Appendix III

Timber Supply Analysis Information Package

Timber Supply Analysis Report
Tree Farm License 54

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1.0 INTRODUCTION

This Timber Supply Analysis Report has been prepared in support of Management Plan No. 4 for TFL 54. This document presents the harvest level that has been found to be sustainable, describes the methods by which it was calculated, and shows the impact of that level of harvest on other resource values. Many sensitivity analyses have been conducted to test the assumptions underlying the base case scenario.

This timber supply analysis is significantly different from previous analyses for TFL 54, and from analyses recently completed for other TFL's. This difference is due primarily to three issues:

- the requirement that an area-based harvest level be determined as defined under the ABAAC Pilot Project Legislation and Regulations;
- the implementation of the Scientific Panel Recommendations that amongst many recommendations, suggest area based planning within Watershed Planning Units establishment of reserve networks; maintaining watershed rates of cut, and
- the widespread use of variable retention (VR), multi-entry silvicultural systems that leave between 15% and 70% of volume after the first pass.

This timber supply analysis for does not model any of the proposed modifications to the Scientific Panel Recommendations, arising from adaptive management, as identified in the Conservation and Sustainable Forestry Plan (Management Plan No. 4) for TFL 54. Any approved modifications will be modeled at the time of the next timber supply analysis.

2.0 GENERAL DESCRIPTION OF THE LAND BASE AND TENURE

The landbase for TFL 54 was described in detail in the Timber Supply Analysis Information Package. Table 2-1 is reproduced from that document and shows the netdown process by which the timber harvesting landbase was determined.

Table 2-1 Timber Harvesting Landbase Determination

	All TFL 54 (Ha)		
Classification	**Total**	**Productive**	**Net**
Total TFL Landbase	49,298.0	48,121.0	
Non-forest	1,177.1		
Total Productive	48,121.0	48,121.0	48,121.0
Reductions			
Meares Island	3,813.4	3,795.7	3,795.7
Watershed Planning Reserves	14,183.1	13,345.3	13,345.3
Generated Reserves	1,237.7	1,190.7	1,190.7
Inoperable	10,276.7	9,333.4	5,187.1
Operable			**24, 602.2**
Non-commercial	2.4	2.4	-
Existing Roads	664.2	644.4	515.8
Operable Reductions			
Reduced Landbase			**24,086.4**
Future Changes			
Roads, Trails, Landings			
Net Long-term Landbase			**24,086.4**

3.0 FOREST INFORMATION

3.1 Growth and Yield

The growth and yield work undertaken in conjunction with this analysis exceeded the norms for timber supply analysis in two important respects:

1. the G/Y impacts of variable retention (VR) silviculture were modeled; and
2. economic minimum harvest ages (MHA) were established.

A wide range of variable retention silviculture is carried out on TFL 54 to meet operational requirements and the objectives of the Clayoquot Sound Scientific Panel. For modelling purposes, these silviculture practices have been grouped into the six VR prescriptions shown in Table 3-1.

Table 3-1 Variable Retention Prescriptions

Prescription	First Pass Removal	Second Pass Removal	Permanent Retention
P1 and P2	85%		15%
P3	60%	25% at +30 years	15%
P4	30%	55% at +30 years	15%
P5	30%	30% at +30 years	40%
P6	30%		70%

All stands in the THLB were assigned to one of these prescriptions.

MHA is critical factor in area-based timber supply analysis. These limits were established by merchandizing each yield curve so that a forecast of stand value over age could be made. The expected logging costs were subtracted, and the age at which the stand first became profitable to harvest was determined. This information, and a minimum volume per hectare limit, were used to set the MHA for each stand in the THLB. (The process of constructing the yield curves and setting MHA's is described in detail in the Timber Supply Analysis Information Package.)

Although yield curves (both existing and future) were produced for each stand in that THLB, this data set proved too large for the forest estate model. Since the only yield curve information the model requires when making harvesting decisions is MHA, stand were aggregated into analysis units on this basis. This resulted in a data set with 57 existing and 64 future yield curves.

3.2 Non-Timber Resource Values

Current operational practices used to protect non-timber resource values were modelled using cover constraints. These are summarized in Table 3-2.

Table 3-2 Forest Cover Requirements

Resource Issue	Limiting Criteria	Threshold	Subject Area
Watershed Rate of Cut			
5% in 5 years	age less than 5 years	5%	Basins
10% in 10 years	age less than 10 years	10%	
Visual Quality			
Natural Appearing	height less than 8 metres	20%	Scenic Inventory Polygons
Small Scale Alteration	height less than 7 metres	30%	
Minimal Alteration	height less than 6 metres	40%	
IRM	height less than 3 metres	25%	Hesquiat/Escalante and Kennedy/Beach
Old Seral	age greater than 140 years	40%	Watershed Planning Unit

3.2.1 Watershed Planning Reserves

Many resource values that need to be considered individually in other timber supply analyses have been dispensed with here because they have been adequately dealt with through the watershed planning process. Watershed Reserve Networks are identified in Watershed Plans, which are prepared in accordance with the Clayoquot Sound Land Use Decision. These plans identify and map reserves that:

- protect hydroriparian resources;
- protect sensitive soils and unstable terrain;
- protect red- and blue-listed plant and animal species;
- protect forest-interior conditions in late successional forest;
- represent all ecosystems;
- ensure linkages among watershed-level planning areas; and
- protect culturally significant areas.

These reserves replace reserves that would otherwise had to have been separately modeled for wildlife habitat, ESA's, OGMA's and FPC riparian buffers

3.3 Basin Rate-of-Cut Limitations

Along with MHA, watershed rate-of-cut will be a key factor in determining the sustainable harvest level for TFL 54. The Scientific Panel made the following recommendations regarding watershed rate-of-cut:

- Limit the area cut in any watershed larger than 500 ha in total area to no more than 5% of the watershed area within a five-year period.
- In primary watershed of 200-500 ha in total area, limit the area cut to no more than 10% of the watershed area within a 10-year period. (This prescription provides flexibility for harvesting within small watersheds.)

- In any watershed larger than 500 ha in total area, and primary watersheds of 200-500 ha in total area in which harvest has exceeded 20% of the watershed area in the most recent 10 years, allow no further harvest until the watershed conforms with the specified rate-of-cut.
- In any watershed specified in the previous recommendations and in which the recent harvest is greater than 5% in the last five years, but less than 20% in the last 10 years, allow no further cutting until a watershed sensitivity analysis and stream channel audit have been completed. If these assessments indicate significant hydrological disturbance, substantial or chronic increase in sediment yield, or significant deterioration in aquatic habitat, cease harvesting until undesirable conditions are relieved. Otherwise, harvest may continue at a rate which will bring the drainage unit within the recommended rate -of-cut limits within five years.
- In any watershed larger than 500 ha in total area (and primary watersheds of 200 - 500 ha in total area) in which harvest has occurred, require a watershed sensitivity analysis and stream channel audit once every five years. Where such assessments identify hydrological disturbance, substantial increase in sediment yield, or significant deterioration in aquatic habitat, cease harvesting until these conditions are relieved. If such conditions are recognized at any other time, sensitivity analysis and/or stream channel audit shall be undertaken immediately.
- In watersheds where the harvestable area is less than 30% of the total area, allow resource managers to use professional judgment to vary these standards without changing the intent to regulate rate of harvest to minimize hydrological change.

These objectives were met by applying disturbance cover constraints to basins as described in Appendices III and IV of the Timber Supply Analysis Information Package

3.4 Visual Quality

The inventory of scenic resources that was completed for Clayoquot Sound differs from the visual inventories that have been completed for the rest of the province in two significant ways:

- the categories used to classify visually sensitive area are unique to the Clayoquot; and
- while the assigned levels of acceptable landscape alteration provide much qualitative guidance to operational planners, they do not provide the quantitative rules needed for strategic planning.

Based on discussions with the Ministry of Forest, the Visual Quality cover constraints listed in Table 3-2 were devised and have been applied during this analysis.

