more likely that there will be more operational constraints at the beginning of the DFMP when significant changes to management are being felt for the first time. As time progresses and the landscape is rehabilitated, there will tend to be fewer conflicts between operations and non-timber resources.

Figure 41. Scenario 4C: Deciduous Harvest Flow from 640,000 Even-flow Coniferous



Source: ORM compiled data

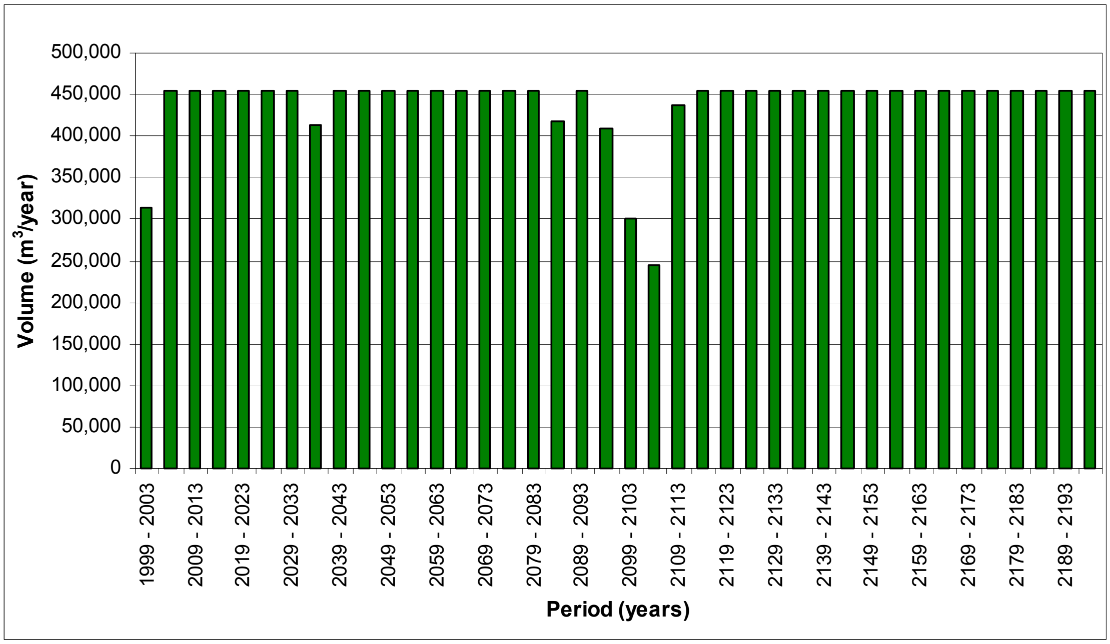
Table 30. Scenario 4C: Deciduous Harvest Flow from 640,000 Even-flow Coniferous

Period	Deciduous Volume (m^3/yr)		
	Pure	Incidental	Total
1999-2003	193,678	121,271	**314,949**
2004-2008	370,381	89,038	**459,419**
2009-2013	325,160	124,694	**449,855**
2014-2018	331,673	127,660	**459,333**
2019-2028	308,216	156,352	**464,567**
2029-2038	245,508	218,521	**464,030**
2039-2048	148,501	308,332	**456,833**
2049-2058	141,920	323,770	**465,689**
2059-2068	136,751	318,110	**454,861**
2069-2078	147,735	301,610	**449,345**
2079-2088	209,471	251,421	**460,892**
2089-2098	270,179	188,207	**458,386**
2099-2108	122,635	177,381	**300,016**
2109-2118	282,555	161,707	**444,261**
2119-2128	300,403	162,723	**463,125**
2129-2138	269,553	195,554	**465,107**
2139-2148	250,732	202,969	**453,700**
2149-2158	240,397	206,232	**446,629**
2159-2168	228,540	231,053	**459,593**
2169-2178	231,648	234,665	**466,312**
2179-2188	158,723	204,860	**363,583**
2189-2198	150,744	191,528	**342,272**

Source: ORM compiled data

A WOODSTOCK run (Scenario 1W) also confirmed the presence of these drops in deciduous flows as shown by Figure 42 and Table 31. However, it is interesting to note that the spatial simulation seems to produce better results with less significant drops in deciduous flows when one would normally expect the opposite result. The reason for this discrepancy was not investigated but it is believed to be the result of sub-optimal local solutions, which tend to occur in more complex models with many constraints. This trend was consistently found during the *Resource and Timber Supply Analysis*.

Figure 42. Scenario 1W: Deciduous Harvest Flow from Even-flow Coniferous Harvest



Source: ORM compiled data

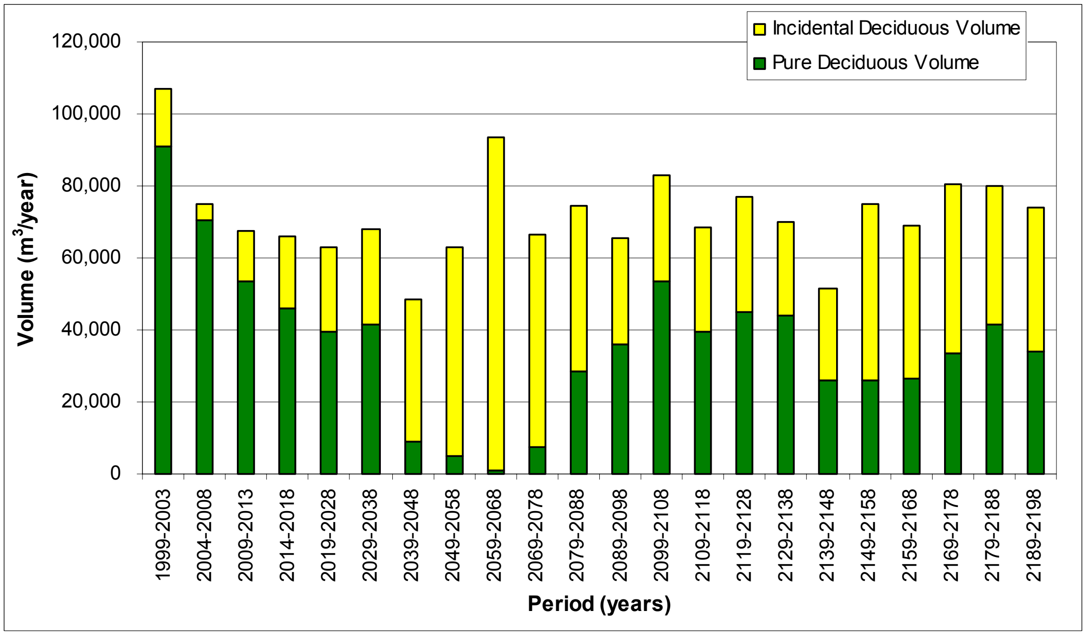
Table 31. Scenario 1W: Deciduous Harvest Flow from Even-flow Coniferous Harvest

Period	Deciduous Volume (m^3/year)	Period	Deciduous Volume (m^3/year)	Period	Deciduous Volume (m^3/year)	Period	Deciduous Volume (m^3/year)
1999 - 2003	312,977	2049 - 2053	453,712	2099 - 2103	301,840	2149 - 2153	453,712
2004 - 2008	453,712	2054 - 2058	453,712	2104 - 2108	243,875	2154 - 2158	453,712
2009 - 2013	453,712	2059 - 2063	453,712	2109 - 2113	436,633	2159 - 2163	453,712
2014 - 2018	453,712	2064 - 2068	453,712	2114 - 2118	453,712	2164 - 2168	453,712
2019 - 2023	453,712	2069 - 2073	453,712	2119 - 2123	453,712	2169 - 2173	453,712
2024 - 2028	453,712	2074 - 2078	453,712	2124 - 2128	453,712	2174 - 2178	453,712
2029 - 2033	453,712	2079 - 2083	453,712	2129 - 2133	453,712	2179 - 2183	453,712
2034 - 2038	412,575	2084 - 2088	416,845	2134 - 2138	453,712	2184 - 2188	453,712
2039 - 2043	453,712	2089 - 2093	453,712	2139 - 2143	453,712	2189 - 2193	453,712
2044 - 2048	453,712	2094 - 2098	409,363	2144 - 2148	453,712	2194 - 2198	453,712

Source: ORM compiled data

Deciduous volumes were controlled in terms of their split between Forest Management Units (FMUs) G2C and G5C/E8C. Figure 43 and Table 32 show that the flow in FMU G2C varies between 48,274 and 93,421 m^3/year with the maximum reached in the 2059-2068 period. However, all of this deciduous volume is generated from the coniferous harvest. The average harvest from FMU G2C is 70,471 m^3/year, which does exceed the 60,500 m^3/year deciduous allocation level. However, this flexibility in cut allocation contributed to maximizing the deciduous wood supply. Figure 44 and Table 33 show a variation in harvest levels within FMUs G5C/E8C between 342,934 and 401,175 m^3/year with the maximum reached in the 2059-2068 period. The average harvest from FMUs G5C/E8C is 378,703 m^3/year.

Figure 43. Scenario 4C: Deciduous Harvest Flow in the FMU G2C



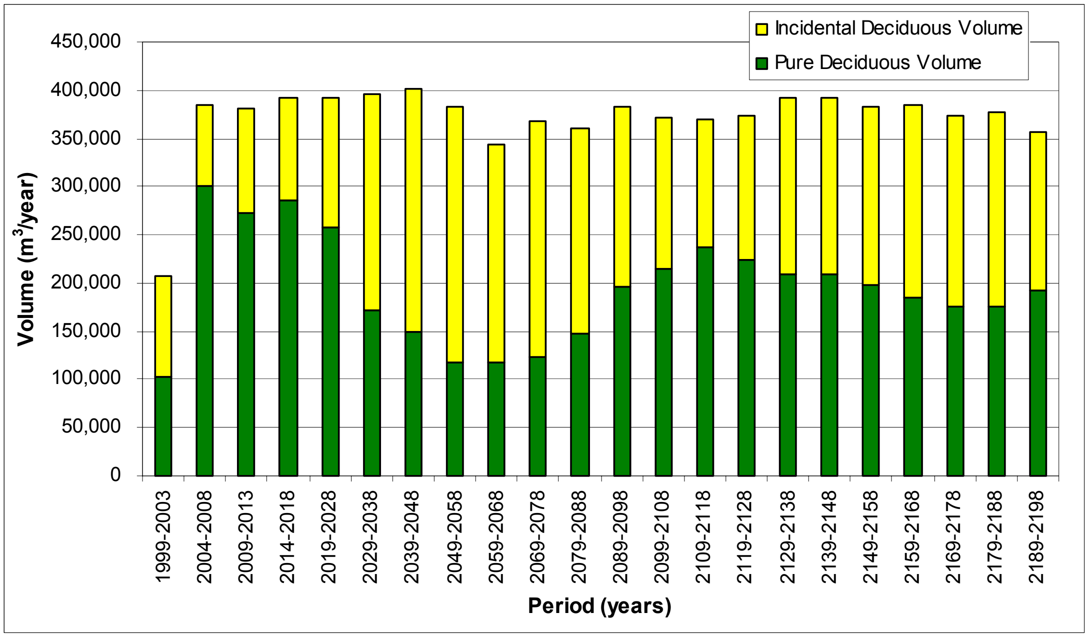
Source: ORM compiled data

Table 32. Scenario 4C: Deciduous Harvest Flow in the FMU G2C

Period	Deciduous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	91,113	16,027	**107,140**
2004-2008	70,437	4,469	**74,906**
2009-2013	53,392	14,215	**67,607**
2014-2018	45,966	20,060	**66,026**
2019-2028	39,329	23,796	**63,125**
2029-2038	41,331	26,633	**67,964**
2039-2048	8,872	39,402	**48,274**
2049-2058	4,753	58,386	**63,139**
2059-2068	1,220	92,201	**93,421**
2069-2078	7,321	59,167	**66,488**
2079-2088	28,526	45,854	**74,380**
2089-2098	35,914	29,511	**65,425**
2099-2108	53,625	29,440	**83,065**
2109-2118	39,687	28,794	**68,481**
2119-2128	44,952	32,241	**77,193**
2129-2138	43,806	26,184	**69,990**
2139-2148	26,192	25,414	**51,606**
2149-2158	25,942	49,158	**75,100**
2159-2168	26,732	42,501	**69,233**
2169-2178	33,664	46,969	**80,633**
2179-2188	41,354	38,567	**79,921**
2189-2198	34,239	39,681	**73,920**

Source: ORM compiled data

Figure 44. Scenario 4C: Deciduous Harvest Flow in the FMUs G5C and E8C



Source: ORM compiled data

Table 33. Scenario 4C: Deciduous Harvest Flow in FMUs G5C and E8C

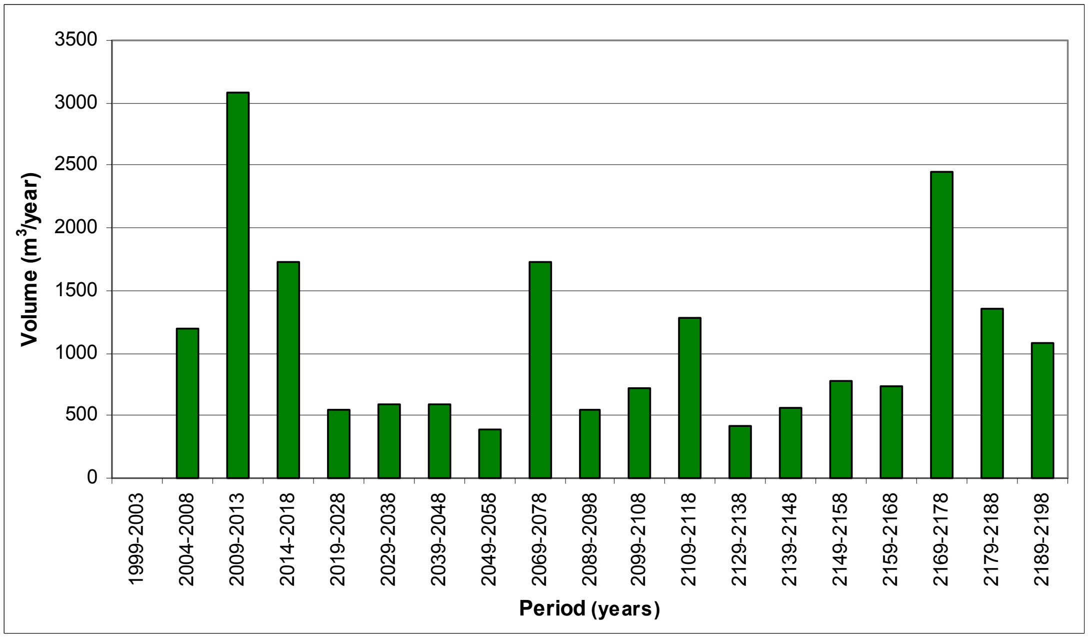
Period	Deciduous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	102,564	105,243	**207,807**
2004-2008	299,944	83,820	**383,764**
2009-2013	271,768	108,416	**380,184**
2014-2018	285,708	106,271	**391,979**
2019-2028	258,506	133,176	**391,682**
2029-2038	171,382	223,591	**394,973**
2039-2048	149,173	252,002	**401,175**
2049-2058	117,452	264,665	**382,117**
2059-2068	117,962	224,972	**342,934**
2069-2078	122,812	245,740	**368,552**
2079-2088	147,286	212,436	**359,722**
2089-2098	195,871	187,168	**383,039**
2099-2108	214,118	156,889	**371,007**
2109-2118	236,780	133,088	**369,868**
2119-2128	224,670	148,167	**372,837**
2129-2138	208,561	182,750	**391,311**
2139-2148	209,880	183,120	**393,000**
2149-2158	198,470	183,883	**382,353**
2159-2168	184,937	200,137	**385,074**
2169-2178	175,628	198,338	**373,966**
2179-2188	176,065	201,097	**377,162**
2189-2198	192,936	163,121	**356,057**

Source: ORM compiled data

The coniferous harvest also generates some incidental deciduous volume from FMUs G8C and E8C of the Forest Management Agreement area (FMA area) as shown in

Figure 45 and Table 34. This volume is not part of the current deciduous allocation level although it is included in any deciduous volume summaries within this document.

Figure 45. Scenario 4C: Deciduous Harvest from Non-Contributing Areas (FMUs G8C and E8C)



Source: ORM compiled data

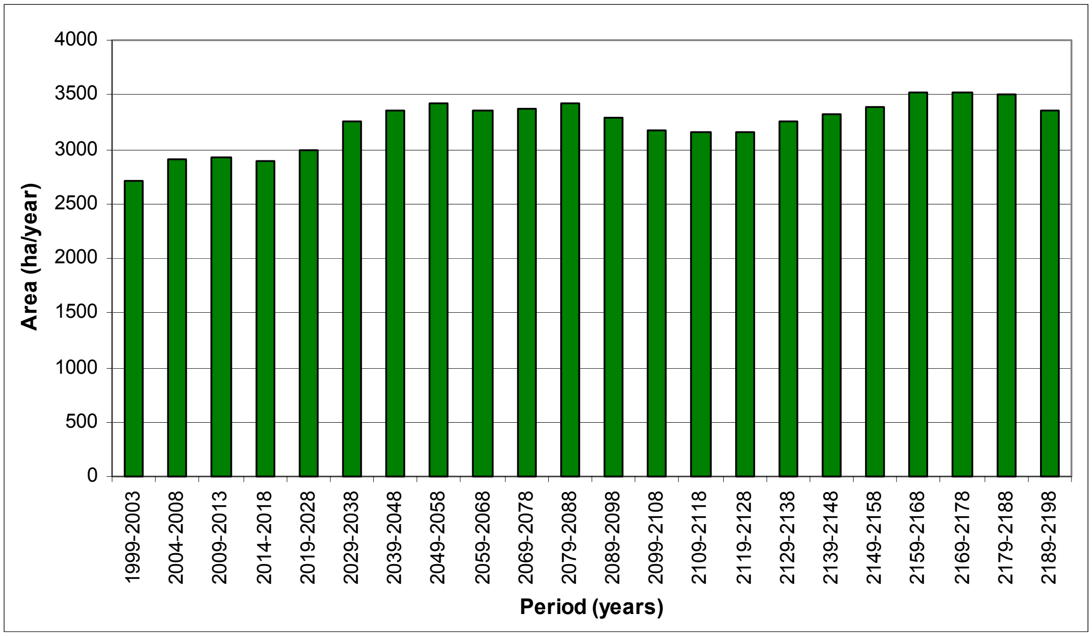
Table 34. Scenario 4C: Deciduous Harvest from Non-Contributing Areas (FMUs G8C and E8C)

Period	Deciduous Volume (m^3/year)
1999-2003	0
2004-2008	1,199
2009-2013	3,078
2014-2018	1,731
2019-2028	552
2029-2038	594
2039-2048	587
2049-2058	388
2069-2078	1,722
2089-2098	544
2099-2108	724
2109-2118	1,287
2129-2138	423
2139-2148	556
2149-2158	776
2159-2168	731
2169-2178	2,450
2179-2188	1,357
2189-2198	1,083

Source: ORM compiled data

The area harvested in coniferous priority types remains relatively constant with an increase after year 20, when the harvest level increases from 640,000 to 670,000 m^3/year as shown in Figure 46. The average harvested coniferous volume per ha is approximately 213 m^3/ha in the first 20 years when harvest sequencing is applied. Beyond that point, it remains relatively constant ranging between185 and 207 m^3/ha for the remaining periods as shown in Table 35 and Figure 47.

Figure 46. Scenario 4C: Annual Area Harvested in Coniferous Priority Types



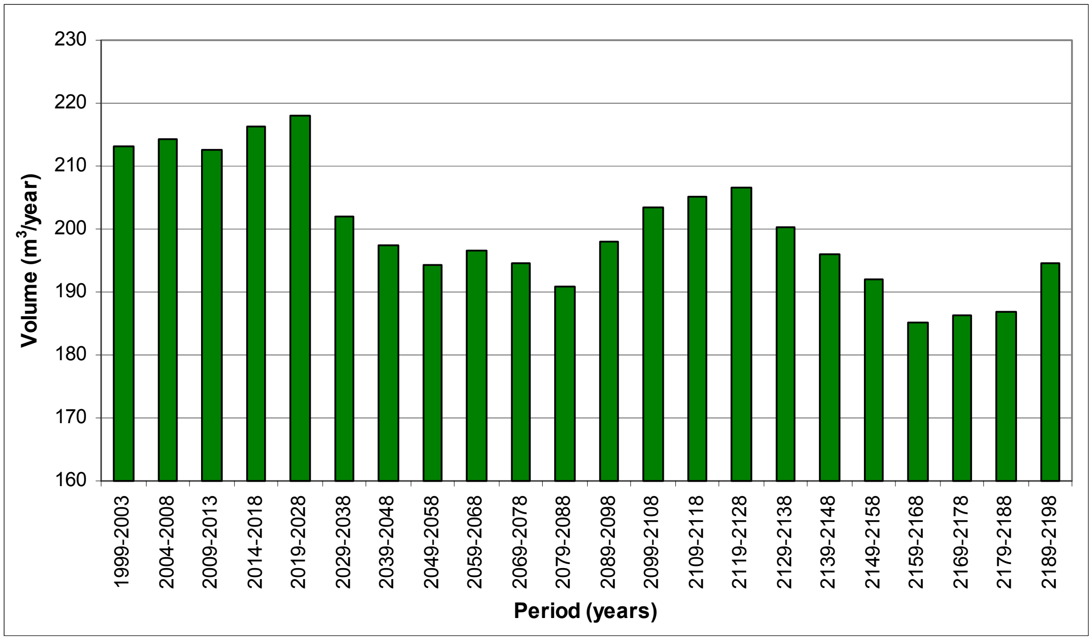
Source: ORM compiled data

Table 35. Scenario 4C: Annual Area Harvested and Average Volume Per Hectare in Coniferous Priority Types

Period	Area (ha)	Average Volume (m3/ha)	Period	Area (ha)	Average Volume (m3/ha)
1999-2003	2,708	213	2089-2098	3,288	198
2004-2008	2,907	214	2099-2108	3,177	204
2009-2013	2,932	213	2109-2118	3,152	205
2014-2018	2,885	216	2119-2128	3,160	207
2019-2028	2,998	218	2129-2138	3,249	200
2029-2038	3,259	202	2139-2148	3,316	196
2039-2048	3,357	197	2149-2158	3,392	192
2049-2058	3,419	194	2159-2168	3,528	185
2059-2068	3,358	197	2169-2178	3,517	186
2069-2078	3,379	195	2179-2188	3,499	187
2079-2088	3,428	191	2189-2198	3,356	195

Source: ORM compiled data

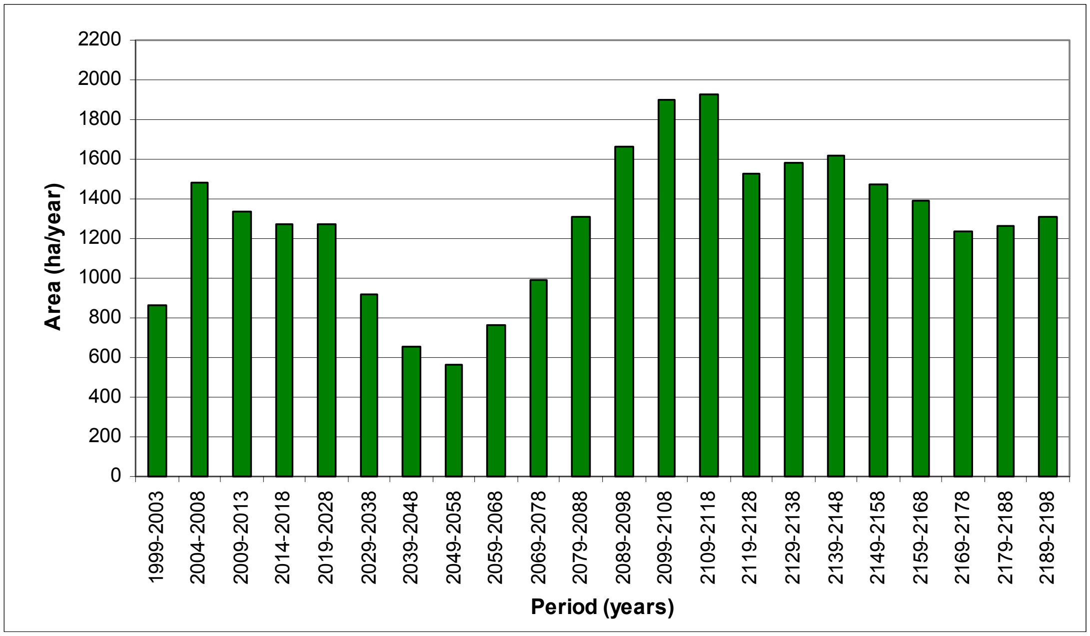
Figure 47. Scenario 4C: Average Volume Per Hectare in Coniferous Priority Types



Source: ORM compiled data

Figure 48 and Table 36 show that there is significantly more variation in the area harvested in deciduous priority types, ranging between 566 and 1,926 ha per year. This is due to the age class distribution of the deciduous priority types which shows that there is a large supply of older timber with high per ha volumes and thus less area is required to be harvested early on. As this timber ages and moves on to the decline portion of the yield curve, the average volume per ha declines as well. In addition, some stands are harvested at an early age since some older stands are held in reserve to meet seral stage or other non-timber resource targets. Again, this contributes to reduced per ha volumes as is shown in Figure 49.

Figure 48. Scenario 4C: Annual Area Harvested in Deciduous Priority Types



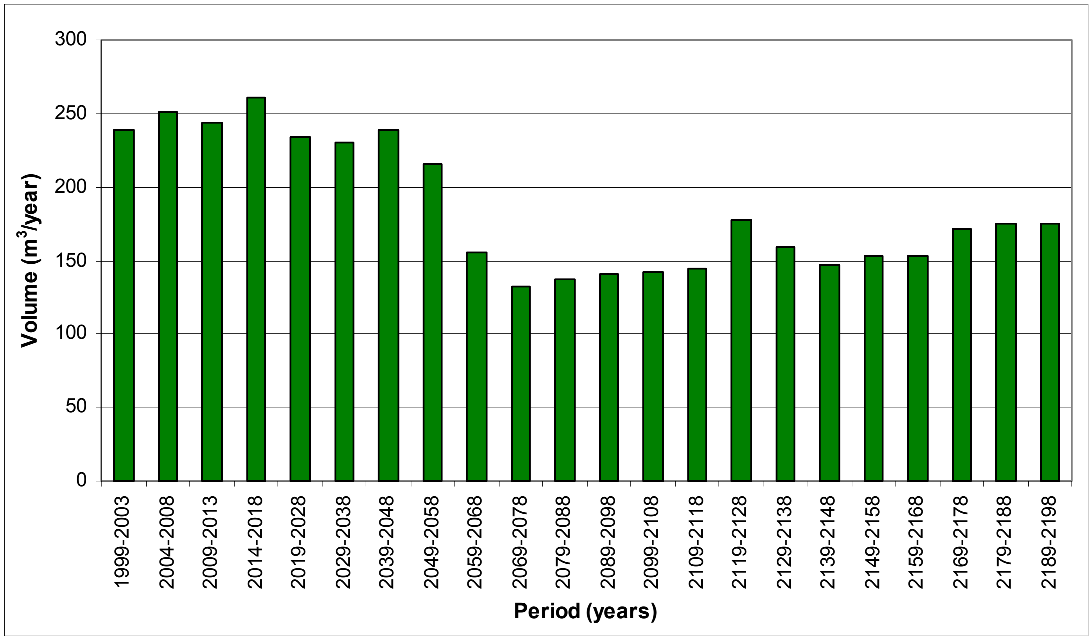
Source: ORM compiled data

Table 36. Scenario 4C: Annual Area Harvested and Average Volume Per Hectare in Deciduous Priority Types

Period	Area (ha)	Average Volume (m^3/ha)	Period	Area (ha)	Average Volume (m^3/ha)
1999-2003	859	239	2089-2098	1,668	141
2004-2008	1,478	251	2099-2108	1,898	142
2009-2013	1,337	243	2109-2118	1,926	145
2014-2018	1,273	261	2119-2128	1,527	178
2019-2028	1,277	234	2129-2138	1,584	159
2029-2038	922	230	2139-2148	1,618	146
2039-2048	658	238	2149-2158	1,475	153
2049-2058	566	216	2159-2168	1,395	153
2059-2068	767	155	2169-2178	1,237	171
2069-2078	992	132	2179-2188	1,260	175
2079-2088	1,312	137	2189-2198	1,308	176

Source: ORM compiled data

Figure 49. Scenario 4C: Average Volume Per Hectare in Deciduous Priority Types

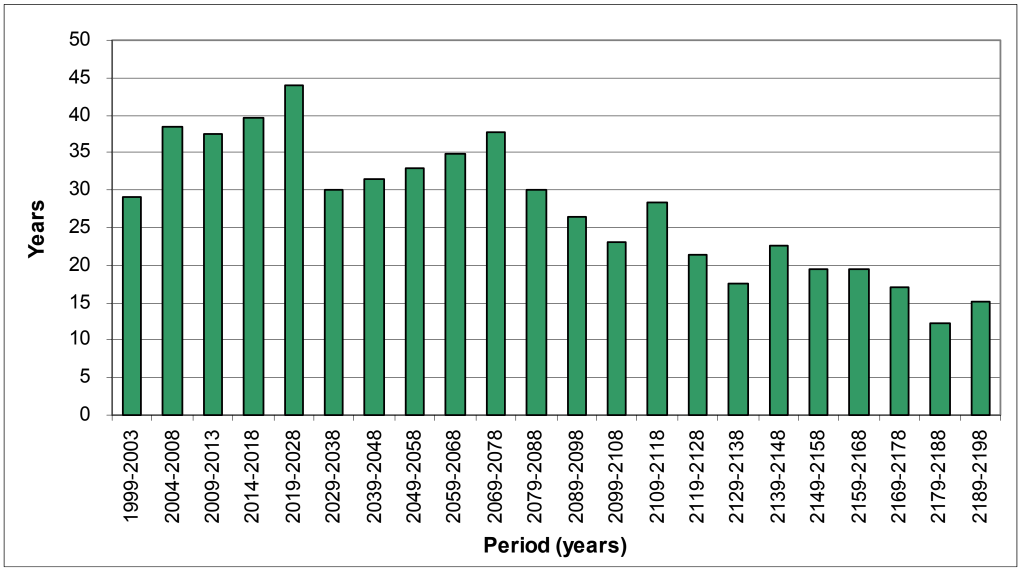


Source: ORM compiled data

The coniferous per ha volume shows a long-term declining trend as the harvesting moves to shorter rotation ages. The average harvest age (Figure 50) never reaches the minimum age because the non-timber resource objectives have the effect of increasing the real rotation age by delaying the availability of stands to meet these other objectives.

