Western Forest Products Limited

Tree Farm Licence 25

Timber Supply Analysis

MANAGEMENT PLAN 10

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Executive Summary

This analysis examines timber supply projections for Tree Farm Licence 25, which is comprised of five administrative units. Two are located on Vancouver Island at Jordan River (Block 1) and Naka Creek (Block 3). Two are on the Mainland coast at Loughborough Inlet (Block 2) and Swanson Bay (Block 5) and the fifth is on Moresby Island (Block 6) in Haida Gwaii.

Complan 3.0, a spatially-explicit harvest model, was used to simulate current management practices for protection and maintenance of ecological values and to estimate the residual timber potential through the year 2252.

After allowances for non-recoverable losses, the simulation of current management practice as agreed and set out in the associated information package suggests the following area-based AAC by block for the term of the proposed management plan:

Block	Location	AAC (hectares)
1	Jordan River	290
2	Loughborough Inlet	123
3	Naka Creek	87
5	Central Coast	491
6	Haida Gwaii	251
	Total	1,242

The proposed harvest levels should accommodate ecological concerns in the short and longer terms. The simulation suggests that a minimum of 124,600 ha (46% of productive forest) will be maintained in older forests (>140 yrs) and a minimum 64,000,000 m^3 of merchantable growing stock will be retained throughout the 250-year simulation horizon. These forests are expected to contribute significantly to biodiversity conservation and complement protected areas (~240,800 ha) adjacent to the Tree Farm Licence. The timber flowing from the proposed harvests would be sufficient to maintain existing people and communities dependent on harvesting and forest management in the short term, and may allow for an expansion in the future.

The analysis suggests that with time, timber volumes realized from this fixed harvest area will begin to increase as will stand ages, standing volume, and associated environmental values. Projections of cedar harvest and availability suggest that these species remain available for cultural and commercial uses throughout the simulation.

Sensitivity analyses suggest that the current management simulation is sensitive to land base and minimum harvest age changes. Policies that change either or both of these parameters may have significant impacts on area and volume harvest levels.

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Acknowledgements

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1.0 Introduction

1.1 Purpose

Tree Farm Licence 25 is located in coastal British Columbia and consists of five independent blocks encompassing 480,149 hectares, of which 138,078 hectares are considered available for long term timber production. The TFL was established in 1958 with the intent of maintaining a sustainable harvest level indefinitely. Since that time the AAC has been re-determined periodically and more recently at five-year intervals. This report provides the technical basis for re-determination of the AAC.

1.2 Objectives

The primary objective of this report is to estimate achievable and sustainable annual area harvests and associated timber flows for the consideration of the Provincial Chief Forester in making his determination of Allowable Annual Cut for the term of Management Plan 10. More specifically the timber supply model is to be programmed to ensure the following primary objectives:

1. Non-timber values such as fish and wildlife habitat, biodiversity, recreation, visual quality, and terrain stability are to be given priority over timber. Protection of non-timber values will be satisfied by land base removals, yield net downs and/or by maintaining a percentage of polygons in older stands.
2. Annual harvest area is to be derived as a residual after non-timber values are accommodated. The proposed harvest level will consider harvestable inventory, growth potential of present and future stands, silvicultural treatments, potential timber losses, operational and legislative constraints.
3. Annual area harvested is held constant throughout the 250-year time horizon of the simulation.

Secondary objectives include:

4. Estimation of growing stock and age class changes through time as a coarse gauge of future habitat supply.
5. Evaluation of the impacts of and effectiveness of existing and alternative forest policies and land uses.
6. Identification of potential silvicultural or other interventions that may have social and/or ecological benefit.
7. Identification of data, inventory, or modelling uncertainties or shortcomings that may, if reduced or eliminated in future, significantly improve model predictions.

1.3 Timber Supply Model

Timber supply simulations were completed with Complan 3.2006 software developed by Olympic Resource Management and predecessors and currently owned by Timberline Forest Inventory consultants. Complan is a spatially-explicit supply model and is described in more detail in the associated information package (MP 10, Appendix IV, section 4.1)

The inventory database was current to January 1, 2001 and the simulation was set up to include a one-year initial harvest period to force actual 2001 harvesting to bring the effective inventory date ahead to 2002. This initialization year was included in all runs but is not presented in the tables or graphs herein. For each of the five blocks, a 20-year plan was prepared based on the first two decades of model output to depict the current management simulation. Total simulation horizon was set at 250 years.

Analysis units and associated yield curve parameters are described in more detail in the associated information package (MP 10, Appendix IV, sections 7 & 8).

To ensure optimization of harvest scenarios, harvest request levels were incrementally changed until a one-hectare change induced a small deficit, typically occurring in the vicinity of the transition to second growth. The reported harvest level is the last requested level where no deficit is evident.

2.0 Current Management or Base Case

The current management (CM) simulation includes the following assumptions and modelling parameters that are described in more detail in the associated information package (MP 10, Appendix IV, section 3.2):

- Future Wildlife Tree Patches are projected to occupy 13% of the land base, 3.25% of which is assumed to come from the otherwise harvestable land base[1,2]. Universal volume reductions ranging from 5.0% (Blocks 1, 2, 3, 6) to 8.5% (Block 5) were used to simulate the overall volume impacts of WTPs, partial cutting, and EBM. Old seral stage targets are maintained based on specific Biodiversity Emphasis Options where available, or the TSR II recommendations of 10% high, 45% intermediate, and 45% low biodiversity emphasis where landscape units have not been drafted or finalized. Green-up heights are assigned based on Resource Management Zoning established in the Vancouver Island Land Use Plan. Vancouver Island "Special" and

[1] As the locations of future WTPs and partial cutting are not known, the percentage is not area based. Therefore growing stock and age class distributions and summaries do not reflect this reserved area or volume.

As these volume deductions are not reflected in area calculations some options for determination of AAC and cut control are:

Option A – net down the area-based AAC Determination for WTPs (assumed 3.25%) in THLB and partial cutting (% as below). Then when determining area harvested for cut control, do not include partial cutting. This approach would require establishment of a threshold basal area removal, may invite partial cutting manipulations or abuses to avoid cut control, and assumes the WTP/THLB overlap is as estimated. (Cut control area = net block clearcut area + harvestable productive forest in PAS right-of-way outside cutblocks[2]).

Option B – net down the area-based Determination for partial cutting only (1.75% for Blocks 1,2,3,6 and 5.25% for Block 5). Then for cut control purposes include as area harvested any WTP area overlapping the THLB, but as per Option A ignore partial cutting areas. Including WTP on THLB as part of area harvested is a more direct approach to determining the percentage of THLB occupied by WTP and brings the concept of THLB closer to the operational level. The timber resource would be better utilized if field personnel observed an immediate cut control effect from unnecessary or excessive reservation of THLB. As well this approach would facilitate better tracking of WTP overlap with THLB to determine the validity of the currently assumed 3.25% and encourage updating of THLB mapping to reflect block level assessments of terrain, etc. (Cut control area = net block clearcut area + THLB in WTP + harvestable productive forest in PAS right-of-way outside cutblocks[2]).

Option C – do not adjust the area-based AAC Determination for WTPs or partial cutting but include as area harvested for cut control any WTP area overlapping the THLB and include partial cutting using a percentage-of-basal-area-removed adjustment to calculate a clearcut equivalency area. This direct-measurement-of-results approach reduces potential partial cutting abuses and makes percentage estimates of the WTP/THLB overlap and/or partial cutting irrelevant to the AAC Determination. (Cut control area = net block clearcut area + THLB in WTP + partial cut area stated as clearcut equivalent + harvestable productive forest in PAS right-of-way outside cutblocks[2]).

Note that if partially cut area were to be included as 100% clearcut, operational personnel would find this approach unfair and partial cutting could be unduly discouraged.

[2] If the "disturbed area" approach to determining area harvested for cut control is used, in theory it is also necessary to make an upward adjustment of the AAC Determination to make allowance for NP (e.g. non-forested area on access road) or unmerchantable stands (young, unharvestable second growth or lower site stands outside the THLB) that may be disturbed in developing cutblocks. A direct measurement of this at the cut control stage would be more transparent.

“General” zones as well as Mainland blocks have a 3m green-up requirement, whereas “Enhanced” zones on Vancouver Island have a 1.3m limit.

- The operable land base includes stands accessible to helicopter and conventional cable or ground-based harvesting systems.

- All harvested stands are planted promptly. Future plantations are assumed to use seed orchard stock. Yield reductions for stocking gaps and decay are 20% at one hundred years.

- Visual quality restrictions are based on the latest inventory revisions with upper range denudation assumed. Recreation constraints as described in the information package are generally of little impact.

- Minimum harvestable ages are based on attainment of profitable minimum mean stand diameters. Minimum acceptable stand diameters increased 10cm from poor to good growing sites and 7cm from low cost, south coast operations to higher cost operations to the north.

- Alder volumes contribute to the timber supply.

- Harvest priorities are generally to minimize growth loss and harvest oldest stands. In Block 1 the oldest first rule was not invoked to better reflect current operations that include significant second growth harvesting. Existing forest development plan blocks were harvested in the initial years as model constraints permitted.

The Current Management summary statistics for each block are presented in Table 1 below and harvest levels are presented in Figure 1 below. More detailed graphs of output parameters and sensitivity analyses are presented by TFL block in the sections following and in Appendix V-A (page 69).

In terms of annual area harvest, the order of importance of the blocks is: Block 5 (40%), Block 1 (23%), Block 6 (20%), Block 2 (10%), Block 3 (7%). This order remains even after Central Coast Candidate Protected Areas announced April 1, 2001 are removed, although the Block 5 area harvest is reduced by about a quarter (128 ha or 26%). In terms of projected annual volume flow, the short term block order is the same, but in the longer term Block 6 surpasses Block 1 as the age class imbalance induced by the 1988 withdrawal of the Gwaii Haanas reserve from the management unit is eventually overcome.

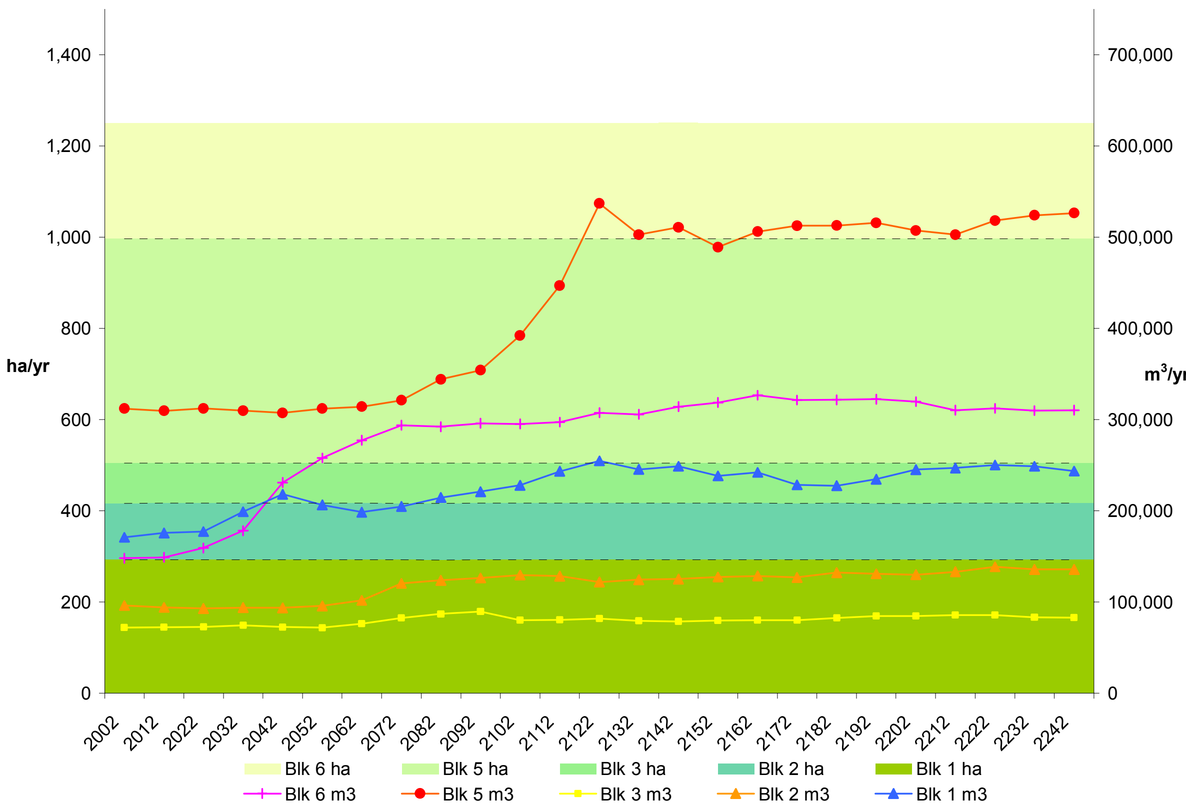

Figure 1. Area harvest (background bands) and predicted volume flow (lines) to 2252 for each block under current management

The indicated annual harvest area for the TFL of 1,250 ha is less than both the Long-Run Sustainable Area harvest calculation (LRSA) and the Long-Run Sustainable Area harvest calculation if all stands were harvested when marginally profitable (mLRSA). Future stands would on average be harvested beyond culmination of mean annual increment and be of sufficient size to ensure a reasonable economic return for future generations.

Table 1. Current management harvest summary

Block	mDBHq[3] (cm)	Indicated Annual Harvest (ha)	THLB[4] (ha)	Implied average rotation age[5] (yrs)	Predicted average annual volume to 2022[6] (m^3/yr)	Average culmination age[4] (yrs)	LRSA[7] (ha)	Average age mDBHq attained	mLRSA[8] (ha)	NRL[4] (ha)
1	40/35/30	292	25,562	88	164,534	95	269	85	301	2
2	43/38/34	124	15,002	121	90,234	96	156	115	130	1
3	43/38/34	88	9,444	107	68,342	105	90	108	87	1
5	47/42/37	492	62,901	128	284,258	103	611	126	499	1
5^{-PA}	47/42/37	364	47,966[9]	132	210,134	104	461	128	375	1
6	47/42/37	254	25,169	99	140,873	83	303	85	296	3
All		1,250	138,078	110	748,241	100	1,429	109	1,313	8
All^{-PA}		1,122	123,143	110	674,117	97	1,279	107	1,189	8

3 Minimum harvestable quadratic mean stand diameter for Good, Medium, and Poor sites respectively.
4 from the information package (MP 10, Appendix IV) for future stands.
5 THLB divided by expected annual area harvest.
6 Actual harvest volume will vary; this parameter is not suitable for conversion of area to volume for administrative or operational purposes.
7 Theoretical Long Run Sustainable Area harvest calculated as THLB divided by area-weighted culmination age of future managed stands.
8 Theoretical Long Run Sustainable Area if harvest occurs at mDBHq, calculated as THLB divided by area-weighted age that future managed stands attain mDBHq.
9 Original THLB hectares less THLB in Order-in-Council designated Protected Areas.

3.0 Block 1 Analysis (Jordan River)

3.1 Current Management – 292 ha/year

Figure 2 below summarizes for the current management or "base case" simulation, the trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting.

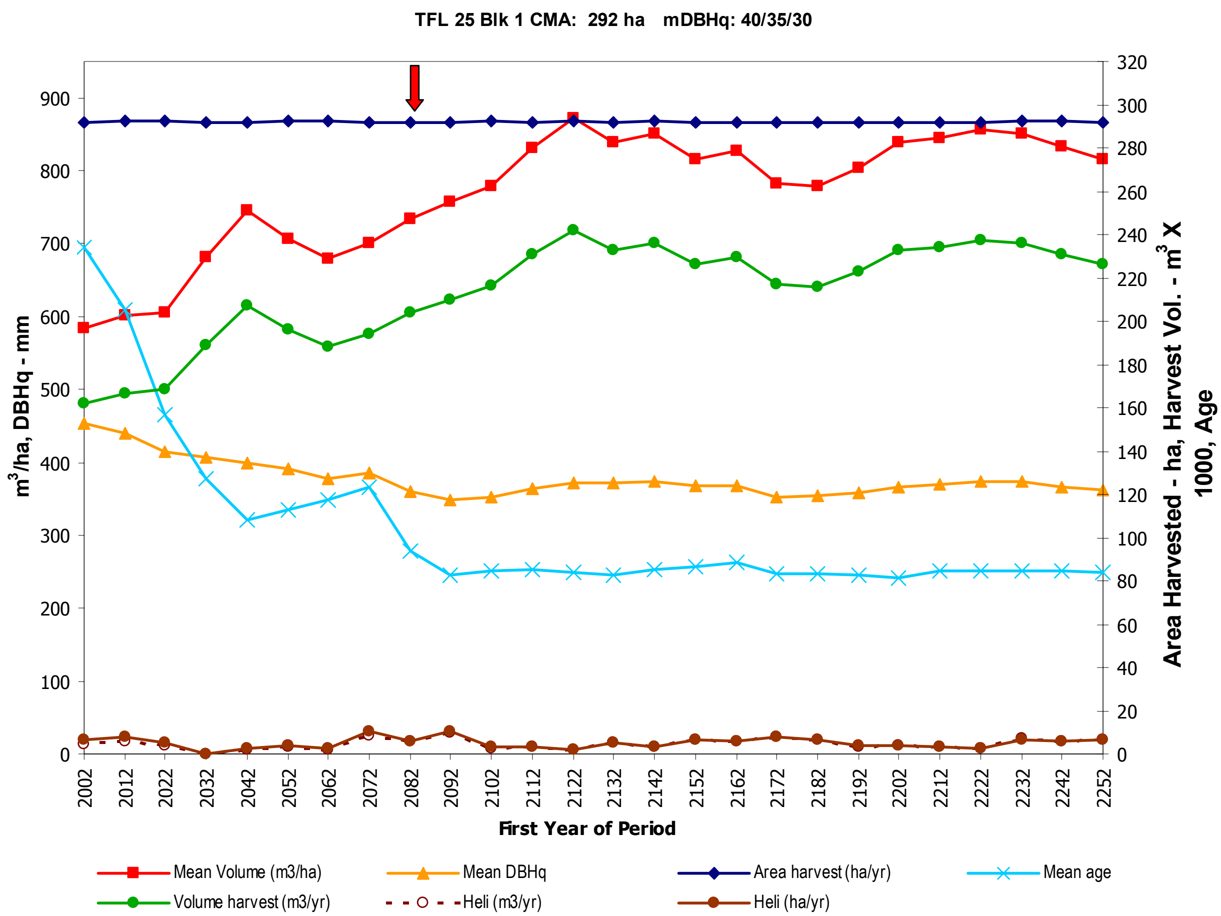

Figure 2. Block 1 Current Management harvest statistics through 250 years[10]

As the transition to second growth occurs, average age and diameter of harvested stands declines until the transition is complete. The transition will be largely complete within the next 40 years but nevertheless old forests would be a significant portion of the harvest profile until about 90 years into the future. As the transition progresses average merchantable stand volumes at harvest increase from under 600 m^3/ha initially to the 800-850 m^3/ha range in the long term. This effect is primarily related to expected gains from current silviculture practices. As the area harvest is constant, annual harvest volumes increase[11] in tandem with the increasing stand volumes. In the long term, ages at harvest average 82-88 years and average harvest diameters are around 35-37 cm (individual stands ranging 30-65+ cm).