4.0 TIMBER FLOW OBJECTIVES

The timber flow objectives of this analysis are:

- To determine the amount of area the can be harvested annually over the entire planning horizon (250 years).
- To attempt to balance harvesting among the different VR prescriptions so as to dampen volume fluctuations between periods.
- While respecting rate-of-cut constraints in watersheds and in visually sensitive areas, to harvest the oldest timber earlier in the planning horizon.

5.0 TIMBER SUPPLY ANALYSIS METHODS

5.1 Forest Estate Model

This timber supply analysis was completed using COMPLAN, a proprietary simulation model owned by Timberline. COMPLAN is a spatially explicit forest estate model that has been upgraded to allow for the area-based regulation of harvesting.

COMPLAN offers a number of key features that make it ideally suited for both strategic and operational planning:

- Spatial location is defined by a hierarchical structure of compartments, subcompartments, and stands. In addition, spatially located cover constraints for basins and visually sensitive areas have been superimposed over these compartments, subcompartments and stands.
- Inventory and harvest are spatially located so that specific harvest units and forest stands used in the model can be identified on maps. Resultant polygons became COMPLAN subcompartments. These subcompartments were aspatially subdivided into first-pass, second-pass and retention stands based on their VR prescription.
- Although COMPLAN can model adjacency, it is has not been required for this analysis. Operationally, other resource values are protected through the reserve network that was mapped during the watershed planning process, and by managing retention at the cutblock level. The usual approach of modelling for these issues using adjacency and greenup rules is not applicable to TFL 54.
- Periodic availability can be simulated for harvest at both the compartment and subcompartment levels. This has been used in the base case analysis to recruit THLB stands to meet old seral requirements in the Kennedy Lake watershed. This approach will also be used in a sensitivity analysis to test the impact of deferring harvest in the Sydney / Pretty Girl watersheds until 2009.
- An even-aged approach to yield curve development and forest estate modelling has been taken. In order to accurately track both cut control and cover constraints, a system of dummy harvests and yield curve shifts has been implemented.
- Stand-based yield curves have been aggregated based on MHA for this analysis. Because not every simulated harvest is a "real" harvest on the ground, "real" stand age has been added to the yield tables as an attribute.
- Yield curve volumes are not needed by COMPLAN when determining an area-based harvest level. However, proxy volumes were assigned to the yield curves to provide ballpark harvest volume estimates while the model was running. The COMPLAN "Approach to Normality" function was used to track the growth of stands where the initial volume did not equal the predicted yield curve volume. Consequently, model output volumes should be fairly accurate in the short term. Accurate harvest volumes could be compiled for the entire planning horizon by linking the COMPLAN output harvest schedule back to the original unaggregated yield curves.

- A high priority was placed on harvesting identified FDP blocks.
- To the extent possible, COMPLAN attempted to log from each VR prescription in proportion to the area that was available for harvest.
- The simulation time-step for harvest and inventory was annual. Cut-control was applied in ten-year periods starting in 2004.

5.2 Cut Control Approach

The cut control approach being used for this analysis is not the one that was initially envisioned at the outset of the project. Briefly, the two possible approaches are:

1. Charge a full hectare against cut control the first time that a block is entered for harvesting; second-pass entries do not enter into cut control calculations.

2. charge a full hectare against cut control every time a block is entered

Initial forest estate model runs were done using the first approach. Following discussions with the MoF, it was decided that the second approach would be used for all timber supply analysis runs. While this will simplify the task of cut control, it will lead to a nominally higher harvest level.

It should be noted that this is primarily a technical modelling issue. Both approaches, if properly implemented, would lead to a similar flow of timber from the TFL over the long term.

6.0 BASE CASE SCENARIO

The Base Case scenario is designed to find the harvest level that can be achieved under the assumption that current management practices are continued into the future. The details of the management practices, and the manner in which they are modelled, have been established based on extensive consultations between Interfor, the Ministry of Forests, J.S. Thrower and Associates and Timberline.

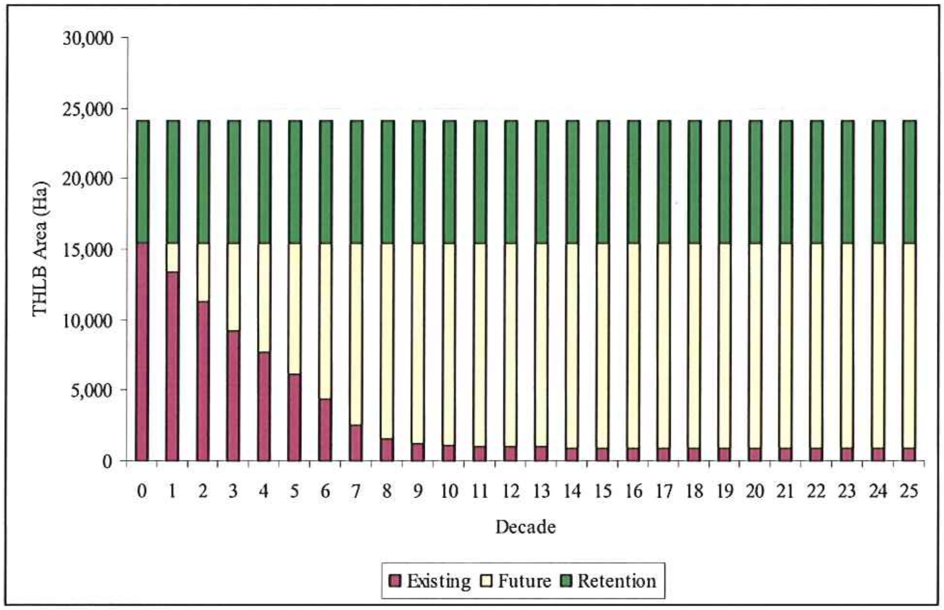
Major forest management considerations and issues incorporated into this base case analysis are:

- an updated and adjusted forest inventory database;
- buffering of all roads in the road inventory;
- incorporation of reserve networks as dictated by approved and pending Watershed Plans;
- revisions to operability mapping in light of the new VRI, and with adjustments to include all logged areas or areas identified in FDP's that were previously mapped as inoperable;
- current management regimes, especially variable retention prescriptions and standards;
- minimum harvestable ages based on forecast species and grade distributions;
- adherence to the recommendations of the Clayoquot Sound Scientific Panel Recommendations (1995) regarding watershed rates-of-cut;
- prioritized harvest of FDP blocks; and
- G/Y modelling based on immature plantation history and realistic regeneration assumptions.

This base case will provide a baseline from which to assess risk associated with any of the assumptions in the sensitivity analysis.

The Complan model runs completed for this base case analysis show that 336 hectares per year can be harvested from TFL 54. Based on this harvest rate, Figure 6-1 shows the transition of the inventory from existing to future stands. It also shows the how much area will be effectively retained on the blocks through the application of the VR prescriptions described in Section 3.0

Figure 6-1. Progression of harvesting into future stands



Some existing THLB stands are not harvested over the entire planning horizon because they are required to meet old seral requirements in the Kennedy Lake and Beach Watershed Planning Units

Figure 6-2 shows how average harvest age varies throughout the planning horizon. This declines sharply over the first eighty years as the existing old growth timber is logged, reaches a minimum in the ninth decade, and then stabilizes at an average stand age of about 75 years. Second pass volumes on VR prescriptions P3, P4 and P5 have been excluded from this calculation.