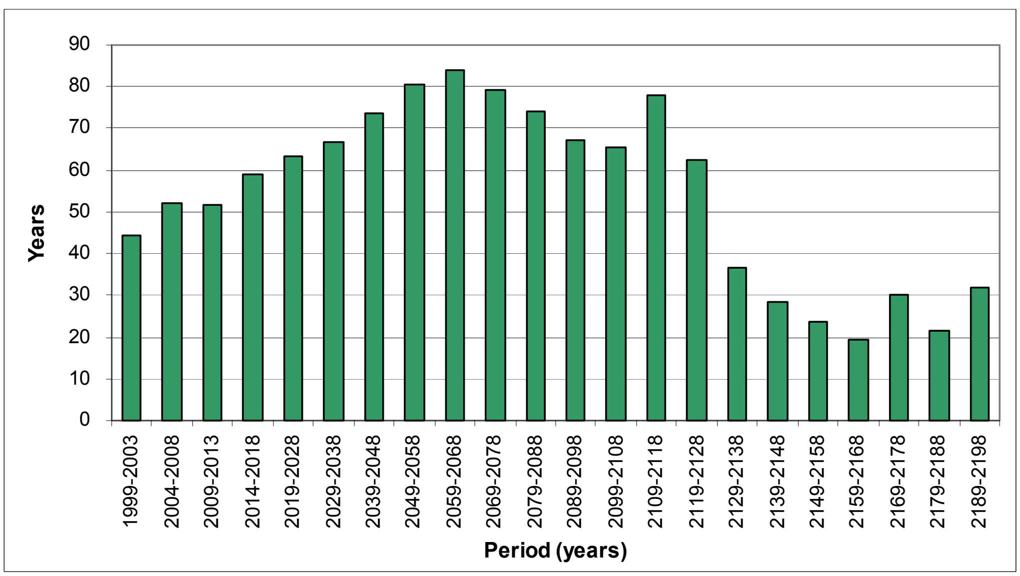
Figure 51 shows that the average deciduous harvest age reaches its peak in period 2059-2068, which is approximately when the average volume per ha for deciduous priorities reaches its minimum. This indicates that the primary factor driving the lower per ha volumes at that point is the harvesting of older timber, which is losing volume as per the decline portion of the yield table. Later on in the planning horizon there is better correlation between the minimum harvest age and the lower per ha volumes as by that point the old stands have all been harvested.

Figure 50. Scenario 4C: Years Above Minimum Harvest Age for Coniferous stands



Source: ORM compiled data

Figure 51. Scenario 4C: Years Above Minimum Harvest Age for Deciduous Priority Stands



Source: ORM compiled data

The results of the 20-year harvest sequencing are shown in Appendix VI, Map 8. It depicts the intended harvest sequence geographically in 5-year periods from 1999 to 2018. The results can also be seen in Table 37.

Table 37. Scenario 4C: 20 Year Harvest Sequence Cut Control Harvest Volume

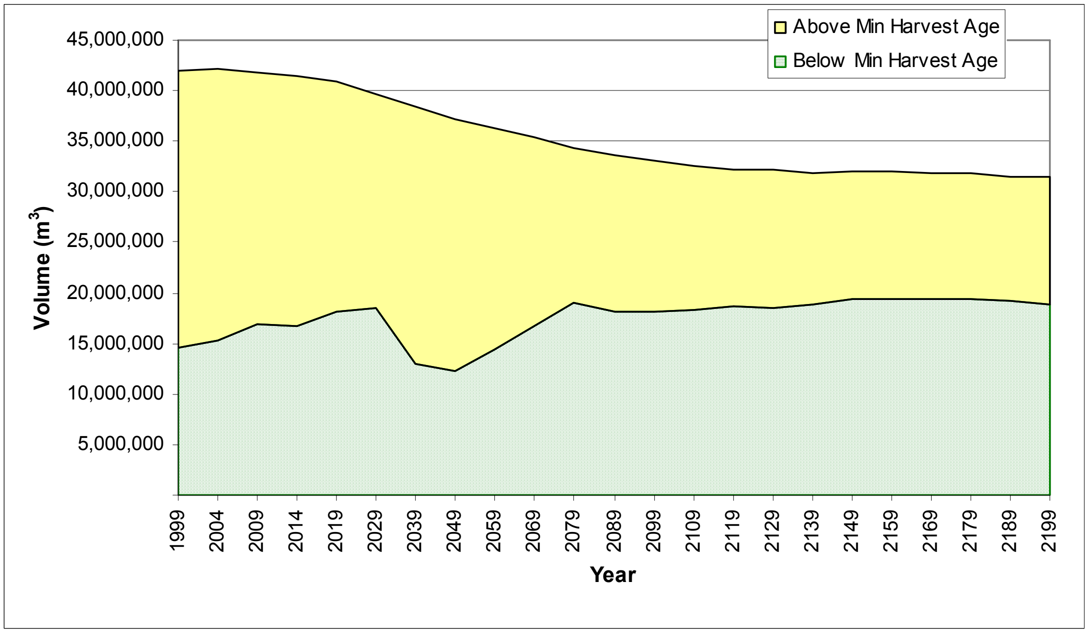
Subunit	Operational Subunit	1999-2003 Coniferous	Deciduous	2004-2008 Coniferous	Deciduous	2009-2013 Coniferous	Deciduous	2014-2018 Coniferous	Deciduous
DN	DN-1	58,856	11,156	67	763	166,454	49,132	236,929	40,683
	DN-2	69,654	11,147	76	770	853	11,637	175	3,680
	DN-3	220,276	50,144	294	2,263	951	10,653	3,664	52,067
	DN-4	35,252	2,440	181	2,061	851	10,203	212,636	71,442
	DN-5	410,240	46,800	118	1,277	181	2,784	119,337	24,838
DN Total		**794,277**	**121,686**	**736**	**7,134**	**169,290**	**84,409**	**572,740**	**192,710**
DS	DS-2	168,793	8,531	493,263	27,825				
	DS-3			40,701	2,114	369,283	26,665	248,618	16,969
DS Total		**168,793**	**8,531**	**533,964**	**29,938**	**369,283**	**26,665**	**248,618**	**16,969**
E8	E8-1	154,715	23,122	295,759	25,336	41,483	3,228		
	E8-2	0	0	0	0	214,150	22,812	199,292	20,888
	E8-4	228,507	15,563						
E8 Total		**383,221**	**38,685**	**295,759**	**25,336**	**255,633**	**26,040**	**199,292**	**20,888**
EN	EN-1	135	1,265	3,031	84,953	178,736	214,416	216	6,211
	EN-3	17	1,055	45,560	12,326				
	EN-4	163,147	299,229	92	3,770	1,103	8,762	925	22,695
	EN-5	37,492	161,643	106,826	546,692	386	9,567	450	14,350
EN Total		**200,792**	**463,193**	**155,510**	**647,741**	**180,225**	**232,745**	**1,591**	**43,256**
ES	ES-1	12,250	48,106	297,902	190,531	431	9,916	9,541	229,698
	ES-2			138,623	30,394	378,729	154,635	384,234	172,388
	ES-3	1,430	186	33	697	505	12,038	184,422	49,083
ES Total		**13,679**	**48,292**	**436,558**	**221,622**	**379,665**	**176,590**	**578,197**	**451,170**
LAT	LAT-1	204,234	103,877			20,206	547,785	33,557	794,803
	LAT-2			168,004	266,237	153,826	103,073	581	14,222
	LAT-3			528,534	141,349	261,293	82,726		
LAT Total		**204,234**	**103,877**	**696,538**	**407,586**	**435,326**	**733,583**	**34,137**	**809,025**
PEACE	PEACE-2			16,101	3,741	38,835	10,313	6,182	2,311
	PEACE-3							34,994	4,334
PEACE Total		**0**	**0**	**16,101**	**3,741**	**38,835**	**10,313**	**41,176**	**6,644**
PUSK	PUSK-1	350	20,537	8,454	141,344	142,157	157,598	134,683	113,037
	PUSK-2	135,179	471,874	3,474	61,842	5,738	68,529	8,529	139,753
	PUSK-3	100,012	30,278	108,306	148,777	144,598	104,986	142,742	67,332
	PUSK-4	89,100	13,017	81,445	22,570	218	6,920	770	10,008
PUSK Total		**324,642**	**535,706**	**201,679**	**374,533**	**292,711**	**338,033**	**286,724**	**330,130**
SIM	SIM-1			366	6,312	398,199	242,415	853	11,900
	SIM-2	50,875	87,220	7,099	140,515	10,174	116,808	7,228	58,861
	SIM-3	778,600	160,576	230,378	38,514			3,082	18,416
	SIM-4	342	2,820	307	1,184	18,613	8,931	913,004	253,057
SIM Total		**829,817**	**250,617**	**238,150**	**186,525**	**426,985**	**368,153**	**924,167**	**342,234**
SMOKY	SMOKY-1	18,619	4,160	223,383	152,511	268	2,637	597	12,158
	SMOKY-2			180,387	92,227	161	3,534	181	3,366
	SMOKY-3			217,607	118,975	504	8,407	198	2,417
	SMOKY-4			3,347	23,333	311,601	149,001	218	2,766
	SMOKY-5					143,472	5,337		
	SMOKY-6			282	5,893	196,040	83,827	312,164	62,936
SMOKY Total		**18,619**	**4,160**	**625,005**	**392,939**	**652,046**	**252,743**	**313,358**	**83,642**
Grand Total		**2,938,074**	**1,574,745**	**3,200,000**	**2,297,094**	**3,200,000**	**2,249,273**	**3,200,000**	**2,296,667**
Average m^3/year		**587,615**	**314,949**	**640,000**	**459,419**	**640,000**	**449,855**	**640,000**	**459,333**

Source: ORM compiled data

6.7.2 Inventory

The coniferous standing inventory volume follows a typical pattern for a wood supply with a well-dispersed age class distribution. Figure 52 and Table 38 show that the available standing volume shows a slight decline as the rate of harvesting is increased and older, high volume stands are harvested. It then settles to a constant rate as the landscape reaches a “steady state” within the new forest management objectives.

Figure 52. Scenario 4C: Coniferous Standing Inventory Volume



Source: ORM compiled data

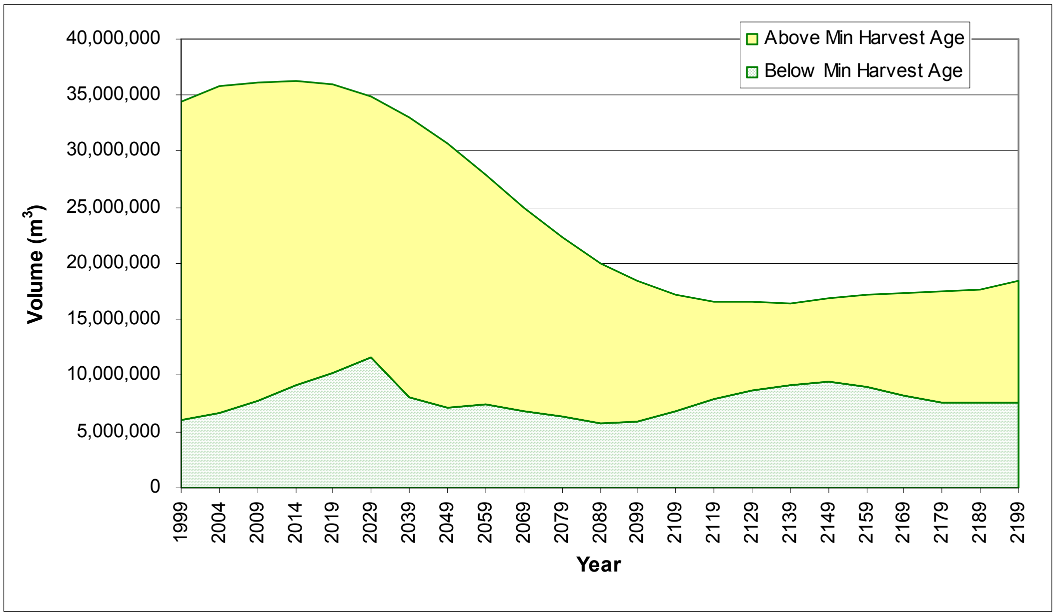
Table 38. Scenario 4C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,157
2004	26,897,141	15,222,512
2009	24,922,311	16,891,069
2014	24,686,115	16,740,378
2019	22,745,094	18,212,909
2029	21,133,249	18,555,869
2039	25,367,314	13,058,485
2049	24,883,789	12,352,106
2059	21,819,664	14,479,766
2069	18,741,000	16,632,633
2079	15,276,790	19,073,105
2089	15,478,224	18,216,446
2099	14,799,325	18,222,267
2109	14,193,074	18,395,823
2119	13,511,575	18,702,439
2129	13,736,927	18,483,155
2139	13,122,629	18,791,641
2149	12,761,065	19,309,119
2159	12,628,375	19,332,737
2169	12,476,425	19,387,363
2179	12,494,306	19,300,543
2189	12,268,129	19,298,012
2199	12,529,160	18,928,291

Source: ORM compiled data

The deciduous standing inventory shows a completely different pattern with a very sharp decline to a steady state. This is due to the high proportion of stands that are above the minimum harvest age of 50 years for deciduous types. This is seen very clearly in Figure 53 and Table 39, which shows the age class distribution of deciduous priority types.

Figure 53. Scenario 4C: Deciduous Standing Inventory Volume



Source: ORM compiled data

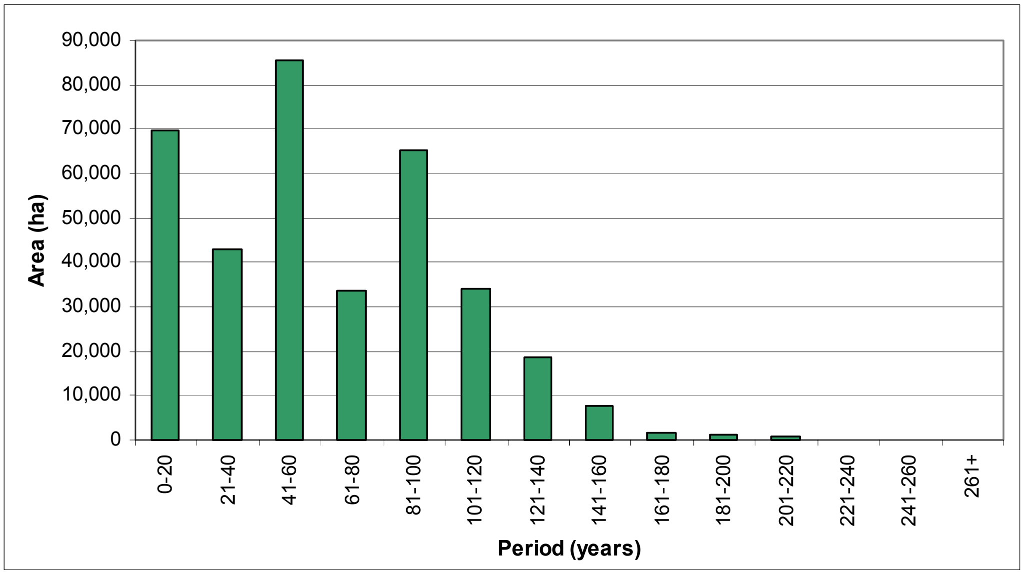
Table 39. Scenario 4C: Deciduous Standing Inventory Volume

Year	Deciduous Volume (m³)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,301
2004	29,033,070	6,718,415
2009	28,263,115	7,799,779
2014	27,030,982	9,218,362
2019	25,798,581	10,184,759
2029	23,350,552	11,554,088
2039	25,081,311	7,996,684
2049	23,585,392	7,139,643
2059	20,444,906	7,493,833
2069	18,152,721	6,790,278
2079	15,889,285	6,361,520
2089	14,350,212	5,663,726
2099	12,446,453	5,948,224
2109	10,346,694	6,850,048
2119	8,641,221	7,923,710
2129	7,834,060	8,682,389
2139	7,340,348	9,077,562
2149	7,391,498	9,496,156
2159	8,124,349	9,029,888
2169	9,211,309	8,140,307
2179	9,893,910	7,581,578
2189	10,112,344	7,600,024
2199	10,790,842	7,634,738

Source: ORM compiled data

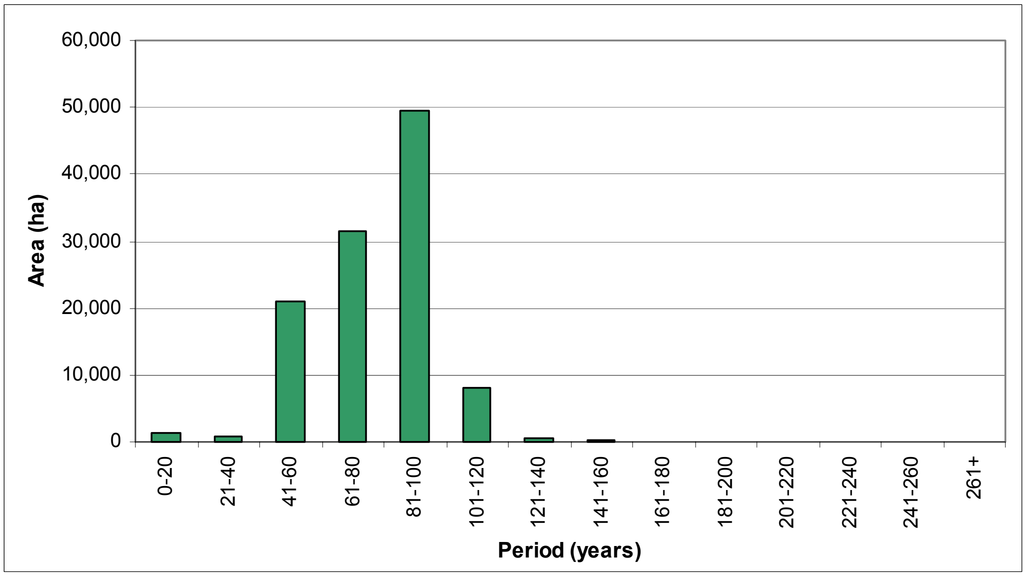
Figures 54 and 55 show the age class distribution of the coniferous and deciduous priority stands for the year 1999. The coniferous stands show the traditional inverse J-curve distribution representative of fire-based ecosystems while the deciduous stands show a distribution which is reflective of the fact that deciduous harvesting does not have a long-history within the Forest Management Area. Almost all of the deciduous timber is beyond the minimum harvest age of 50.

Figure 54. Scenario 4C: 1999 Coniferous Priority Type Age Class Distribution within the Timber Harvesting Landbase



Source: ORM compiled data

Figure 55. Scenario 4C: 1999 Deciduous Priority Type Age Class Distribution within the Timber Harvesting Landbase

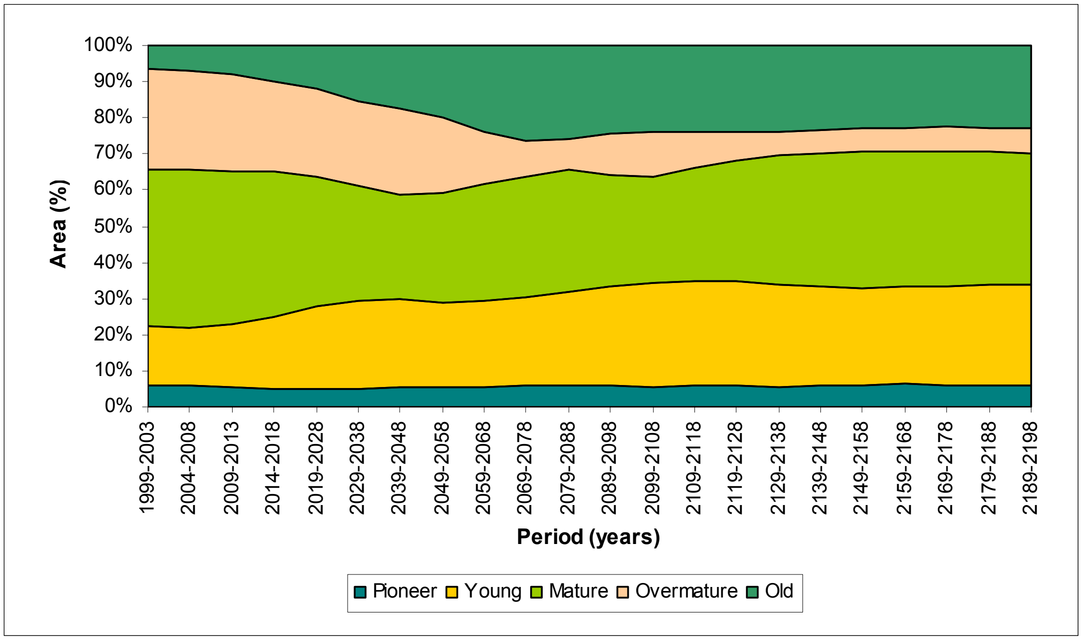


Source: ORM compiled data

6.7.3 Non-Timber Resources

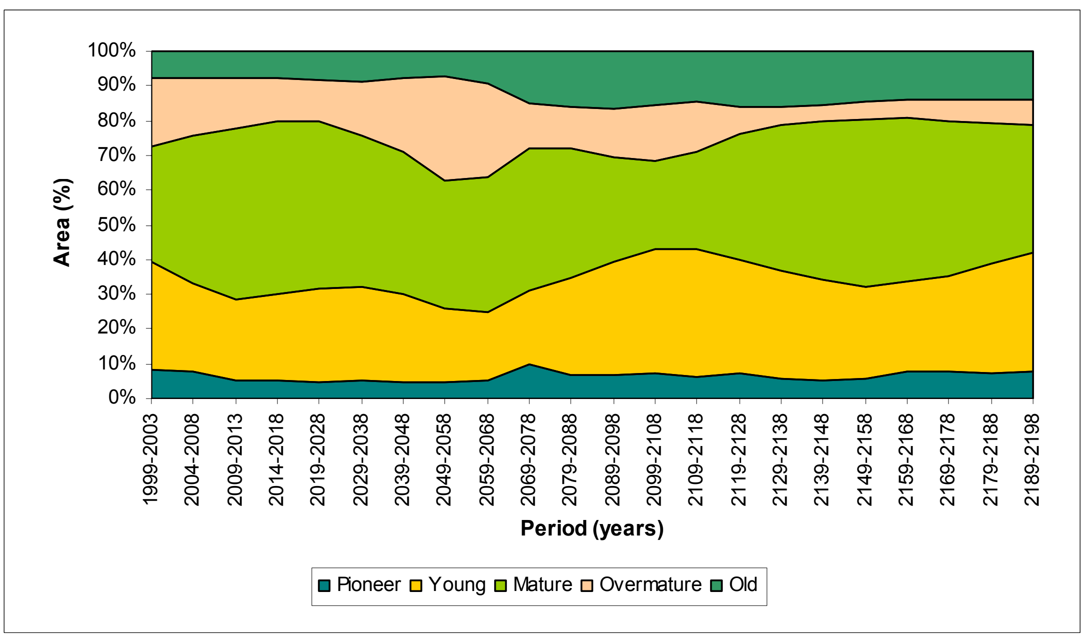
Seral stage distribution targets are met throughout the time horizon with the exception of the old seral stage target which cannot be met in several instances at the beginning of the planning horizon. This is due to the fact that there is simply not enough old seral timber at the beginning of the planning horizon and stands must be recruited and temporarily removed from the Timber Harvesting Landbase (THLB) so that they can age and contribute to this requirement. This situation is common when introducing a new management strategy for non-timber resources. The seral stage distribution figures (Figures 56 through 62) show that the amount of old seral stage has the greatest increase in the areas where harvest is most restricted. This occurs in the Caribou Area and in the G2C Forest Management Unit.