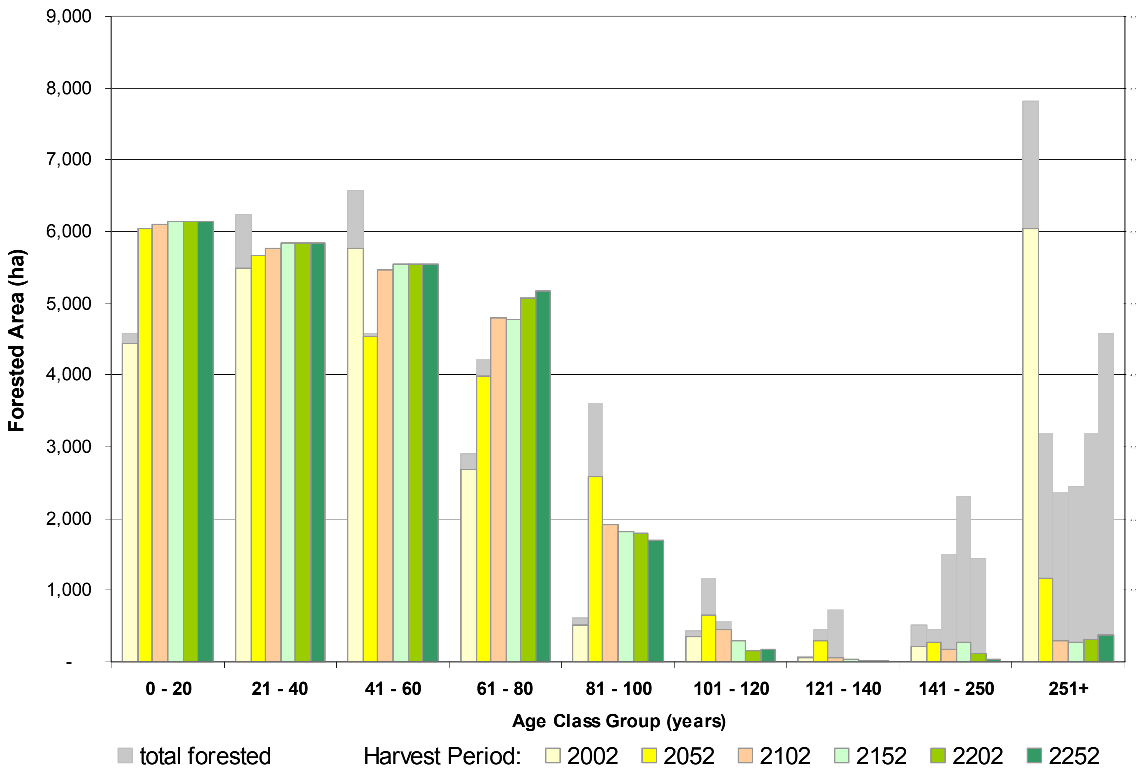

Figure 3. Age class progression on Block 1 THLB (+ total forested) for current management through 250 years

In this Block the indicated harvest level is midway between the LRSA and mLRSA calculations (Table 1), suggesting that near the pinch point (circa 2082) and beyond stands are on average harvested before culmination of mean annual

[10] Red arrow indicates point where an area harvest deficit occurs if harvest request is increased by 1 ha.
[11] This "fall-up" effect is the reverse of the oft-cited "falldown" effect observed in some stands (Douglas-fir for example). At the stand level the effect is commonly observed on coastal hemlock, balsam, or cedar sites where old forests are severely decayed and of low merchantable volume when compared to second growth growing on similar sites.

increment but above the threshold minimum harvest age needed to ensure a profitable harvest.

Age class distributions are examined in Figure 3 above. On the THLB, with the exception of the 41-60 class, the age classes less than 101 years increase modestly from current levels initially and then stabilize through the remainder of the simulation. 101- to 250-year-old stands remain present in low abundance throughout the simulation. On the THLB the oldest stands decline dramatically through the first part of the simulation as the transition to second growth harvesting is completed.

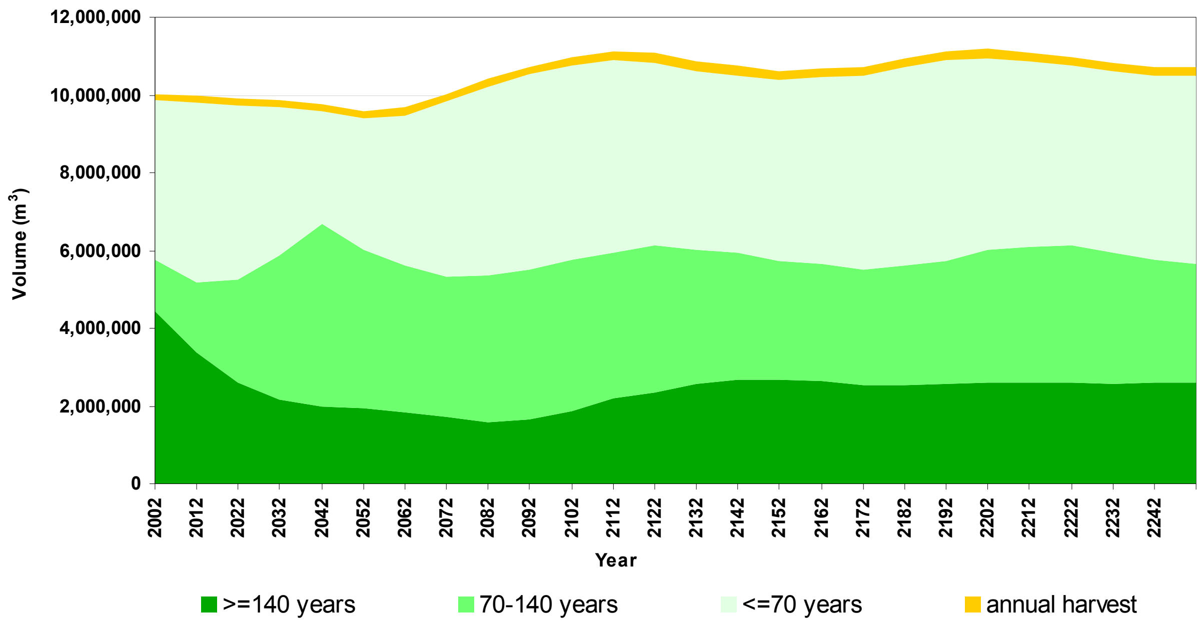

Figure 4. Merchantable growing stock on total Block 1 land base through 250 years

On the total forest land base, forest greater than 250 years old declines from the current level of about 7,800 ha to about 2,400 ha and then rebuilds to the 4,600 ha level. However during the deficit period stands in the 141- to 250-year-old class are increasing so that at least 3,900 ha of forest older than 140 years is forecasted to be present and contributing to the perpetuation of old-growth dependent processes or organisms.

Figure 4 above illustrates gross growing stock levels for the total land base. Initially levels are somewhat below 10 million m^3 but rise modestly to near 11 million m^3 in the longer term. The proportion of older forest drops initially from the current level of about 4.4 million m^3 to about 1.6 million m^3 and then stabilizes near 2.6 million m^3 in the long term. This 10-11 million m^3 standing inventory of wood permanently provides the basis for sustainable timber flow in the long term and provides substantial habitat and other environmental benefits to supplement values in adjacent park land (935 ha). The proportion of younger growing stock is initially 42% and in the long term stabilizes in the range of 43-47% of total growing stock. The 71- to 140-year-old growing stock provides the primary source of sustainable timber production through the simulation.

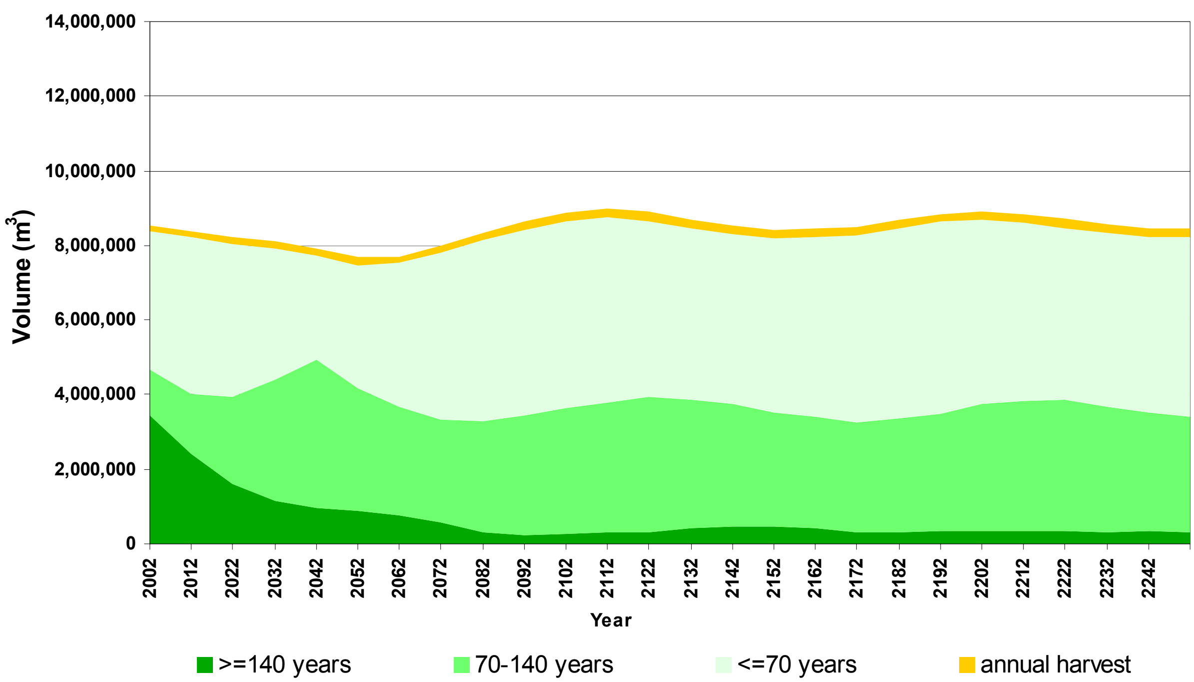

Figure 5. Merchantable growing stock on Block 1 THLB through 250 years

In the future the older growing stock is for the most part, but not entirely, in reserves or area projected to be unavailable for timber harvest. Figure 5 above displays growing stock through time for the THLB only. For non-timber reasons, some timber is held significantly beyond normal rotation ages and reaches ages in excess of 140 years before other stands become equally or more suitable for satisfying the non-timber objective(s). When this timber is released, its harvest could provide a small but ongoing supply of older stems possibly suitable for specialty manufacturing or cultural purposes.

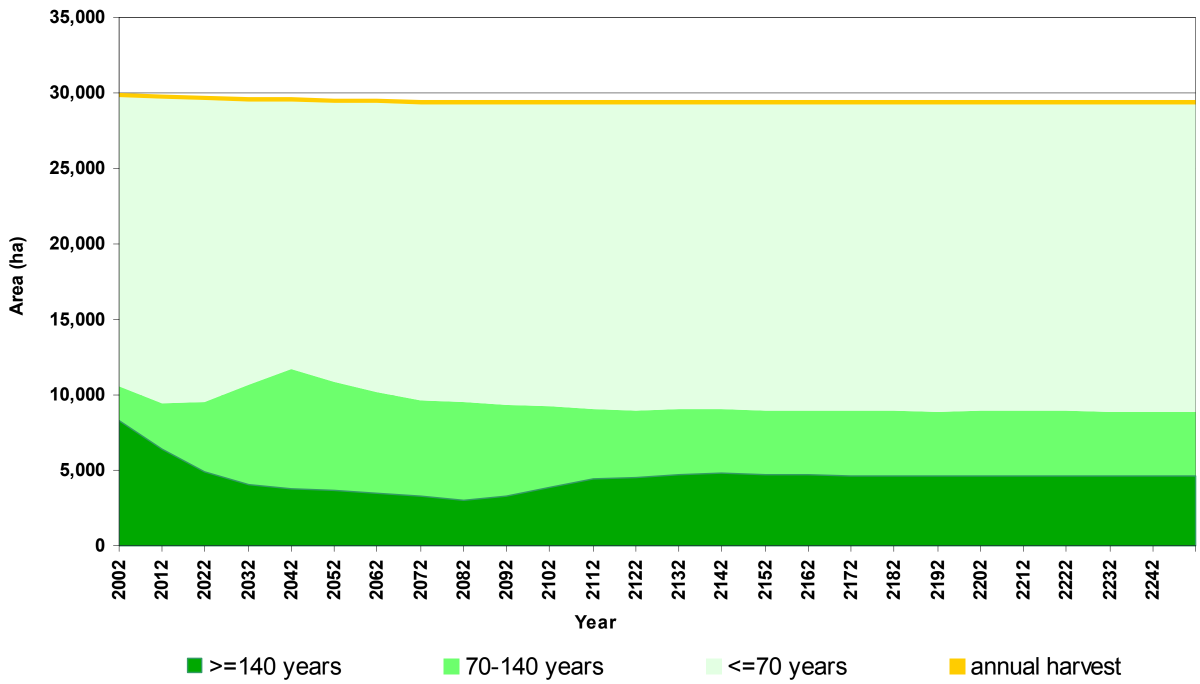

Figure 6. Age-group areas for Block 1 total land base through 250 years

Figure 6 above is as per Figure 4 except data is presented on an area basis rather than a volume basis and simplifies the age class data presented in Figure 3. There is a slight drop in the productive forest area from the initial level as new roads are built and withdrawn from the productive area.

Initially the area of old growth declines, the area of maturing stands increases, and the area of younger stands remains relatively stable. Contrary to popular opinion, as the transition from old growth progresses, at the landscape level old growth area is not replaced by clearcut area (young stands decrease from 64% to 63% through 2252), but rather by 71- to 140-year-old stands (increases from 8% to 25%). Under the current management regime, young stands will occur no more frequently after the completion of the transition to second growth than they do today.

Figure 6 also clearly demonstrates that the age class distribution is already much different than the natural disturbance type (NDT1) or recent historical range of natural variability for the area would dictate. Clearly any attempt to impose or return to an age class distribution representative of infrequent disturbances would be extremely difficult, as well as economically devastating and socially irresponsible.

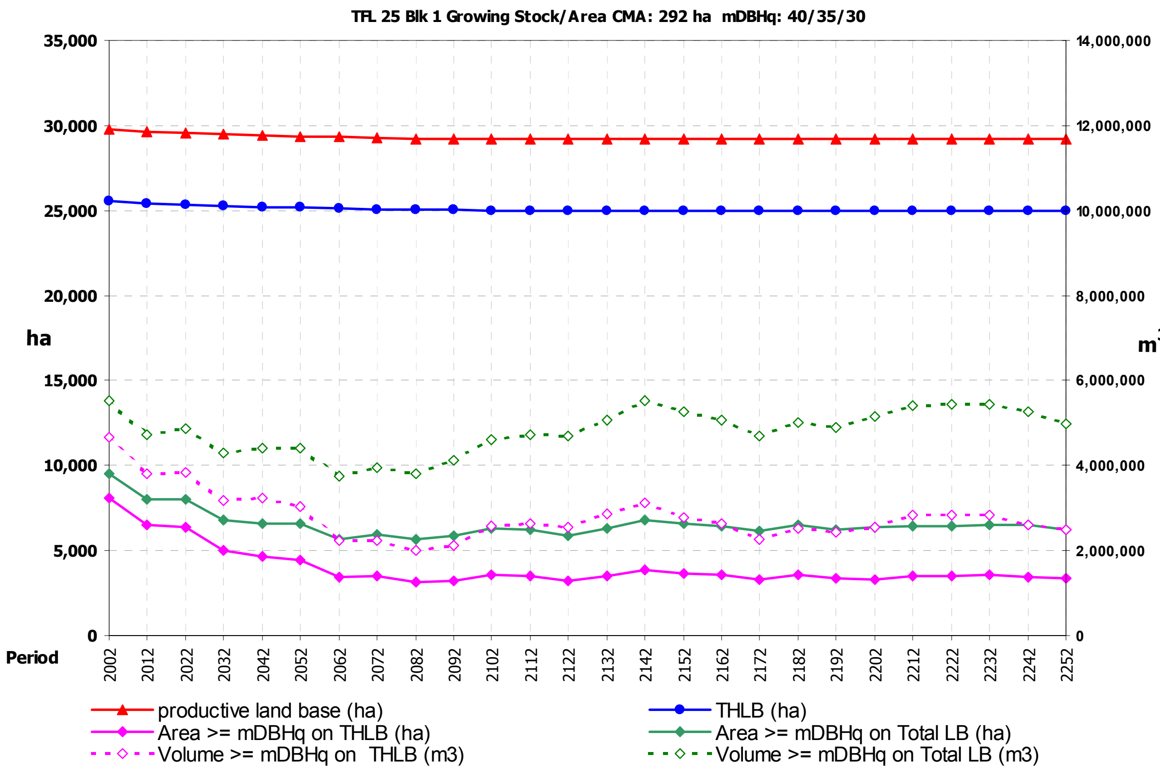

Figure 7. Merchantable growing stock in harvestable (>mDBHq) stands through 250 years for Block 1.