Figure 6-2. Average Age at Harvest by Year

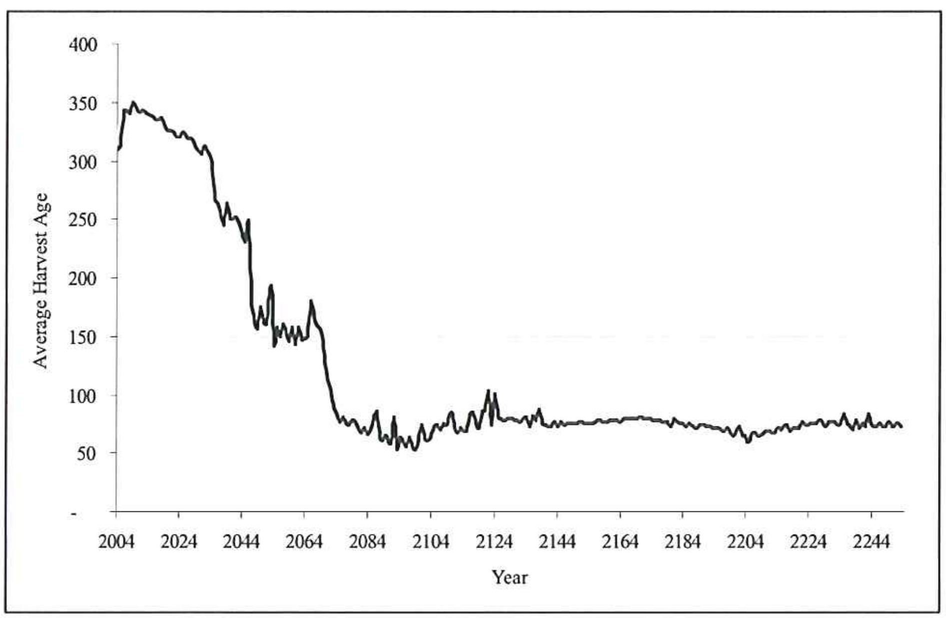


Figure 6-3 shows the area harvested by year. Specifically, it shows the cut control area and the components that make it up. When a harvesting entry is made to a block, cut control will be charged against:

- areas from which volume is removed – the harvest area
- areas that will be harvested in the future, but are not harvested at this entry – these areas are deferred
- on-block retention areas that will never be harvested

In some years between 2097 and 2103, the total area harvested exceeds the request of 336 hectares. This is offset by a corresponding harvest shortfall in other years of that period. This is the pinch point in this timber supply scenario. The harvest for the 10-year period (the cut control) does not, however, exceed the limit of 3360 hectares

Figure 6-3. Area Harvested by Year

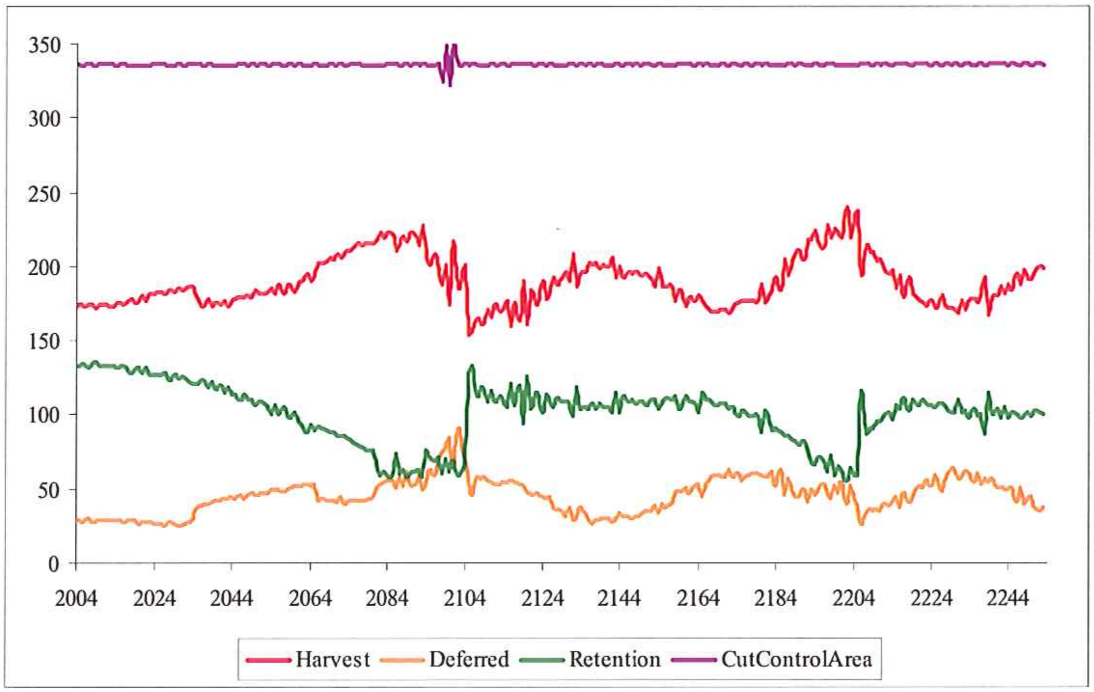
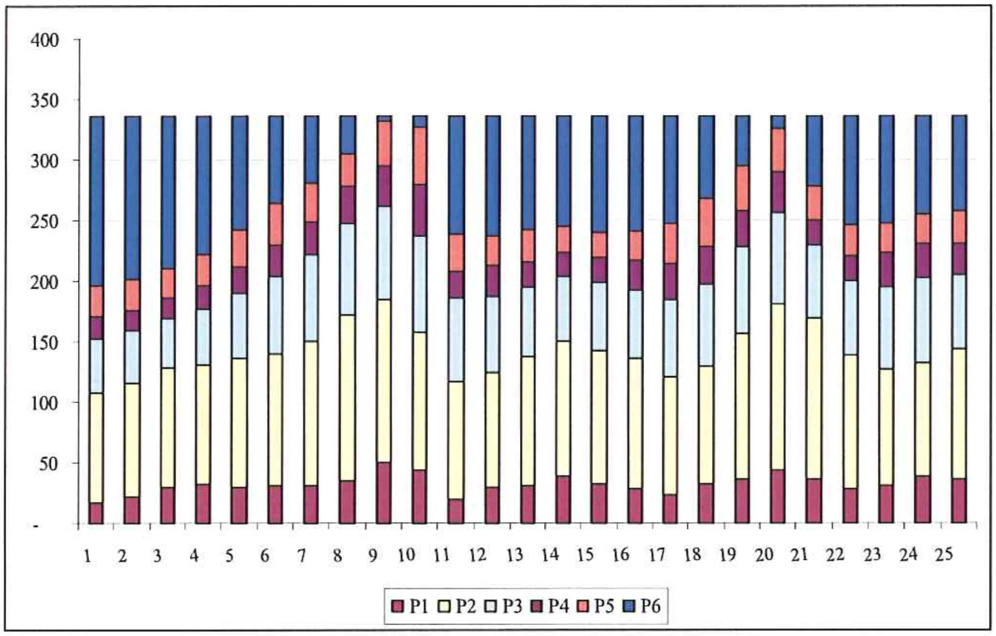


Figure 6-4 shows the distribution of harvest by VR prescription and period. The resultant data set was compartmentalized on the basis of VR prescription. During the simulation runs, the model attempted to harvest from each prescription in proportion to the amount of area that was available for harvest in that year. Initially, a large area of P6 is in old growth and available for harvest. Because it is being managed on a 100-year rotation age, the area that is available for harvest decline steadily over the first 90 years as it is logged and falls below MHA. After 100 years, the areas that were first logged become available again, and there is a sharp increase in the amount of P6 available for harvest.

Figure 6-4. Area Harvested by Period and VR Prescription



The rate of harvest in visually sensitive areas is also of concern. Figure 6-5 shows the harvest from these areas in relation to the overall harvest level.