Figure 56. Scenario 4C: Seral Stage Distribution – FMA



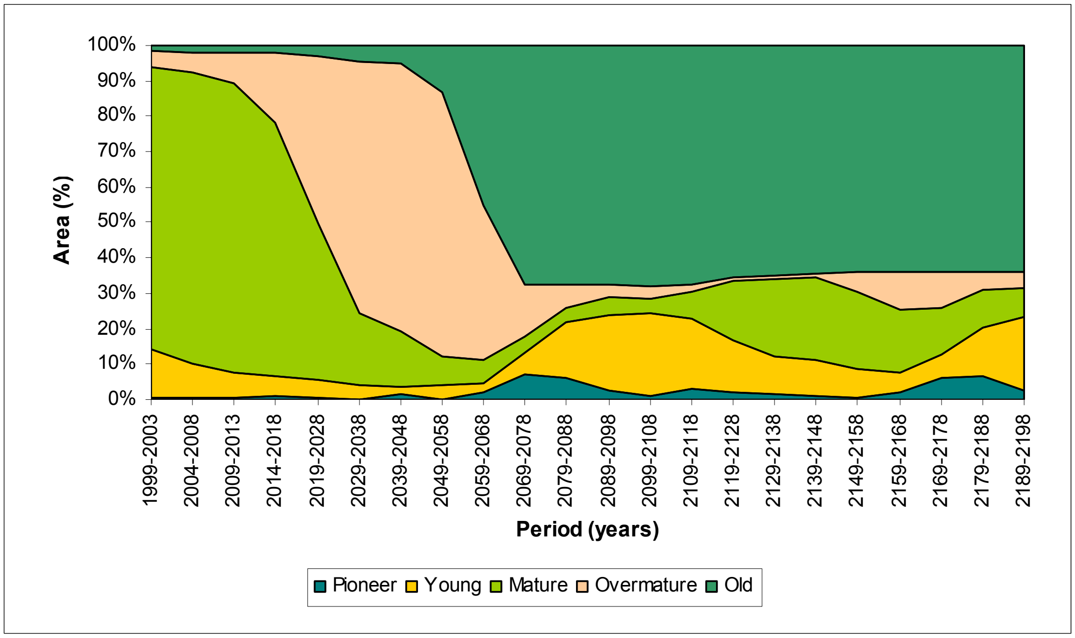
Source: ORM compiled data

Figure 57. Scenario 4C: Seral Stage Distribution – FMU G2C



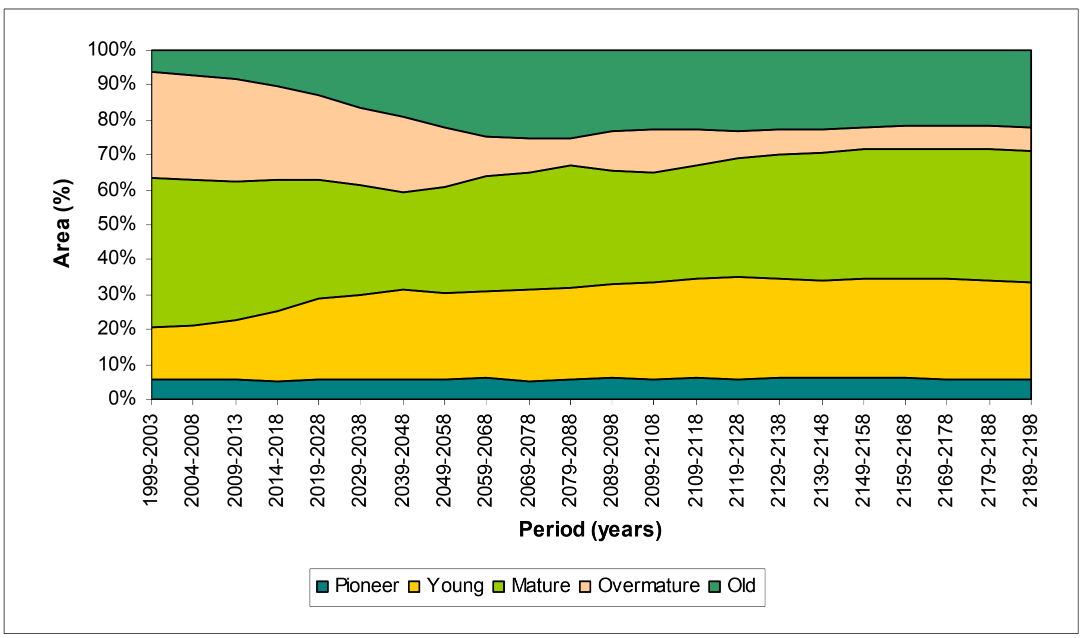
Source: ORM compiled data

Figure 58. Scenario 4C: Seral Stage Distribution – FMU G8C



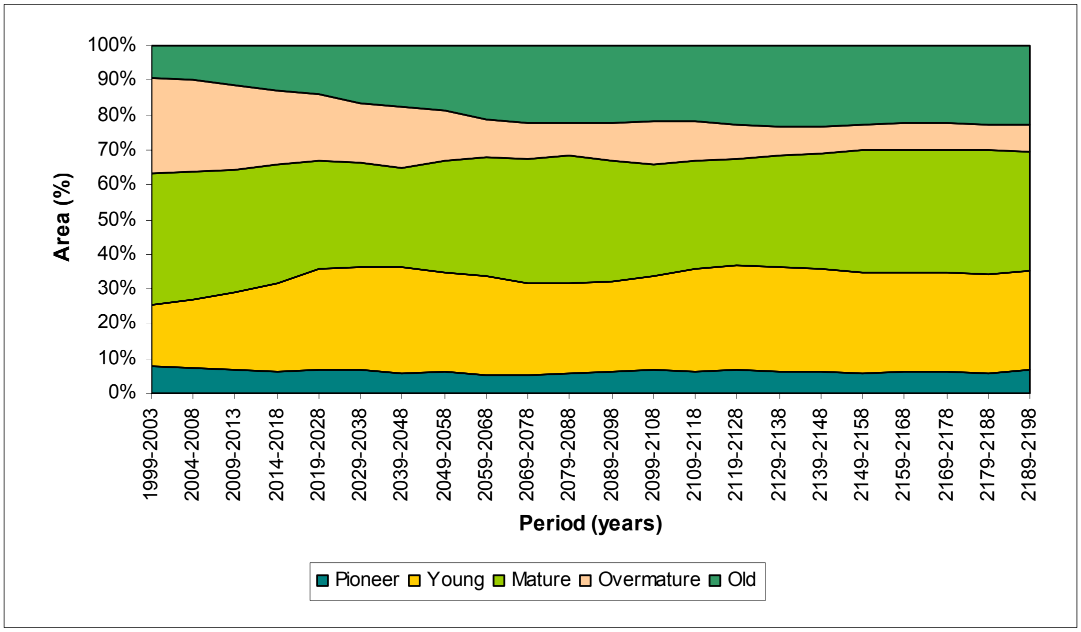
Source: ORM compiled data

Figure 59. Scenario 4C: Seral Stage Distribution – FMUs G5C and E8C



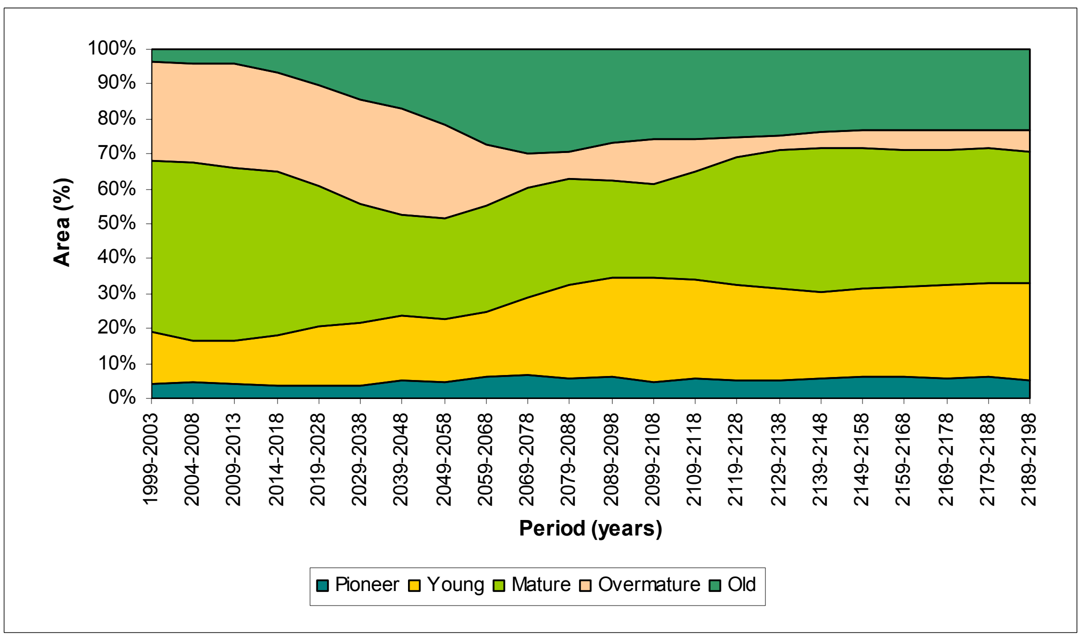
Source: ORM compiled data

Figure 60. Scenario 4C: Seral Stage Distribution – Foothills Natural Region



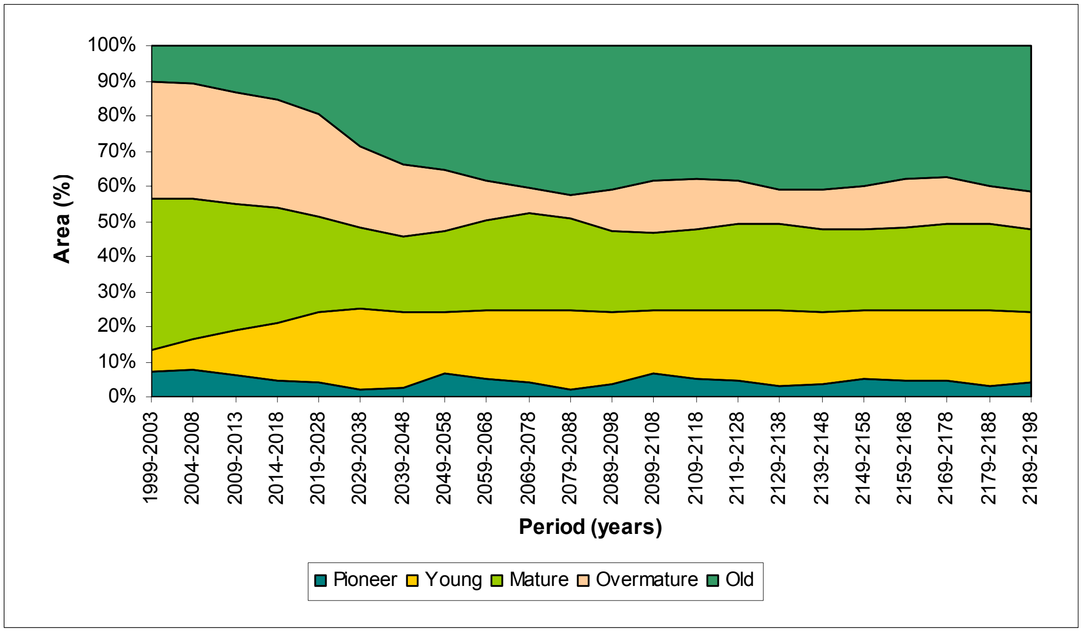
Source: ORM compiled data

Figure 61. Scenario 4C: Seral Stage Distribution – Boreal Forest Natural Region



Source: ORM compiled data

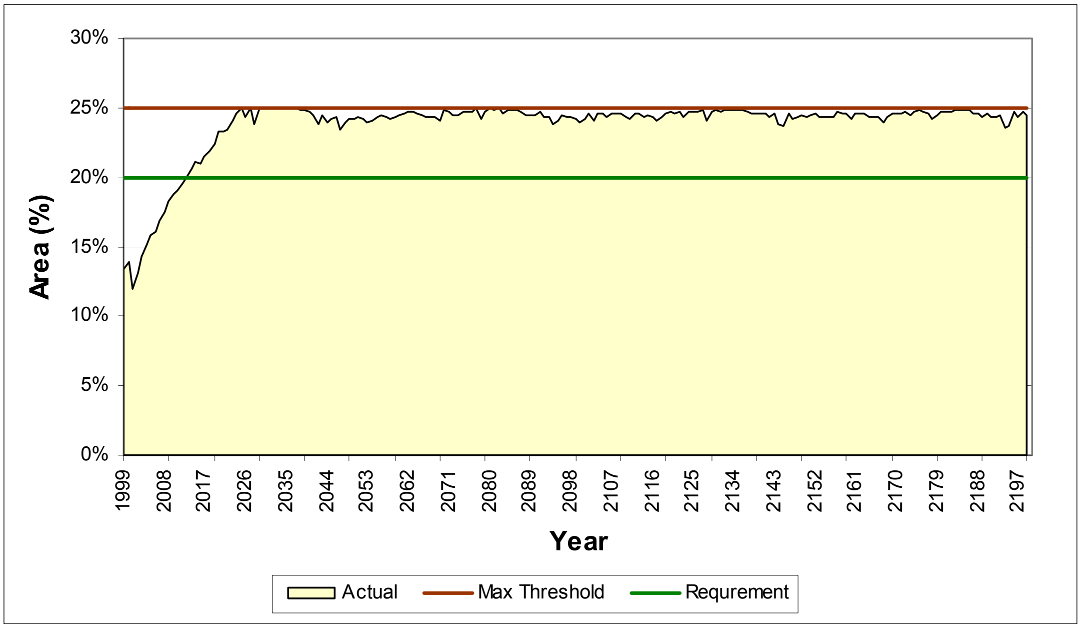
Figure 62. Scenario 4C: Seral Stage Distribution - Caribou Area



Source: ORM compiled data

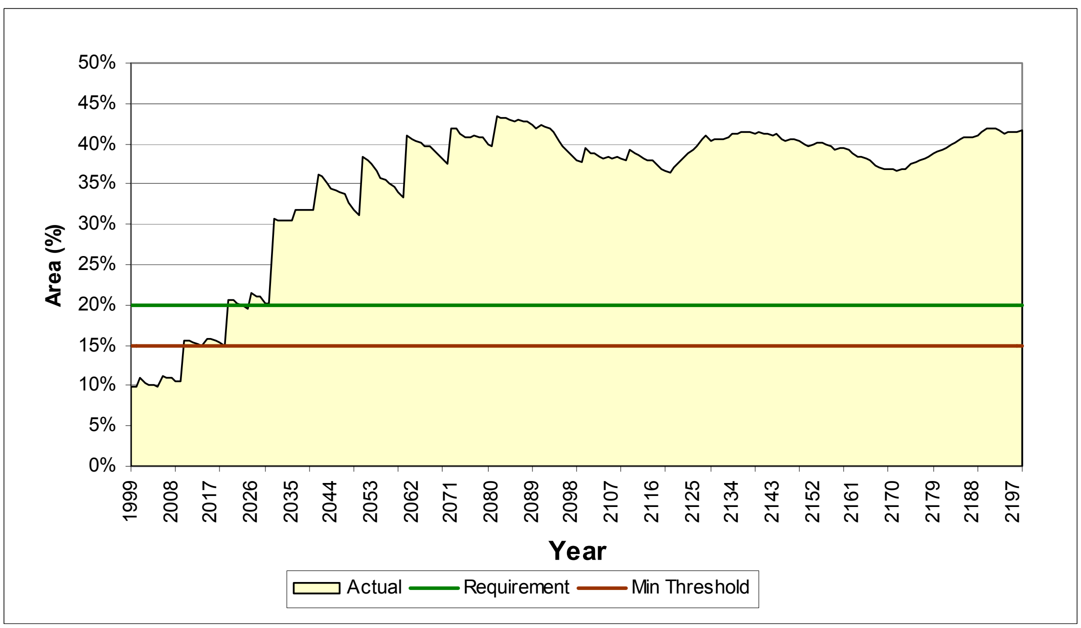
Figure 63 shows that caribou habitat is maintained with the prescribed levels in terms of the combination of the pioneer and young seral stages. The requirement for old seral stage as part of the caribou habitat management is exceeded by a significant degree as shown in Figure 65. This indicates that the pioneer and young seral constraints have a much greater impact on harvest that the old seral stage requirement.

Figure 63. Scenario 4C: Pioneer and Young Seral Stage Habitat in the Caribou Area



Source: ORM compiled data

Figure 64. Scenario 4C: Old Seral Stage Habitat in the Caribou Area

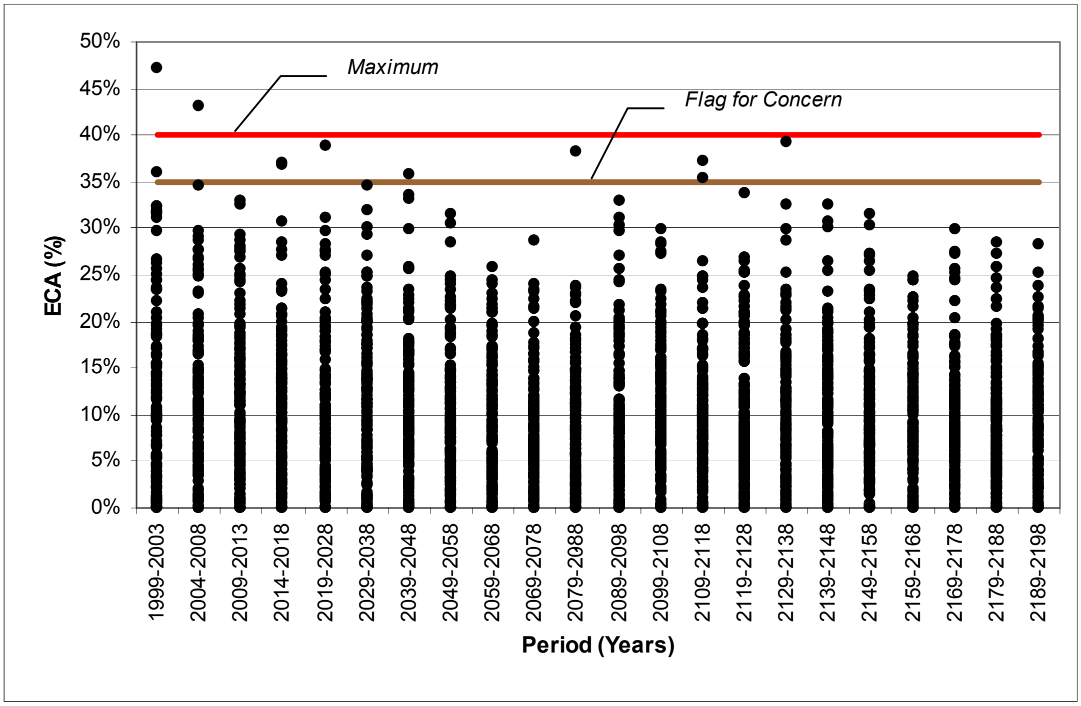


Source: ORM compiled data

Equivalent Clearcut Area (ECA) is maintained below 40% in watersheds shown in Figures 66 through 68. The exception to this are 2 watersheds which had an ECA of approximately 47% and 44% respectively, however this watershed recovers to below the

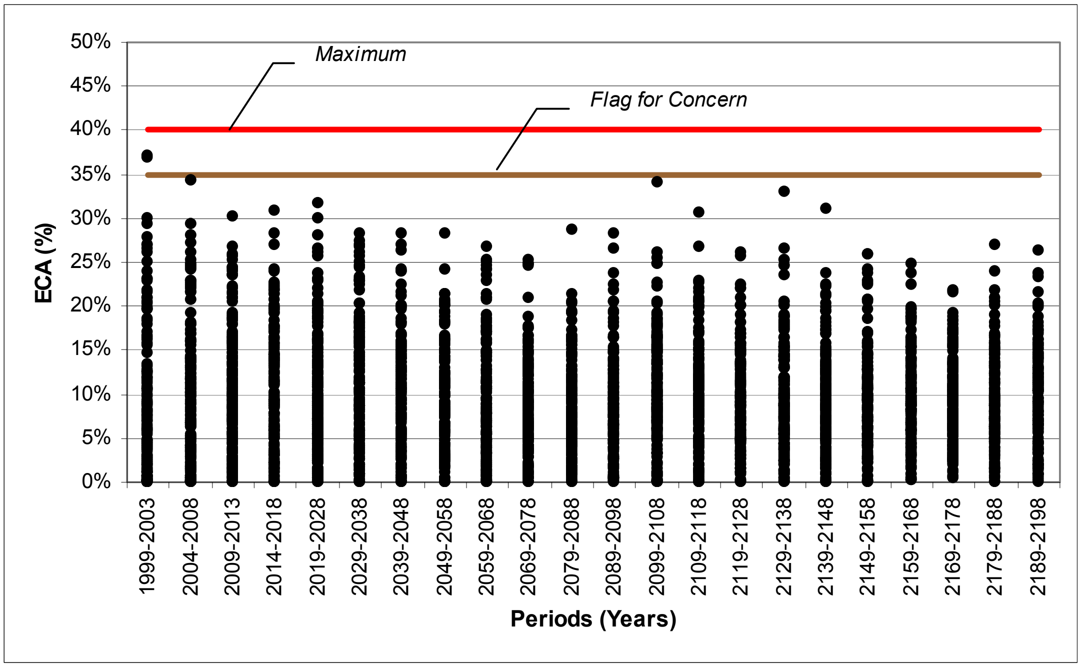
40% threshold within 10 years due to restricted harvested during that time period (Figure 65). In addition, Figures 65 and Figure 66 show that very few watersheds identified as bull trout habitat have an ECA above 35.

Figure 65. Scenario 4C: Hydrological Recovery in Watersheds With Bull Trout – H60 Portion



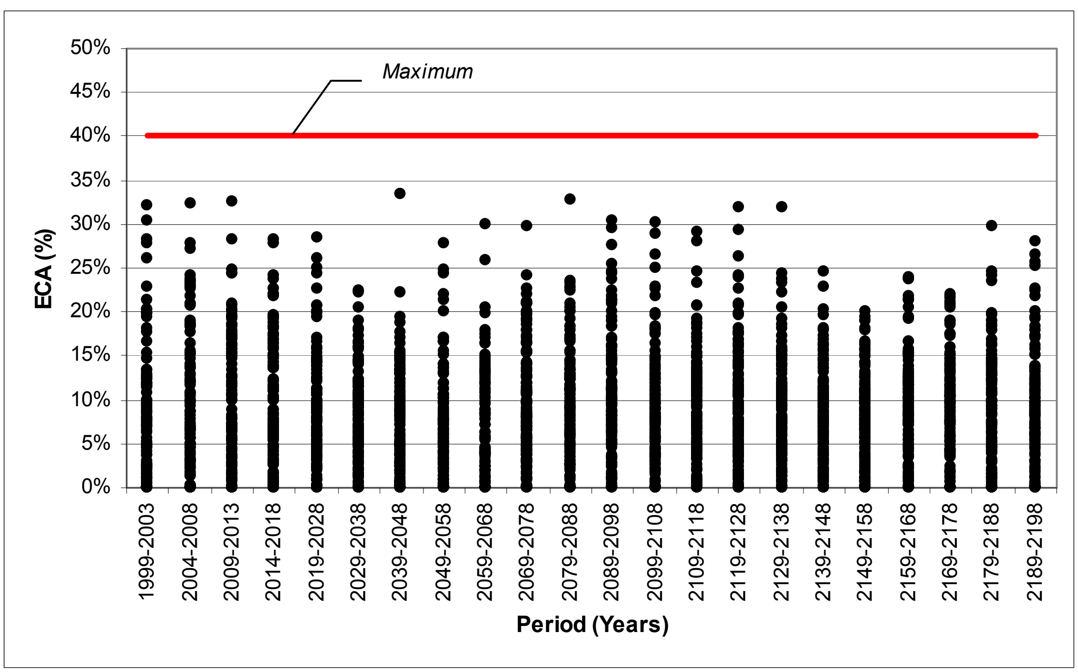
Source: ORM compiled data

Figure 66. Scenario 4C: Hydrological Recovery in Watersheds With Bull Trout – Entire Area



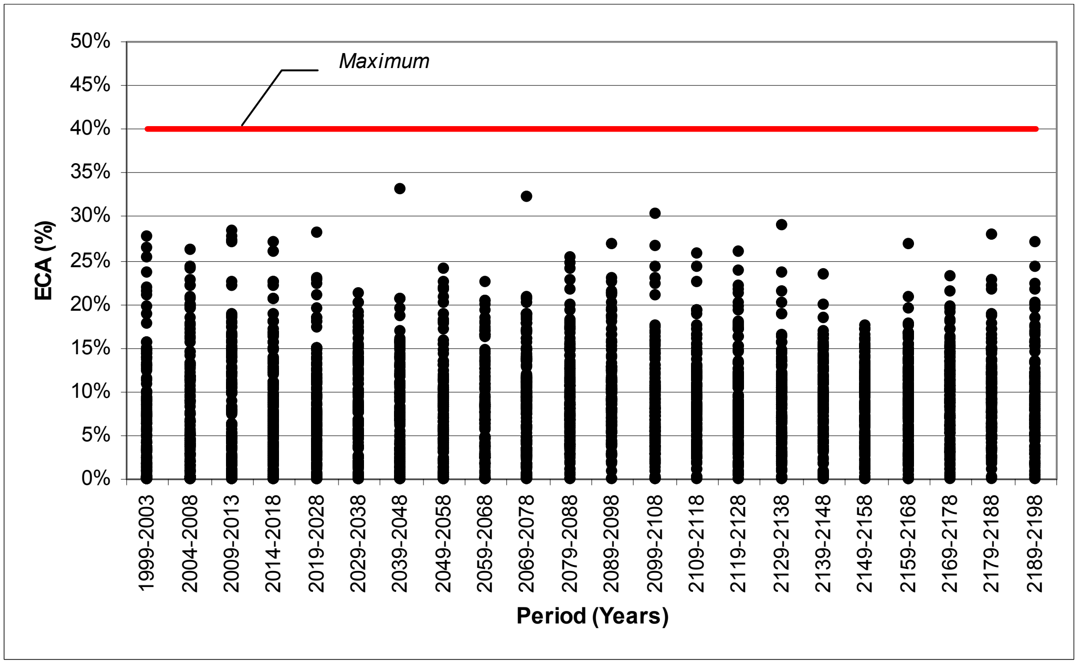
Source: ORM compiled data

Figure 67. Scenario 4C: Hydrological Recovery in Watersheds Without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 68. Scenario 4C: Hydrological Recovery in Watersheds Without Bull Trout – Entire Area



Source: ORM compiled data

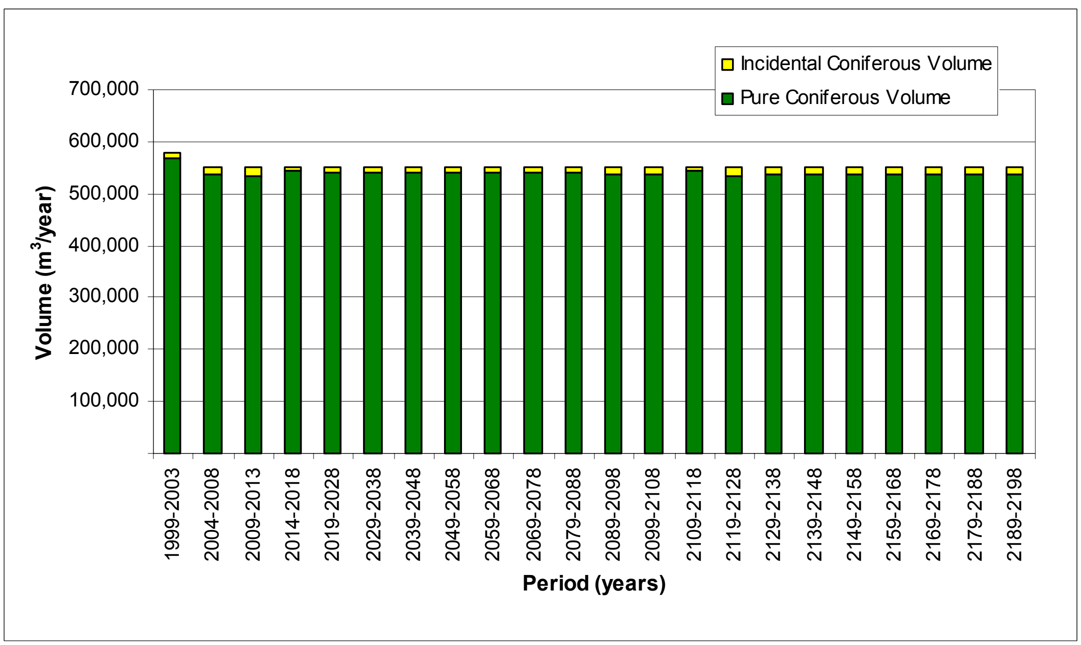
6.8 Scenario 5C

Results for Scenario 5C are discussed in the following sections.

6.8.1 Timber Harvest

Eliminating the benefits from enhanced silviculture results in a significant decrease in the long-term coniferous harvest level from 670,000 m^3/year to 550,000 m^3/year as seen in Figure 69 and Table 40. The close linkage between the coniferous and deciduous harvests is very evident in this run as the deciduous harvest is also reduced significantly. The deciduous flow, as seen in Figure 70 and Table 41, has not been smoothed but does result in an average harvest level of approximately 345,000 m^3/year. However, when this deciduous harvest level was attempted as an even-flow in concert with the 550,000 m^3/year level, it was found that neither the coniferous or deciduous harvest level could be achieved. Reducing the coniferous harvest further served only to make the deciduous supply even worse. A WOODSTOCK run (Scenario 2W) was used to identify an even-flow deciduous harvest level. It showed that a deciduous harvest level of 234,000 m^3/year could be maintained when the coniferous level was held at 550,000 m^3/year.