Figure 7 above presents growing stock in terms of merchantable volume and area that is larger than the minimum harvestable[12] DBHq.

Roughly 4,200 ha or 14% of the productive land base is unavailable for harvesting for the long term. Because the locations of future Wildlife Tree Patches and partial retention along streams or elsewhere could not be easily predicted, they were modelled as a yield curve volume net down. Consequently these net downs

[12] The term "merchantable" is used to refer to the net volume as indicated by growth and yield models: typically less a 30 cm high stump, a 10 cm top diameter, trees less than 12.5 cm dbh, and decay, waste and breakage estimates. The term "harvestable" is used here to refer to stands that have grown to mDBHq. Although a particular stand may have some, or considerable, merchantable volume it is not considered harvestable until it has attained sufficient volume and stem sizes to be deemed profitable.

are not represented in any of the aforementioned Figures and the actual volume and/or hectares illustrated understate the old forest reserved from harvest by about 5% of THLB area or volume.

On the THLB, harvestable stands become less available until the transition to second growth is complete and are maintained thereafter between 3,100 and 3,500 ha, or roughly 11-14 years worth of harvesting at the indicated harvest level. The ratio of harvestable area to annual harvest is somewhat higher than for other blocks and reflects a higher influence of policy factors (adjacency, cover %) rather than a shortage of physically available stands (mDBHq, age class structure). This confirms that the annual harvest area recommendation after making provision for non-timber values, makes more or less optimal use of the land base's residual timber capacity. Operational flexibility in the selection of harvest locations can be expected to be most limited around pinch points at 2062, 2082 and 2122.

A strategic focus for silviculture treatments could be to increase the harvestability of stands through the 2052-2132 period where area available for harvesting is projected to be lowest. A second objective would be to increase volume/ha during the anticipated dip from 2052-2082 (Figure 2, p. 7). Generally though, the differences are subtle and silviculture treatments which increase the future volume, merchantability or quality of stands may be more or less equal in terms of strategic importance and could therefore be ranked using stand-level financial analysis.

3.2 Alternate Harvest Levels

3.2.1 10% Increase

Figure 8 below shows that a higher area harvest request induces area and volume shortfalls at the transition to second growth and the rotations beyond. Average harvest age and DBHq decline sooner and remain somewhat lower in the long term. Average volume per hectare is lower in the longer term as stands are harvested earlier than was the case in the current management run. Note that relative to the current management simulation, this run produces modestly more volume (625,348 m^3 or 2,500 m^3 annually on average) through 250 years (see Appendix V-B, Table 12, p.106).

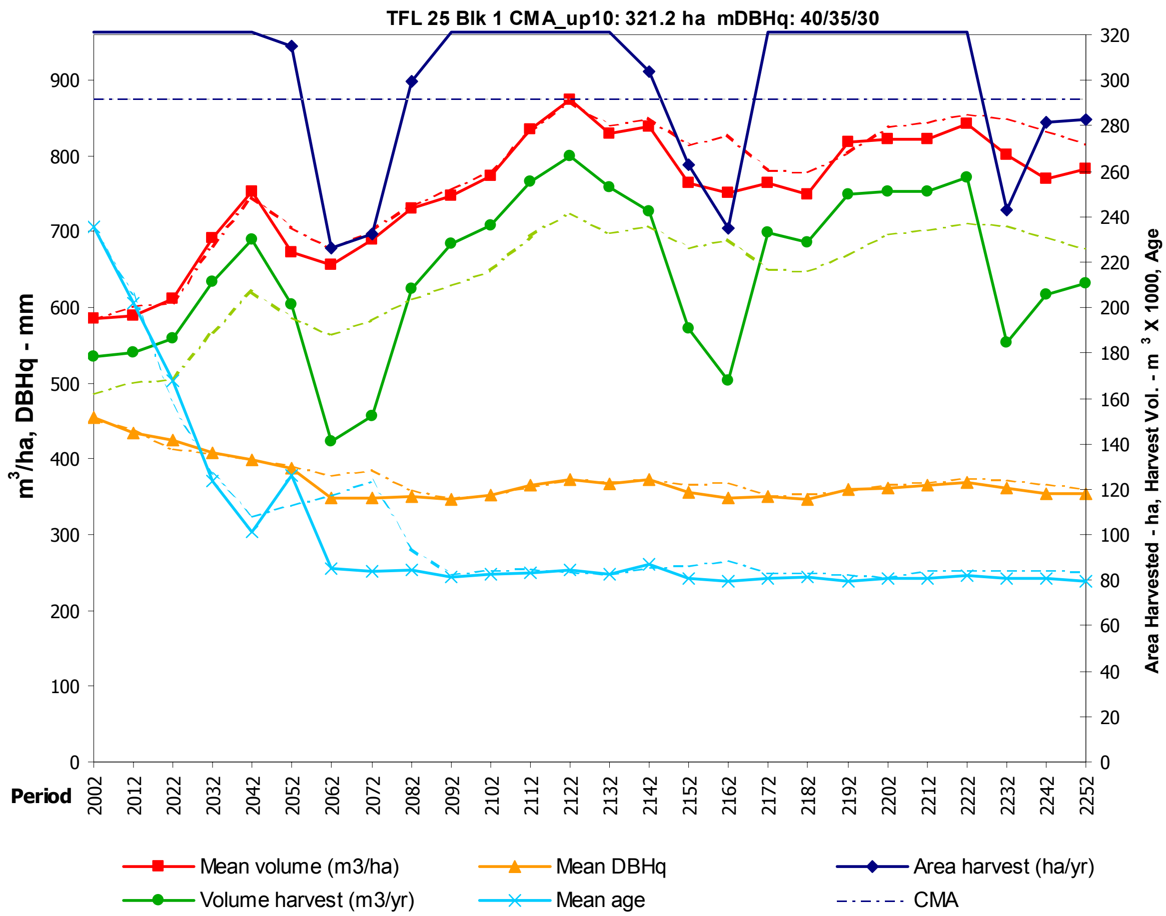

Figure 8. Block 1 harvest statistics[13] through 250 years for current management area harvest plus 10%

3.2.2 10% Decrease

Lowering the harvest request level by 10% (Figure 9 below) has the effect in the short term of lowering the harvest volume in proportion (-10.1%) to the area change. This is because existing old growth stands are assumed to be neither adding nor losing volume through time. Once second growth becomes an appreciable component of the harvest profile, harvest age and DBHq are significantly higher (longer rotation) with the result that stand volumes per hectare at harvest are higher as well. This tends to compensate for the loss of area harvested such that the overall volume harvest is less affected in the longer term (-5.6%) versus the short term (-10.1%) (Appendix V-B, Table 12, p.106).

[13] Dashed lines in background represent current management statistics.

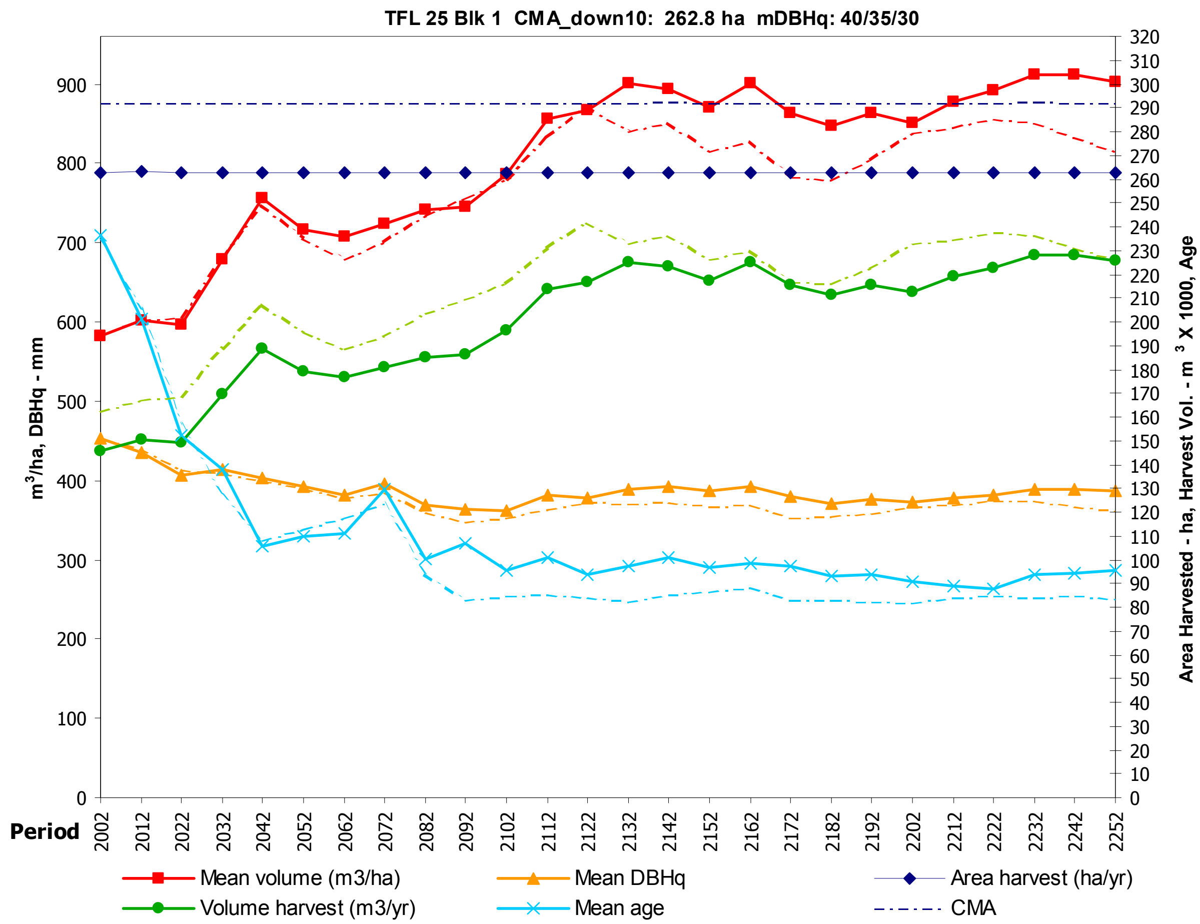

Figure 9. Block 1 harvest statistics through 250 years for current management area harvest less 10%

3.3 Sensitivity Analyses

Harvest output statistics for all sensitivity runs are presented in Appendix V-A (p. 69). In the harvest output graphs, decreases in area harvest relative to the base case are presented both unadjusted and as a new flat line. For increases in area harvest, a new, higher, flat-line harvest level was established. Flat-line flows were established by increasing area harvest requested until a deficit occurred, and then dropping back to the nearest whole number where the deficit disappears. Appendix V-B (p.103) summarizes changes in area (Table 10, Table 11) and near, mid, and long term volume (Table 12).

Table 2 presents the area results of sensitivity analyses for Block 1.

Block 1 is most sensitive to changes that alter the minimum harvest age (-SI3m, +age, +ageX2). The "+/-age" results are unbalanced and suggest that an increase in rotation age has a much stronger impact than a decrease in rotation age. This effect is most pronounced in Block 1 and is related to a pinch-point shift from harvestability limitations at the pinch point to increased adjacency or cover restrictions as rotation ages shorten (see +ageX2, +age, -age, and –ageX2 sensitivities).

Table 2. Block 1 Sensitivity results

	Harvest	Change		Description
Run ID	(ha)	(ha)	%	
CMA	292	-	-	Area-based current management option
+Oe	294	2.0	0.7	Include Oce and Ohe polygons in THLB (1.0% of THLB)
-Oh	286	-6.0	-2.1	Remove helicopter operable polygons (1.6% of THLB)
-SI3m	236	-56.0	-19.2	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	309	17.0	5.8	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	239	-53.0	-18.2	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	283	-9.0	-3.1	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to mDBHq)
-midVQ	289	-3.0	-1.0	Use mid range disturbance target
+ageX2	196	-96.0	-32.9	Increase minimum harvest age by increasing mDBHq by 3X2=6cm
-ageX2	318	26.0	8.9	Decrease minimum harvest age by decreasing mDBHq by 3X2=6cm

4.0 Block 2 Analysis (Stafford-Apple-Heydon)

4.1 Current Management - 124 ha/year

Figure 10 summarizes for the current management or "base case" simulation, the trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting.

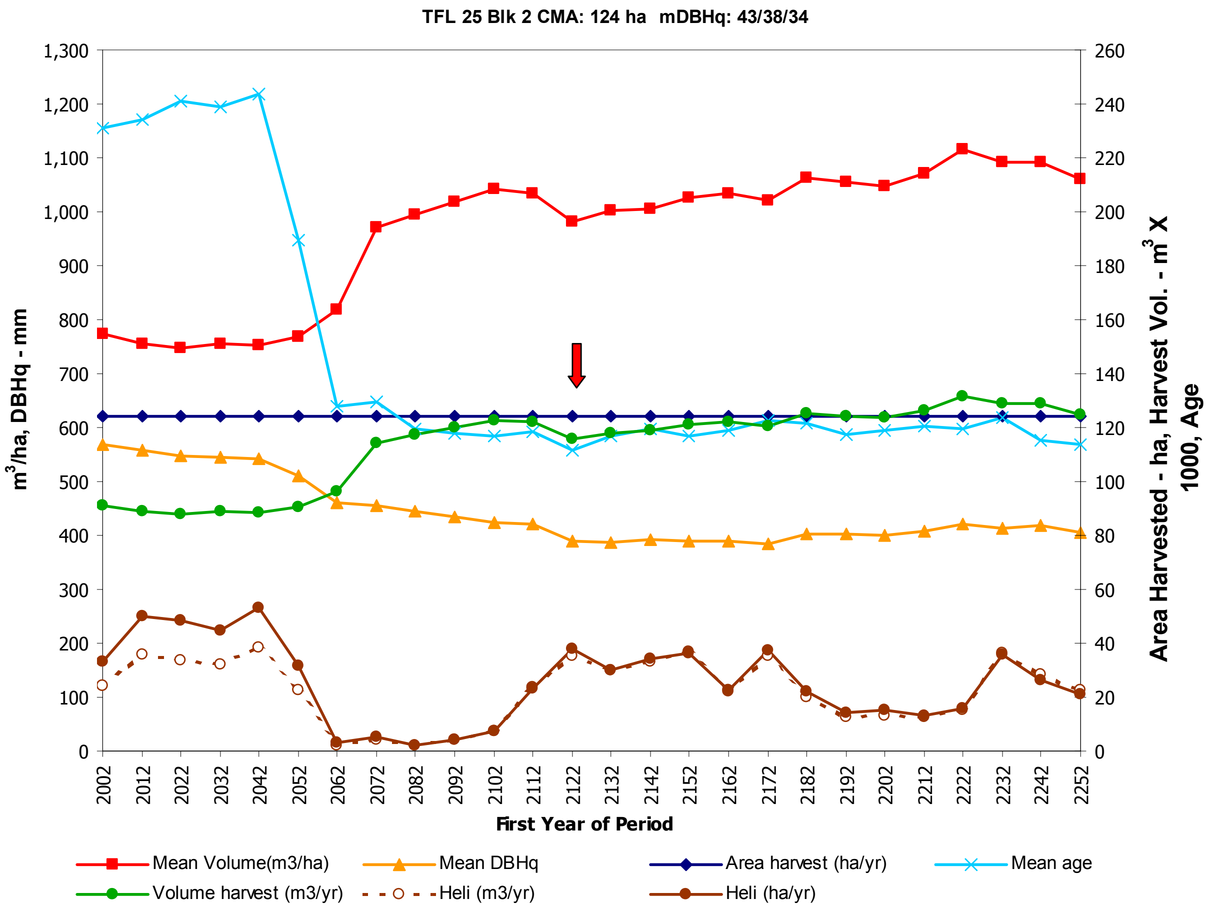

Figure 10. Block 2 Current Management harvest statistics through 250 years[14]

In this simulation the transition to second growth occurs quickly as average harvest age drops abruptly through the 2052 to 2062 periods and stabilizes around 113-124 years. Average stand diameter at harvest also drops abruptly at the transition and a gradual decline continues through the mid term before settling into the 39-42 cm range in the long term. As the second growth comes on stream

[14] Red arrow indicates point where area harvest deficit occurs if harvest request is increased by 1 ha.

average merchantable stand volumes at harvest “fall up”[11] from the old growth norm of about 750 m^3/ha to about 1000 m^3/ha and continue to trend upward to near 1100 m^3/ha in the long term. The volume harvest directly reflects the volume/ha trend as it holds steady at about 89,000 m^3/year, jumps to 115,000 after the transition, and slowly climbs to near 127,000 m^3/year in the long term.

In this block, timber only accessible to heli-logging makes up a significant portion of the land base and the harvest profile. In the current model configuration there is no satisfactory method to regulate the helicopter portion within the overall area regulation. However, a simulation of the flat line harvest flow from the helicopter-accessible land base only (CMA-Oc, Table 3) and the difference between the base case (CMA) and conventional only (CMA-Oh) harvest levels suggest that the helicopter portion makes up about 23-24 ha of the 124 ha annual flow forecast.