Figure 6-5. Area Harvested by Period and Visual Category

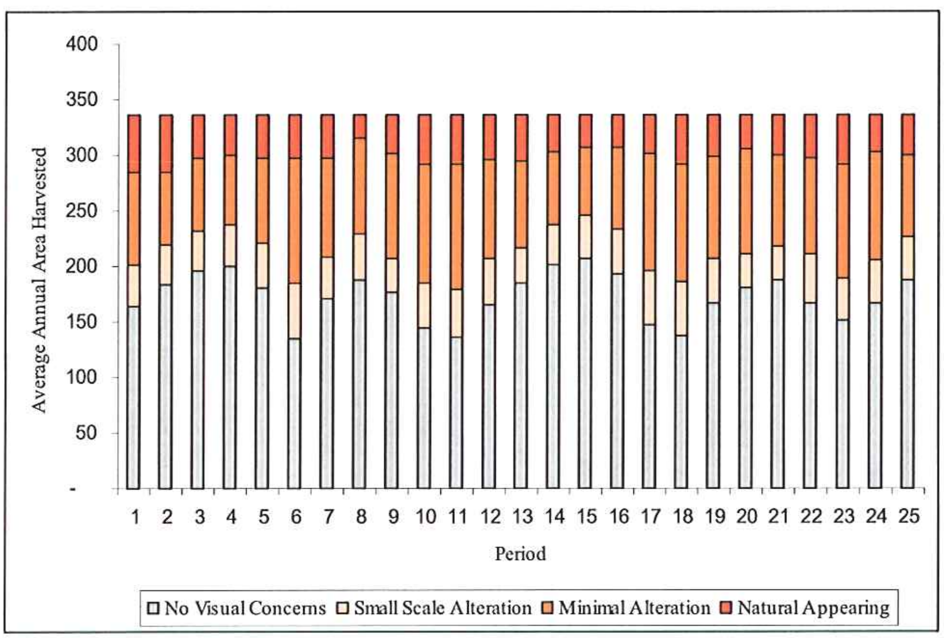
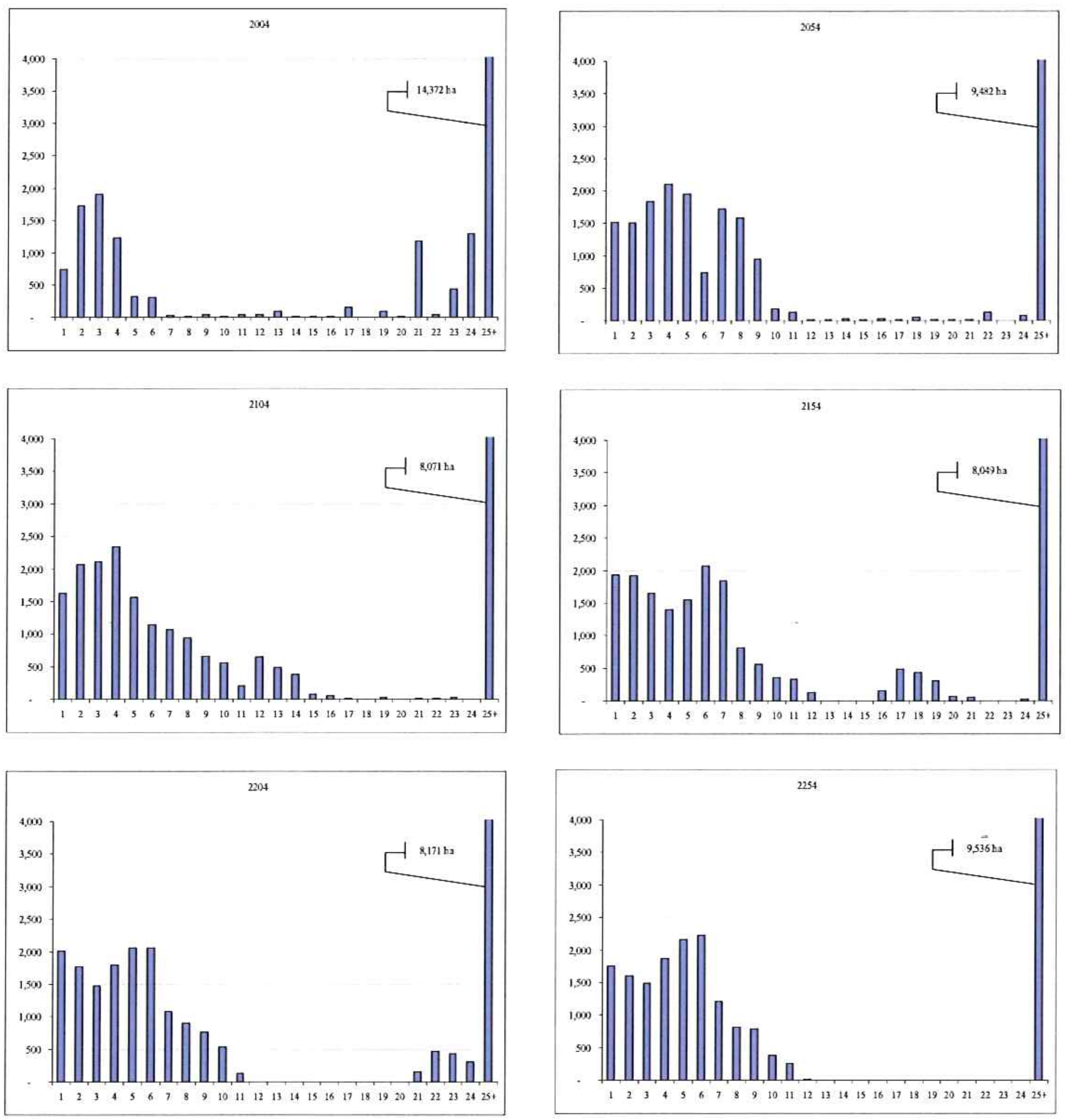


Figure 6-6 shows how the age class distribution of the THLB changes over the planning horizon.

Figure 6-6. Current and Future Age Class Distributions



Areas in watershed reserve network are not shown in these distributions. However, the portions of cutblocks that are left for permanent retention are included. After fifty years, the amount of old growth retained on blocks has fallen from 14,000 to 9,500 hectares. Basin rate-of-cut constraints prevent it from falling to its long-term level of about 8,000 hectares until 100 years have passed. In the meantime, the second-growth retention areas age; this is apparent in the rightward shift of mature second growth that is first apparent in 2014 and continues until 2204. By the end of the planning horizon in 2254, these areas have become old growth.

7.0 SENSITIVITY ANALYSIS

Sensitivity analysis provides a measure of the upper and lower bounds of the base case harvest forecast, reflecting the uncertainty inherent in assumptions made in the base case. The magnitude of the change in the sensitivity variables reflects the degree of uncertainty associated with each variable. By developing and testing a number of sensitivity issues, it is possible to determine which variables most affect results. This in turn facilitates the management decisions that must be made in the face of uncertainty.

To allow meaningful comparison of sensitivity analyses, they are performed using the base case and varying only the assumption being evaluated. All other assumptions remain unchanged.

Table 7-1 Sensitivity Analyses

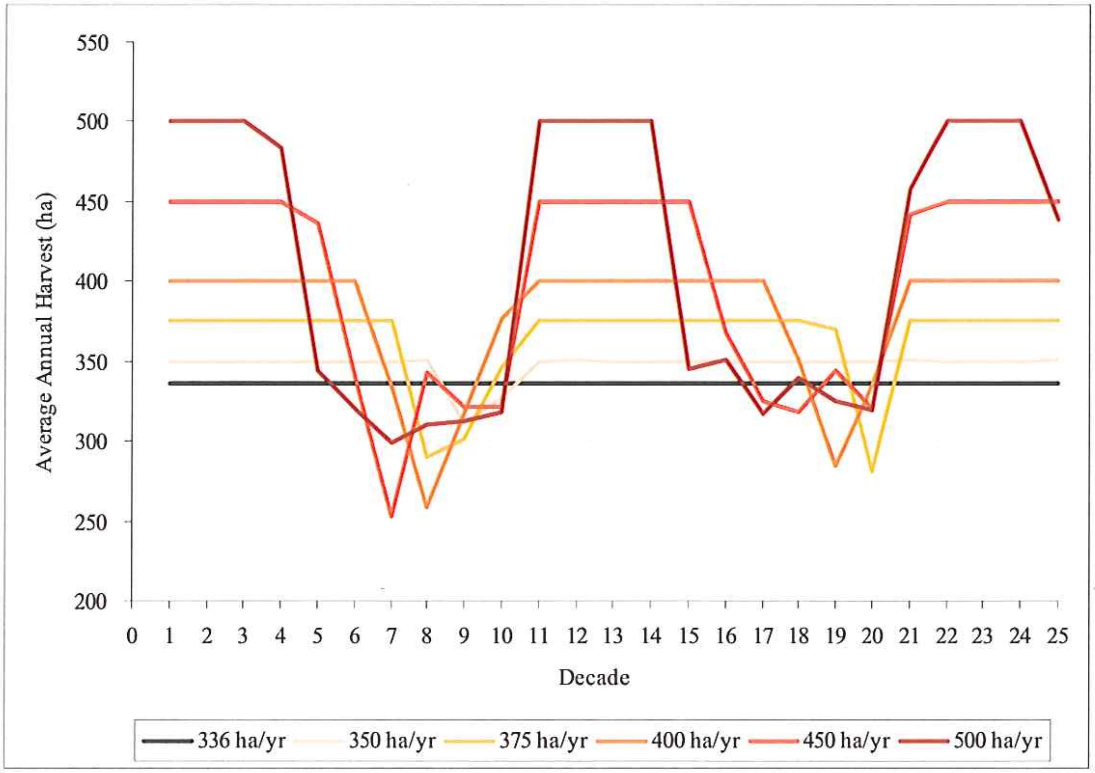
Issue	Sensitivity analysis	Sensitivity level to be tested
Harvest Flow	Shortfalls Due to Higher Harvest Levels	Harvest 350, 375, 400, 450 and 500 ha / year
Inventory	Inventory Volume Adjustment	Use unadjusted inventory volume
Landbase revisions	Change operability assumptions	THLB limit at 350m^3/ha
		THLB limit at 450 m^3/ha
		Exclude inoperable >200m from core THLB
		Exclude inoperable >100m from core THLB
	Marbled Murrelet	Remove draft reserves from THLB
Growth and yield	Increase Minimum Harvest Age	+10%, +20%, +30%
	Decrease Minimum Harvest Age	-10%
	Basin Rate-of-Cut	IRM constraint on all primary basins
		5% / 5-year on all primary basins
	Visual Quality Objectives	+/- 10% maximum % removal
		+/- 2 metres VEG greenup height
VR Prescription Harvest Balance	Apply Harvest Quota to P6	83 hectares per year
	Remove Harvest Balance Constraints	