Figure 69. Scenario 5C: Coniferous Harvest Flow



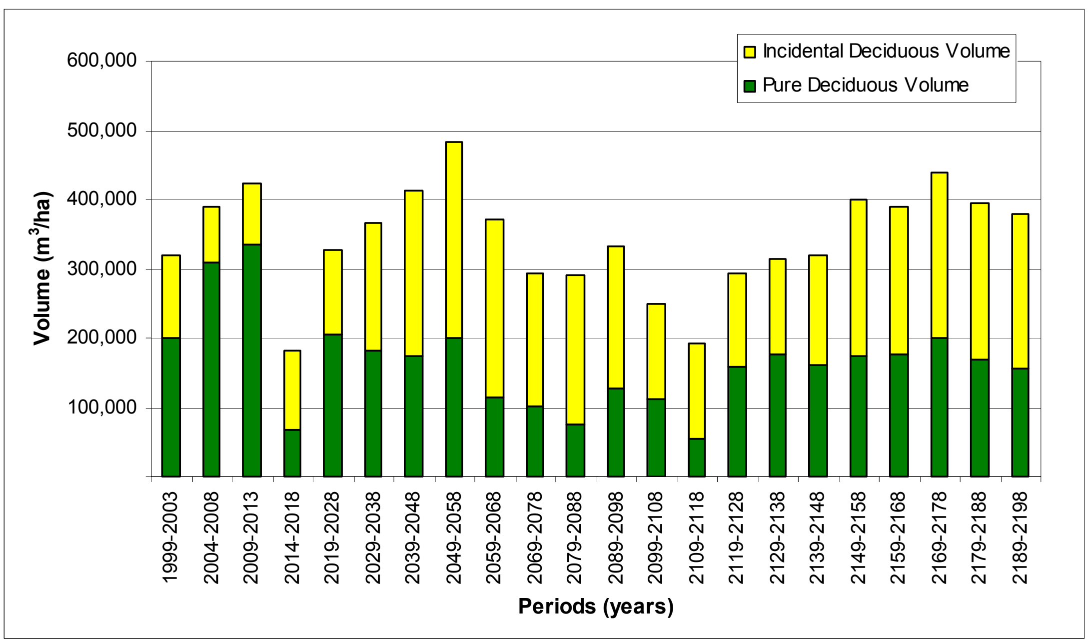
Source: ORM compiled data

Table 40. Scenario 5C: Coniferous Harvest Flow

Period	Coniferous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	567,232	12,768	**580,000**
2004-2008	536,137	13,863	**550,000**
2009-2013	533,207	16,793	**550,000**
2014-2018	545,063	4,937	**550,000**
2019-2028	539,069	10,931	**550,000**
2029-2038	539,879	10,121	**550,000**
2039-2048	540,144	9,856	**550,000**
2049-2058	539,961	10,039	**550,000**
2059-2068	539,768	10,232	**550,000**
2069-2078	539,257	10,743	**550,000**
2079-2088	539,843	10,157	**550,000**
2089-2098	536,790	13,210	**550,000**
2099-2108	537,424	12,576	**550,000**
2109-2118	544,475	5,525	**550,000**
2119-2128	534,616	15,384	**550,000**
2129-2138	536,932	13,068	**550,000**
2139-2148	536,749	13,251	**550,000**
2149-2158	536,697	13,303	**550,000**
2159-2168	536,586	13,414	**550,000**
2169-2178	536,639	13,361	**550,000**
2179-2188	537,303	12,697	**550,000**
2189-2198	537,782	12,218	**550,000**

Source: ORM compiled data

Figure 70. Scenario 5C: Deciduous Harvest Flow



Source: ORM compiled data

Table 41. Scenario 5C: Deciduous Harvest Flow

Period	Deciduous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	199,802	120,959	**320,760**
2004-2008	308,644	80,744	**389,388**
2009-2013	334,885	88,370	**423,255**
2014-2018	67,792	113,391	**181,183**
2019-2028	204,035	123,570	**327,605**
2029-2038	182,308	184,797	**367,104**
2039-2048	174,041	239,804	**413,845**
2049-2058	199,579	283,480	**483,059**
2059-2068	113,581	258,583	**372,164**
2069-2078	100,859	191,676	**292,534**
2079-2088	76,571	213,624	**290,195**
2089-2098	128,142	204,006	**332,148**
2099-2108	111,638	138,427	**250,065**
2109-2118	54,864	137,143	**192,008**
2119-2128	157,260	135,164	**292,424**
2129-2138	177,623	135,405	**313,028**
2139-2148	161,111	159,542	**320,653**
2149-2158	173,334	227,830	**401,164**
2159-2168	175,973	213,700	**389,673**
2169-2178	200,696	237,719	**438,414**
2179-2188	169,610	224,818	**394,428**
2189-2198	156,373	222,280	**378,653**

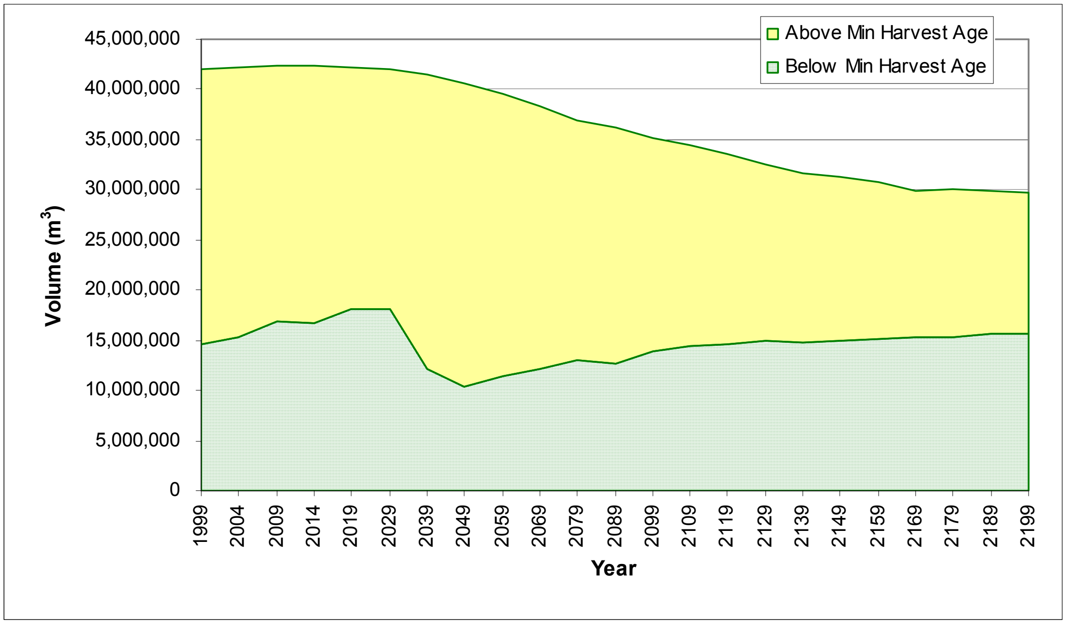
Source: ORM compiled data

6.8.2 Inventory

The coniferous standing inventory volume as shown in Figure 71 and Table 42 exhibits a similar pattern to that seen in Scenario 4C. The only difference is that the long-term standing coniferous volume is slightly lower which is reflective of the lower regenerated stand volumes used in this run.

The deciduous standing inventory shown in Figure 72 and Table 43 is difficult to compare to that in Scenario 4C since this run did not have an even-flow of deciduous volume although the levels are very similar at the end of the planning horizon.

Figure 71. Scenario 5C: Coniferous Standing Inventory Volume



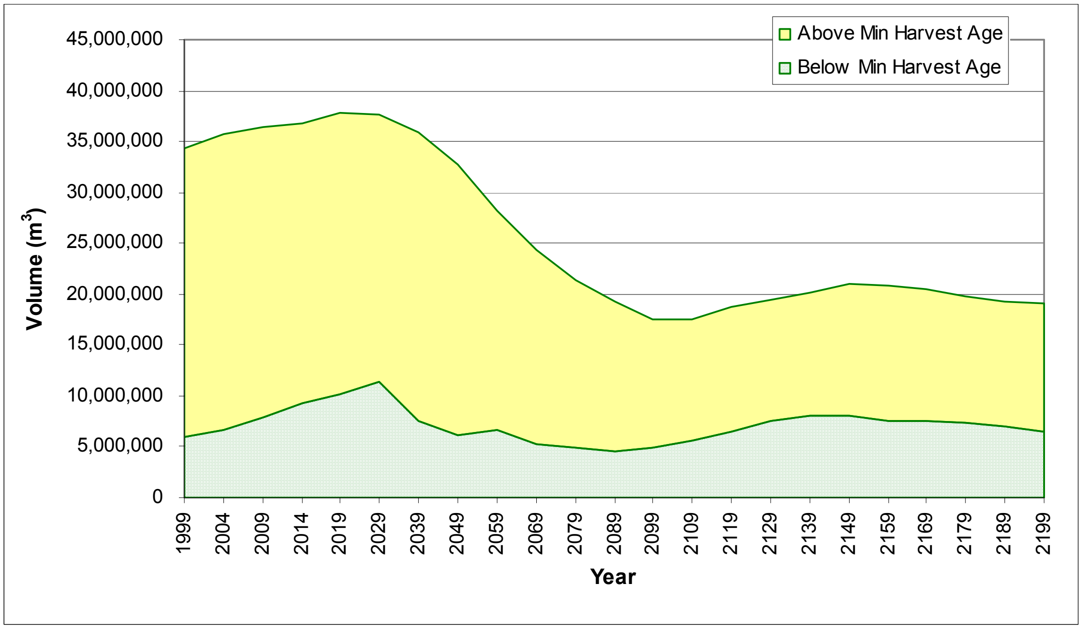
Source: ORM compiled data

Table 42. Scenario 5C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,146
2004	26,935,657	15,222,772
2009	25,430,508	16,879,234
2014	25,645,577	16,689,454
2019	24,180,671	18,085,763
2029	23,812,485	18,140,988
2039	29,339,686	12,065,559
2049	30,142,553	10,434,041
2059	28,225,645	11,401,659
2069	26,343,684	12,051,989
2079	23,919,336	12,953,738
2089	23,575,125	12,638,484
2099	21,198,071	13,937,768
2109	20,117,362	14,343,095
2119	18,903,109	14,595,652
2129	17,622,600	14,877,184
2139	16,853,595	14,734,108
2149	16,292,803	14,968,134
2159	15,625,149	15,197,772
2169	14,723,118	15,236,664
2179	14,636,931	15,365,394
2189	14,129,114	15,685,967
2199	14,021,633	15,718,383

Source: ORM compiled data

Figure 72. Scenario 5C: Deciduous Standing Inventory Volume



Source: ORM compiled data

Table 43. Scenario 5C: Deciduous Standing Inventory Volume

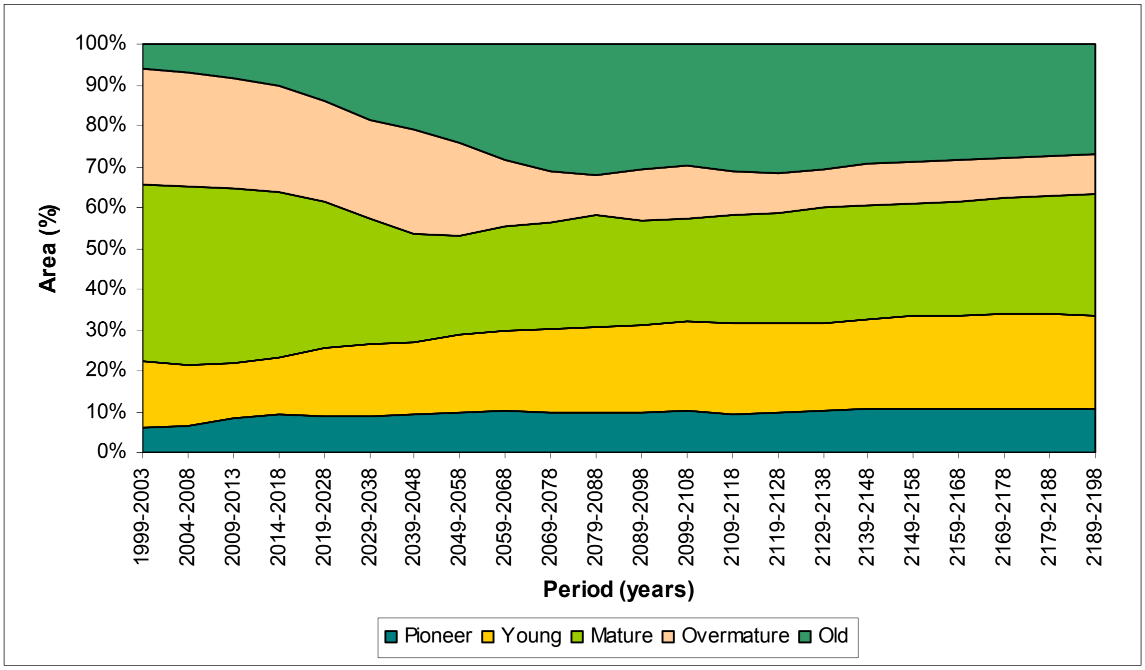
Year	Deciduous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,278
2004	29,003,459	6,718,139
2009	28,586,998	7,794,176
2014	27,494,795	9,204,280
2019	27,638,895	10,137,408
2029	26,205,289	11,374,671
2039	28,472,127	7,471,444
2049	26,785,318	6,041,405
2059	21,555,198	6,598,168
2069	19,105,035	5,261,600
2079	16,434,494	4,852,717
2089	14,717,671	4,502,617
2099	12,618,110	4,866,901
2109	11,901,533	5,565,495
2119	12,348,571	6,442,168
2129	11,882,956	7,545,727
2139	12,135,134	8,028,106
2149	12,917,949	8,106,588
2159	13,259,558	7,589,672
2169	13,043,113	7,522,887
2179	12,372,919	7,385,891
2189	12,382,823	6,964,647
2199	12,543,252	6,554,911

Source: ORM compiled data

6.8.3 Non-timber Resources

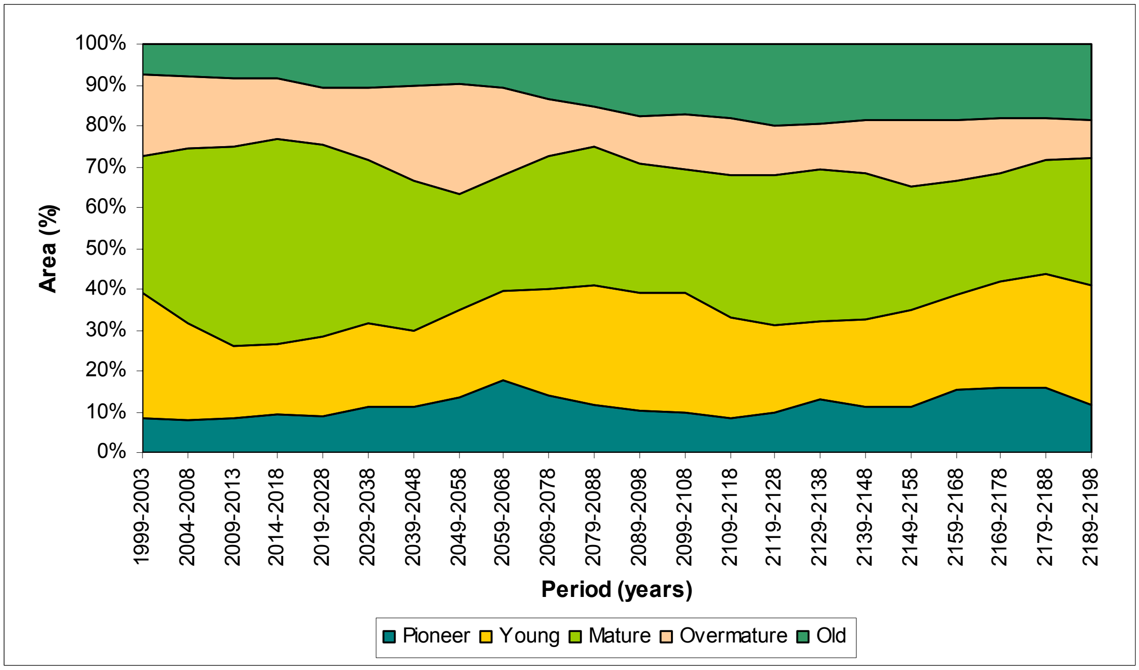
Figures 73 through 85 show that the status of the seral stage distribution, caribou habitat and hydrological recovery is very similar to that shown in Scenario 4C. Although the harvested volume is much less in this Scenario, the area harvested is relatively the same since the harvest is constrained with the same objectives. These objectives limit the amount of area that can be harvested rather than directly limiting the amount of volume that can be harvested.

Figure 73. Scenario 5C: Seral Stage Distribution – FMA



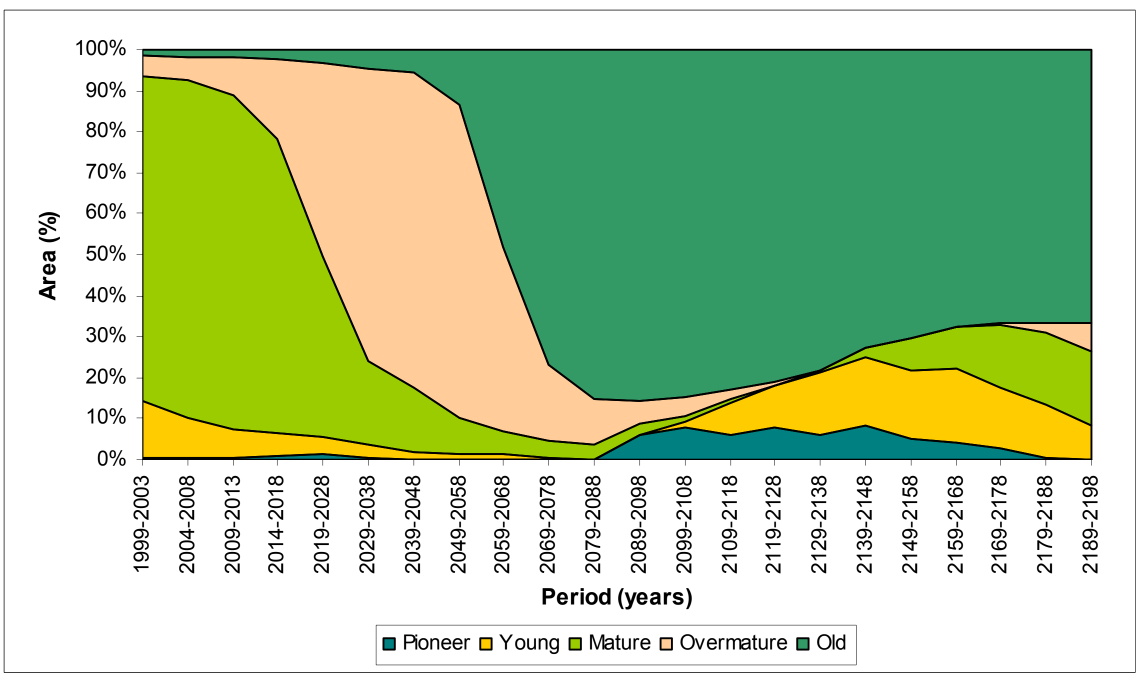
Source: ORM compiled data

Figure 74. Scenario 5C: Seral Stage Distribution – FMU G2C



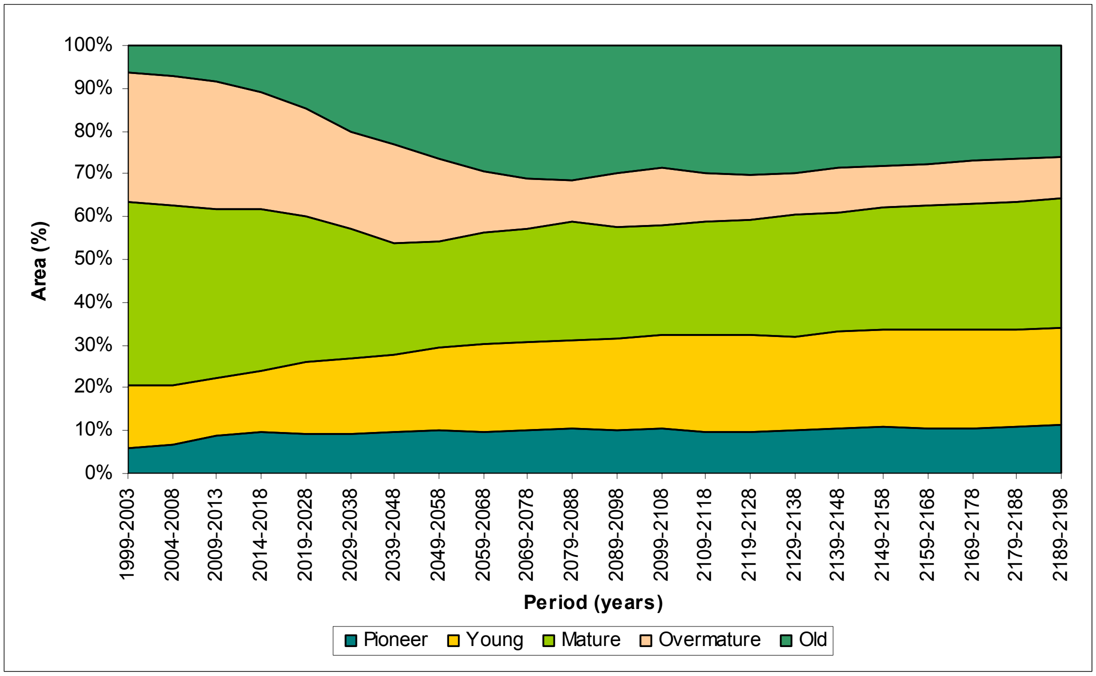
Source: ORM compiled data

Figure 75. Scenario 5C: Seral Stage Distribution – FMU G8C



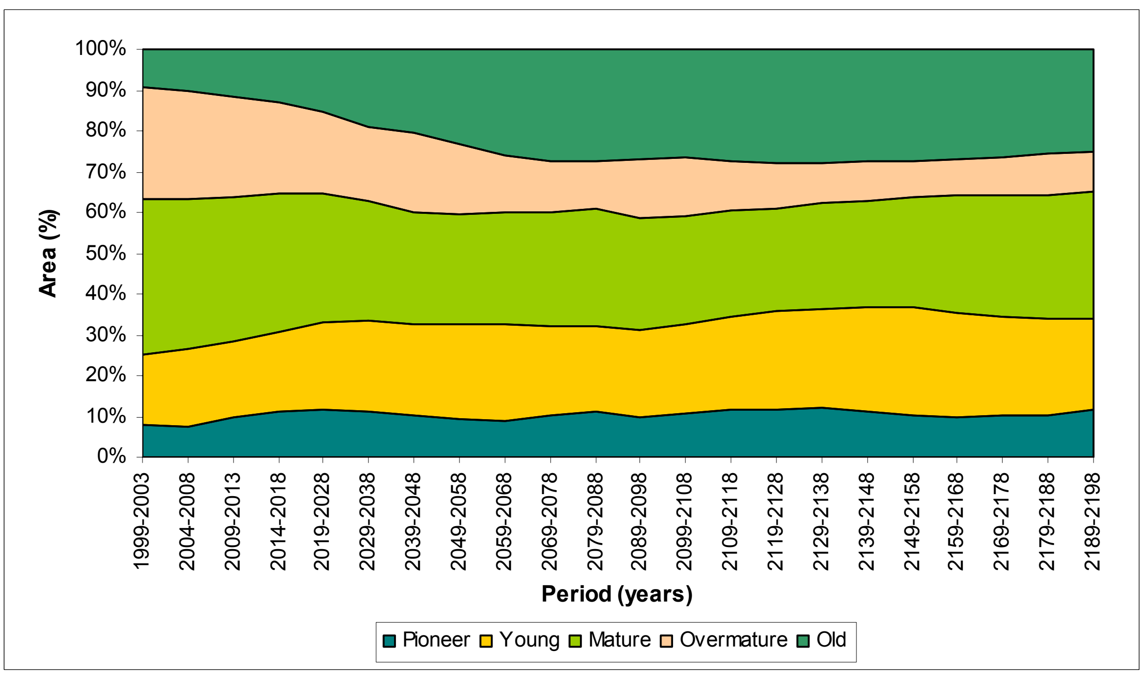
Source: ORM compiled data

Figure 76. Scenario 5C: Seral Stage Distribution – FMUs G5C and E8C



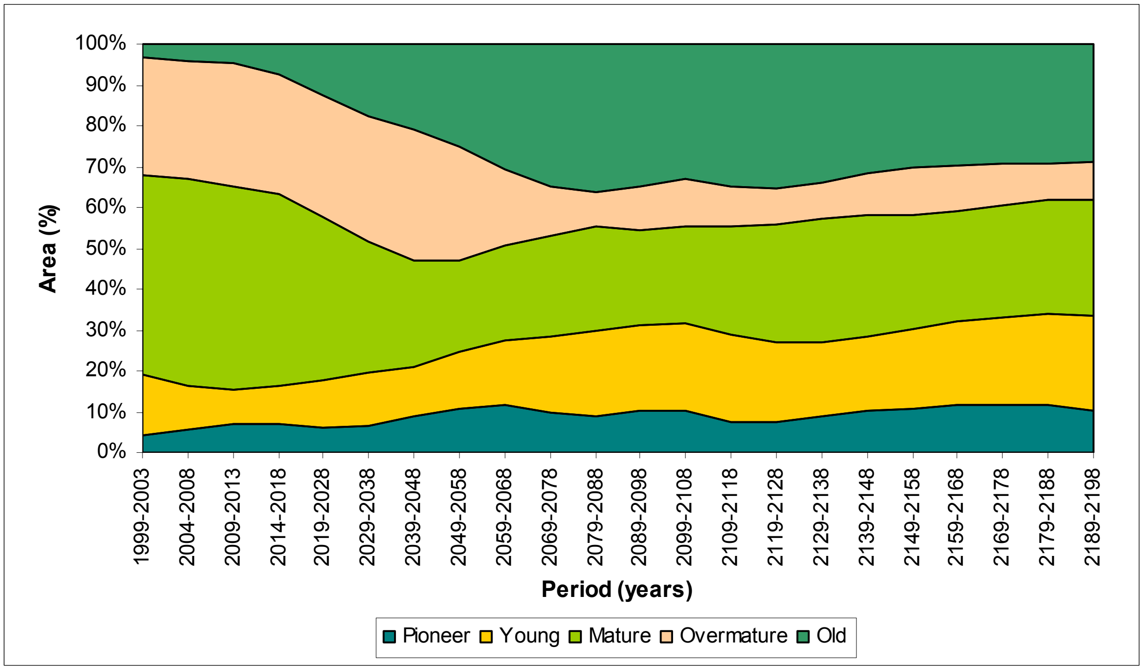
Source: ORM compiled data

Figure 77. Scenario 5C: Seral Stage Distribution – Foothills Natural Region



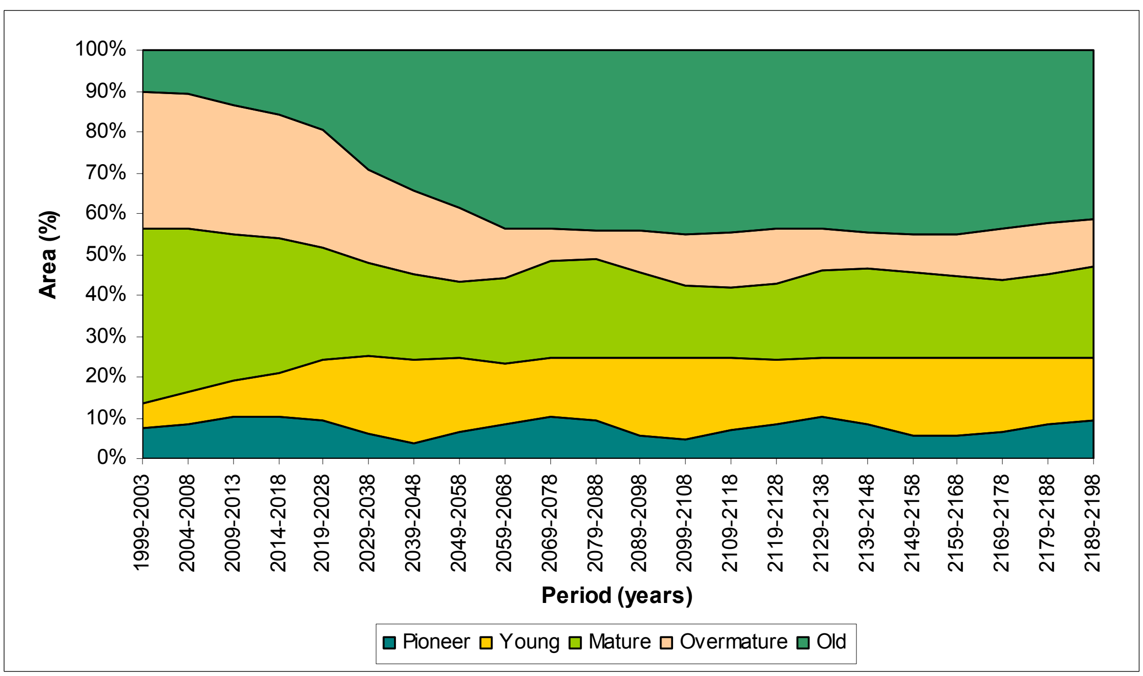
Source: ORM compiled data

Figure 78. Scenario 5C: Seral Stage Distribution – Boreal Forest Natural Region



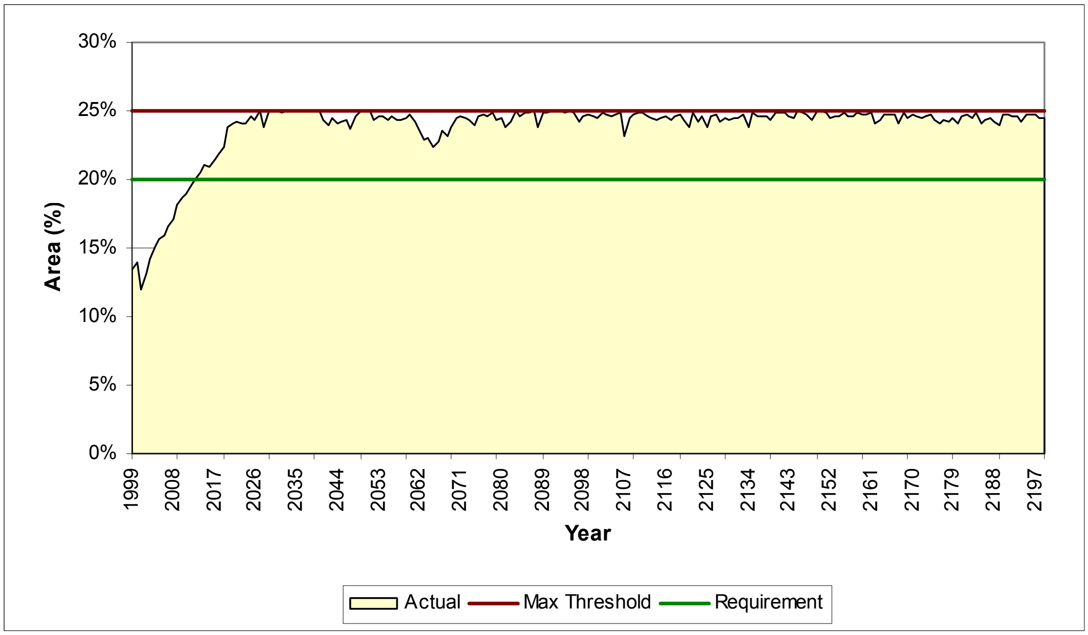
Source: ORM compiled data

Figure 79. Scenario 5C: Seral Stage Distribution – Caribou Area



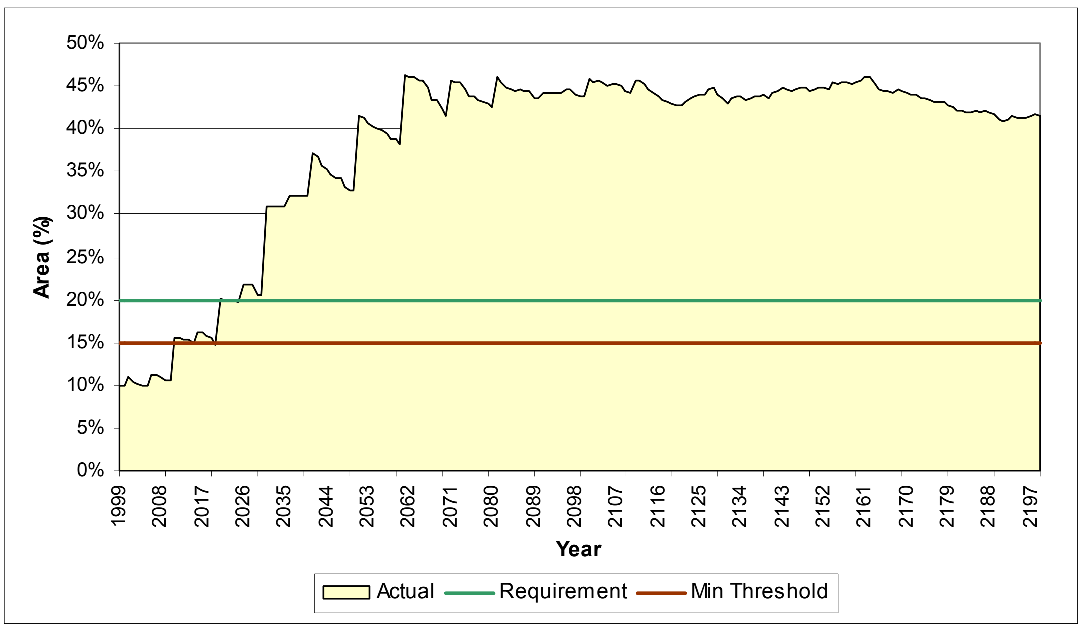
Source: ORM compiled data

Figure 80. Scenario 5C: Pioneer and Young Seral Stage Habitat in the Caribou Area