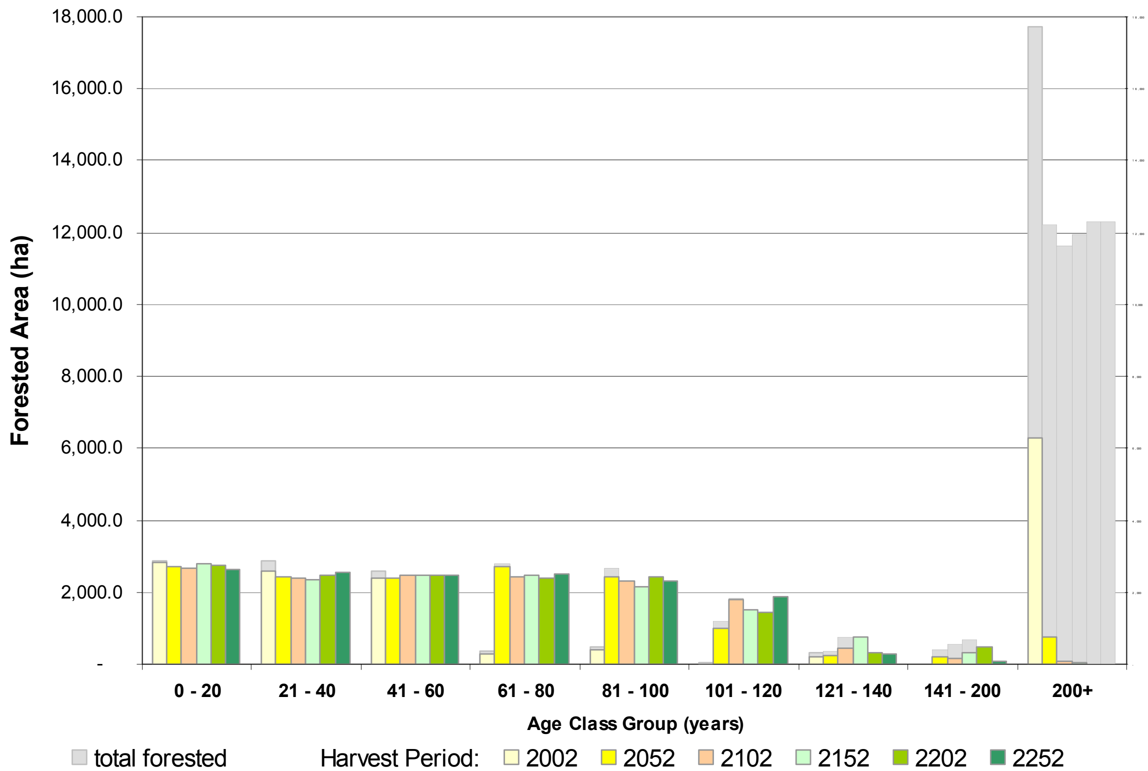

Figure 11. Age class progression on Block 2 THLB (+ total forested) for current management through 250 years

In this Block the indicated harvest level is less than both the LRSA and mLRSA calculations (Table 1). This illustrates that the pinch point or bottleneck at 2122 is preventing an optimal area harvest and in effect for most of the simulation stand harvests are delayed well beyond culmination age and beyond the mDBHq age. This pinch point is also noteworthy in that it is not associated with the old growth to second growth transition.

Age class distributions are examined in Figure 11. The younger age (≤ 60 years) classes remain relatively stable from the current state and occupy between 2,350 and 2,900 ha each indefinitely. Second growth age classes approaching harvestable ages increase significantly in the first 50-year period and then stabilize. 121- to 200-year-old stands are present in low abundance throughout the simulation and are actually increasing in abundance through the first century. On the THLB the oldest stands decline dramatically through the first part of the simulation as the transition to second growth harvesting is completed.

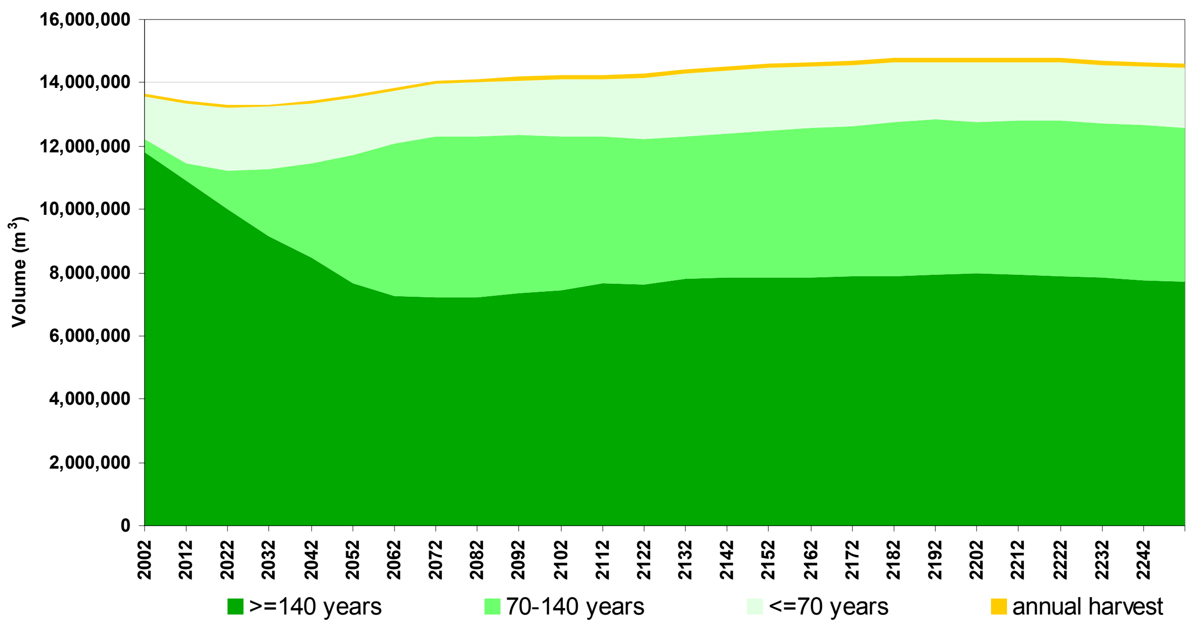

Figure 12. Merchantable growing stock on total Block 2 land base through 250 years

On the total forest land base, forest greater than 200 years old declines from the current level of just under eighteen thousand hectares to a stable long term level of about twelve thousand hectares. Old forest will continue to dominate this landscape under current management assumptions.

Figure 12 above illustrates gross growing stock levels for the total land base. Initially levels drop slightly and then slowly build to in excess of fourteen million cubic metres (m^3). The proportion of older forest drops initially from the current level of about twelve million m^3 and stabilizes at 7-8 million m^3. The older forest volume is replaced by middle-aged volumes (rising to 32-37%), whereas the younger stands remain more or less constant at around 11-15% of total merchantable growing stock. This fourteen million m^3 standing inventory of wood permanently provides substantial habitat and other environmental value while the smaller five million m^3 of 71- to 140-year-old stock therein provides the primary source of sustainable timber production (represented by the thickness of the orange “line” in Figure 12.

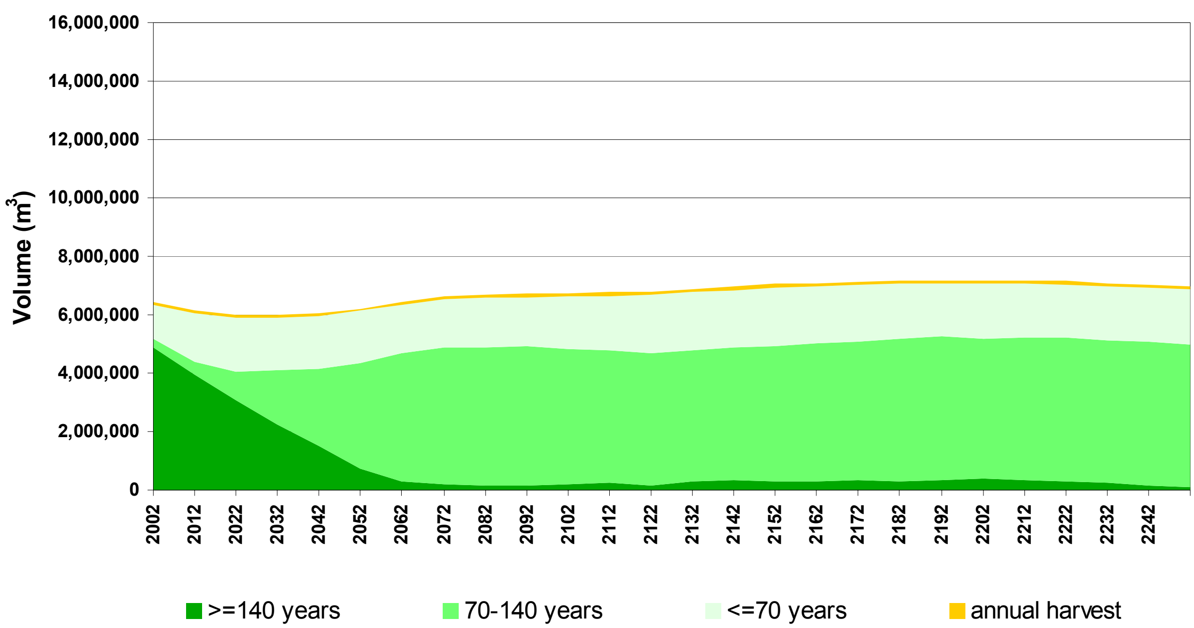

Figure 13. Merchantable growing stock on Block 2 THLB through 250 years

In future, the older growing stock volume is for the most part, but not entirely, in reserves or area projected to be unavailable for timber harvest. Figure 13 displays growing stock through time for the THLB only. For non-timber reasons, some harvestable timber is held significantly beyond normal rotation ages and reaches ages in excess of 140 years before other stands become equally or more suitable for satisfying the non-timber objective(s). When this timber is released, its harvest could provide a small but ongoing supply of older stems possibly suitable for specialty manufacturing or cultural purposes.

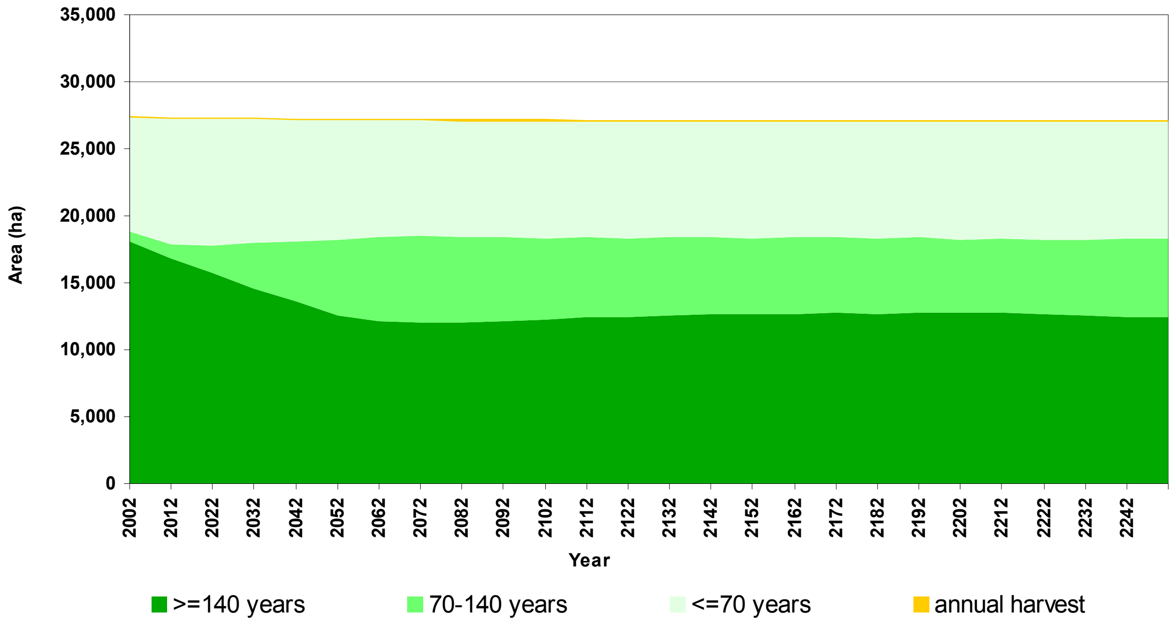

Figure 14. Age-group areas for Block 2 total land base through 250 years

Figure 14 is as per Figure 12 except data is presented on an area basis rather than a volume basis and simplifies the age class data presented in Figure 11.

Initially the area of old forest declines, the area of maturing stands increases, and the area of younger stands remains relatively stable. Contrary to popular opinion, as the transition from old forest progresses, at the landscape level old forest area is not replaced by clearcut area, but rather by 71- to 140-year-old stands. A century into the future under the current management regime, young stands will occur no more frequently than they do today and continue to occupy less than a third of the forested landscape throughout the simulation.

Figure 14 also demonstrates that the age class distribution is already different than the natural disturbance type (NDT1) or recent historical range of natural variability for the area would dictate. To impose or return to an age class distribution representative of infrequent disturbances would be very difficult as well as economically disruptive.

Figure 15 presents growing stock in terms of merchantable volume and area that is larger than the minimum harvestable DBHq.

Roughly 12,300 ha or 45% of the productive land base is unavailable for harvesting for the long term. Because the locations of future Wildlife Tree Patches and partial retention along streams could not be easily predicted, they were modelled as a yield curve volume net down. Consequently these net downs are not represented in any of the aforementioned Figures and the actual volume and/or hectares illustrated understate the old forest reserved from harvest by about 5% of THLB area or volume.

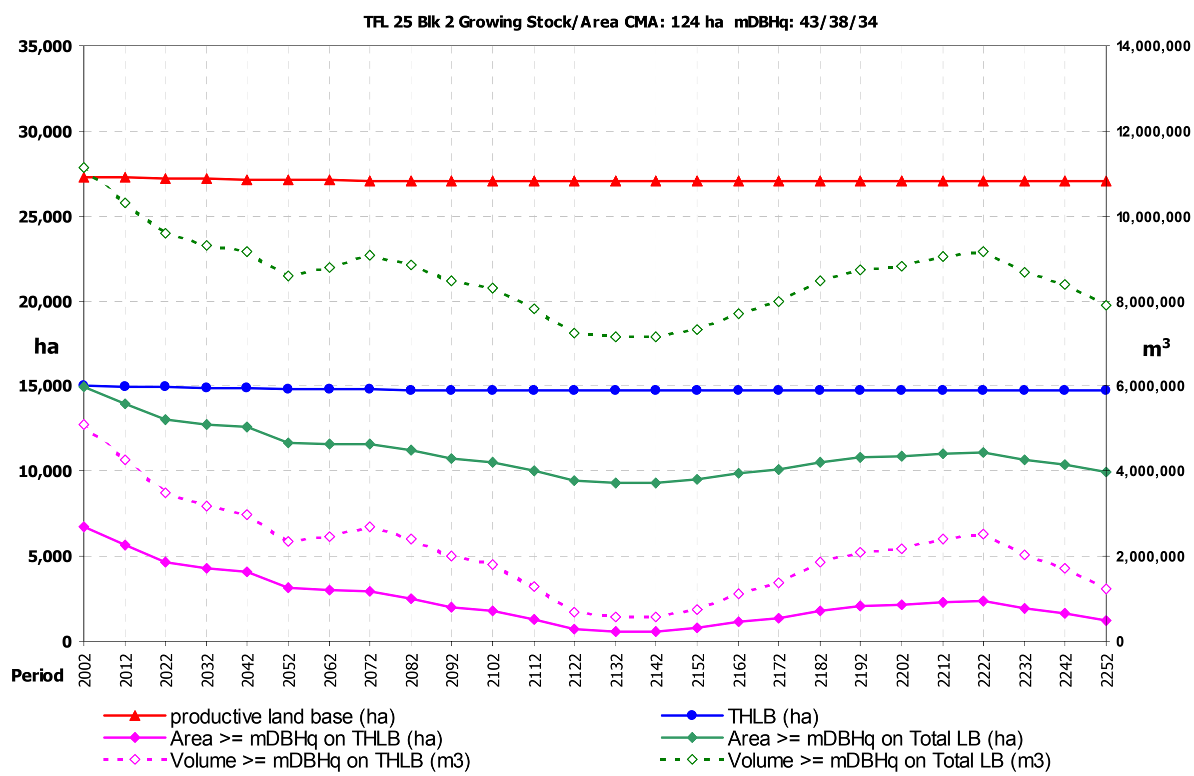

Figure 15. Merchantable growing stock in harvestable (>mDBHq) stands through 250 years for Block 2.

On the THLB, harvestable (>mDBHq) stands become less available until the pinch point is passed and then rebuid thereafter. At the low point harvestable stands amount to about 588 ha, or roughly 5 years worth of harvesting at the indicated harvest level. As the ratio of harvestable area to annual harvest is lower than in other blocks, policy factors such as adjacency are less important than the physical availablity of harvestable stands. The annual harvest area recommendation makes optimal use of the land base's residual timber capacity but operational flexibility could prove difficult through the 2122 to 2161 period. This pinch point rematerializes in the rotation beyond at the end of the simulation.

A strategic focus for silviculture treatments and density regimes could be to increase the number of harvestable stands through the 2122-2161 period where area available for harvesting is projected to be lowest. If the harvestability can be improved an Allowable Cut Effect could be realized. In terms of volume/ha and volume flow there is a slight decline associated with the pinch point so treatments that increase volume per hectare through this period would be of operational benefit.

Silviculture treatments which increase the future volume, merchantability or quality of stands outside the critical harvestability period would be more or less equal in terms of strategic importance and should therefore be ranked using stand-level financial analysis.

4.2 Alternate Harvest Levels

4.2.1 10% Increase

Figure 16 shows that a higher area harvest request induces large area and volume shortfalls starting seventy years into the future. Average harvest age and DBHq decline sooner, recover to base case levels and then decline again at the end of the simulation where a 130-year echo of the 2112 deficit occurs. Average volume per hectare becomes lower in association with area deficits as stands are harvested earlier than was the case in the current management run. Note however volume/ha is relatively unchanged elsewhere in the simulation so that relative to the current management simulation, this run produces 1.7% more volume (487,356 m^3 or 2,000 m^3 annually on average) through 250 years (see Appendix V-B, Table 12, page 106).