7.1 Harvest Flow

The base case harvest level is the amount of area that can be harvested annually over the entire 250 year planning horizon. With volume-based AAC calculation, the harvest may be set using timber flow strategies that rise or fall in the future. Using area-based AAC calculations, alternative flow strategies need not be considered – a single harvest level has been mandated.

However, for the purpose of examining the dynamics of the resource, the base case model was run using a series of higher harvest requests. This shows where timber shortfalls would occur if higher harvest levels were attempted. Figure 7-1 shows, by decade, the shortfalls that occur when harvest requests of 350, 375, 400, 450 and 500 hectares per year are attempted.

Figure 7-1. Harvest Shortfalls Under Different Levels of Attempted Harvest



A harvest request of 350 hectares can be met for the first 80 years of the planning horizon. Shortfalls occur in decades 9 and 10, but the harvest can be sustained thereafter. A harvest request of 375 hectares per year fails in decades 8, 9 and 10, and again in decades 19 and twenty. As the annual harvest request is raised in 50 hectare increments, this pattern is magnified – the shortfalls occur earlier and last longer.

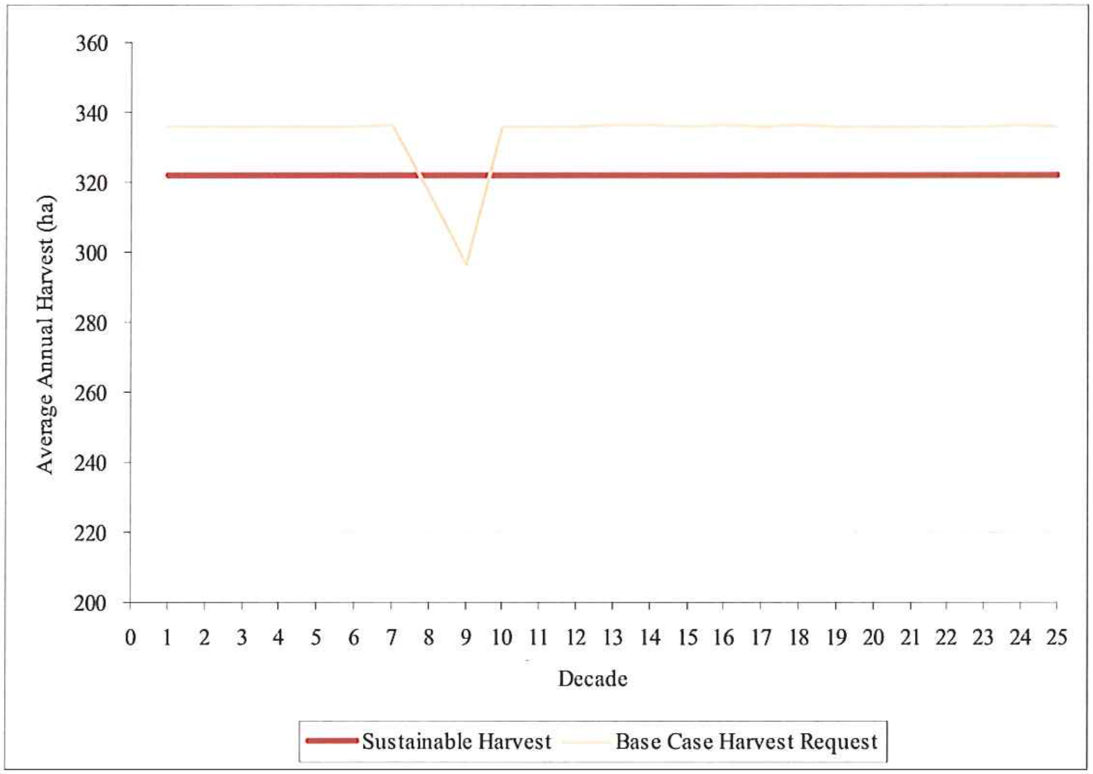
7.2 Inventory Volume Adjustment[jem1]

The size of the THLB was determined in part by excluding old growth areas that were below a limiting volume of 400 m^3/ha. The adjusted inventory volume[1] was used to make this exclusion. If original inventory volumes are used instead, the size of the THLB falls from 24,086 hectares to 20,100 hectares. This results in a decrease from the base case harvest level – but a much smaller one than might be expected given the 17% reduction in the THLB. The areas excluded for this sensitivity analysis were mature stands being managed using a P6 prescription (with a 100-year rotation) in the base case. Consequently, they were harvested early in the simulation, and were unavailable during decades 8 and 9

[1] see Timber Supply Analysis Information Package - Tree Farm License 54 – Appendix I – Inventory Adjustment Procedure

– the first pinch point in the base case scenario. Figure 7-2 shows the sustainable harvest level, and shows what harvest is achievable if the base case harvest request of 336 hectares per year is attempted.

Figure 7-2. Harvest Level Based on Unadjusted Forest Inventory



7.3 Operability Assumptions

The existing operability lines for TFL 54 were adjusted for this analysis by:

- including areas previously considered inoperable if the volume per hectare exceeded 400 m^3/ha
- excluding areas previously considered operable if the volume per hectare fell below 400 m^3/ha

This determination was made based on the adjusted inventory volumes.

Four sensitivity analyses were conducted around this assumption.

- reduce operable volume limit to 350 m3/ha
- increase operable volume limit to 450 m3/ha
- exclude areas more than 200 metres from old operable
- exclude areas more than 100 metres from old operable

7.3.1 Reduce Operable Volume Limit to 350 m3/ha[jem2]

If the volume limit for recovering previously inoperable areas to the THLB is lowered from 400 m3/ha to 350 m3/ha, then the area of the THLB increases from 24,086 hectares to 26,935 hectares. This

additional area is assigned to a P6 variable retention prescription. Table 7-2 (below) compares the THLB areas and shows the VR prescription area distributions for each of the operability sensitivity analyses.

The impact on the sustainable harvest is only 4 hectares annually; an increase from the base case harvest level to 340 hectares per year.

7.3.2 Increase Operable Volume Limit to 450 m3/ha[jem3]

If the volume limit for recovering previously inoperable areas to the THLB is increased from 400 m3/ha to 450 m3/ha, then the area of the THLB falls from 24,086 hectares to 23,394 hectares. The sustainable harvest level drops from 336 hectares annually to 334 hectares.

7.3.3 Exclude Areas More than 200 Metres from Old Operable[jem4]

If the only consideration in assessing previously inoperable areas for inclusion in the THLB is a volume limit some stands that are remote from existing operable area may be included. A more conservative approach would be to only include those inoperable areas that met the volume criteria, and also fell within a fixed distance of existing THLB stands. Two limiting distances were considered: 200 metres; and a more conservative 100 metres.