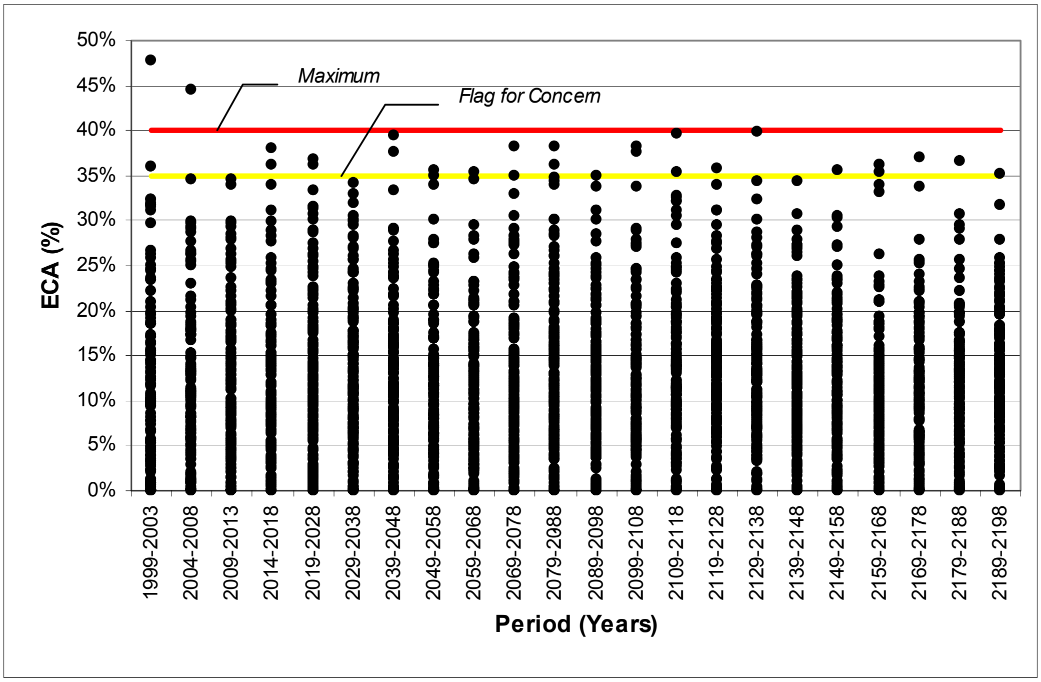
Source: ORM compiled data

Figure 81. Scenario 5C: Old Seral Stage Habitat in the Caribou Area



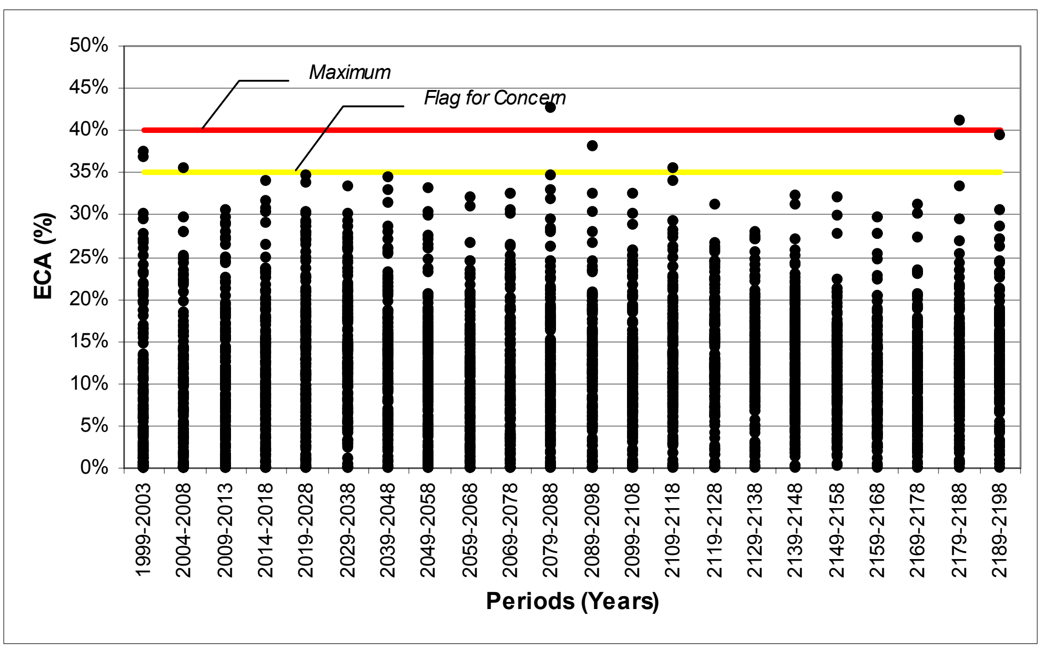
Source: ORM compiled data

Figure 82. Scenario 5C: Hydrological Recovery in Watersheds with Bull Trout – H60 Portion



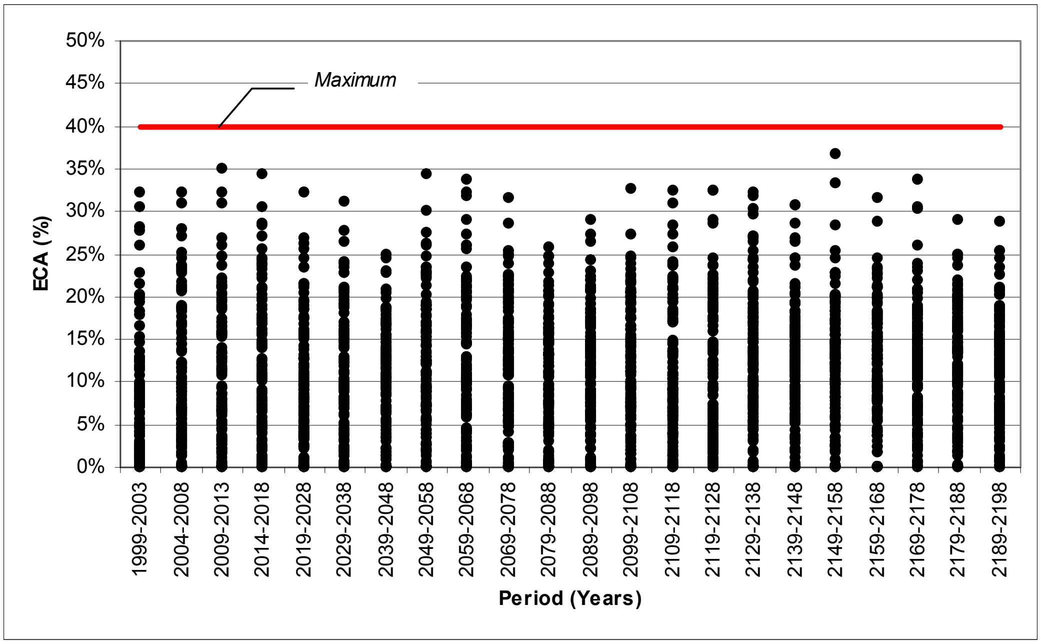
Source: ORM compiled data

Figure 83. Scenario 5C: Hydrological Recovery in Watersheds with Bull Trout – Entire Area



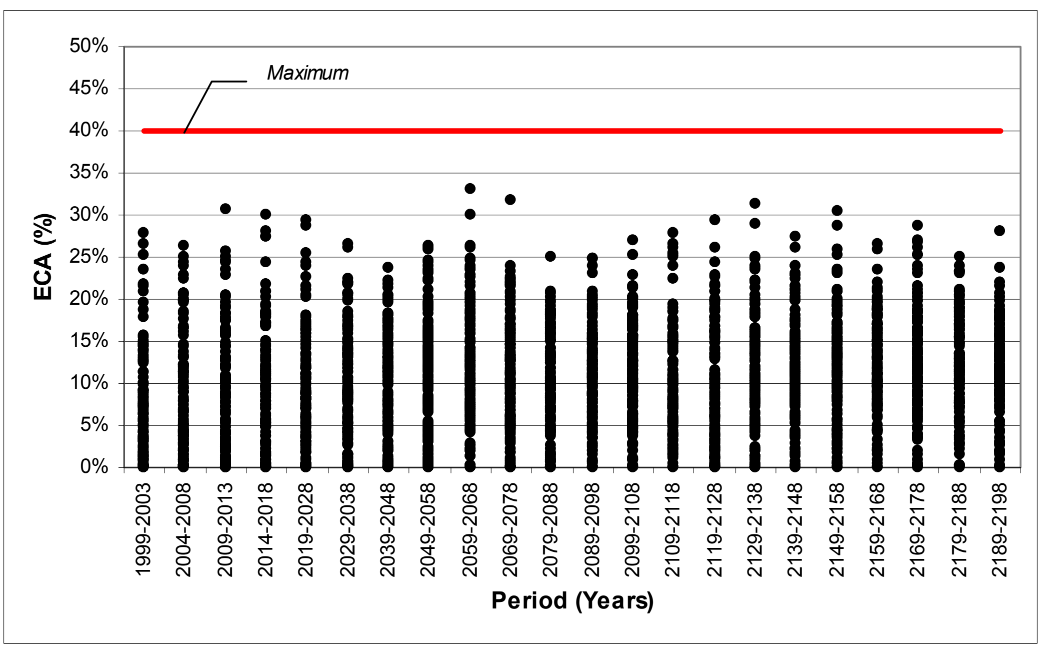
Source: ORM compiled data

Figure 84. Scenario 5C: Hydrological Recovery in Watersheds without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 85. Scenario 5C: Hydrological Recovery in Watersheds without Bull Trout – Entire Area



Source: ORM compiled data

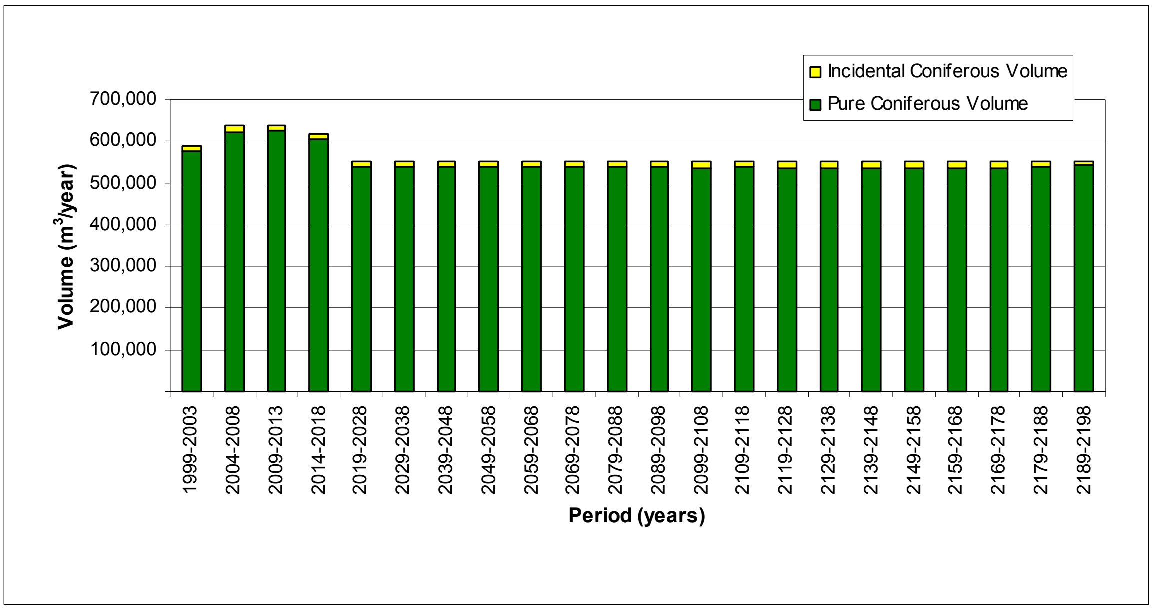
6.9 Scenario 6C

Results for Scenario 6C are discussed in the following sections.

6.9.1 Timber Harvest

The results from Scenario 6C (Figure 86 and Table 44) show that the coniferous harvest level of 640,000 m^3/year can be maintained for 15 years with a reduction to approximately 618,000 m^3/year in years 2014 to 2018, before dropping to the 550,000 m^3/year harvest level from Scenario 5C.

Figure 86. Scenario 6C: Coniferous Harvest Flow



Source: ORM compiled data

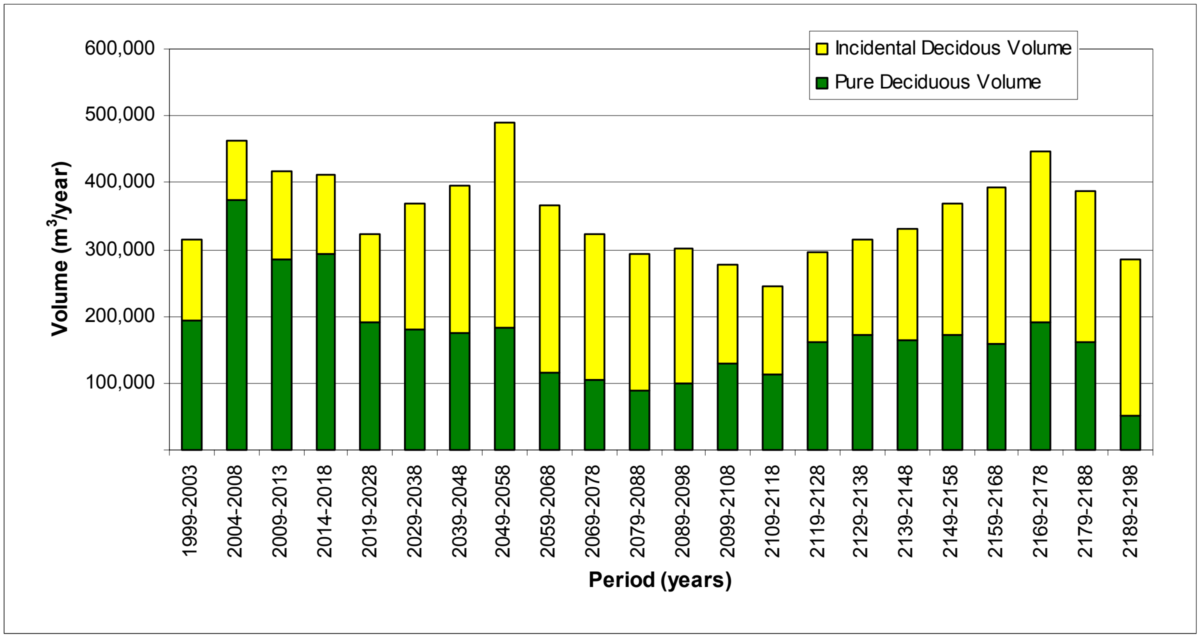
Table 44. Scenario 6C: Coniferous Harvest Flow

Period	Coniferous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	575,688	11,926	**587,615**
2004-2008	622,273	17,727	**640,000**
2009-2013	624,832	15,168	**640,000**
2014-2018	603,884	14,247	**618,132**
2019-2028	539,821	10,179	**550,000**
2029-2038	539,829	10,171	**550,000**
2039-2048	539,736	10,264	**550,000**
2049-2058	540,106	9,894	**550,000**
2059-2068	539,822	10,178	**550,000**
2069-2078	539,714	10,286	**550,000**
2079-2088	539,861	10,139	**550,000**
2089-2098	539,753	10,247	**550,000**
2099-2108	537,165	12,835	**550,000**
2109-2118	538,674	11,326	**550,000**
2119-2128	534,972	15,028	**550,000**
2129-2138	535,745	14,255	**550,000**
2139-2148	536,801	13,199	**550,000**
2149-2158	536,906	13,094	**550,000**
2159-2168	536,772	13,228	**550,000**
2169-2178	536,840	13,160	**550,000**
2179-2188	537,751	12,249	**550,000**
2189-2198	545,214	4,786	**550,000**

Source: ORM compiled data

The deciduous flows are similar to those which were generated in Scenario 5C as well (Figure 87 and Table 45). The average harvested volume is 350,648 m^3/year. However, when this level was attempted on an even-flow basis, similar results to Scenario 5C were seen when the same approach was tried.

Figure 87. Scenario 6C: Deciduous Harvest Flow



Source: ORM compiled data

Table 45. Scenario 6C: Deciduous Harvest Flow

Period	Deciduous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	193,907	121,402	**315,309**
2004-2008	374,181	88,944	**463,124**
2009-2013	285,661	132,524	**418,185**
2014-2018	293,719	117,016	**410,735**
2019-2028	191,927	131,293	**323,221**
2029-2038	181,107	188,322	**369,429**
2039-2048	175,849	219,380	**395,229**
2049-2058	181,935	308,198	**490,134**
2059-2068	116,740	249,672	**366,412**
2069-2078	104,871	217,177	**322,048**
2079-2088	88,744	205,783	**294,527**
2089-2098	99,475	201,767	**301,242**
2099-2108	129,690	146,946	**276,636**
2109-2118	113,015	132,892	**245,907**
2119-2128	162,631	132,850	**295,481**
2129-2138	172,602	142,992	**315,594**
2139-2148	165,020	165,850	**330,870**
2149-2158	173,257	196,159	**369,416**
2159-2168	160,033	232,907	**392,940**
2169-2178	190,148	257,763	**447,911**
2179-2188	162,112	225,656	**387,768**
2189-2198	51,617	232,910	**284,527**

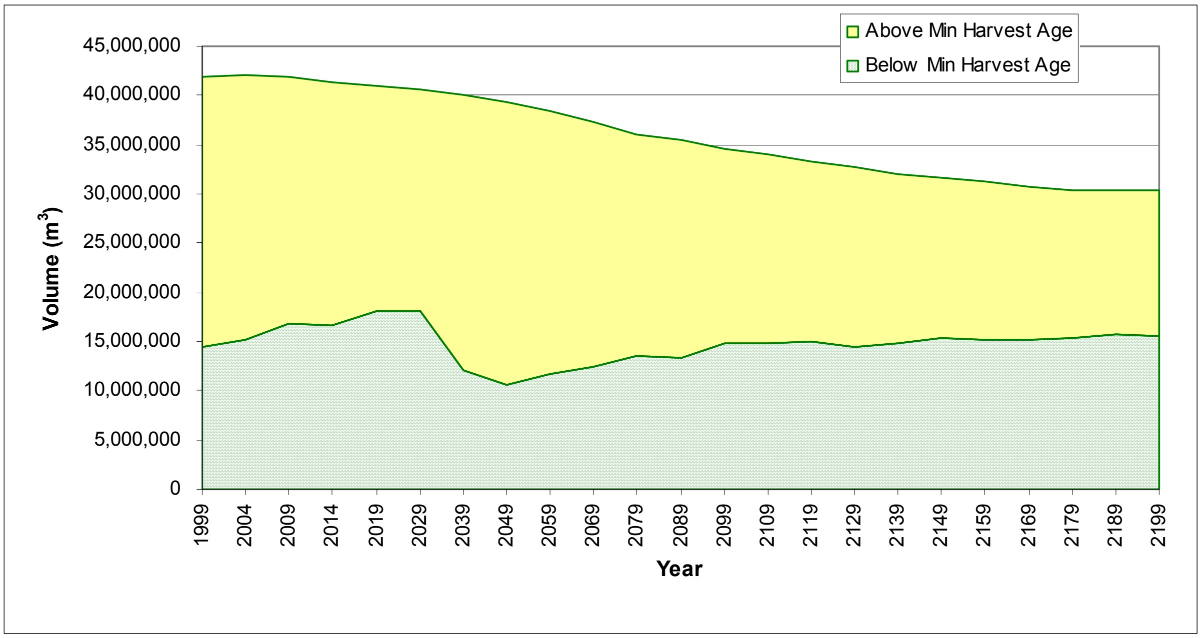
Source: ORM compiled data

The coniferous and deciduous results show that there is minimal risk associated with the assumptions regarding volume gains from regeneration strategy that is put forth in these documents.

6.9.2 Inventory

There is little change in the coniferous and deciduous standing inventory volume from that in Scenario 5C with the lower levels reflective of the lower per ha volumes in the regenerating stands (Figures 88, 89 and Tables 46, 47).

Figure 88. Scenario 6C: Coniferous Standing Inventory Volume



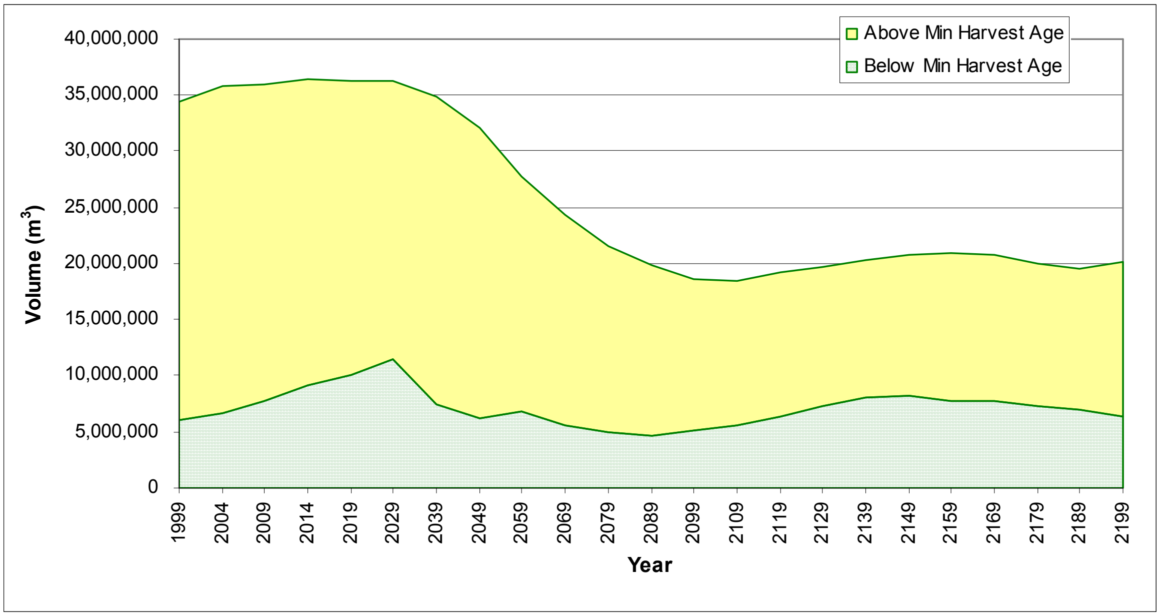
Source: ORM compiled data

Table 46. Scenario 6C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,146
2004	26,897,691	15,222,162
2009	24,921,618	16,878,563
2014	24,681,344	16,687,888
2019	22,845,642	18,088,778
2029	22,449,120	18,158,520
2039	27,895,654	12,124,850
2049	28,672,133	10,578,139
2059	26,754,971	11,672,436
2069	24,894,865	12,479,501
2079	22,470,475	13,531,101
2089	22,112,567	13,405,935
2099	19,793,954	14,767,714
2109	19,198,312	14,825,957
2119	18,387,762	14,964,767
2129	18,174,150	14,531,717
2139	17,231,897	14,777,698
2149	16,225,590	15,419,131
2159	16,105,714	15,213,355
2169	15,578,331	15,201,240
2179	15,003,934	15,413,201
2189	14,606,660	15,710,505
2199	14,749,570	15,603,996

Source: ORM compiled data

Figure 89. Scenario 6C: Deciduous Standing Inventory Volume



Source: ORM compiled data

Table 47. Scenario 6C: Deciduous Standing Inventory Volume

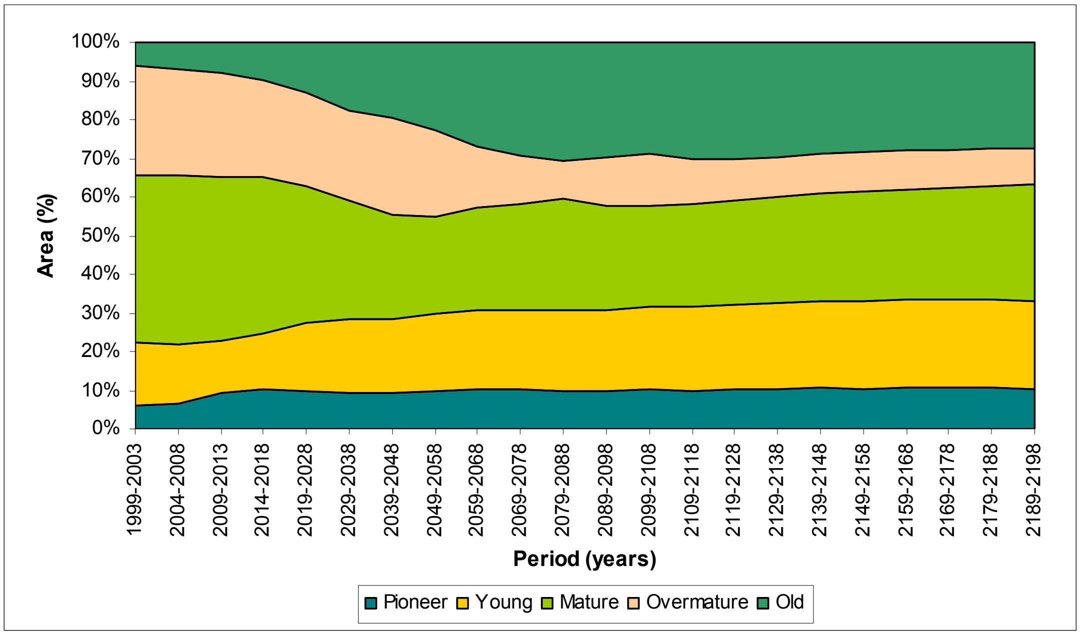
Year	Deciduous Volume (m³)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,278
2004	29,031,430	6,718,082
2009	28,243,334	7,794,112
2014	27,174,361	9,203,133
2019	26,183,503	10,142,758
2029	24,891,096	11,395,678
2039	27,297,764	7,515,689
2049	25,971,599	6,166,543
2059	20,913,697	6,843,161
2069	18,822,478	5,586,859
2079	16,609,623	4,942,916
2089	15,156,433	4,660,786
2099	13,458,953	5,138,763
2109	12,770,772	5,628,901
2119	12,724,846	6,431,324
2129	12,465,396	7,287,993
2139	12,348,134	8,021,668
2149	12,513,498	8,240,121
2159	13,159,267	7,750,868
2169	12,996,861	7,768,828
2179	12,687,315	7,285,484
2189	12,678,471	6,922,922
2199	13,754,410	6,433,423

Source: ORM compiled data

6.9.3 Non-timber Resources

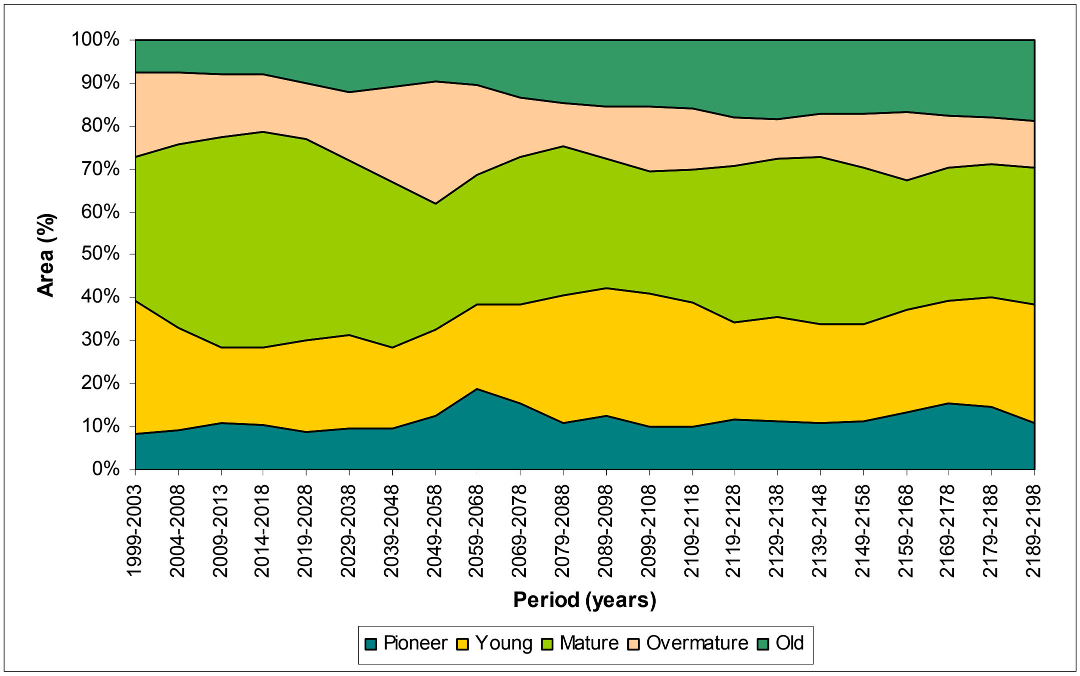
There is very little difference between the non-timber resource results from Scenario 4C, 5C and 6C. This is expected as all of these attributes constrain the harvest in the same manner during each of the scenarios and since these objectives are met before any timber objectives, they take priority. The seral stage distribution, caribou habitat and hydrological recovery are shown in Figures 90 to 102.