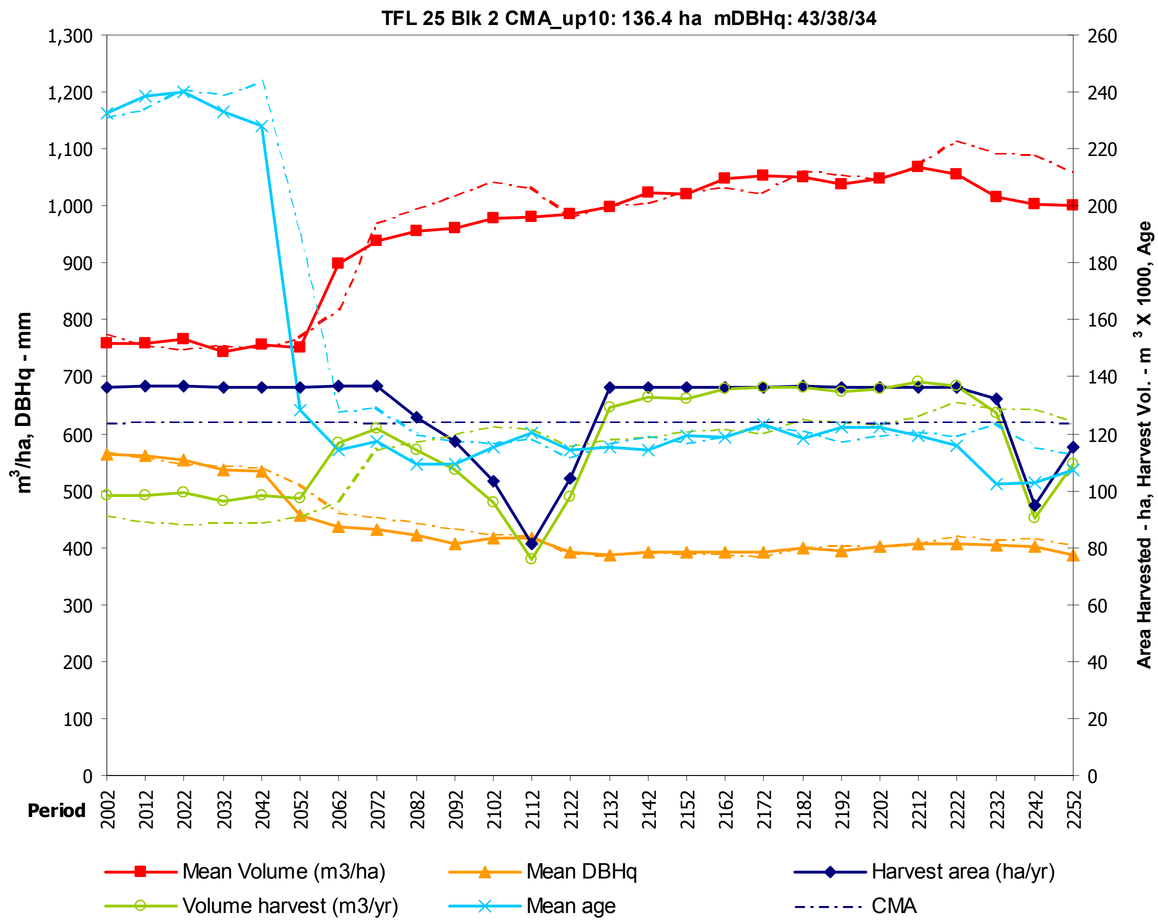

Figure 16. Block 2 harvest statistics[15] through 250 years for current management area harvest plus 10%

4.2.2 10% Decrease

Lowering the harvest request level by 10% has the effect in the short term of lowering the harvest volume about in proportion (-10.3%) to the area change. This is because existing old growth stands harvested in the short term are assumed to be neither adding nor losing volume through time. The lower request delays the transition to second growth by a decade but once second growth becomes an appreciable component of the harvest profile, harvest age and DBHq are significantly higher (longer rotation) with the result that stand volumes per hectare at harvest are higher as well. This tends to compensate for the loss of area harvested such that the overall volume harvest is less affected in the longer term (-5.0%) versus the short term (-10.3%) (Appendix V-B, Table 12).

[15] Dashed lines in background represent current management statistics.

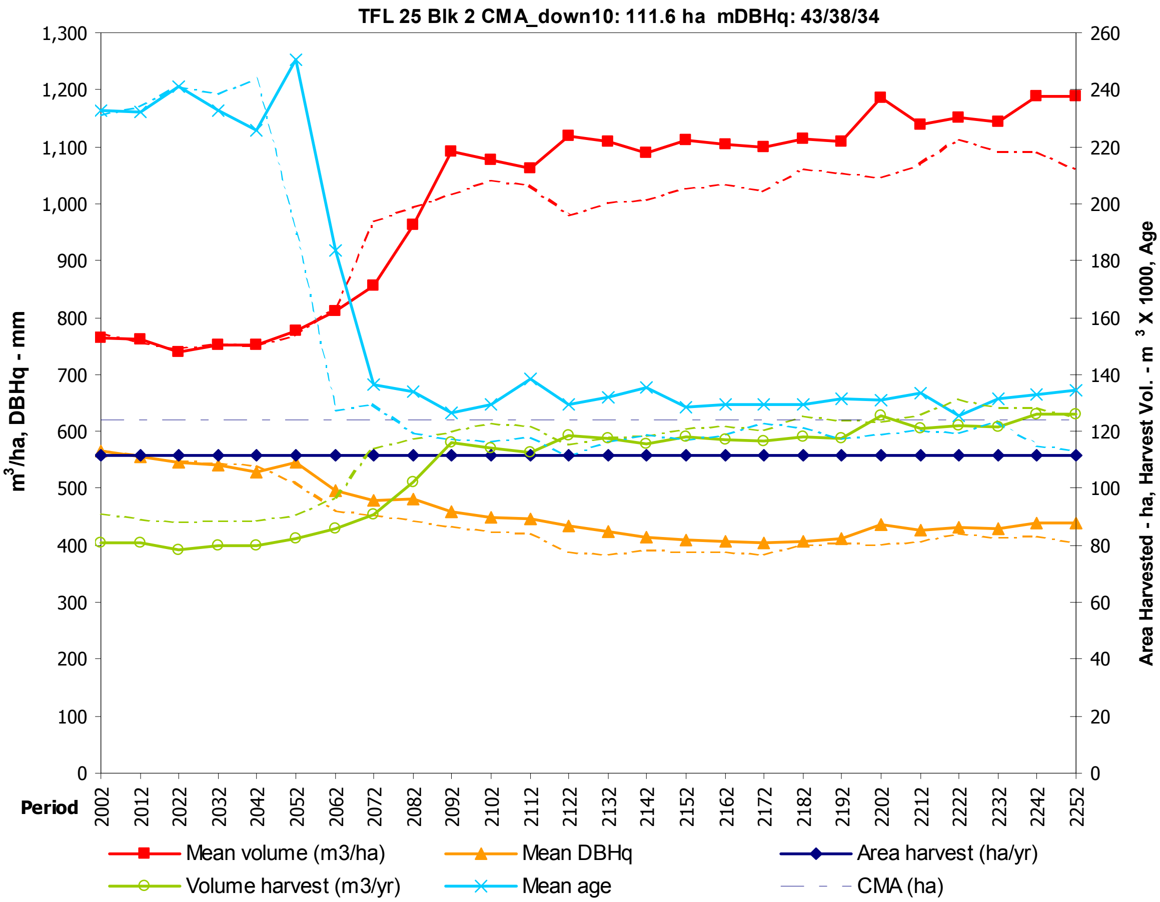

Figure 17. Block 2 harvest statistics[16] through 250 years for current management area harvest less 10%

4.3 Sensitivity Analyses

Harvest output statistics for all sensitivity runs are presented in Appendix V-A. In the harvest output graphs, decreases in area harvest relative to the base case are presented both unadjusted and as a new flat line. For increases in area harvest, a new, higher, flat-line harvest level was established. Flat-line flows were established by increasing area harvest requested until a deficit occurred, and then dropping back to the nearest whole number where the deficit disappears. Appendix V-B (p.103) summarizes changes in area (Table 10, Table 11) and near, mid, and long term volume (Table 12).

[16] Dashed lines in background represent current management statistics.

Table 3. Block 2 Sensitivity results

Run ID	Harvest (ha)	Change (ha)	Change %	Description
CMA	124	-	-	Area-based current management option
+Oe	126	2.0	1.6	Include Oce and Ohe polygons in THLB (3.7% of THLB)
-Oh	101	-23.0	-18.5	Remove helicopter operable polygons (20.0% of THLB)
-SI3m	106	-18.0	-14.5	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	142	18.0	14.5	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	105	-19.0	-15.3	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	120	-4.0	-3.2	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to mDBHq)
-midVQ	122	-2.0	-1.6	Use mid range disturbance target
+BEO	120	-4.0	-3.2	Apply specific BEOs to draft or legislated landscape units where not included in CM0
-Oc	24	-100.0	-80.6	Simulation on THLB accessible by helicopter only to estimate flat line portion of harvest attributable to helicopter harvesting.
-HRules	125	1.0	0.8	turn off oldest first and minimize growth loss harvest rules.

Table 3 presents the area results of sensitivity analyses for Block 2.

Block 2 is most sensitive to changes that alter the minimum harvest age (-SI3m, +/- age). Removing the area operable to helicopters only also has a large impact (-18.5%), but this area represents 20% of the THLB.

The –Oc run was done to test if the large fluctuation in the helicopter harvest component of the base case (Figure 10) was of management concern or merely a modelling artefact. As the flatline harvest indicated by –Oc is about the same as the deficit created by the –Oh run, the fluctuation is more likely a modelling artefact. Harvesting of helicopter operable polygons should target 100 to 120 ha for the next five years of cut control. If harvest average exceeds 17 ha/year (75% of –Oh area change) through the short term, disruptions of future harvest flows should be unlikely and later adjustments, if needed, would not have to be drastic.

5.0 Block 3 Analysis (Naka)

5.1 Current Management - 88 ha/year

Figure 18 summarizes for the Block 3 current management simulation, the trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting.

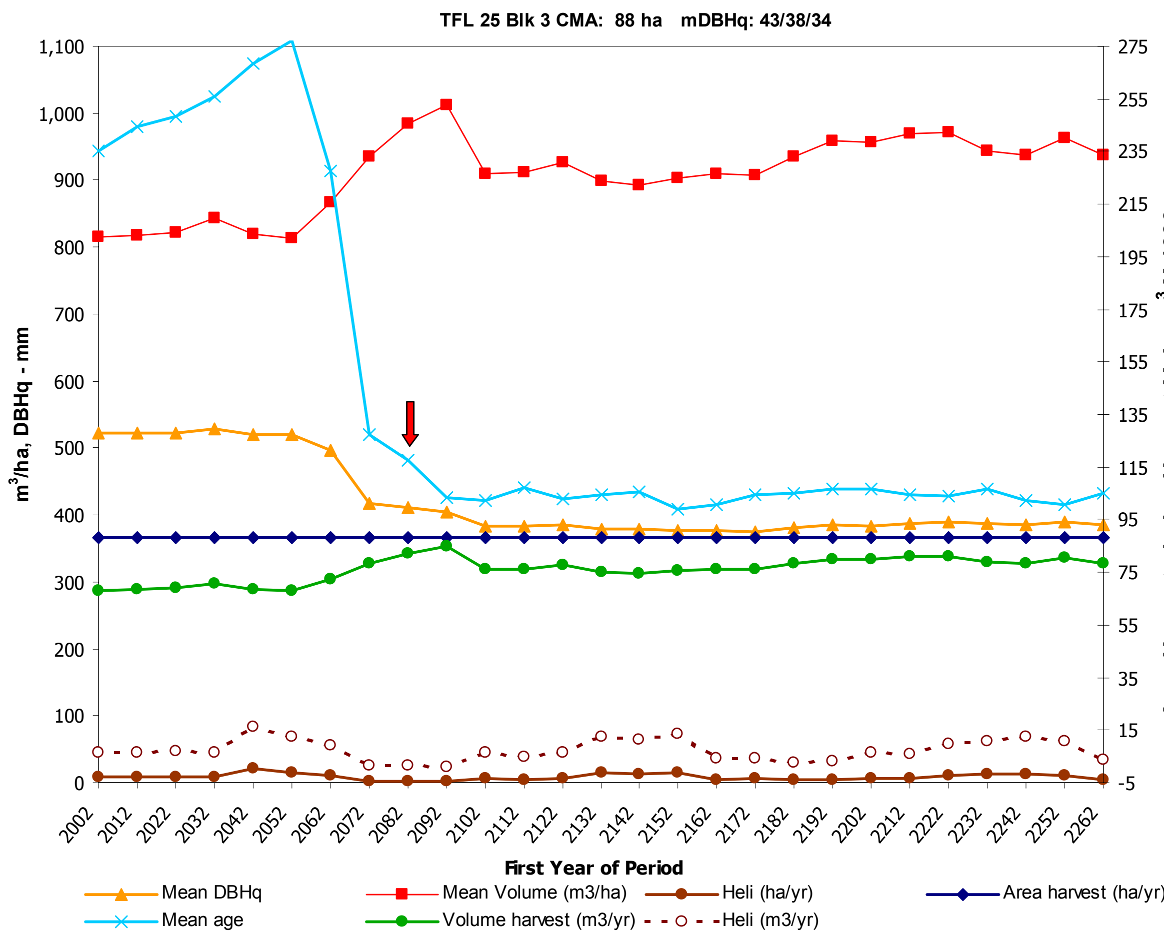

Figure 18. Block 3 Current Management harvest statistics through 250 years[17]

In this block the transition to second growth is abrupt. Average age and diameter of harvested stands declines rapidly within only two decades. Some older stands linger for another few decades and the pinch point occurs as the last of these are being harvested. The pinch point may be associated with an age class imbalance created by the sudden curtailment of harvesting in this block when Blocks 2, 3, and 5 were uncoupled for the purposes of AAC determination and cut control. Old forests make up the entire harvest profile until about 50 years into the future. As the transition progresses average merchantable stand volumes at harvest increase from just over 800 m^3/ha initially and with some fluctuation settle into the 940-970 m^3/ha range in the long term. This effect is primarily related to expected gains from current silviculture practices. As the area harvest is constant, annual harvest volumes increase[11] in tandem with the increasing stand volumes. In the long term, ages at harvest average 101-106 years and average harvest diameters are around 39 cm (individual stands ranging 30-47 cm).

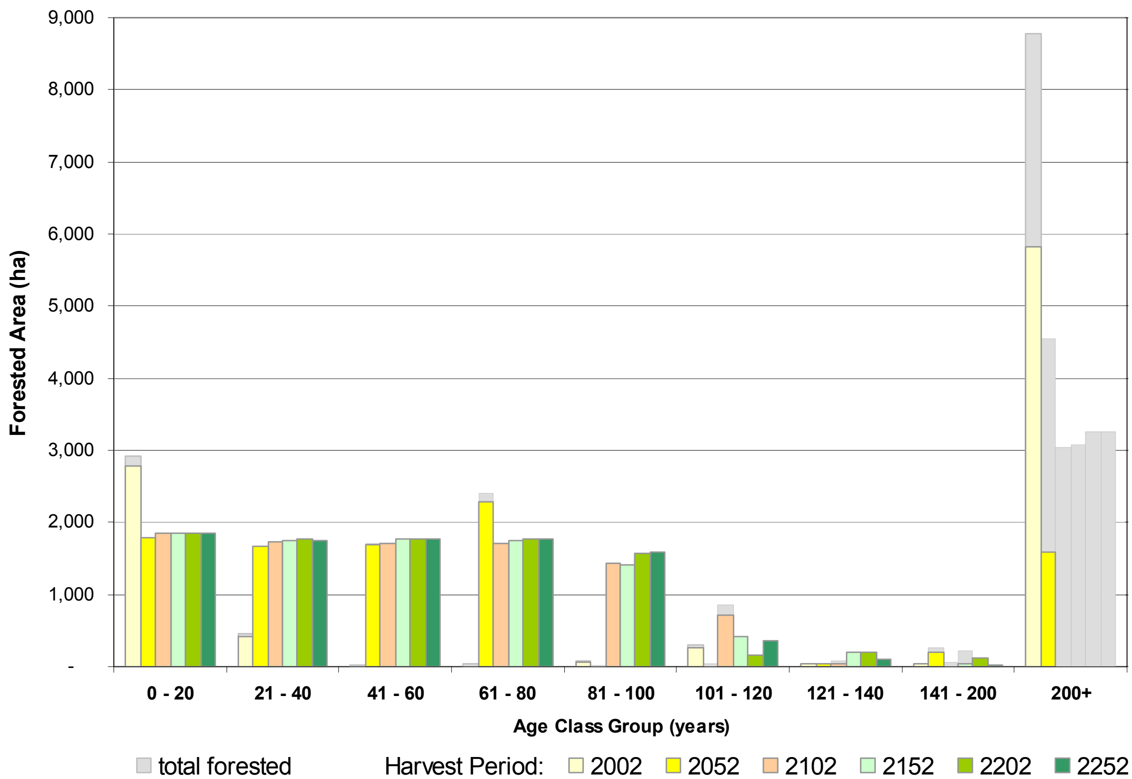

Figure 19. Age class progression on Block 3 THLB (+ total forested) for current management through 250 years

In this Block the LRSA and mLRSA calculations are very similar (Table 1) and the suggested harvest level falls between the two. On average in the long term,

17 Red arrow indicates point where an area harvest deficit occurs if harvest request is increased by 1 ha.

stands are harvested near culmination of mean annual increment and close to the threshold minimum harvest age needed to ensure profitability.

Age class distributions are examined in Figure 19. On the THLB, there is initially a disproportionate area in the youngest age class. Previously this block was the focus of harvesting for the combined Block 2, 3, 5 AAC and this regeneration pulse carries through from the 0-20 to the 61-80 age class by 2052. The 21-40 age class is low initially because harvesting began in this block only about 25 years ago. By the next century a more or less balanced age class distribution is attained. Harvestable second growth age classes increase dramatically by the next century and become the basis of the sustainable harvest. 101- to 200-year-old stands remain present in low abundance throughout the simulation. On the THLB the oldest stands decline dramatically through the first one hundred years of the simulation as the transition to second growth harvesting is completed.