If only the inoperable areas that fall within 200 metres of existing operable areas are returned to the THLB, the area of the THLB falls to 22,936 hectares. This landbase can support an annual harvest of 332 hectares.

7.3.4 Exclude Areas More than 100 Metres from Old Operable[jem5]

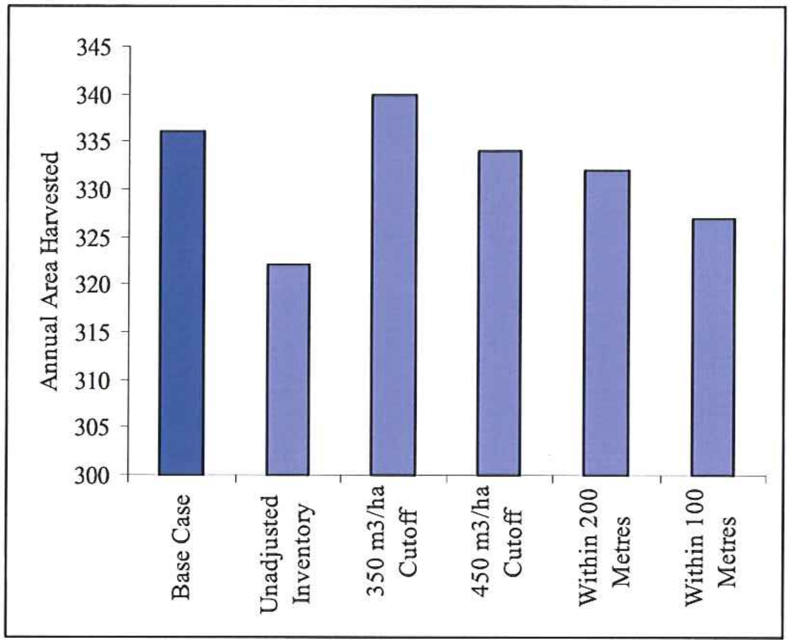
An even more conservative approach is to include only the inoperable stands that fall within 100 metres of stands previously classified as operable. Under this scenario, the THLB falls from 24,086 hectares to 21,617 hectares. The harvest falls from a base case level of 336 hectares annually to 327 hectares.

Table 7-2 (below) compares the THLB areas and shows the VR prescription area distributions for each of the operability sensitivity analyses. Figure 7-3 shows the harvest level that is achievable under each of these scenarios.

Table 7-2 THLB Area and VR Distribution for Operability Sensitivity Runs

	P1	P2	P3	P4	P5	P6	Total
Base Case	2,164	7,954	2,813	1,212	1,570	8,373	24,086
Unadjusted Inventory	2,164	7,954	2,813	1,212	1,570	4,387	20,100
350 m3/ha Cutoff	2,164	7,954	2,813	1,212	1,570	11,223	26,936
450 m3/ha Cutoff	2,164	7,954	2,813	1,212	1,570	7,681	23,394
Within 200 Metres	2,164	7,953	2,809	1,211	1,570	7,229	22,936
Within 100 Metres	2,146	7,946	2,802	1,203	1,564	5,956	21,617

Figure 7-3. Harvest Level Comparison – Operability Scenarios



7.4 Marbled Murrelet Habitat[jem6]

At the time that the Information Package was prepared additional Marbled Murrelet habitat had been identified, but the areas were still in the draft stage. For that reason these areas are being considered in a sensitivity analysis rather than in the base case.

Most of the proposed areas fall within the existing watershed reserve network. Those areas that did overlap THLB were marked as reserves for this sensitivity analysis. The THLB is reduced from the base case by 216 hectares to 23,870 hectares. This has a minimal impact on the sustainable harvest level, which falls from 336 hectares per year to 332 hectares.

Though small, even this is probably an overestimate of the eventual impact of these reserves on the sustainable harvest level. When these Marbles Murrelet reserves are implemented, there will be a partially or completely compensating adjustment of the existing reserve network.

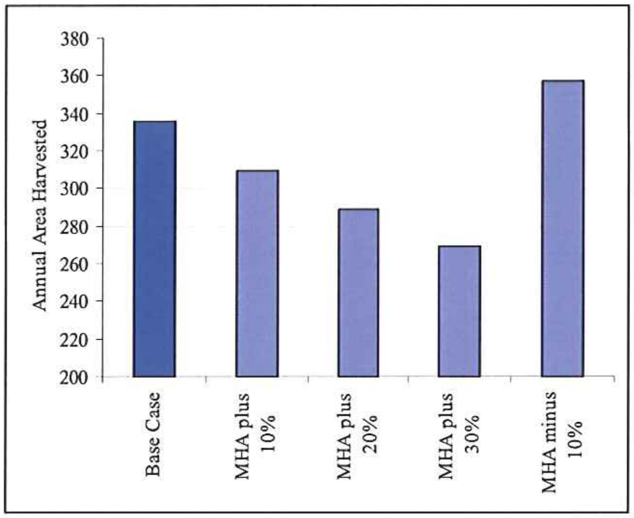
7.5 Minimum Harvest Age

An area-based AAC analysis relies only indirectly on growth and yield information. It is crucial to know the earliest age at which a stand can be harvested. For this analysis, MHA was determined using a combination of growth modelling and harvesting economics, as described in the Section 8 of the information package.

7.5.1 Increase Minimum Harvest Ages[jem7]

Increasing MHA reduces the sustainable harvest level. As Figure 7-4 shows, when the MHA for each stand is increased by 10%, 20% and 30%, the sustainable harvest level fall from 336 hectares to 309, 289 and 269 hectares respectively.

Figure 7-4. Impact of Varying MHA on Sustainable Harvest Level



7.5.2 Decrease Minimum Harvest Ages[jem8]

When the MHA is reduced by 10%, the sustainable harvest can be increased to 357 hectares annually. Figure 7-4 depicts this in relation to the base case and increased MHA scenarios

7.6 Watershed Rate of Harvest[jem9]

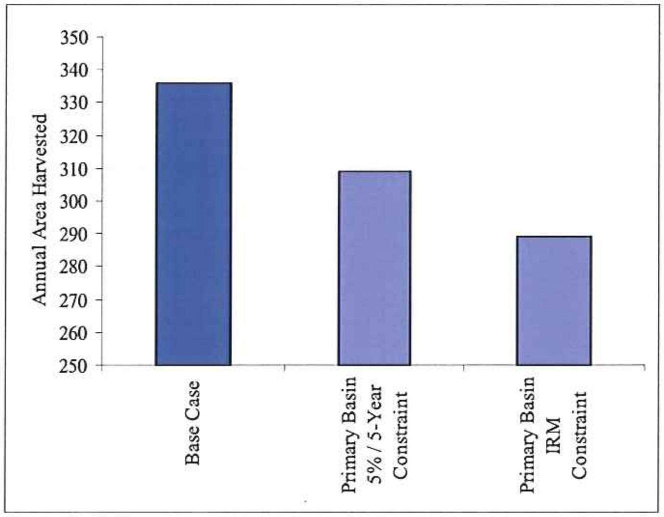
The process for determining the rate-of-cut possible in each watershed was described in Section 10.2.1 of the Information Package. By applying the Scientific Panel recommendations, and after accounting for the portion of basins that fell in parks, the allowable harvest rates presented in Appendices II and III of the Information Package were devised. These were used as constraints for the base case scenario.

In order to test the sensitivity of the base case to these watershed rate-of-harvest constraints, two scenarios were run:

- a five-percent/five year rate-of-cut limit was applied to all primary basins; and
- an IRM constraint was applied in place of all of the watershed rate-of-harvest limits applied in the base case.

These are intended to show the impact of increasing and relaxing the level of the rate-of-cut constraint. Figure 7-5 shows the harvest levels that were sustainable under each of these scenarios, and compares these levels to the base case.

Figure 7-5. Impact of Varying Basin-Rate-of-Cut on Sustainable Harvest Level



The application a limit of five percent of the area of any primary basin that can be less than five years of age was intended to show the effect of a more restrictive rate of cut than was used in the base case. Unexpectedly, this limit turned out to be less restrictive. The sustainable harvest level increased by six hectares to 342 hectares annually.