Figure 90. Scenario 6C: Seral Stage Distribution – FMA



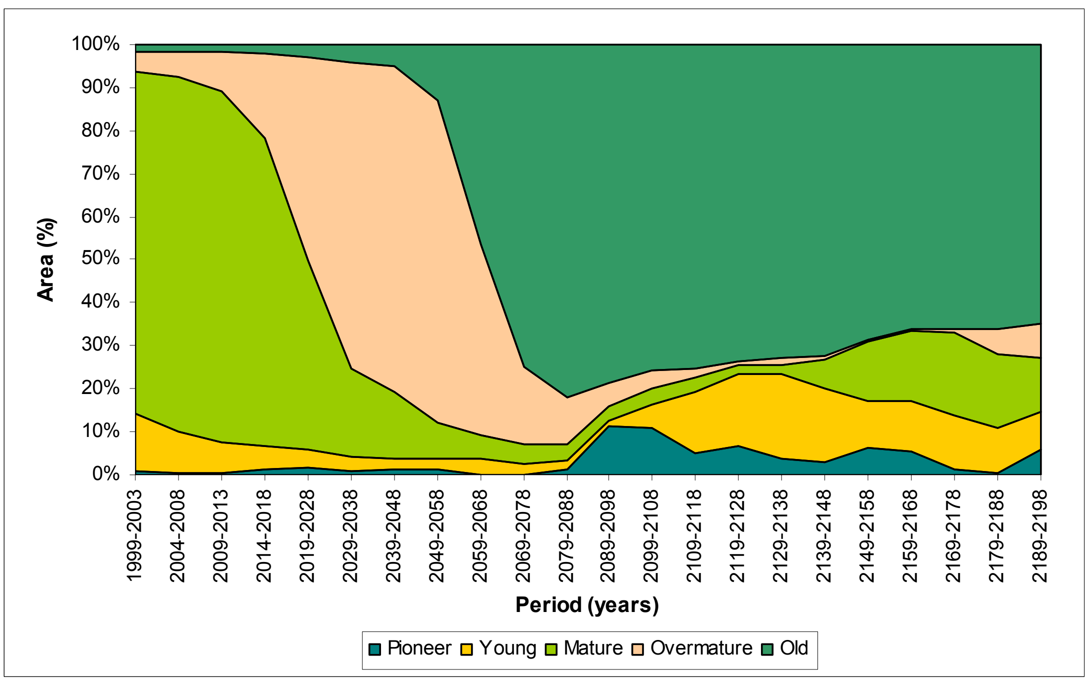
Source: ORM compiled data

Figure 91. Scenario 6C: Seral Stage Distribution – FMU G2C



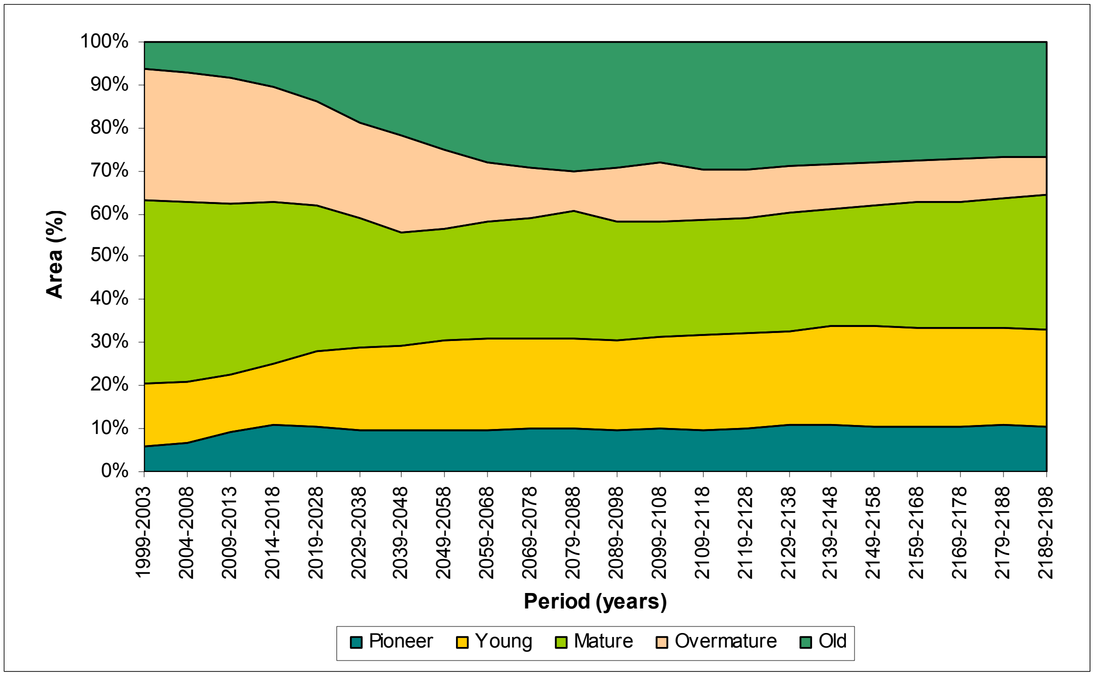
Source: ORM compiled data

Figure 92. Scenario 6C: Seral Stage Distribution – FMU G8C



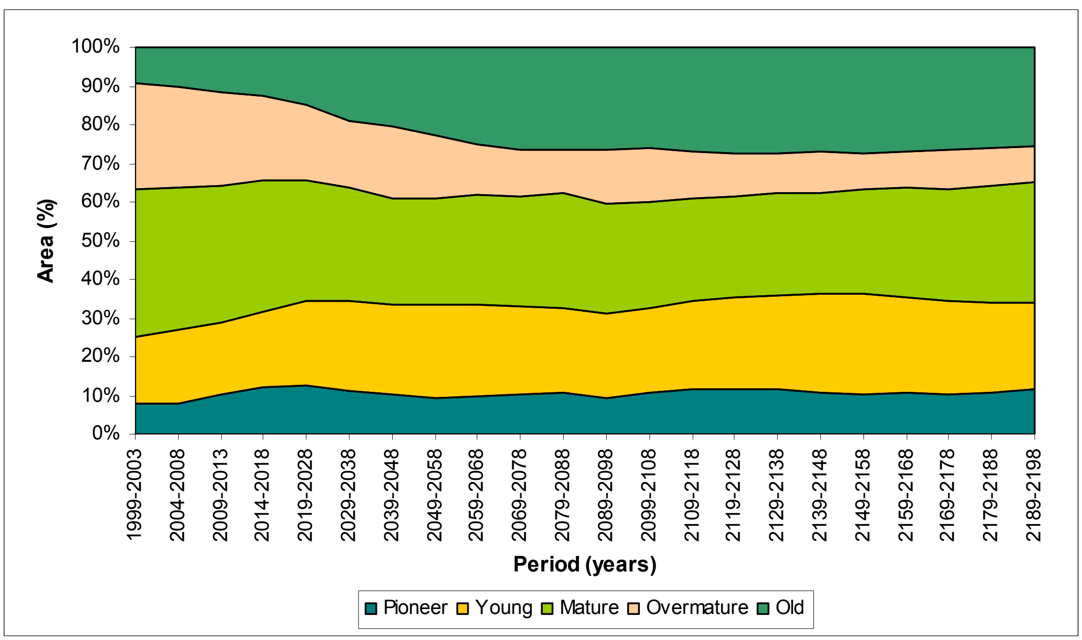
Source: ORM compiled data

Figure 93. Scenario 6C: Seral Stage Distribution – FMU G5C and E8C



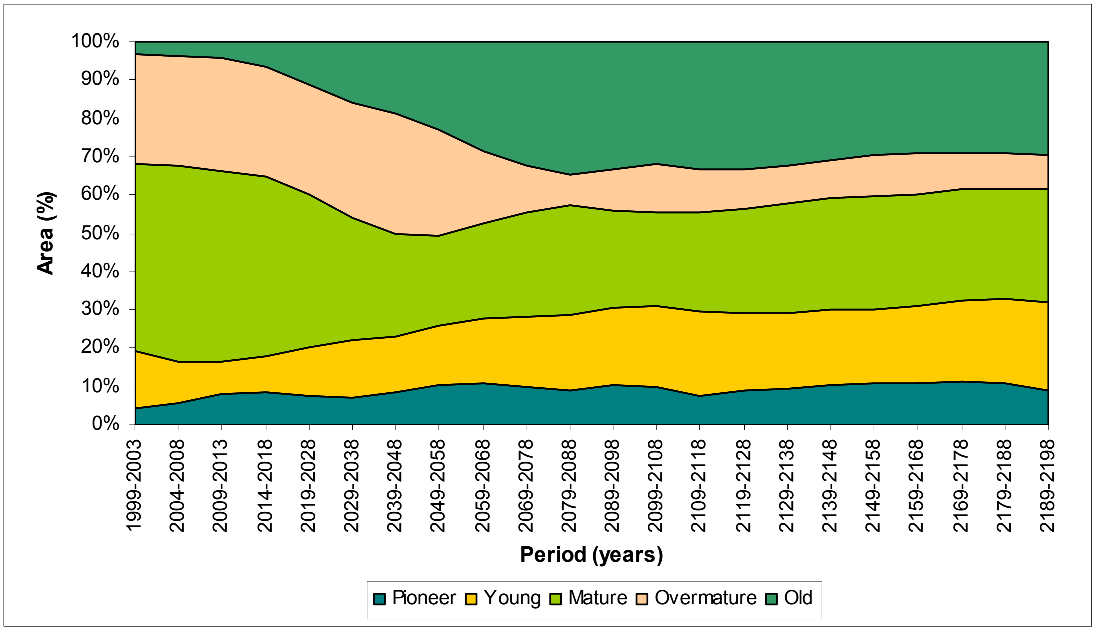
Source: ORM compiled data

Figure 94. Scenario 6C: Seral Stage Distribution – Foothills Natural Region



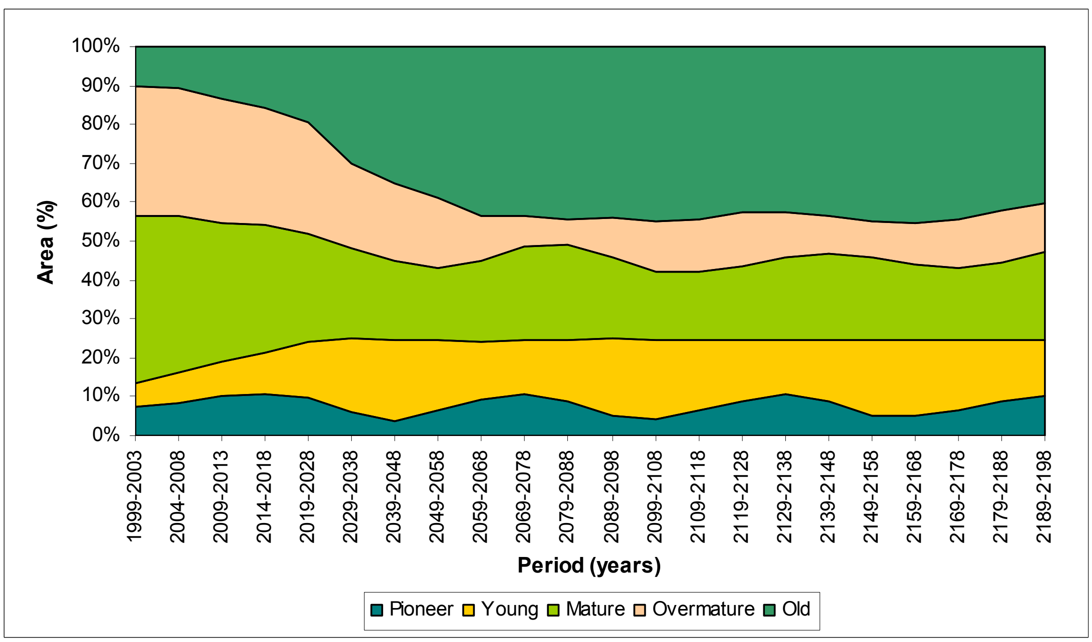
Source: ORM compiled data

Figure 95. Scenario 6C: Seral Stage Distribution – Boreal Forest Natural Region



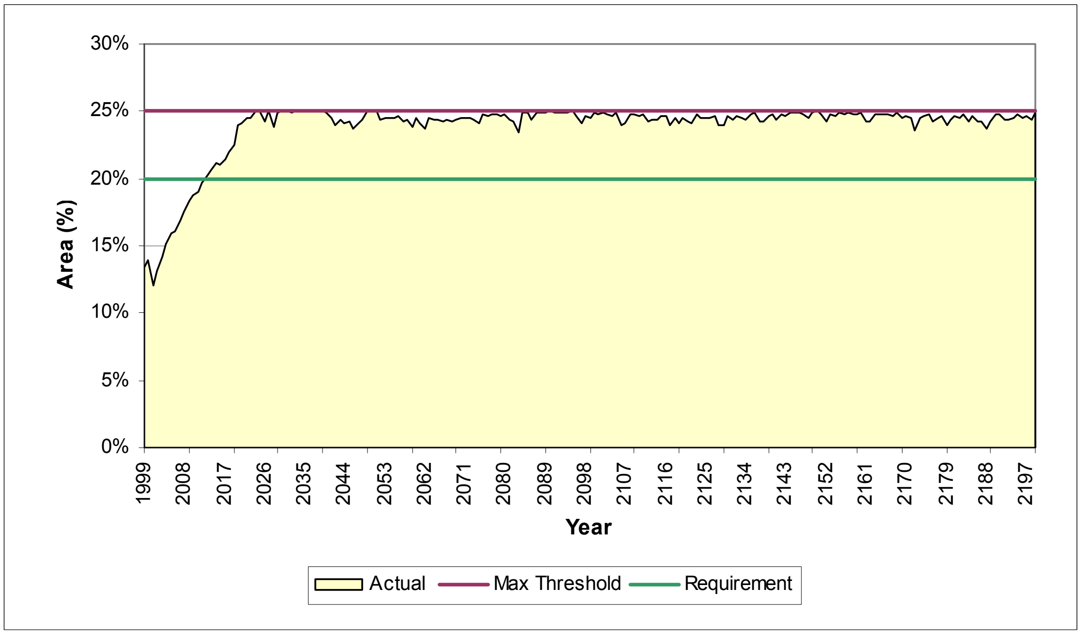
Source: ORM compiled data

Figure 96. Scenario 6C: Seral Stage Distribution – Caribou Area



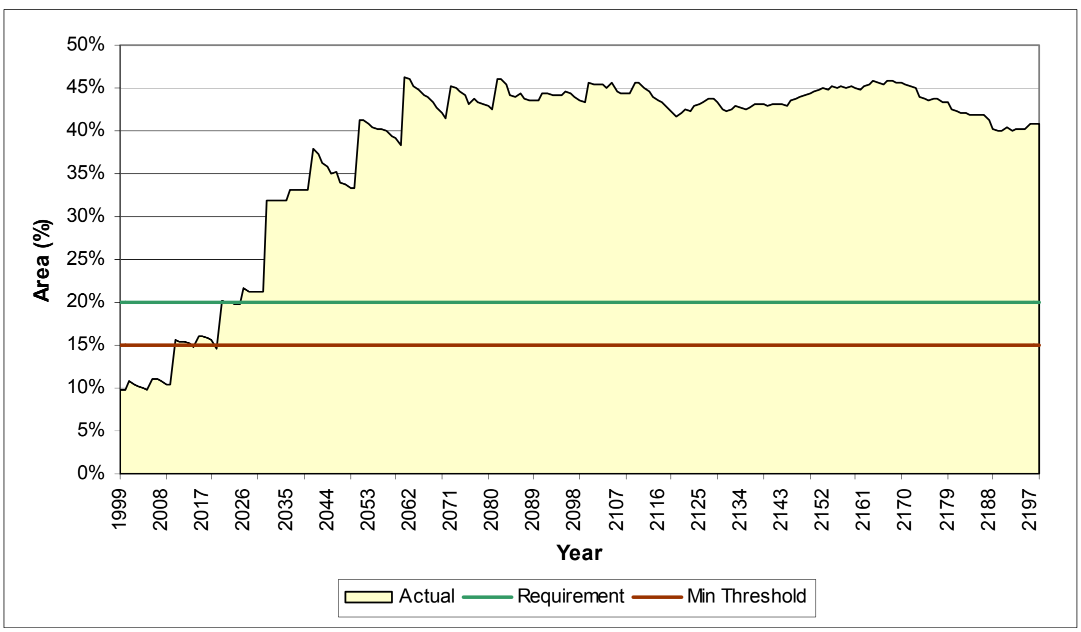
Source: ORM compiled data

Figure 97. Scenario 6C: Pioneer and Young Seral Stage Habitat in the Caribou Area



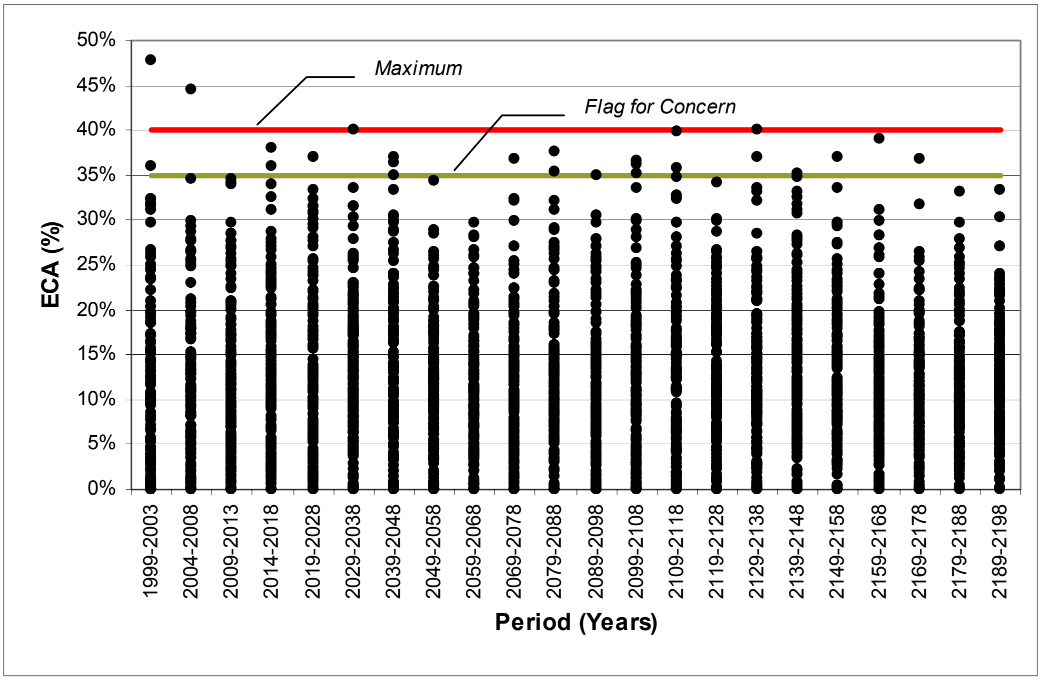
Source: ORM compiled data

Figure 98. Scenario 6C: Old Seral Stage Habitat in Caribou Area



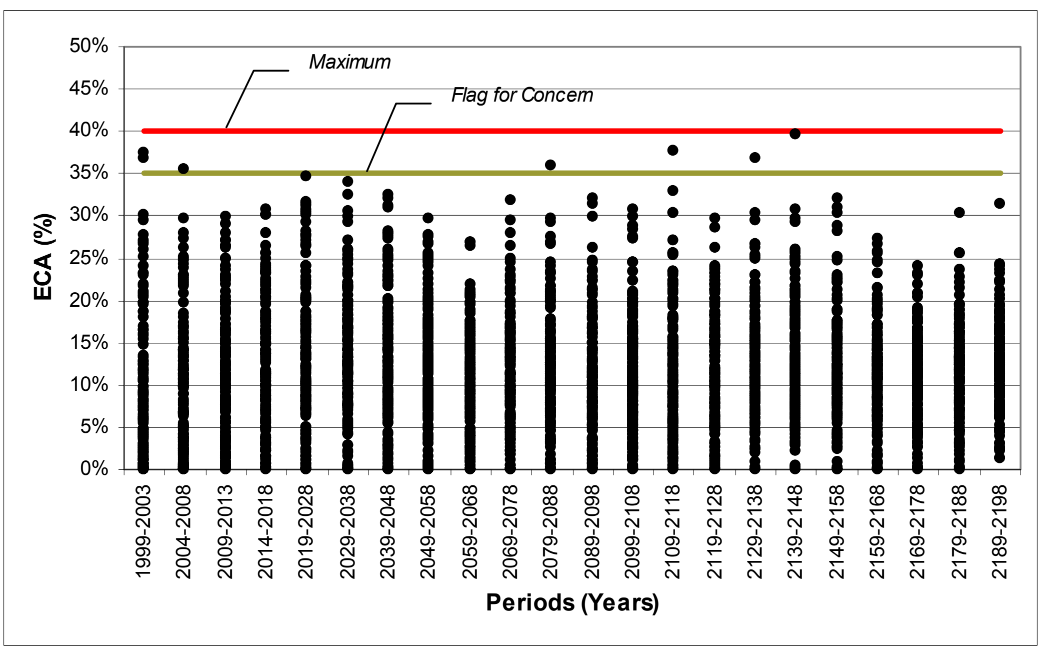
Source: ORM compiled data

Figure 99. Scenario 6C: Hydrological Recovery in Watersheds with Bull Trout – H60 Portion



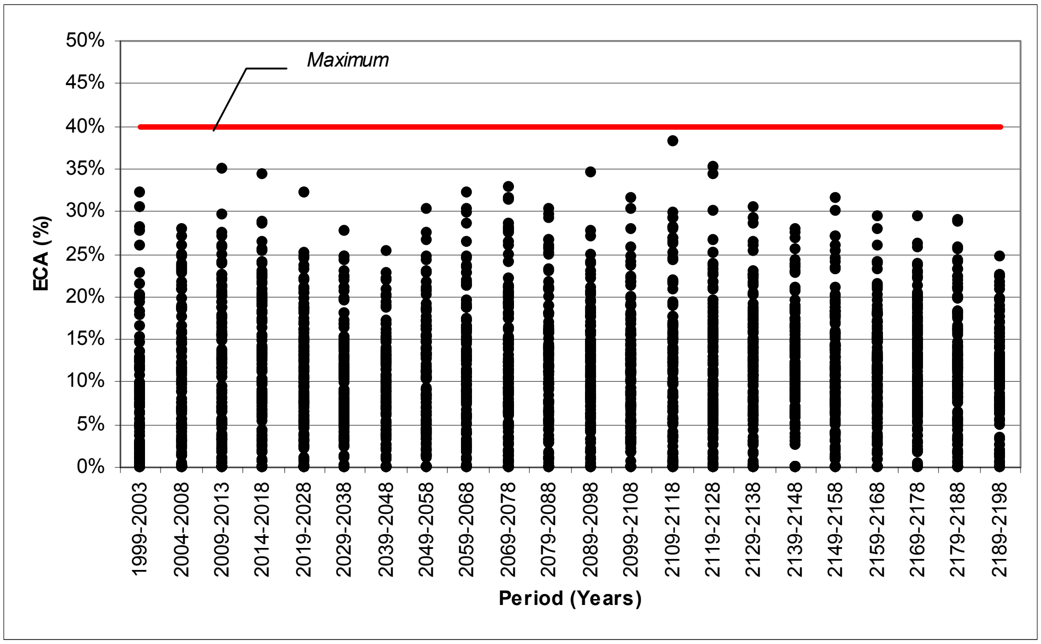
Source: ORM compiled data

Figure 100. Scenario 6C: Hydrological Recovery in Watersheds with Bull Trout – Entire Area



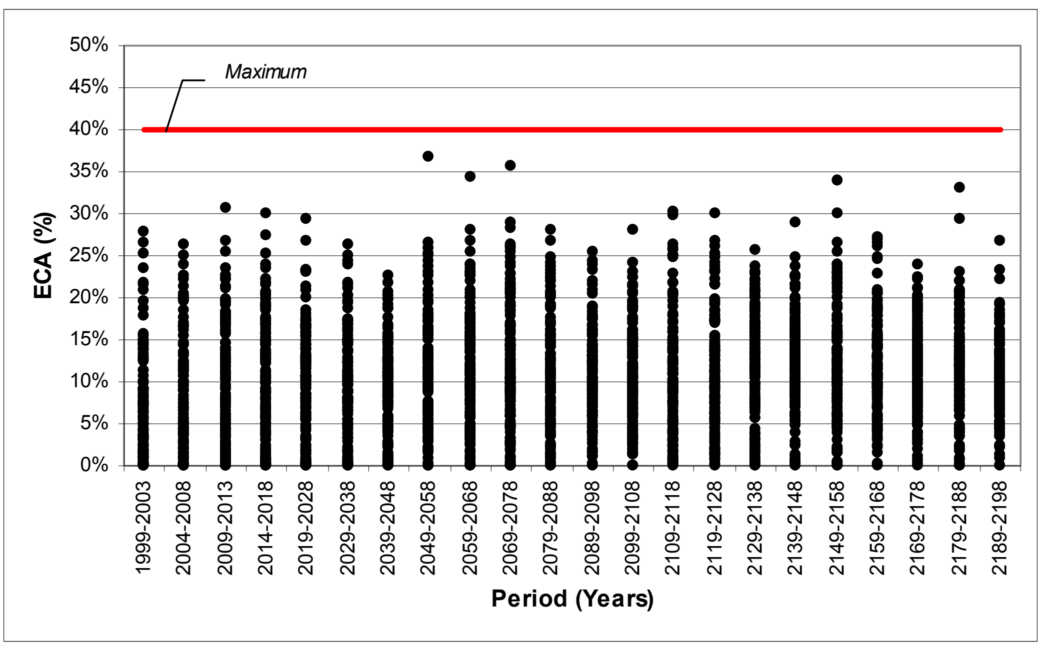
Source: ORM compiled data

Figure 101. Scenario 6C: Hydrological Recovery in Watersheds without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 102. Scenario 6C: Hydrological Recovery in Watersheds without Bull Trout – Entire Area



Source: ORM compiled data

6.10 Scenario 7C

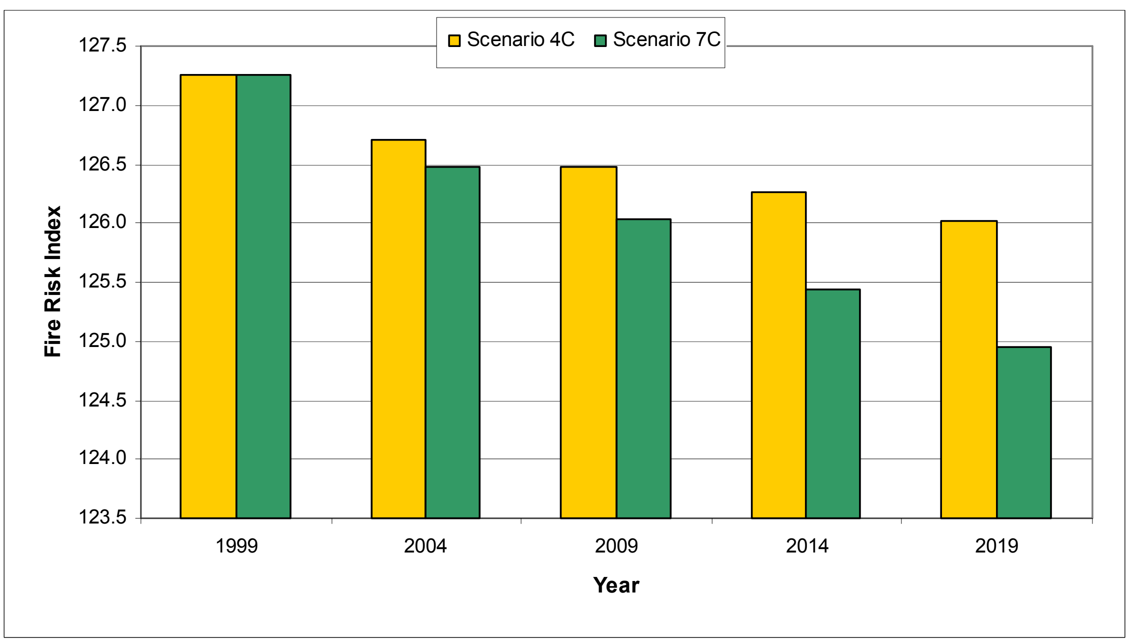
Results for Scenario 7C are discussed in the following sections.