On the total forest land base, forest greater than 200-years-old declines from the current level of about 8,800 ha to about 3,200 ha in the long term. This unharvested old forest should facilitate the perpetuation of most old-growth dependent processes or organisms and complement the 6,640 ha of adjacent ecological reserve and park in the Tsitika Valley.

Figure 20 illustrates gross growing stock levels for the total land base. Initially levels are about 7 million m^3 but decline to 5.6 million m^3 before recovering in the longer term to near 6 million m^3. The proportion of older forest drops from the current level of 6.7 million m^3 to about 2.3 million m^3 in the long term. The 6 million m^3 standing inventory of wood permanently provides the basis for sustainable timber flow in the long term and provides substantial habitat and other environmental benefits to supplement values in adjacent park land (6,640 ha). The proportion of younger growing stock increases initially and then stabilizes at about 22% of total growing stock. The 71- to 140-year-old growing stock provides the primary source of sustainable timber production (orange band) through the simulation.

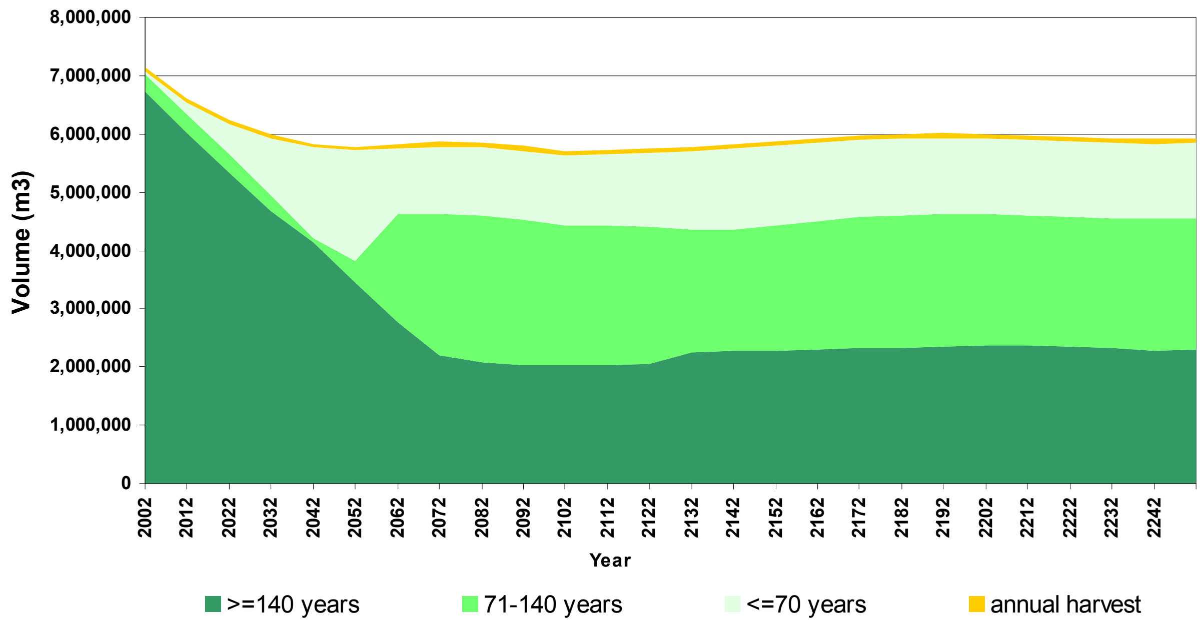

Figure 20. Merchantable growing stock on total Block 3 land base through 250 years

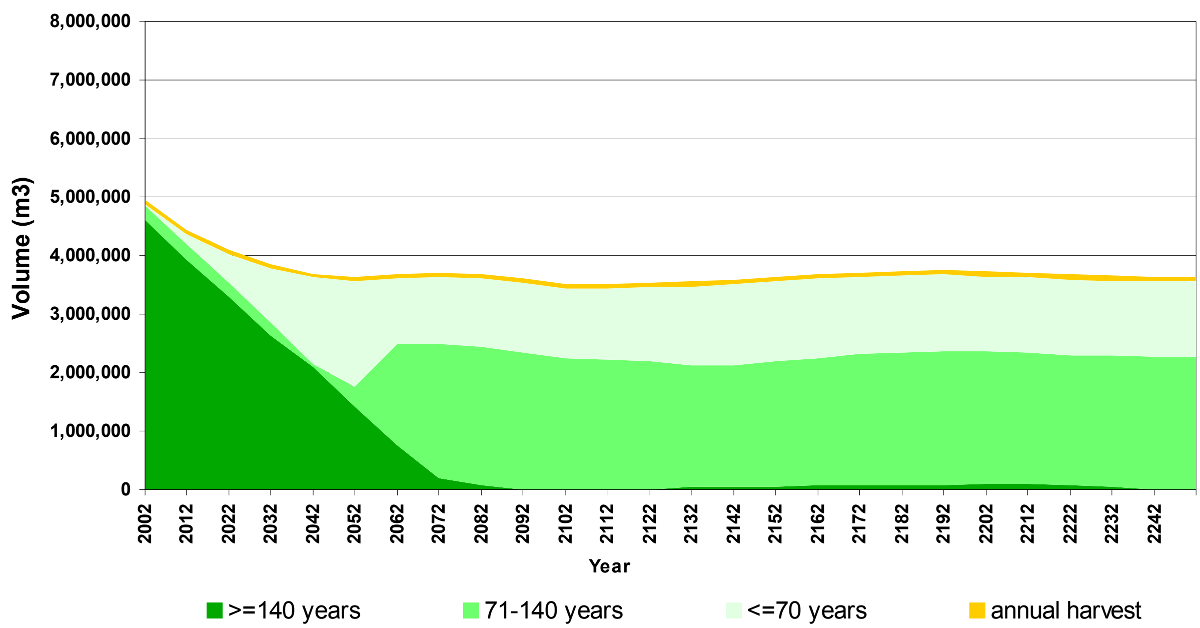

Figure 21. Merchantable growing stock on Block 3 THLB through 250 years

By the next century the older growing stock is for the most part, but not entirely, in reserves or area projected to be unavailable for timber harvest. Figure 21 displays growing stock through time for the THLB only. For non-timber or scheduling reasons, some timber is held significantly beyond normal rotation ages and reaches ages in excess of 140 years before being harvested. This harvest could provide a small but ongoing supply of older stems possibly suitable for specialty manufacturing or cultural purposes.

Figure 22 below is as per Figure 20 except data is presented on an area basis rather than a volume basis and simplifies the age class data presented in Figure 19.

Initially the area of old growth declines, the area of young stands increases and the area of maturing stands remains small. As the transition from old growth nears completion, at the landscape level old growth area is not replaced by clearcut area, but rather by maturing 71- to 140-year-old stands.

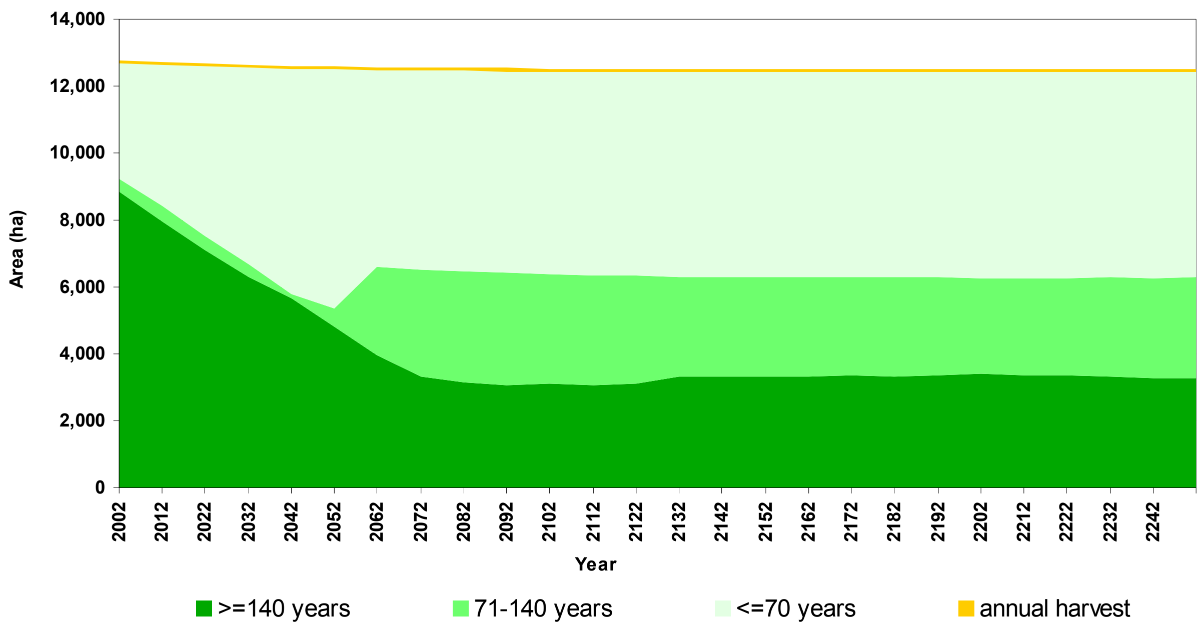

Figure 22. Age-group areas for Block 3 total land base through 250 years

Figure 22 also clearly demonstrates that the age class distribution is already different than the natural disturbance type (NDT1) or recent historical range of natural variability for the area would dictate. Clearly any attempt to impose or return to an age class distribution representative of infrequent disturbances would be very difficult and create timber shortages.

Figure 23 presents growing stock in terms of merchantable volume and area that is larger than the minimum harvestable[12] DBHq.

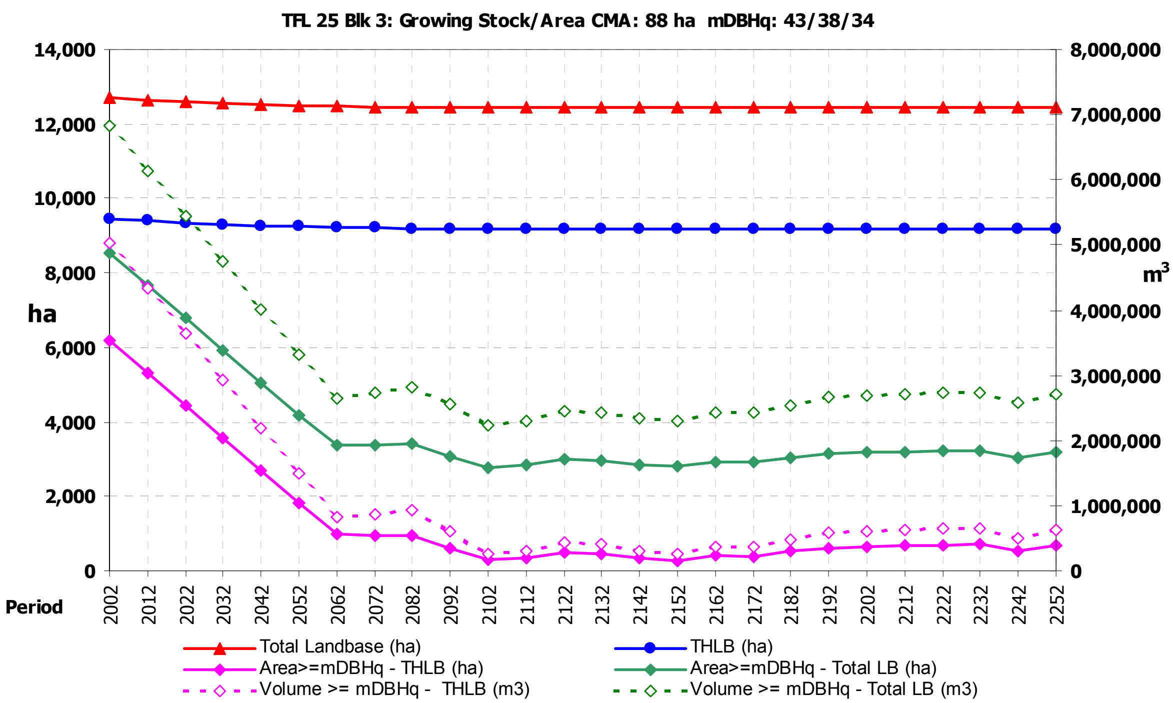

Figure 23. Merchantable growing stock in harvestable (>mDBHq) stands through 250 years for Block 3.

Roughly 3,250 ha or 26% of the productive land base is unavailable for harvesting for the long term. Because the locations of future Wildlife Tree Patches and partial retention along streams or elsewhere could not be easily predicted, they were modelled as a yield curve volume net down. Consequently these net downs are not represented in any of the aforementioned Figures and the actual volume and/or hectares illustrated understate the old forest reserved from harvest by about 5% of THLB area or volume.

On the THLB, harvestable stands become less available and at the pinch point 955 ha, or roughly 11 years worth of harvesting at the indicated harvest level, is of harvestable size. Two decades past the pinch point, this drops to 285 ha or only

3 years worth of harvesting suggesting that adjacency or cover factors are important at the pinch point but thereafter become less important as newly recruited stands are harvested soon after mDBHq is attained. By this point the annual harvest area recommendation makes near optimal use of the land base's residual timber capacity. Operational flexibility in the selection of harvest locations can be expected to be most limited around pinch points at 2102 and 2152.

A strategic focus for silviculture treatments could be to increase the harvestability of stands around the 2082 pinch point and through the 2092-2181 period where area available for harvesting is projected to be lowest. A second objective would be to increase volume/ha during the anticipated dips from 2042 to 2061 and 2102 through 2192 (Figure 18). Otherwise silviculture treatments which increase the future volume, merchantability or quality of stands maturing within the next century may be more or less equal in terms of strategic importance and should therefore be ranked using stand-level financial analysis.

5.2 Alternate Harvest Levels

5.2.1 10% Increase

Figure 24 shows that a higher area harvest request induces area and volume shortfalls at the transition to second growth and several points in the simulation thereafter. Average harvest age and DBHq dips sooner and remains somewhat lower in the long term. Average volume per hectare is lower and declining in the longer term as stands are harvested earlier than was the case in the current management run. Note that relative to the current management simulation, this run produces slightly more volume (267,522 m^3 or 1.4%) through 250 years (Appendix V-B, Table 12), most of which is realized in the nearer terms.

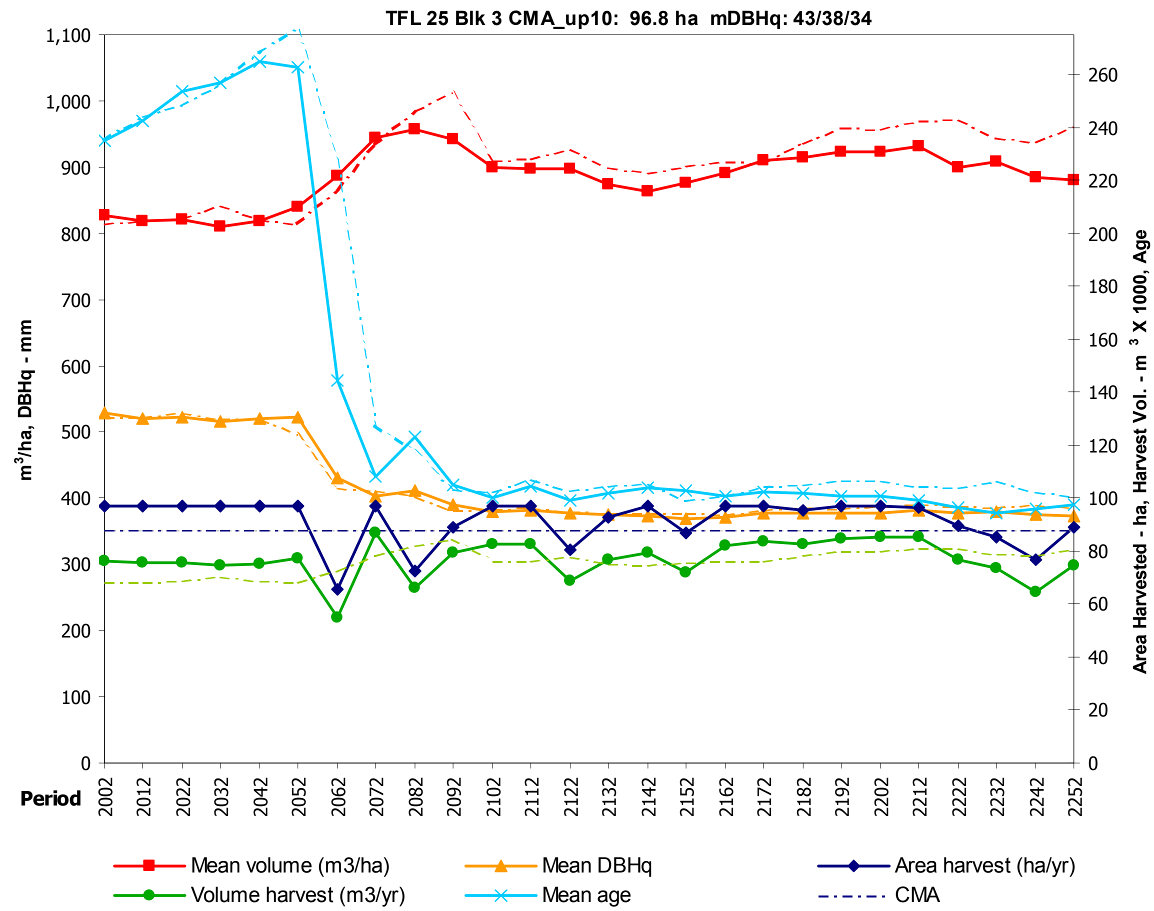

Figure 24. Block 3 harvest statistics[18] through 250 years for current management area harvest plus 10%

5.2.2 10% Decrease

Lowering the harvest request level by 10% (Figure 25) has the effect in the short plus mid term of lowering the harvest volume in proportion (-10.4%) to the area change. This is because existing old growth stands are assumed to be neither adding nor losing volume through time. Once second growth becomes an appreciable component of the harvest profile, harvest age and DBHq are significantly higher (longer rotation) with the result that stand volumes per hectare at harvest are higher as well. This tends to compensate for the loss of area harvested such that the overall volume harvest is less affected in the longer term (-4.6%) (Appendix V-B, Table 12).