To test the impact of relaxing the rate-of-cut constraint, an IRM constraint was applied to all primary basins. An IRM constraint is typically formulated as "no more that 25% of the area can be below three metres in height". Since height is not an attribute of the aggregated yield curves used for this analysis, the age to attain three metres in height was calculated for each stand in the THLB. For each primary basin, the area-weighted average age to reach three metres was calculated. For each basin, the cover constraint was applied to ensure that no more than 25% of the area was below this age. Under this relaxed constraint, 345 hectares could sustainably be harvested annually.

7.7 Visual Quality Objectives

The inventory of visual resources that has been completed for Clayoquot Sound differs significantly from other inventories on the Coast. The rationale for formulating cover constraints based on this inventory is described in Section 10.2.2 of the Information Package. The cover constraints that were agreed upon and used for the base case are given in Table 3-2. Sensitivities were conducted for Visual Quality by adjusting both the allowable maximum disturbance and the visually effective greenup (VEG) height.

7.7.1 Maximum Disturbance[jem10]

The three different visual quality classes had allowable levels of disturbance of 20%, 30% and 40%. For the first sensitivity analysis, these were each decreased by 10%. For the second sensitivity analysis, they were increased by 10%. Neither adjustment had any affect on the sustainable harvest level. It was still possible to log 336 hectares each year, but this level could not be raised in either case.

7.7.2 Green-up Height[jem11]

As originally envisioned, this sensitivity analysis was to be run by adjusting the required greenup heights – decreasing them by 10% in the first instance and increasing them by 10% in the second. Because height was not an attribute of the aggregated yield curves, this sensitivity was evaluated indirectly. For the base case, the area-weighted average age to reach the greenup height was calculated for each visual polygon, and the height-based cover constraint was rewritten as an age-based constraint. So, rather than adjust heights by 10%, these ages were adjusted by the same amount.

As with the sensitivities surrounding maximum disturbance, varying ages as a proxy for adjusting VEG heights had no impact on the sustainable harvest level.

7.8 Sydney / Pretty Girl Deferral[jem12]

Interfor has agreed to delay any harvesting in the Sydney and Pretty Girl until after 2009. The base case scenario did not include this constraint. To model it for this sensitivity analysis, all stands in these two watersheds were made unavailable for harvest until 2010. This short-term deferral had no impact on the sustainable harvest level – 336 hectares per year was still achievable.

7.9 Harvest by VR Prescription

The base case scenario was configured to harvest from each of the six VR prescriptions in proportion to the amount that was available for harvest in a given year. The intent of this harvest priority was to control fluctuations (from one period to the next) in the amount that was harvested under the different prescriptions. This was done to limit the harvest volume swings that might occur if harvesting occurred primarily in low retention prescriptions in one period and from high retention prescription the following period. The application of this balancing algorithm led to the pattern shown in Figure 6-4. The amount of area harvest from P6 starts high, declines steadily for the following nine periods, and then rebounds. It is prudent to determine whether the base case harvest level depends upon high initial harvest in P6, or if lower initial harvest in P6 will also permit the 336 ha/year level to be sustained. Two sensitivities were tested:

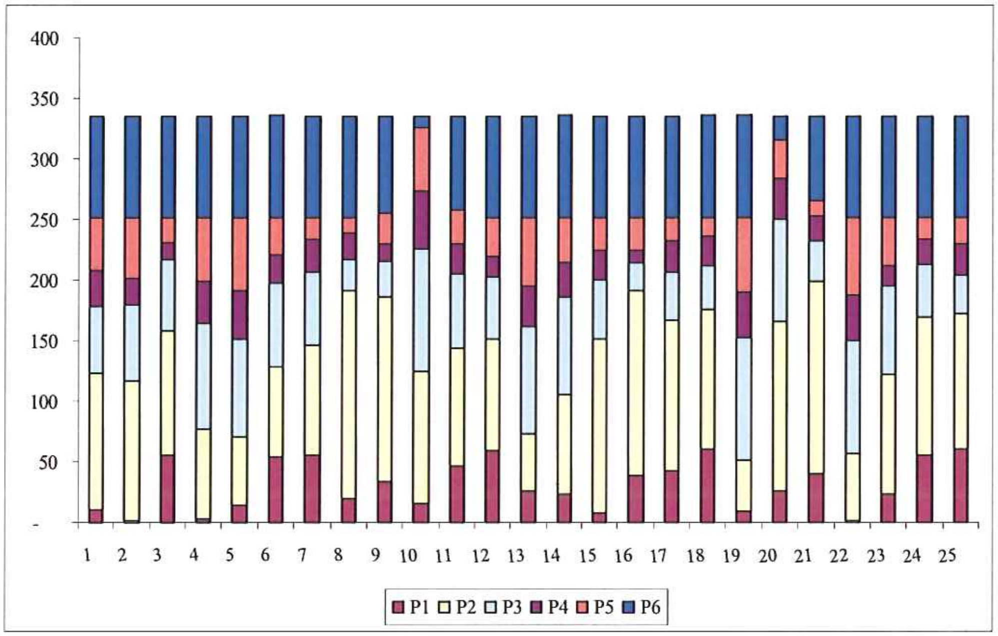
1. apply a periodic quota for harvesting in P6; and
2. remove the Harvest Balancing rule applied in the base case.

7.9.1 Harvest Quota in VR Prescription P6

The base case approach to balancing harvest among VR prescriptions did not have the intended effect. The outcome of harvesting from P6 in proportion to the amount that is available is that the available amount steadily declines because P6 is managed on a 100 year rotation. Consequently, the amount that is actually harvested declined steadily for the first ten decades of the simulation. In decade 11, the large P6 area that was harvested in decade 1 again becomes available. From this point forward the pattern repeats again.

An alternative approach to controlling these fluctuations was attempted. A harvest quota of 83 hectares per year was applied. This figure was calculated by dividing the total area in P6 by the 100-year rotation. With this "constraint" in place, it was in fact possible to raise the annual harvest to 350 hectares. This resulted in a distribution of harvest by VR prescription as shown in Figure 7-6.

Figure 7-6. Area Harvested by Period and VR Prescription-P6 Quota

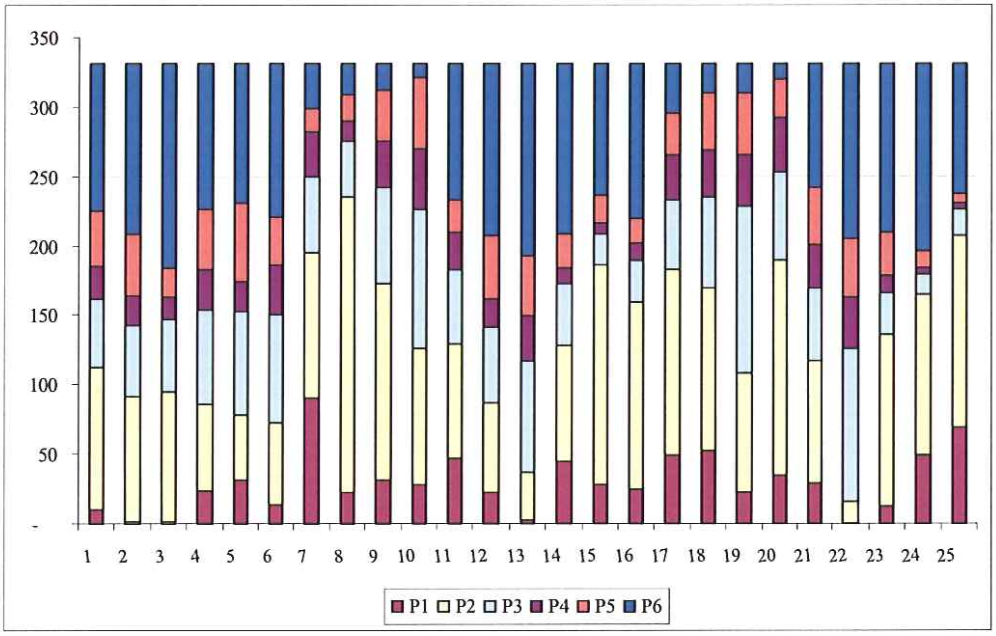


The model harvests the required amount from P6 for the first nine decades. There is a shortfall in the tenth decade because the little remaining mature P6 area is unavailable to be watershed rate-of-cut constraints.