6.10.1 Timber Harvest

This scenario involved an attempt to change the harvest priorities within COMPLAN in such a way that the first factor in determining harvest order was fire risk as compared to yield characteristics which is the dominant factor in all of the other scenarios. A Fire Risk Index (FRI) was established for every stand based on their attributes as of 1999. It was not possible to recalculate the FRIs for the years following that since the FRI calculation is based upon AVI attributes which are not projected through time with the existing yield curves. For the purpose of this analysis, it was assumed that once harvested, a stand would have an FRI of 0 since there was no basis for assigning any other value. Appendix VII contains a brief description of the models and process which were used to calculate the FRI values.

Using Scenario 4C as an area for comparison, an area-weighted FRI value was calculated for the entire FMA for 1999, 2004, 2009, 2014 and 2019. These are shown in Figure 103 and Table 48 along with the corresponding values from this Scenario. The area-weighted average FRI values from Scenario 4C show little change over the 20-year period. This is not unexpected since the high-risk stands were not targeted and there was no obvious correlation between yield group, age or any other factor which drives the harvest. Targeting the high-risk stands resulted in an area-weighted average FRI, which declines as shown in Figure 103. This is supported by Figure 104 and Table 49, which shows less area, classed as either extreme or high-fire risk in Scenario 7C as compared to 4C.

Figure 103. Scenario 7C: Fire Risk Index Comparison with Scenario 4C



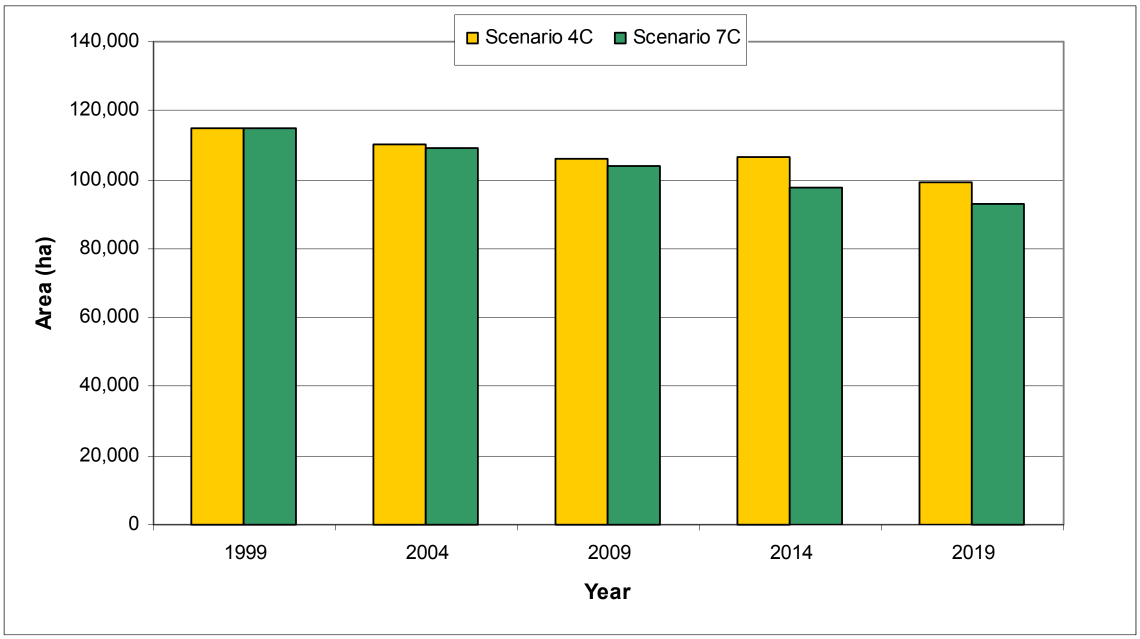
Source: ORM compiled data

Table 48. Scenario 7C: Fire Risk Index Area Summary Comparison with Scenario 4C

Year	Scenario 4C	Scenario 7C
1999	127.2	127.2
2004	126.7	126.5
2009	126.5	126.0
2014	126.3	125.4
2019	126.0	125.0

Source: ORM compiled data

Figure 104. Scenario 7C: Extreme and High Fire Risk Area Summary Comparison with Scenario 4C



Source: ORM compiled data

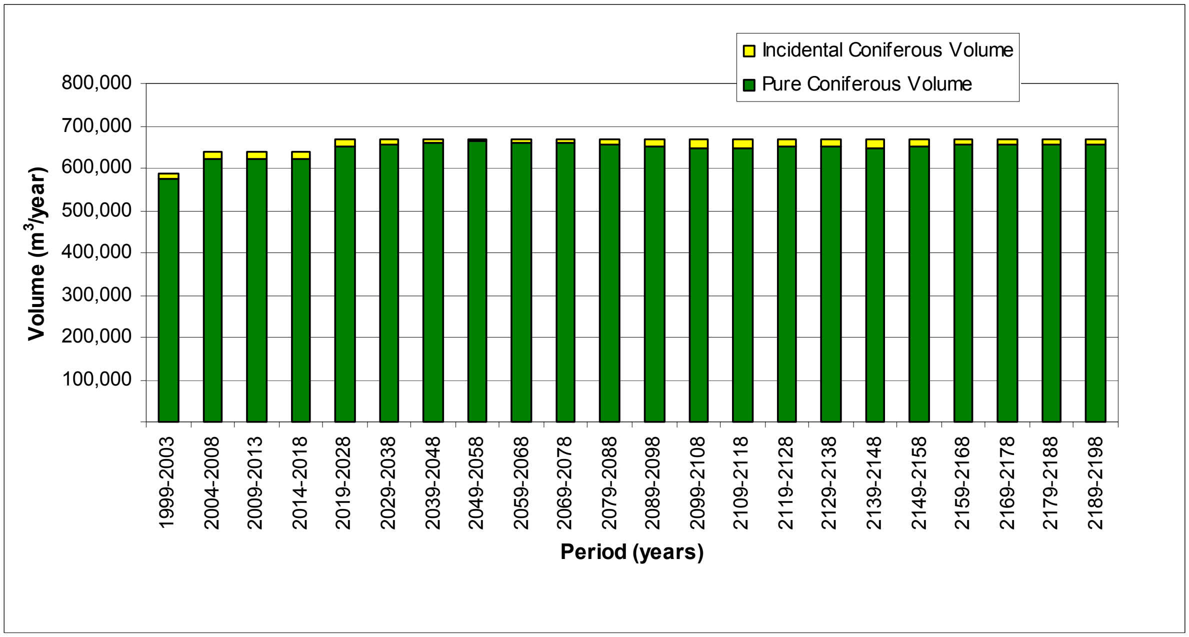
Table 49. Scenario 7C: Extreme and High Fire Risk Area Summary Comparison with Scenario 4C

Year	Scenario 4C	Scenario 7C
1999	114,711	114,711
2004	110,086	108,937
2009	106,274	103,750
2014	106,609	97,650
2019	99,196	92,929

Source: ORM compiled data

The coniferous and deciduous harvest levels (Figures 105, 106 and Tables 50, 51) were able to be maintained when the high-fire risk stands were prioritized for harvest. Although the deciduous flows showed some decline at the end of the planning horizon, it is felt that the target volume (453,712 m^3/year) could be achieved with further iterations based on results from Scenario 4C.

Figure 105. Scenario 7C: Coniferous Harvest Flow



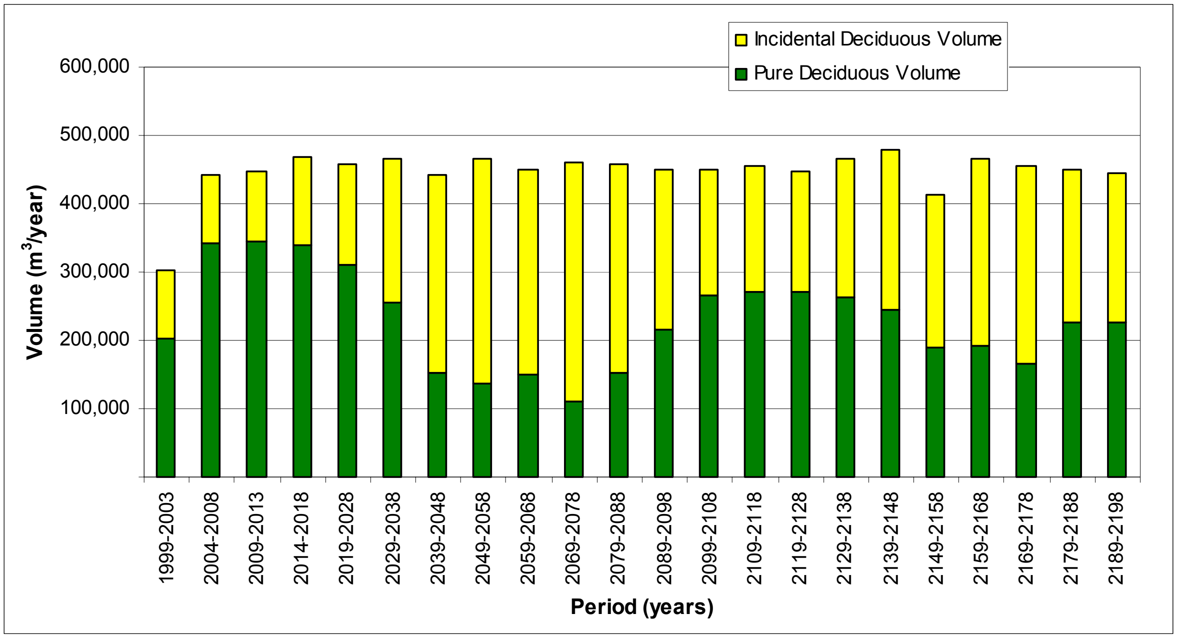
Source: ORM compiled data

Table 50. Scenario 7C: Coniferous Harvest Flow

Period	Coniferous Volume (m^3/year)		
	Pure	Incidental	Total
1999-2003	576,331	11,284	**587,615**
2004-2008	623,346	16,654	**640,000**
2009-2013	623,292	16,708	**640,000**
2014-2018	622,875	17,125	**640,000**
2019-2028	652,156	17,844	**670,000**
2029-2038	656,666	13,334	**670,000**
2039-2048	661,622	8,378	**670,000**
2049-2058	662,094	7,906	**670,000**
2059-2068	659,105	10,895	**670,000**
2069-2078	658,657	11,343	**670,000**
2079-2088	655,913	14,087	**670,000**
2089-2098	651,289	18,711	**670,000**
2099-2108	648,596	21,404	**670,000**
2109-2118	647,164	22,836	**670,000**
2119-2128	649,152	20,848	**670,000**
2129-2138	649,225	20,775	**670,000**
2139-2148	648,357	21,643	**670,000**
2149-2158	651,268	18,732	**670,000**
2159-2168	653,649	16,351	**670,000**
2169-2178	656,885	13,115	**670,000**
2179-2188	653,535	16,465	**670,000**
2189-2198	653,680	16,320	**670,000**

Source: ORM compiled data

Figure 106. Scenario 7C: Deciduous Harvest Flow



Source: ORM compiled data

Table 51. Scenario 7C: Deciduous Harvest Flow

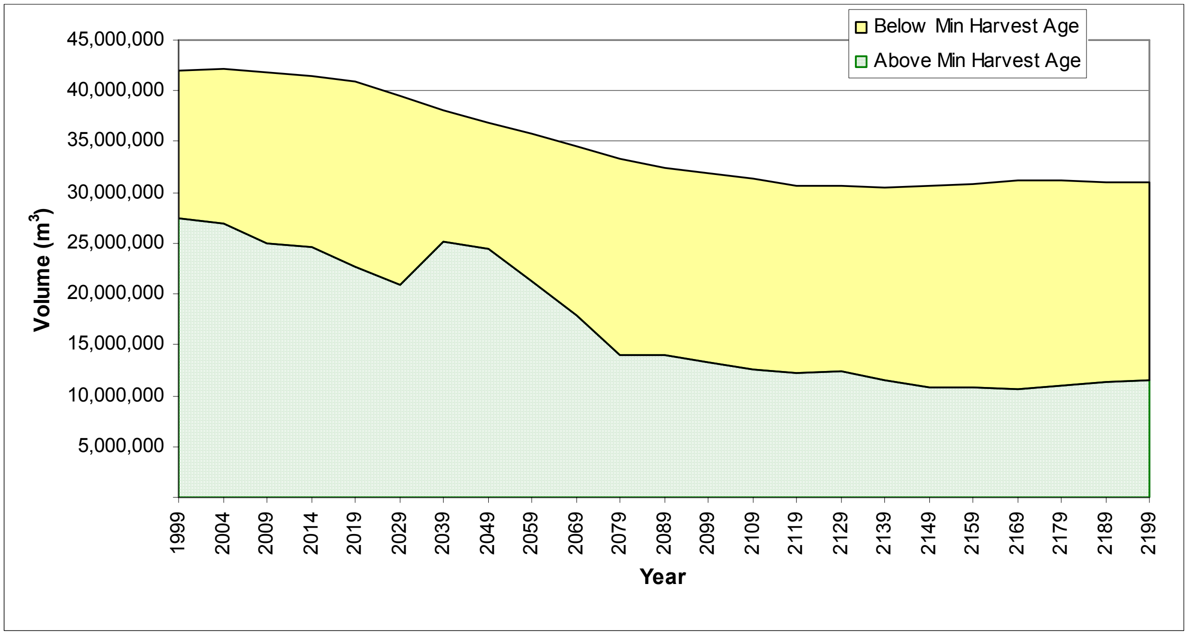
Period	Deciduous Volume (m³/year)		
	Pure	Incidental	Total
1999-2003	203,796	99,089	**302,885**
2004-2008	342,161	99,719	**441,880**
2009-2013	345,734	101,922	**447,656**
2014-2018	338,896	129,519	**468,415**
2019-2028	309,866	148,232	**458,099**
2029-2038	254,090	210,848	**464,938**
2039-2048	151,397	290,144	**441,541**
2049-2058	135,574	329,207	**464,781**
2059-2068	150,900	297,845	**448,745**
2069-2078	111,435	349,767	**461,202**
2079-2088	151,630	306,315	**457,944**
2089-2098	216,248	233,571	**449,819**
2099-2108	265,047	183,887	**448,934**
2109-2118	272,340	181,857	**454,197**
2119-2128	271,476	176,435	**447,912**
2129-2138	262,983	202,938	**465,921**
2139-2148	245,806	231,949	**477,755**
2149-2158	190,063	223,277	**413,340**
2159-2168	192,358	273,995	**466,352**
2169-2178	165,096	289,372	**454,468**
2179-2188	227,010	224,250	**451,260**
2189-2198	225,956	218,185	**444,141**

Source: ORM compiled data

6.10.2 Inventory

The standing inventory volume for both coniferous and deciduous (Figures 107, 108 and Tables 52, 53) shows almost no change from that seen in Scenario 4C. This is not unexpected since the harvest levels are very similar and the same non-timber resource objectives were met.

Figure 107. Scenario 7C: Coniferous Standing Inventory Volume



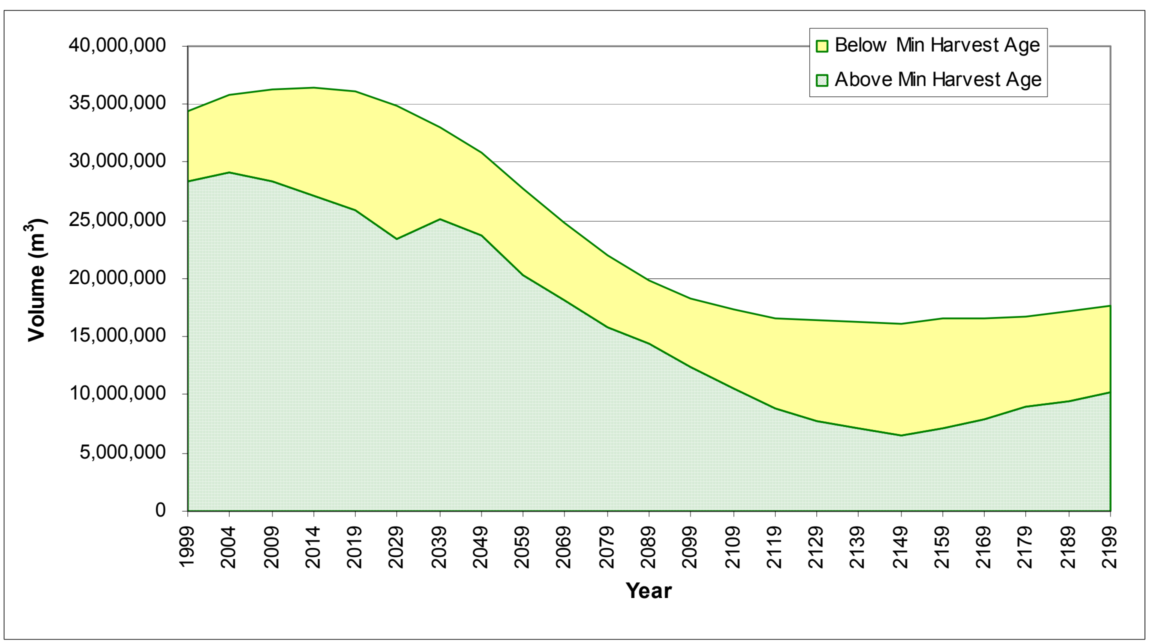
Source: ORM compiled data

Table 52. Scenario 7C: Coniferous Standing Inventory Volume

Year	Coniferous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	27,432,429	14,523,157
2004	26,883,428	15,235,093
2009	24,898,196	16,900,429
2014	24,640,960	16,751,058
2019	22,669,099	18,226,164
2029	20,964,759	18,564,805
2039	25,091,662	13,071,215
2049	24,495,884	12,385,383
2059	21,229,117	14,559,342
2069	17,851,958	16,776,352
2079	14,007,764	19,256,242
2089	14,019,393	18,407,549
2099	13,278,491	18,556,451
2109	12,532,172	18,738,495
2119	12,274,620	18,392,197
2129	12,380,175	18,323,894
2139	11,546,512	18,979,822
2149	10,788,385	19,904,984
2159	10,873,289	20,020,546
2169	10,611,486	20,588,135
2179	11,002,033	20,106,110
2189	11,327,236	19,731,593
2199	11,581,476	19,389,179

Source: ORM compiled data

Figure 108. Scenario 7C: Deciduous Standing Inventory Volume



Source: ORM compiled data

Table 53. Scenario 7C: Deciduous Standing Inventory Volume

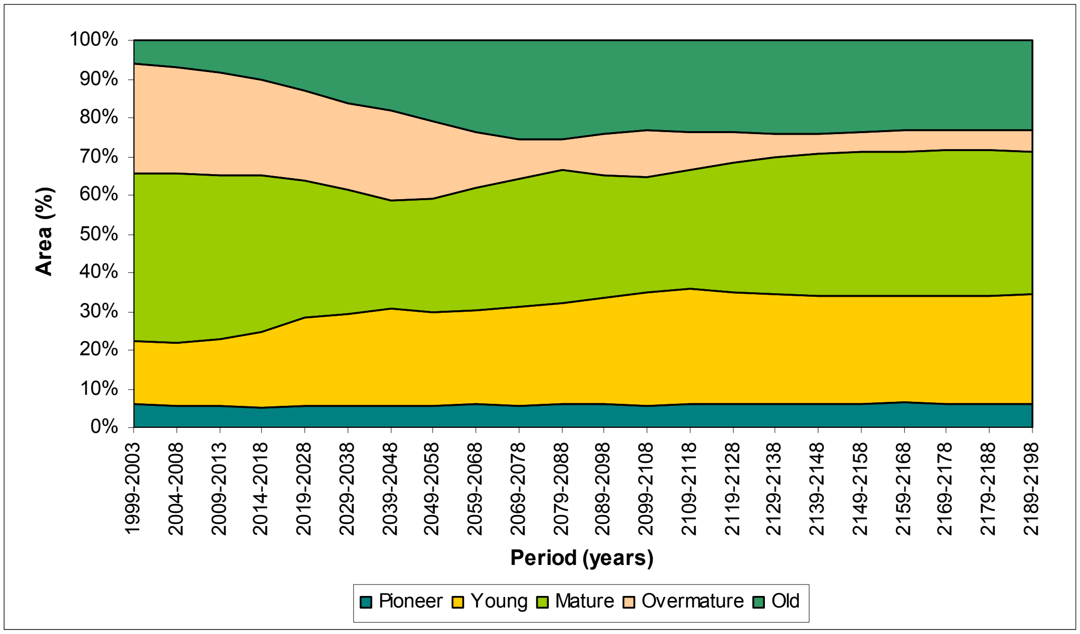
Year	Deciduous Volume (m^3)	
	Above Min Harvest Age	Below Min Harvest Age
1999	28,337,821	6,003,301
2004	29,086,078	6,727,035
2009	28,404,935	7,806,296
2014	27,175,640	9,229,957
2019	25,886,736	10,201,709
2029	23,377,993	11,556,725
2039	25,075,094	7,976,011
2049	23,692,296	7,086,361
2059	20,298,681	7,496,050
2069	18,119,780	6,761,631
2079	15,809,571	6,256,167
2089	14,370,103	5,469,721
2099	12,362,211	5,885,189
2109	10,527,799	6,769,203
2119	8,841,010	7,811,563
2129	7,805,829	8,617,503
2139	7,124,780	9,148,975
2149	6,523,522	9,673,448
2159	7,126,166	9,445,453
2169	7,862,454	8,743,195
2179	8,918,071	7,891,027
2189	9,516,065	7,676,262
2199	10,197,195	7,497,837

Source: ORM compiled data

6.10.3 Non-timber Resources

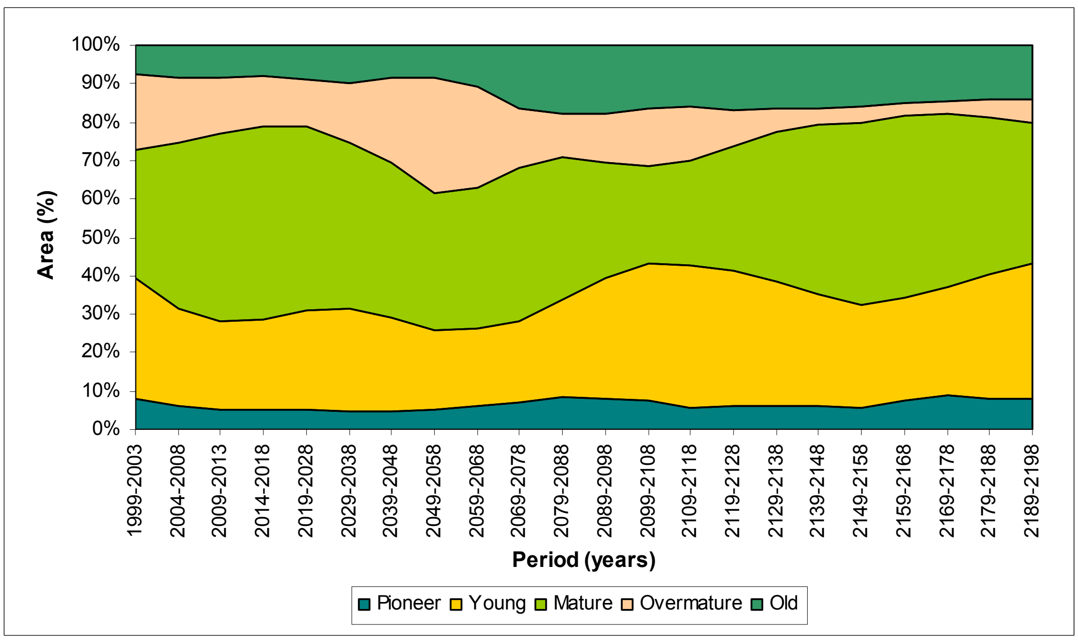
The seral stage distributions, caribou habitat and hydrological recovery are all maintained within their required levels since the non-timber resource objectives still had higher priority than the timber harvest. Figures 109 through 121 show that there is very little change between these results and those from Scenario 7C.