[18] Dashed lines in background represent current management statistics.

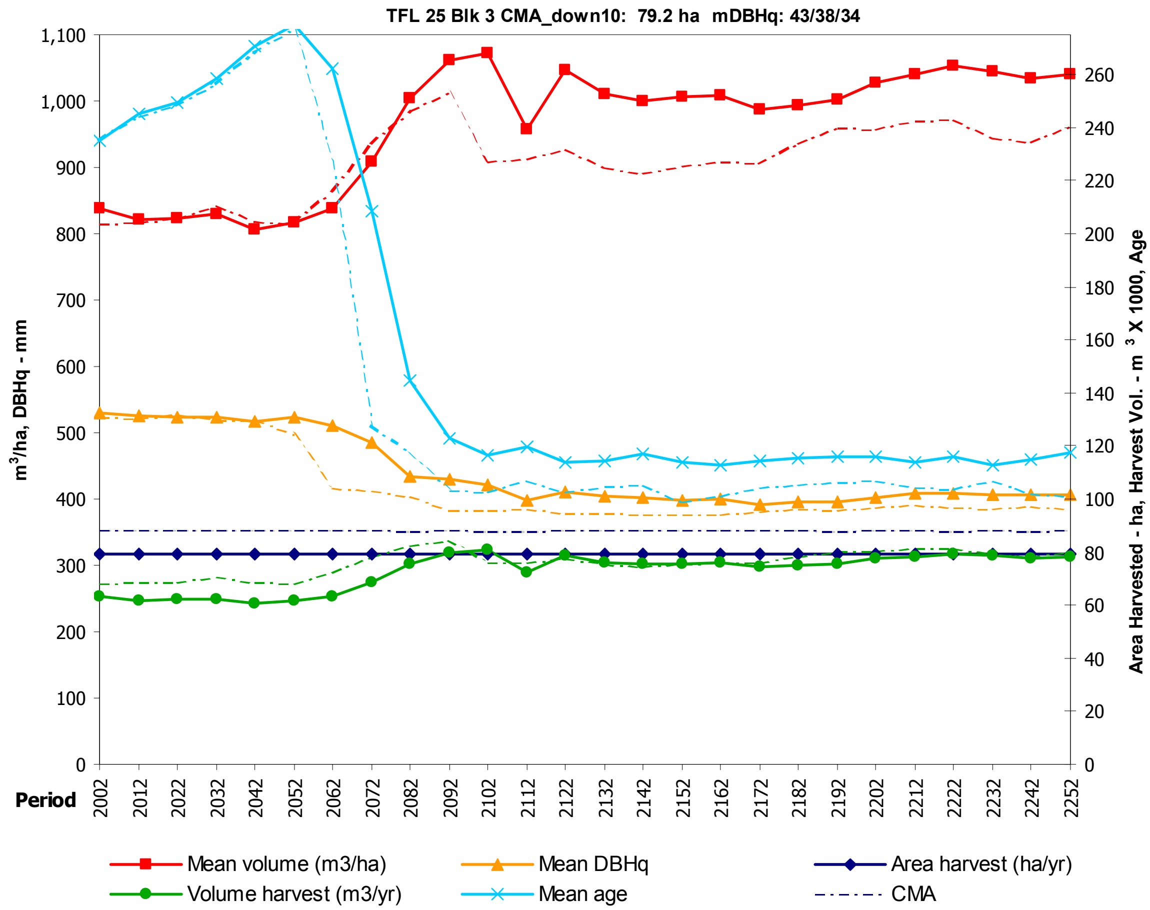

Figure 25. Block 3 harvest statistics through 250 years for current management area harvest less 10%

5.3 Sensitivity Analyses

Harvest output statistics for all sensitivity runs are presented in Appendix V-A. In the harvest output graphs, decreases in area harvest relative to the base case are presented both unadjusted and as a new flat line. For increases in harvest opportunity, a new, higher, flat-line harvest level was established. Flat-line flows were established by increasing area harvest requested until a deficit occurred, and then dropping back to the nearest whole number where the deficit disappears. Appendix V-B (p.103) summarizes changes in area (Table 10, Table 11) and near, mid, and long term volume (Table 12).

Table 4 presents the area results of sensitivity analyses for Block 3.

Block 3 is most sensitive to changes that alter the minimum harvest age (-SI3m, +/- age). Removing the area operable only by helicopter has an impact (-9.1%), about proportional to the 8.9% of the THLB excluded from the simulation.

Visual quality is an important issue along the shores of Johnstone Strait and further reducing the allowable disturbance in this area had an impact of –8.0%.

Table 4. Block 3 Sensitivity Results

	Harvest	Change		Description
Run ID	(ha)	(ha)	%	
CMA	88	-	-	Area-based current management option
+Oe	90	2.0	2.3	Include Oce and Ohe polygons in THLB (2.3% of THLB)
-Oh	80	-8.0	-9.1	Remove helicopter operable polygons (8.9% of THLB)
-SI3m	71	-17.0	-19.3	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	101	13.0	14.8	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	74	-14.0	-15.9	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	84	-4.0	-4.5	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to mDBHq)
-midVQ	81	-7.0	-8.0	Use mid range disturbance target

6.0 Block 5 Analysis (Central Coast)

6.1 Current Management

6.1.1 Protected Area Candidates Included – 492 ha/year

Figure 26 summarizes for the current management or “base case” simulation, the trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting.

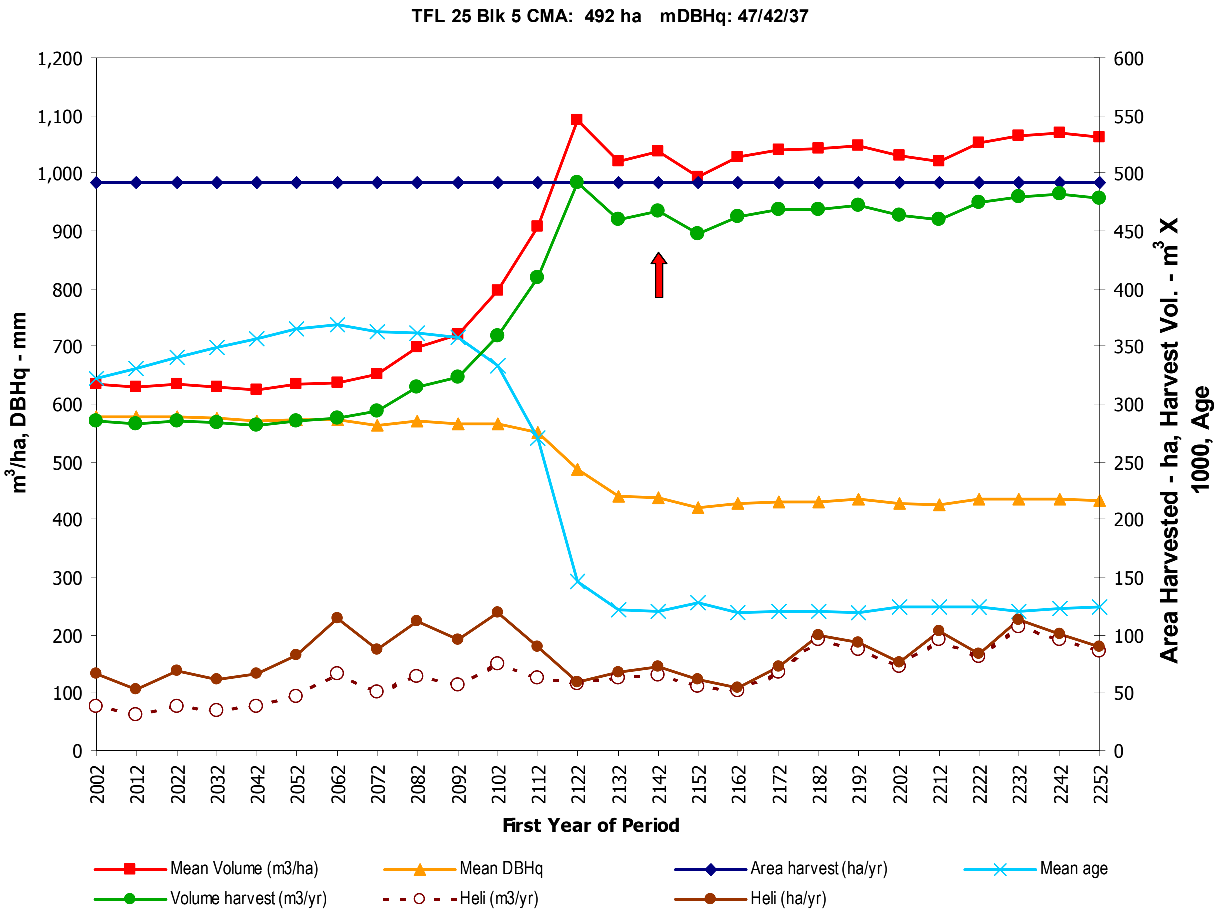

Figure 26. Block 5 Current Management harvest statistics through 250 years[19]

In this Block the primary transition to second growth is not forecast to occur until the start of the next century hence average stand age at harvest climbs until second growth harvesting becomes common. Mean diameters of harvested

[19] Red arrow indicates point where an area harvest deficit occurs if harvest request is increased by 1 ha.

stands remain relatively constant as existing old stands are assumed to neither grow or decline. However a slight downward trend in DBHq, a flattening harvest age trend, and a slow increase in volume per hectare are evident after sixty years, indicating that a small proportion of second growth begins contributing to the harvest before the primary transition occurs. The bulk of the harvest will be from old forest for at least the next one hundred years.

The primary transition to second growth occurs rapidly within a 30-year period as harvest age and DBHq drop sharply. As the transition progresses average merchantable stand volumes at harvest increase from under 650 m^3/ha to the 1000-1070 m^3/ha range in the long term. This effect is primarily related to expected gains from current silviculture practices. As neither site series ecological mapping nor a Vegetation Resource Inventory have been completed for this Block, the second growth yield forecasts used are less certain than in other Blocks. It is conceivable that second growth yield is overstated, yet the volumes/ha indicated are comparable to Block 5 where both ecological mapping and VRI have been recently completed or updated. In any event, the harvest for the foreseeable future is not second growth dependent.

As the area harvest is constant, annual harvest volumes increase[11] in tandem with the increasing stand volumes. In the long term, ages at harvest average 120-124 years and average harvest diameters are around 42-44 cm (individual stands ranging up to 65+ cm).

In this Block the indicated harvest level is well below the LRSA and slightly below mLRSA calculations (Table 1, p.6), suggesting that near the pinch point (circa 2142) and beyond stands are on average harvested near the threshold minimum harvest age needed to ensure profitability and well beyond the culmination of mean annual increment.

Harvest from helicopter-operable polygons averages 83 ha per year through the simulation.

Age class distributions are examined in Figure 27. On the THLB, the younger age classes initially increase from current levels and then stabilize through the remainder of the simulation. Second growth stands in the 61-100 age classes do not increase significantly until the second century and then stabilize. 101- to 200-year-old stands build modestly through the simulation and 250 years into the simulation occupy more area than at present. On the THLB the oldest stands decline dramatically through the first half of the simulation as old forest is harvested but small amounts do remain indefinitely.

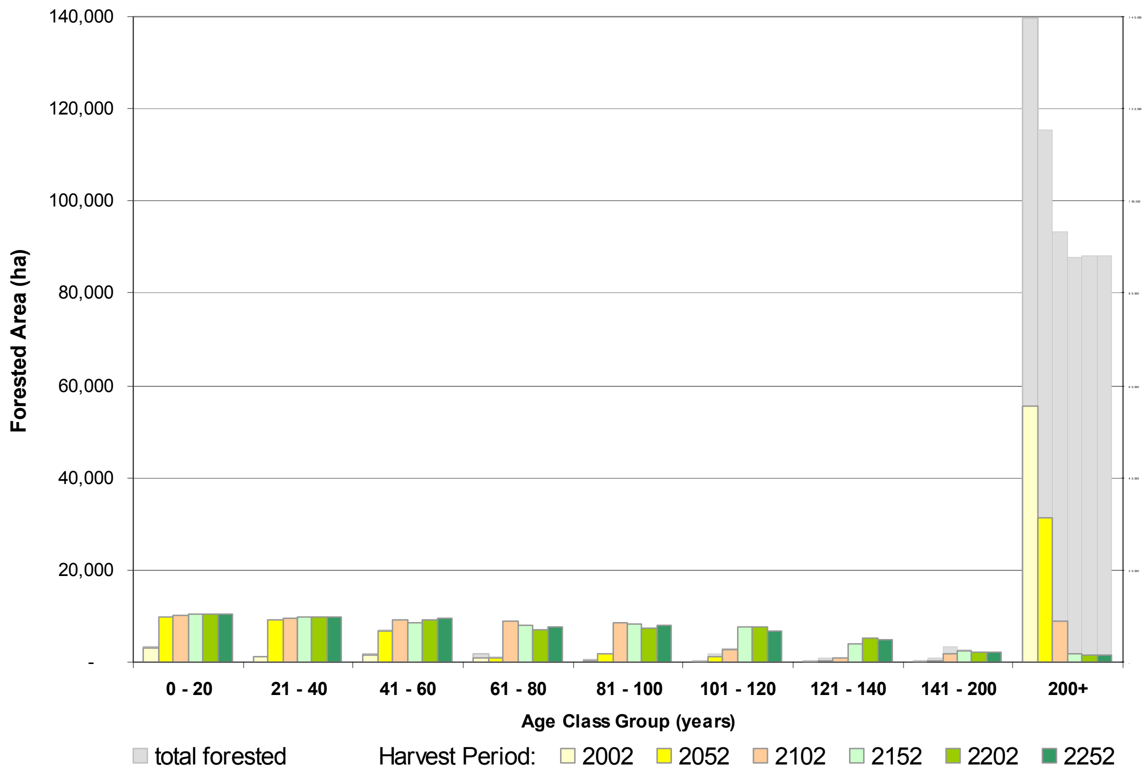

Figure 27. Age class progression on Block 5 THLB (+ total forested) for current management through 250 years

On the total forest land base, forest greater than 200 years old declines from the current level of just under 140,000 ha to about 63% of that level in the long term. At least 88,000 hectares of old forest is forecasted to be present and contributing to the perpetuation of old-growth dependent processes and organisms in the long term.

Figure 28 illustrates gross growing stock levels for the total land base. Initially levels are about 76 million m^3 and fall to about 66 million m^3 through the old forest harvesting phase before recovering to 70 million m^3 in the longer term. The proportion of older forest drops initially from the current level of 74 million m^3 to about 43 million m^3 and then stabilizes near 44 million m^3 in the long term. The 66-76 million m^3 standing inventory of wood permanently provides the basis for sustainable timber flow in the long term and provides substantial habitat and other environmental benefits supplementing values present in the adjacent Fiordland Recreation Area (84,750 ha).

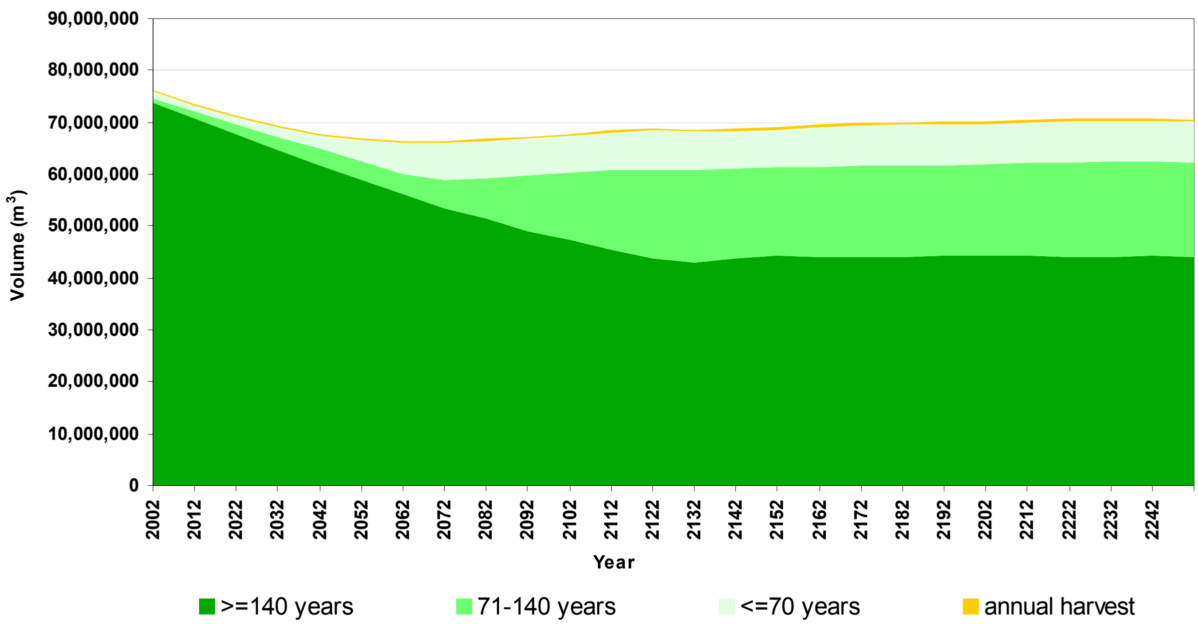

Figure 28. Merchantable growing stock on total Block 5 land base through 250 years

The proportion of younger growing stock increases gradually and then stabilizes at about 11% of total growing stock. The 71- to 140-year-old growing stock, amounting to 26% of total growing stock in the long term, provides the primary source of sustainable timber production through the simulation (represented by the thickness of the orange “line”).