7.9.2 No Harvest Balancing Enforced

Given that the previous sensitivity analysis led to an increase in harvest level over the base case, a version of the base case with no attempt at controlling harvest by VR prescription (either through balancing or harvest quotas) was set up. This resulted in a sustainable harvest of 331 hectares and a distribution of harvesting by VR prescription as shown in Figure 7-7.

Figure 7-7. Area Harvested by Period and VR Prescription – No Balancing



8.0 DISCUSSION OF RESULTS

An effort has been made to present a realistic base case, and to support it by running sensitivity analyses to test key assumptions. Table 8-1 summarizes the results of the base case and sensitivity runs

Table 8-1 Summary of Sensitivity Analysis Harvest Levels

Scenario	Harvest Level (ha/yr)
Base Case	336
Operability based on unadjusted inventory volumes	322
Include inoperable down to 350 m3/ha	340
Include inoperable above 450 m3/ha	334
Include inoperable within 200m of THLB	332
Include inoperable within 100m of THLB	327
Exclude draft Marbled Murrelet areas	332
Increase MHA by 10%	309
Increase MHA by 20%	289
Increase MHA by 30%	269
Decrease MHA by 10%	357
Primary basin rate-of-cut: 5% less than 5 years	342
Primary basin rate-of-cut: IRM	345
Decrease VQO disturbance limit by 10%	336
Increase VQO disturbance limit by 10%	336
Decrease VQO VEG height limit by 10%	336
Increase VQO VEG height limit by 10%	336
Defer harvest in Sydney / Pretty Girl until 2009	336
83 hectare per year quota on P6	350
No VR prescription harvest balancing	331

8.1 Landbase

The size and extent of the landbase within TFL 54 that is available for long term timber production is well understood. The watershed planning process that was mandated by the Clayoquot Sound Scientific Panel led to the creation of a series of reserve networks designed to protect many non-timber resource values. Any stands not in this reserve network are, by definition, available for timber harvesting. As a result of this, TFL 54 is not subject to many of the landbase uncertainties that affect other coastal tenures.

The landbase questions that must be addressed are not related to potential alienations, but rather to operability. In preparation for this Management Plan, Interfor reviewed the operability maps for the TFL in light of changing harvesting practices and economics. This resulted in areas that had not been considered operable for previous timber supply reviews being added to the THLB for this analysis. This process is described in detail in Section 6.2.5 of the Information Package.

The landbase sensitivities that were conducted examined this recovered portion of the THLB. As Table 8-1 shows, the base case harvest level is reasonably insensitive to the assumptions that were made in reassessing the inoperable landbase. Whether the operability reassessment is based on the original inventory, or on different volume per hectare thresholds where the adjusted inventory is used, or if remote areas are preserved as inoperable, the impact on harvest level is much lower than the underlying changes in the THLB would imply.

This is due primarily to the way the previously inoperable areas will be managed – they have been assigned to a P6 VR prescription. The fact that this is a high-retention prescription is immaterial (for an area-based analysis). However, the fact that these areas are managed on a single-pass, 100-year rotation is the key to understanding the harvest level outcomes of these sensitivity analyses. Because of their P6 management regime, these stands contribute less (per hectare) to the harvest level than stands managed on two-pass systems (which are double-counted for AAC and cut-control purposes) and/or shorter rotations (since these may be harvested more frequently, regardless of the VR prescription). Overall, the approach taken to revaluating and including some inoperable areas in the THLB has been conservative, and this is reflective in the results of these sensitivity analyses.

8.2 Minimum Harvest Age

Stand minimum harvest age is a key driving factor for area-based timber supply analysis, and Table 8-1 shows that changes in assumed MHA have a significant impact on the harvest level for TFL 54. This is not an unexpected result, given the trends shown in Figure 6-2 and Figure 6-3. The pinch point in timber supply occurs in the ninth decade of the simulation. Although the forest estate model is able to harvest the required volume over the cut control period, it falls short in two of the ten years. It is also at this point that average harvest age falls to a minimum. From the middle of the eighth decade until the middle of the ninth decade, average harvest age is 62 years. From this point onward, although it varies slightly, harvest age averages about 74 years.

8.3 Cover Constraints

Cover constraints were applied to limit the rates of harvest in specific basins, maintain old growth at the watershed level, and to protect visually sensitive areas.

8.3.1 Watershed Rate-of-Cut

Rate-of-cut limits were applied to 86 basins. Most basins are logged to their rate-of-cut limit at some point over the planning horizon, and many reach this limit repeatedly. The sensitivity analyses that were proposed in the Information Package were intended to show the impact on harvest level of increasing and relaxing these constraints. For simplicity, these analyses were to be conducted on primary basins only, on the assumption that this would account for most of the limitations associated with the basin constraints. This assumption turned out to be incorrect.

Applying a five percent under five year limit to all primary basins represents a considerable increase in the constraint level for those basins. In the base case, many were only constrained over ten years, and many had nominal rates of cut higher than the mandated one percent because the limits were adjusted for parks (that will never be logged) in the same basins. However, the harvest level possible under this scenario was higher than for the base case. This suggests that the constraints applied to secondary, tertiary and quaternary basins are significant in limiting the overall sustainable harvest level.

Relaxing the cover constraint on primary basins to an IRM level did not allow much increase in the sustainable harvest level. This suggests that in the crucial period leading up to the pinch point in decade nine, MHA is a more significant factor in limiting harvest level than is basin rate-of-cut.

8.3.2 Old Growth Requirements

No sensitivities were conducted around the watershed-level old growth constraints of 40%. In most watersheds, sufficient old grow exists within the watershed reserve network to meet old growth requirements. Two exceptions were noted and dealt with in the base case run.

- The TFL 54 portion of the Kennedy Lake watershed does not have sufficient old growth to meet the old growth requirement. Furthermore, the requirement will not ever be met by stands in the (as yet incomplete) reserve network. Recruitment areas sufficient of meet the old growth requirement were identified within the THLB and marked as unavailable for harvest for the entire planning horizon. Once these areas were explicitly identified, the old growth cover constraint for the Kennedy Lake watershed was no longer required.

- The Beach watershed has sufficient old growth to meet the requirement, but much of this is in the THLB. Since Complan does not automatically handle old seral recruitment, a separate cover constraint was applied to the Beach old growth, and the basin-wide 40% cover constraint was removed. This prevented the entire basin from being restricted from harvesting once the old growth limit is reached.

Old growth requirements have been evaluated entirely on the TFL 54 portion of each watershed. As a general rule, the watershed reserve networks and basin rate-of-cut constraints are sufficient to prevent the old growth requirements from being constraining to the base case harvest level over the long term.

8.3.3 Visual Quality

The base case harvest level is not sensitive to assumptions about visual quality objectives. Having said that, the landscape inventory used for this analysis is not well structured for quantitative approaches to planning. Considerable discussion with Interfor and MoF staff was necessary in order to arrive at and agree upon the disturbance levels and VEG heights that were used for the base case.

8.4 Harvest Balancing

Sensitivities around harvest balancing were not anticipated at the outset of this timber supply analysis. However, since the approach taken to distributing harvest among the different VR prescriptions did not have the intended effect, two additional sensitivity analyses were run.

When a harvest quota is applied to VR prescription P6, a higher sustainable harvest level can be achieved. When all attempts at balancing are removed, the harvest level falls below the base case level. It appears that higher harvest levels are possible when the amount harvested from the long-rotation P6 prescription is moderated. Further efforts at modelling (and perhaps optimizing) the harvest schedule among prescriptions and watersheds might find even (slightly) higher sustainable harvest levels. However, given that the VR prescriptions used for this analysis are categorizations and abstractions of the range of silvicultural prescriptions applied in the field, optimizing among them would amount to an exercise in producing the best model outcomes rather than finding the best solution to real world issues. The base case harvest level presented here remains the best basis for the sound management of TFL 54.