Figure 109. Scenario 7C: Seral Stage Distribution – FMA



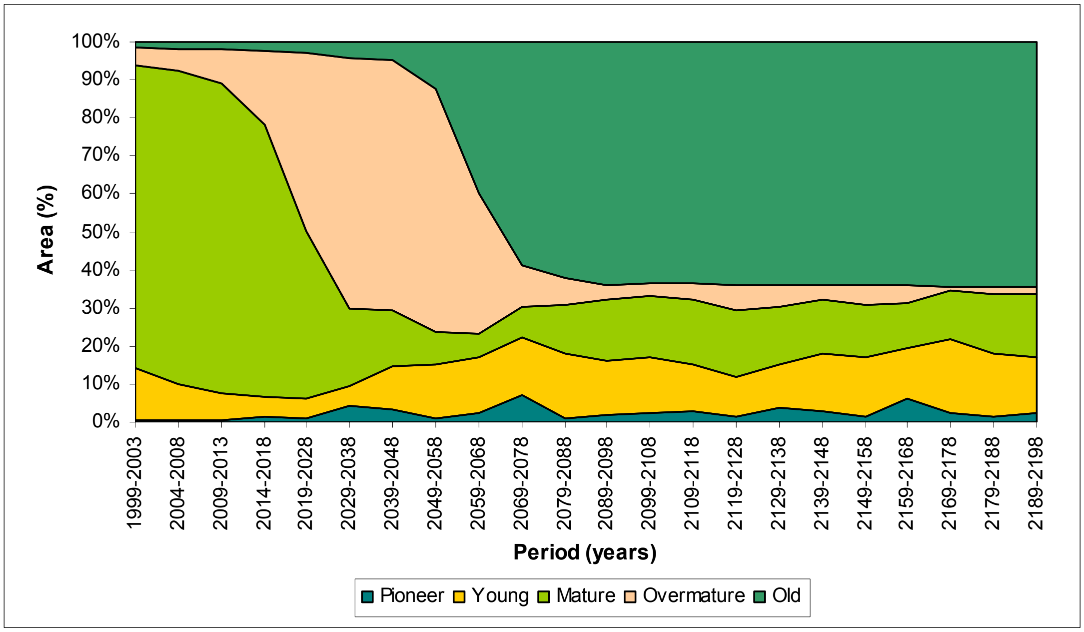
Source: ORM compiled data

Figure 110. Scenario 7C: Seral Stage Distribution – FMU G2C



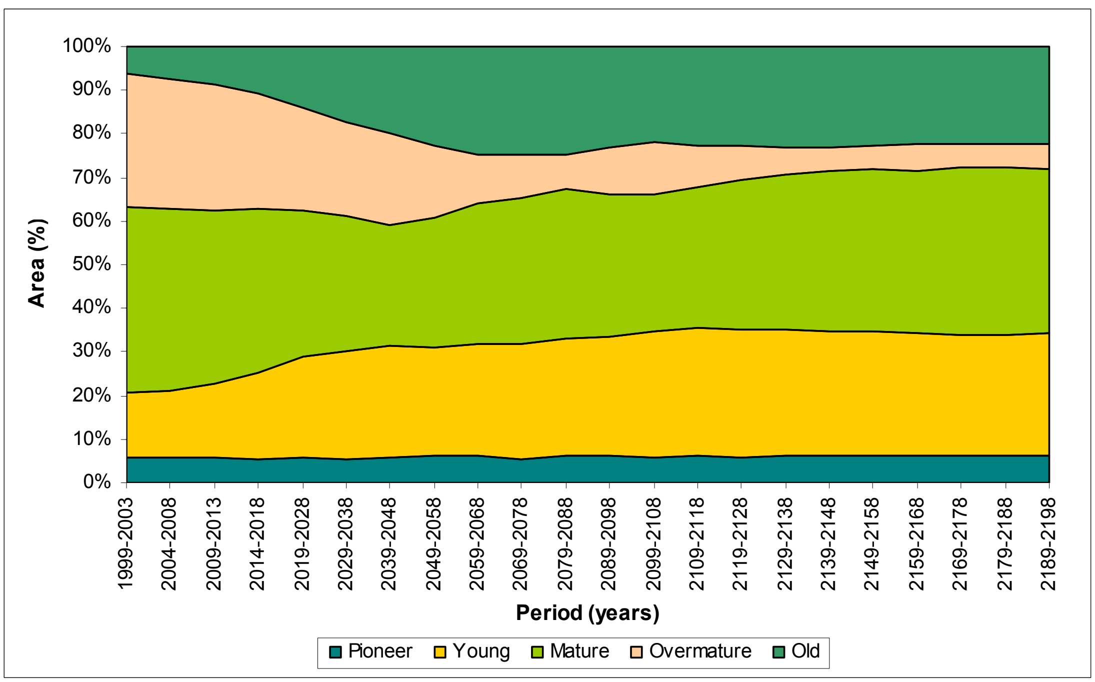
Source: ORM compiled data

Figure 111. Scenario 7C: Seral Stage Distribution – FMU G8C



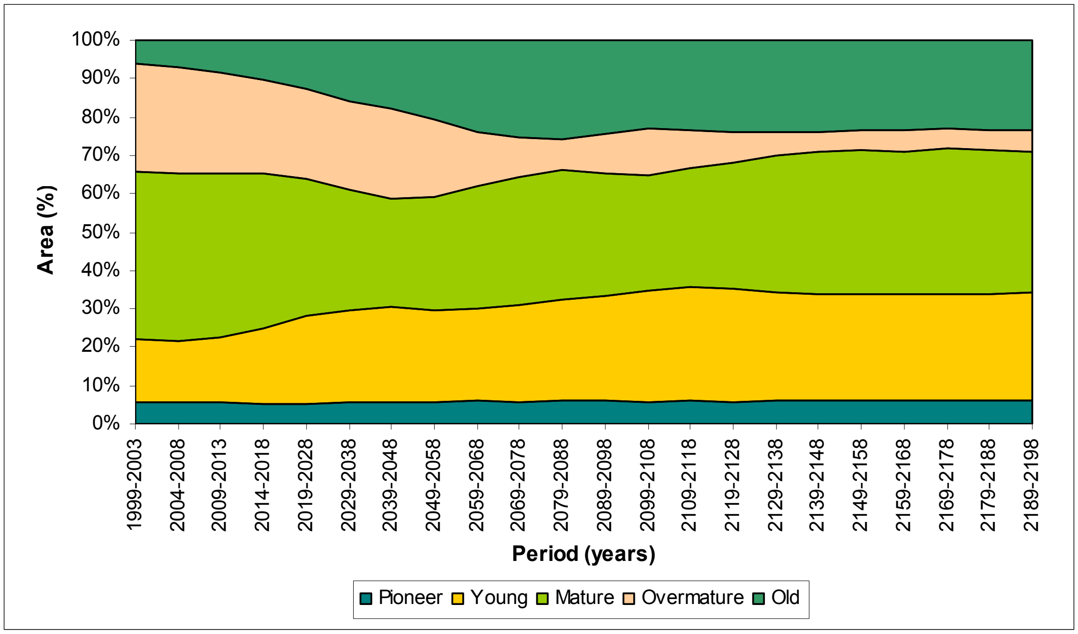
Source: ORM compiled data

Figure 112. Scenario 7C: Seral Stage Distribution – FMU G5C and E8C



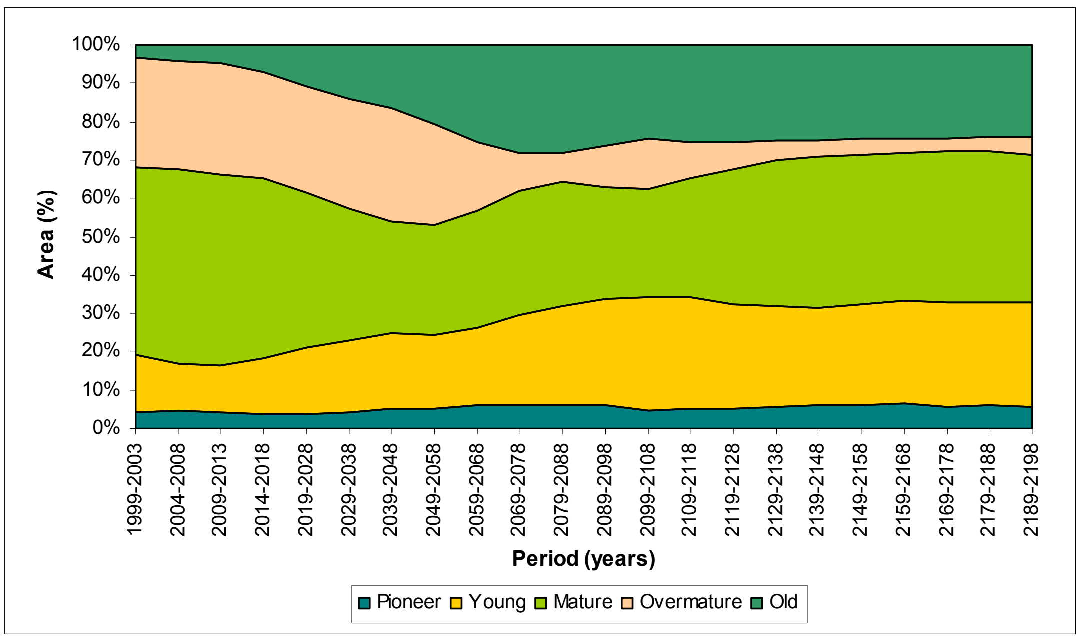
Source: ORM compiled data

Figure 113. Scenario 7C: Seral Stage Distribution – Foothills Natural Region



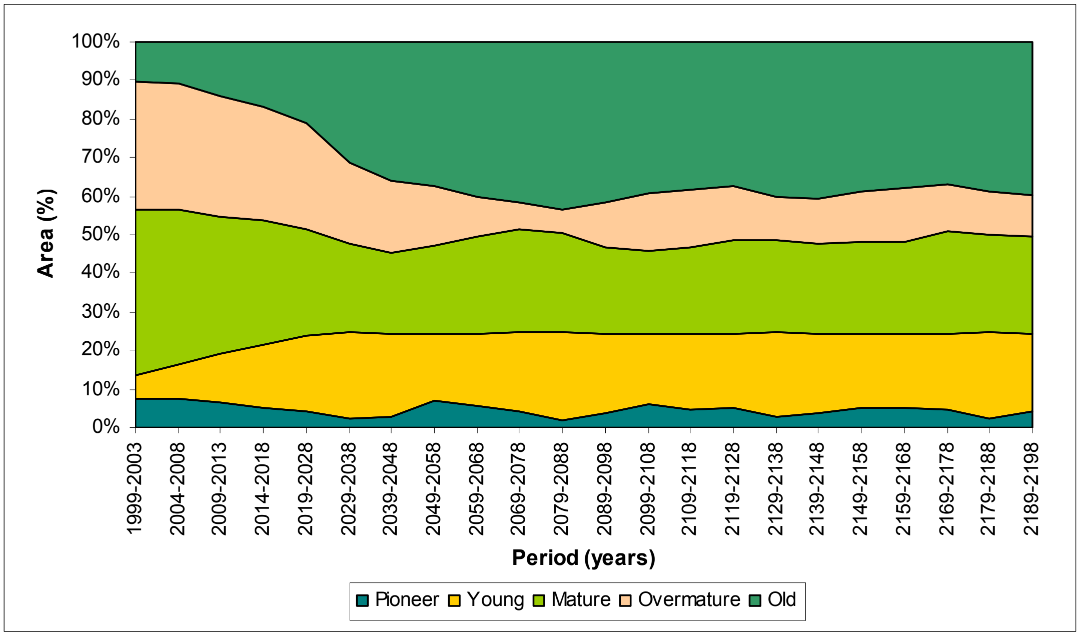
Source: ORM compiled data

Figure 114. Scenario 7C: Seral Stage Distribution – Boreal Forest Natural Region



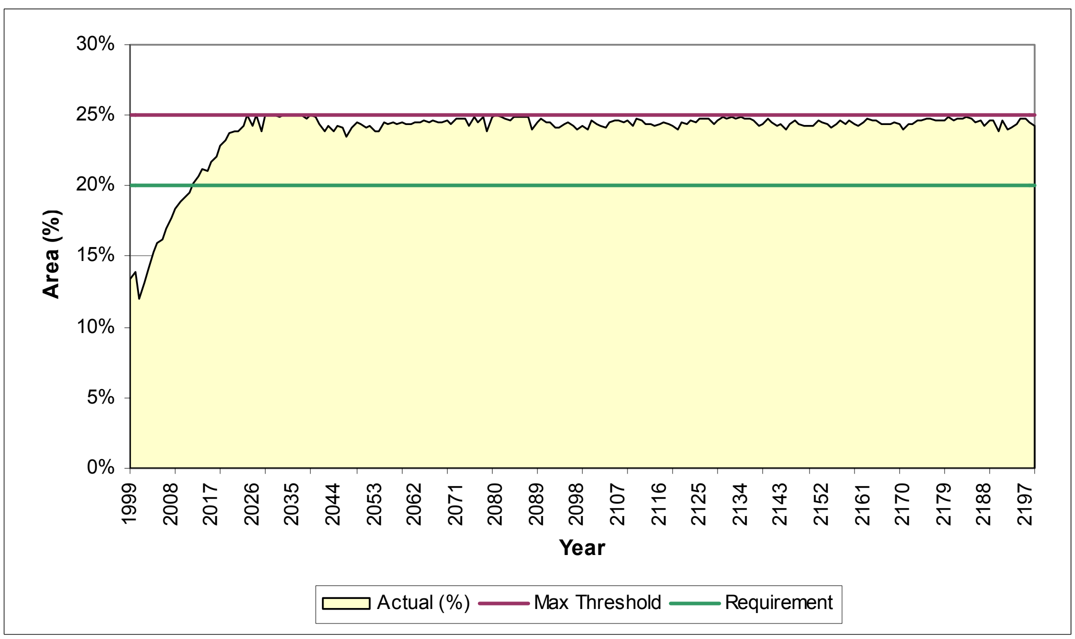
Source: ORM compiled data

Figure 115. Scenario 7C: Seral Stage Distribution – Caribou Area



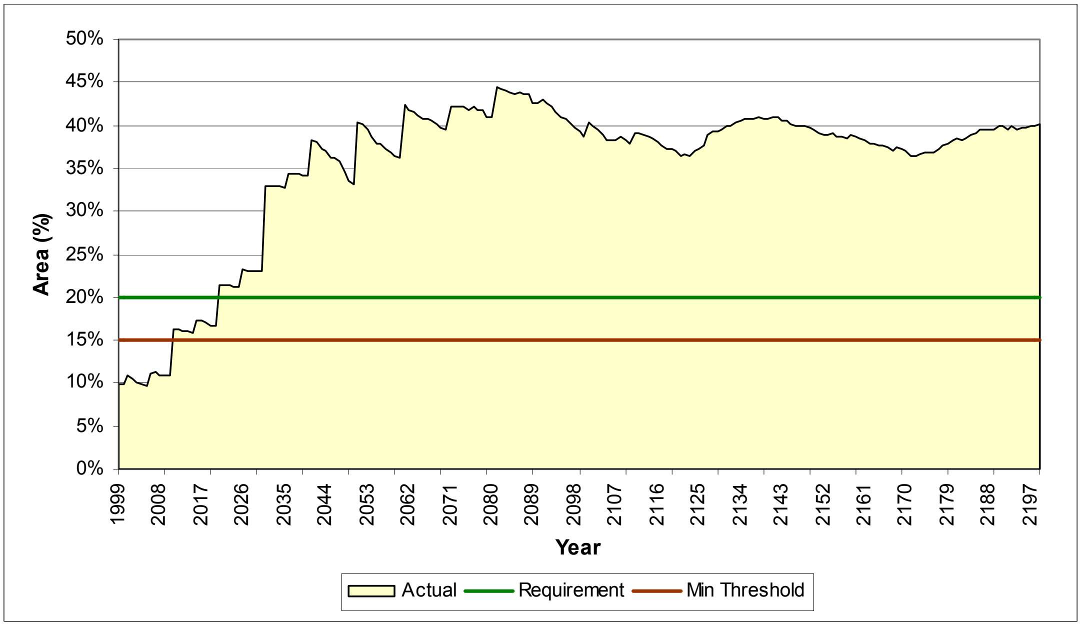
Source: ORM compiled data

Figure 116. Scenario 7C: Pioneer and Young Seral Stage Habitat in the Caribou Area



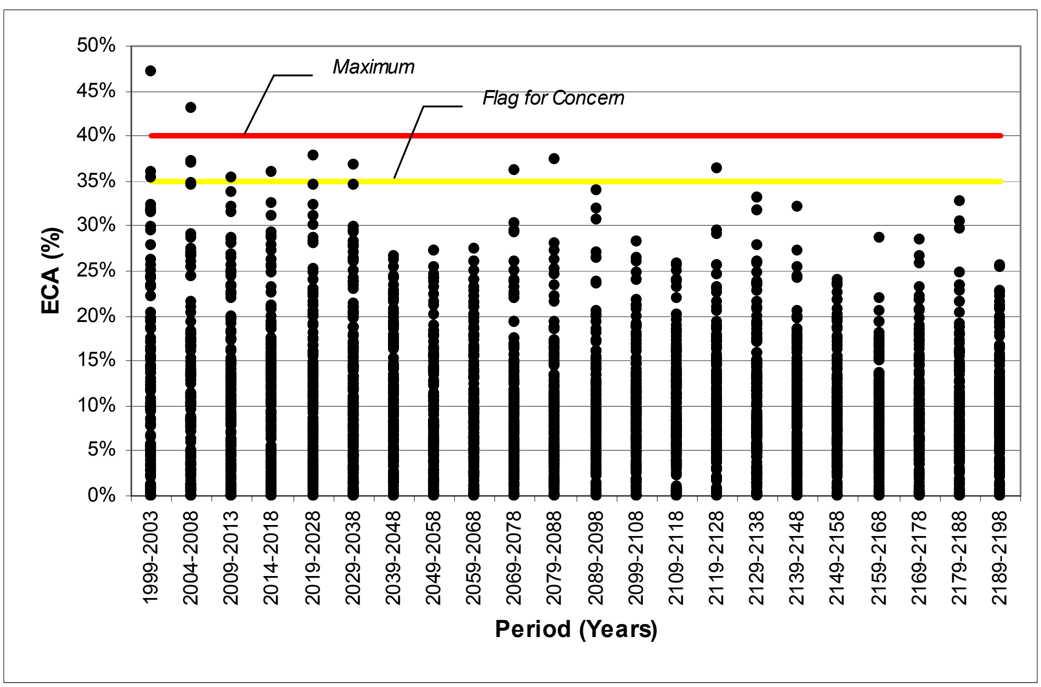
Source: ORM compiled data

Figure 117. Scenario 7C: Old Seral Stage Habitat in the Caribou Area



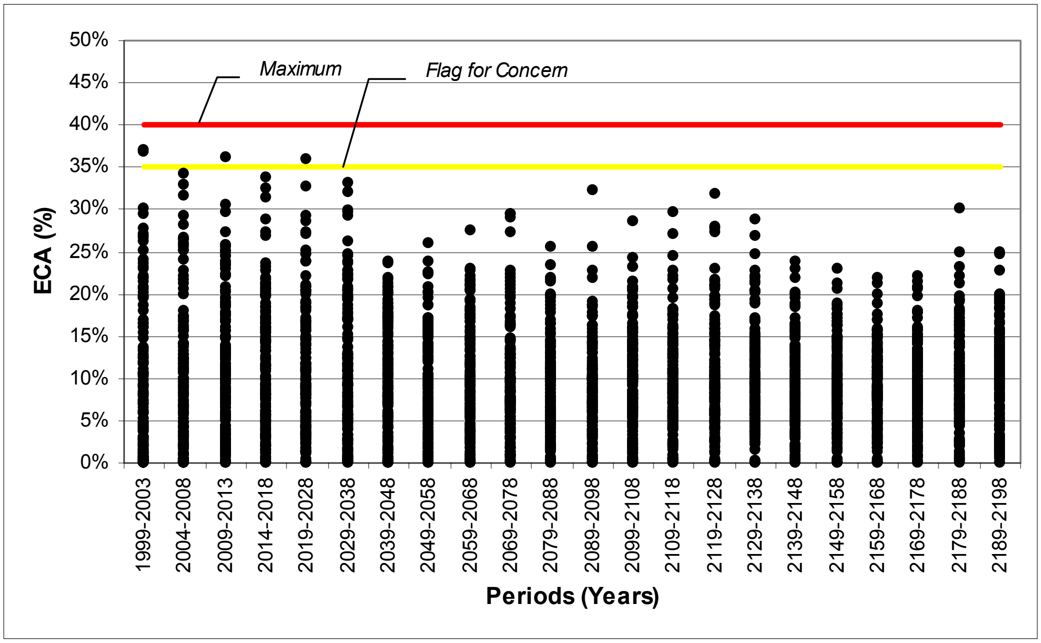
Source: ORM compiled data

Figure 118. Scenario 7C: Hydrological Recovery in Watersheds with Bull Trout – H60 Portion



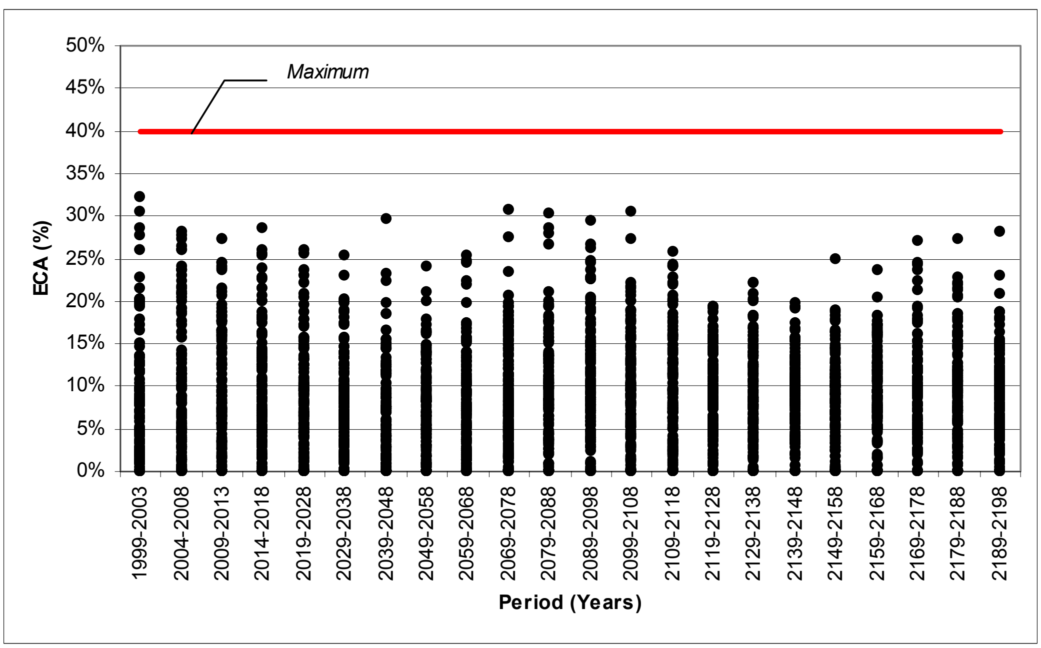
Source: ORM compiled data

Figure 119. Scenario 7C: Hydrological Recovery in Watersheds with Bull Trout – Entire Area



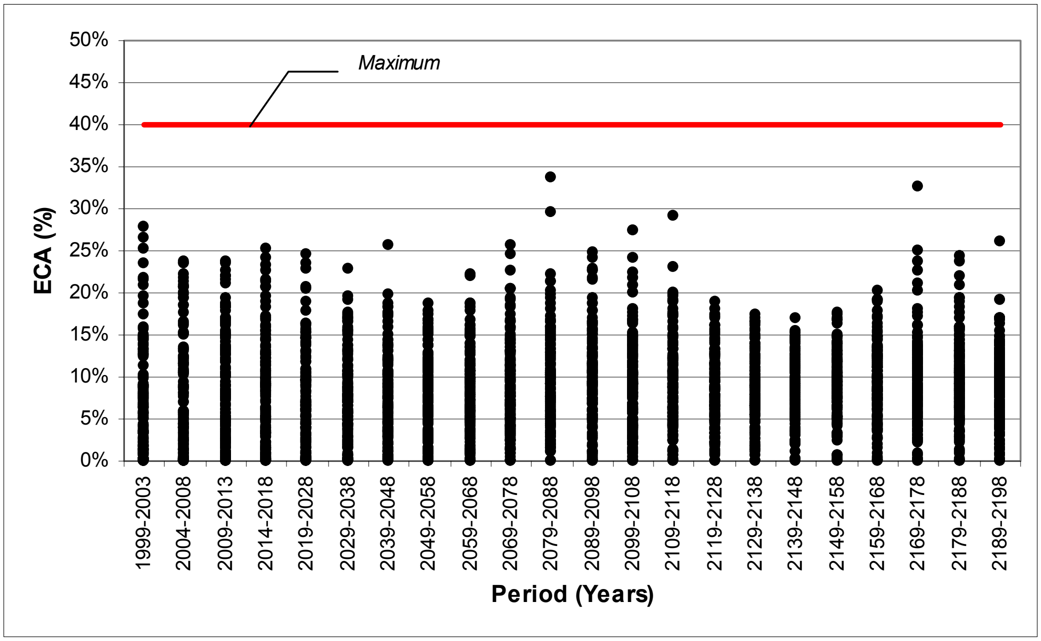
Source: ORM compiled data

Figure 120. Scenario 7C: Hydrological Recovery in Watersheds without Bull Trout – H60 Portion



Source: ORM compiled data

Figure 121. Scenario 7C: Hydrological Recovery in Watersheds without Bull Trout – Entire Area



Source: ORM compiled data

7 RECOMMENDATIONS AND FINDINGS

The preferred management strategy (Scenario 4C) results in sustainable coniferous and deciduous wood flows. These harvest levels are achieved while assuring that non-timber resources are also maintained on a sustainable basis. These resources include natural biodiversity, wildlife habitat for numerous key species and water quality that is controlled on a watershed basis.

The results from the timber supply analysis show that a coniferous harvest (annual allowable cut) of 670,000 m^3/year is achievable in the long term. This level of coniferous harvest will is required to support a deciduous annual allowable cut of 453,000 m^3/year. However, the model runs also indicate that a lower level of coniferous harvest is initially necessary; until 2018, only 640,000 m^3/year can be harvested, if 670,000 m^3/year is to be sustained for the long term.

The current inventory and age class distribution of deciduous stands is such that a higher initial deciduous harvest level might be considered. Under the current scenario, the average harvest age of deciduous stands increases steadily for the first 75 years. These stands are being held long enough that they are reaching the declining portion of the yield curve. This results in some of the deciduous volume being lost to mortality. A higher initial deciduous harvest level could conceivably capture some of this mortality.

However, any possibility for an initial increase in the deciduous harvest level must be examined cautiously. Due to the current deciduous age class structure, the flow of timber would be sensitive to the timing and degree of decline in the deciduous yield tables. This decline needs to be better understood, for both coniferous and deciduous yield tables, before any modification to harvest levels is considered. In the absence of strong quantitative information, a conservative estimation of deciduous stand decline has been used. Improved stand decline information is more likely to permit an increase in deciduous harvest level than it is to force a decrease.

Further caution must be exercised in examining the deciduous harvest in isolation. This is an integrated plan; the entire land base and timber profile must be considered when interpreting results and drawing conclusions. Deciduous stands that are being held for extended periods may be satisfying other forest-level constraints, and their harvest may have consequences that can not be predicted without additional model runs and analysis.

The risk associated with the assumed volume gains from the regeneration strategy appears to be minimal based on the results of Scenarios 5C and 6C. Although Scenario 5C demonstrates a coniferous non-declining even-flow harvest of 550,000 m^3/year if less optimistic regeneration assumptions are used, Scenario 6C indicates that this flow could be maintained even if 640,000 m^3/year was harvested for the first twenty years. In other words, a twenty-year window of opportunity exists wherein the harvest level could be reduced from 640,000 m^3/year to 550,000 m^3/year without jeopardizing the long-term sustainability of this lower level. On this basis, it is fair to state that the risks associated with harvesting at the higher level while regeneration performance is verified are negligible.

Scenario 5C and 6C also showed that the deciduous harvest level is very sensitive to changes in the coniferous harvest level. Under a coniferous harvest level of 550,000 m^3/year, a deciduous harvest level of approximately 200,000 m^3/year could be maintained. This represents a drop of approximately 55% whereas the coniferous reduction was approximately 20%.

Scenario 7C evaluated the feasibility of adopting a harvest strategy that prioritized timber for harvesting based on its risk to fire loss. The analysis was hampered by the fact that the fire models required inputs that were not a component of the growth and yield portion of this analysis. As such, fire risk levels could not be predicted for stands as they aged through time and thus were assumed to have a static fire risk level that only changed after harvesting when it was set to 0. The results showed that both the coniferous and deciduous harvest levels could be maintained while adopting a reduced fire-risk strategy. However, the analysis didn't probe into how much, if any, of a conflict there was between this strategy and the non-timber resource objectives. One indication that there is no conflict is that there was no readily apparent relationship between age and/or growth type and fire risk, and the main effect of non-timber resource objectives is to lengthen effective rotation ages.

In addition to deciduous stands in the AVI having a coniferous understory, other stands having coniferous understories are known to exist but cannot be located spatially. To account for these, coniferous understories have been assigned to deciduous stands on a subjective basis. This approach addresses the impact of the understories on long-term harvest levels, however it does present some problems in terms of harvest scheduling although this would only become a significant issue if an alternative silviculture system were employed to harvest the deciduous overstorey.

This analysis used both a simulation model and an optimization model in a complementary fashion. This methodology where one model validates the results from the other is particularly appropriate in situations where both deciduous and coniferous flows are of concern and are both subject to many non-timber resource based objectives. This methodology should be carried forward to ensure that volume is maximized from both species and at the same time assuring that all non-timber resource objectives are met. The strength of the simulation model is that it allows the full complexity of the analysis to be represented, however it's weakness is in assuring that the harvest volume of a second species is being maximized. On the other hand, the optimization model's strength is in maximizing harvest levels but the full complexity of the problem cannot be modelled without significant simplification of the problem at hand.

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APPENDICES

Appendix I

Glossary of Forestry Terms

Appendix II

Supplementary Timber Supply Analysis: Benchmark Run Results and Amended Timber Supply Analysis Information Package

Appendix III

COMPLAN Description

Appendix IV

WOODSTOCK Description

Appendix V

Area Validation

Appendix VI

Maps

Appendix VII

Fire Modelling on CANFOR Grande Prairie FMA Area

Appendix VIII

Scenario 4 Detailed Summaries