The older growing stock is for the most part, but not entirely, in reserves or area projected to be unavailable for timber harvest. Figure 29 displays growing stock through time for the THLB only. For non-timber reasons, 9-12% of growing stock is held significantly beyond normal rotation ages and reaches ages in excess of

140 years before other stands become equally or more suitable for satisfying the model's non-timber objective(s). When this timber is released, its harvest could provide a small but ongoing supply of older stems possibly suitable for specialty manufacturing or cultural purposes.

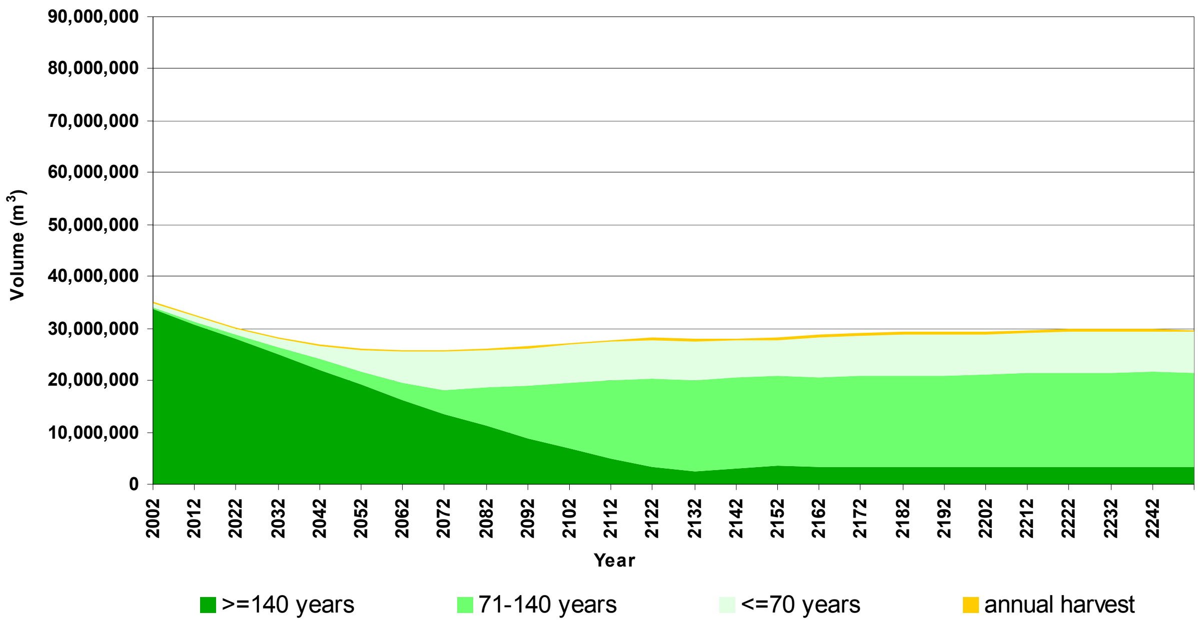

Figure 29. Merchantable growing stock on Block 5 THLB through 250 years

Figure 30 below is as per Figure 28 except data is presented on an area basis rather than a volume basis and simplifies the age class data presented in Figure 27.

The area of old forest declines gradually and the area of young forest increases in proportion through the first 70 years. As the transition to second growth harvesting approaches, the area of younger forest stabilizes and the area of maturing forest builds to provide the basis of a sustainable second growth harvest after the transition. Even in the long term, old forests would dominate this landscape.
Figure 31 presents growing stock in terms of merchantable volume and area that is larger than the minimum harvestable[12] DBHq.

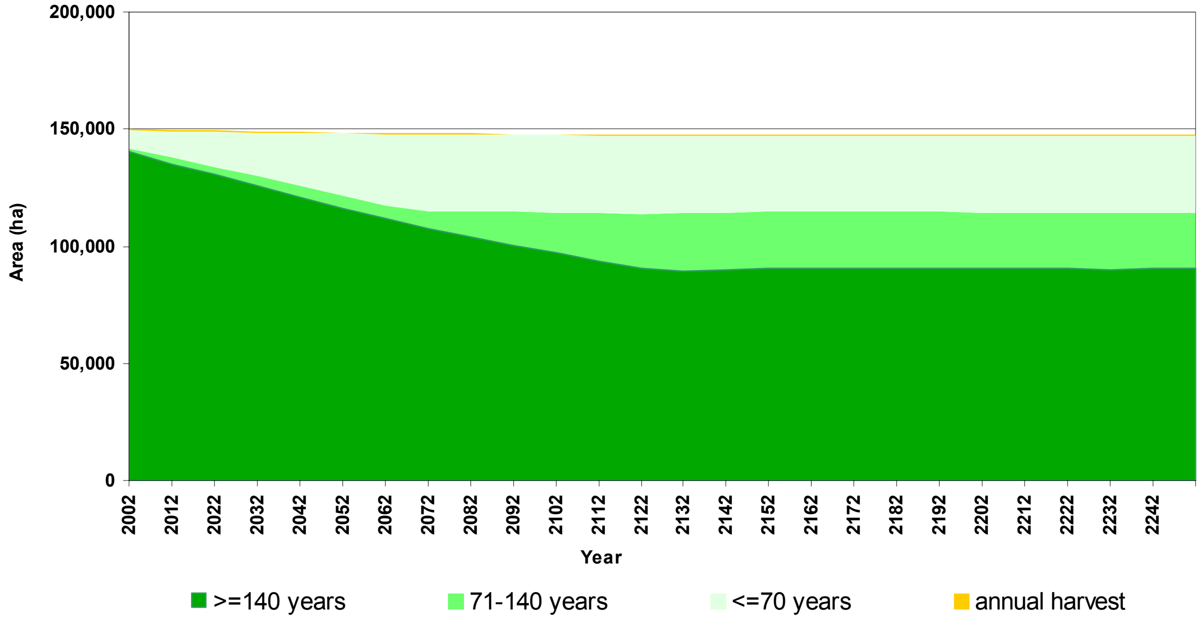

Figure 30. Age-group areas for Block 5 total land base through 250 years

Roughly 86,000 ha or 59% of the productive land base is unavailable for harvesting for the long term. Because the locations of future Wildlife Tree Patches, partial harvests along streams, or retention associated with ecosystem-based management could not be easily predicted, they were modelled as a yield curve volume net down. Consequently these net downs are not represented in any of the aforementioned Figures and the actual volume and/or hectares illustrated understate the old forest reserved from harvest by about 8.5% of THLB area or volume.

On the THLB, harvestable stands become less available until the pinch point and at 2152 amount to about 2,900 ha, or roughly 6 years worth of harvesting at the indicated harvest level. This confirms that the annual harvest area recommendation, after considering non-timber values, makes more or less optimal use of the land base's residual timber capacity while maintaining flexibility to locate harvest blocks. Operational flexibility in the selection of harvest locations can be expected to be most limited through the 2142 through 2181 period where that ration or harvestable area to annual harvest is lowest.

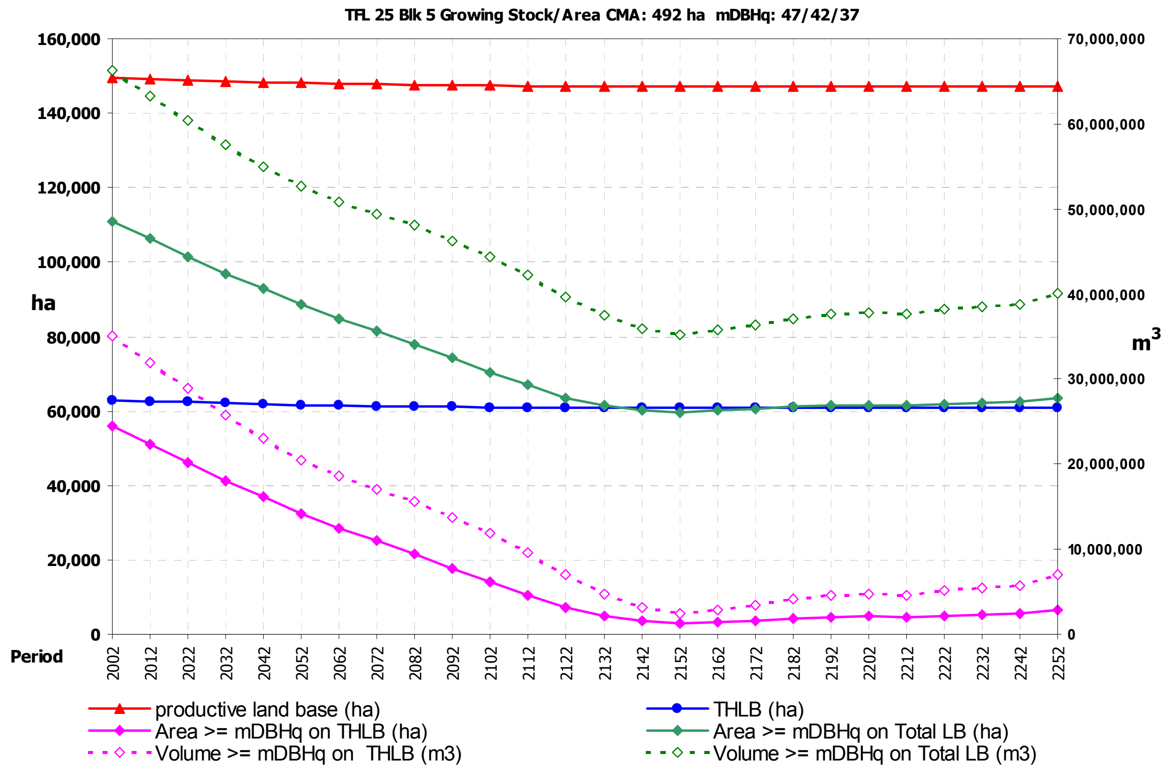

Figure 31. Merchantable growing stock in harvestable (>mDBHq) stands through 250 years for Block 5

Silviculture treatments to increase the harvestability or volumes of stands through the 2142-2181 period may prove worthwhile, but given the modelling and land use uncertainties involved, require more study before recommendation. Silviculture treatments which increase the future volume, merchantability or quality of stands may be more or less equal in terms of strategic importance and should therefore be ranked using stand-level financial analysis.

6.1.2 Protected Area Candidates Excluded – 364 ha/year

Figure 32 summarizes the current management simulation with Candidate Protected areas excluded. Trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting are presented.

In this simulation the output statistics and characteristics relative to the base case - with the large exceptions of area and volume harvested - are relatively unchanged. Annual area and short term volume harvest are reduced by 26% or

128 ha and 74,000 m^3/year. In the long term the impact is greater as annual volume harvest is reduced 128,000 m^3/year (27%) by the end of the simulation.

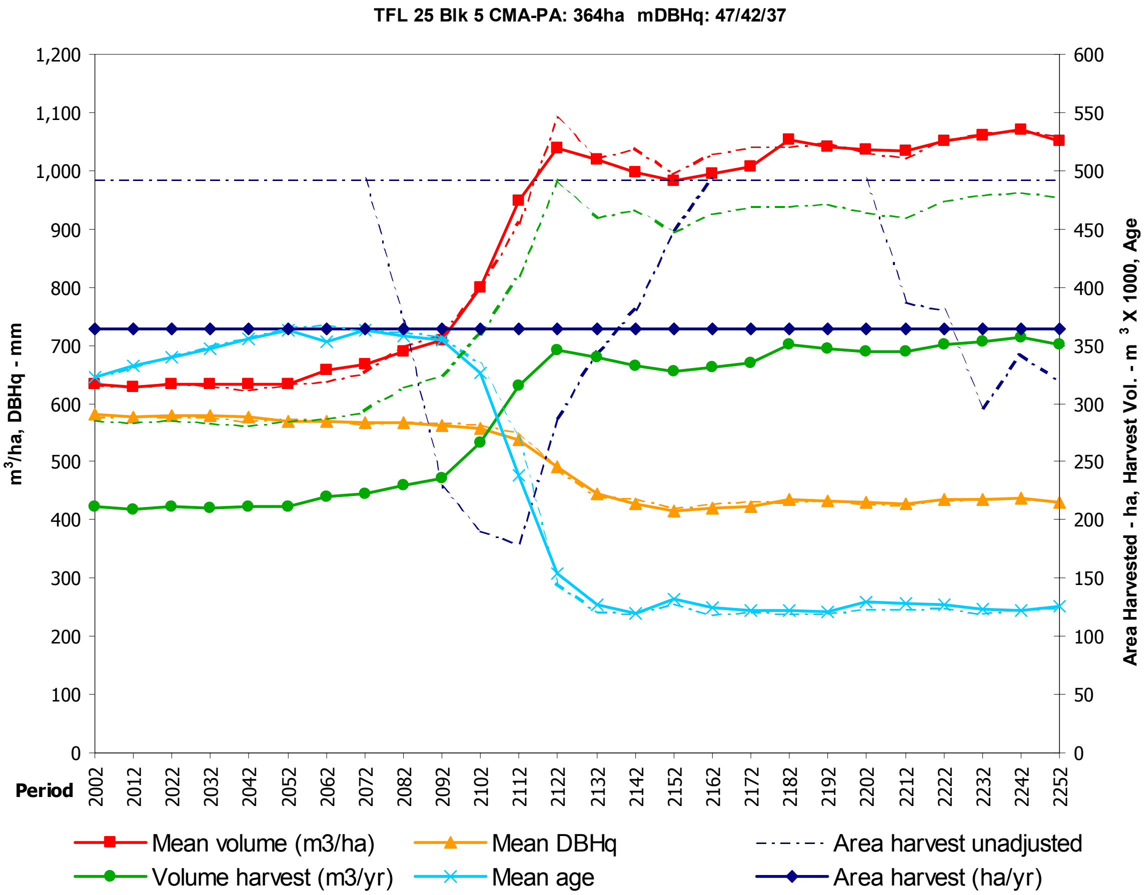

Figure 32. Block 5 Current Management with Candidate Protection Areas excluded - harvest statistics through 250 years[20]

6.2 Alternate Harvest Levels

6.2.1 10% Increase

Figure 33 shows that a higher area harvest request induces area and volume shortfalls at the transition to second growth and advances the transition by a decade. Note that the volume trough created at 2112 remains above volume estimates for the next 80 years. Average harvest age and DBHq dips sooner but is only slightly lower in the long term. Average volume per hectare trends somewhat lower in the long term. Note that relative to the current management

[20] Dashed lines in background represent current management statistics.

simulation, this run produces more volume (5,789,110 m^3 or 23,200 m^3 annually on average) through 250 years (see Appendix V-B, Table 12).

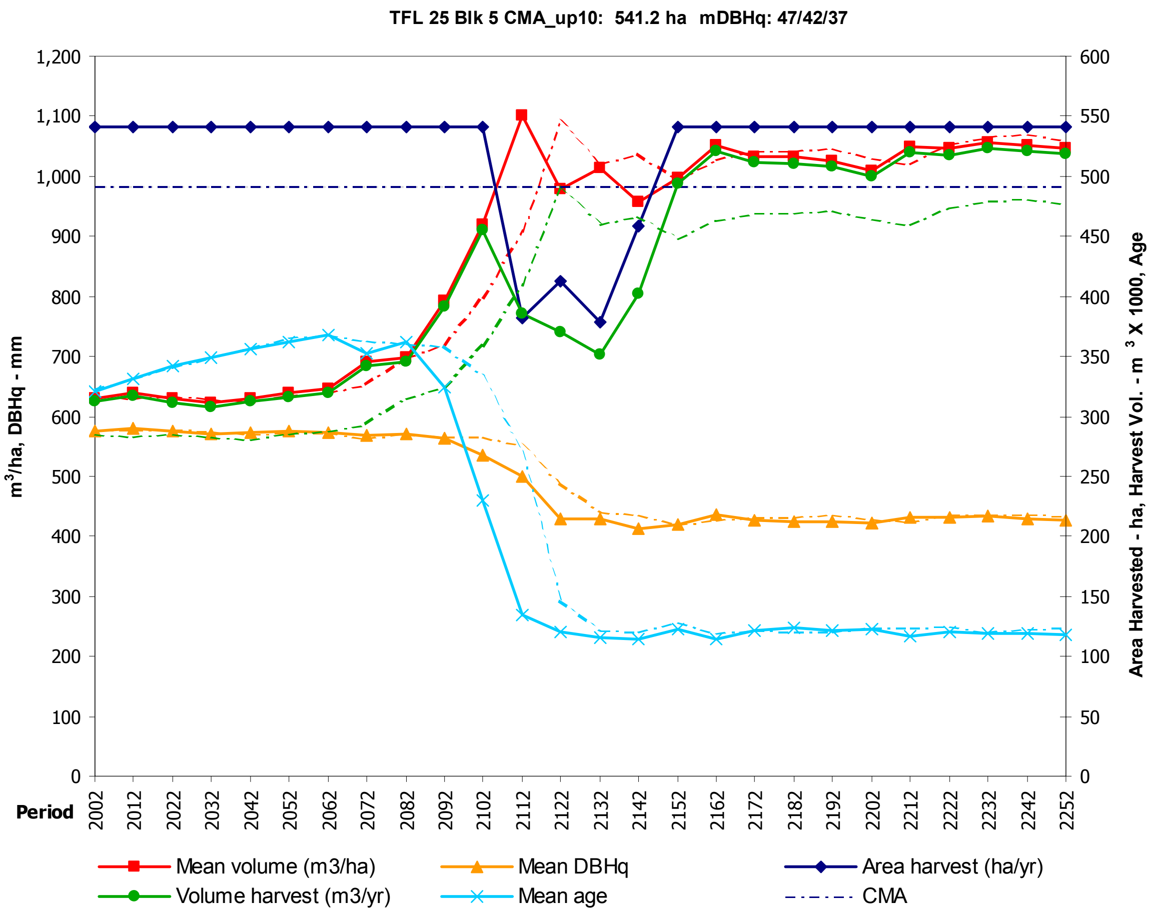

Figure 33. Block 5 harvest statistics through 250 years for current management area harvest plus 10%

6.2.2 10% Decrease

Lowering the harvest request level by 10% (Figure 34) has the effect in the short plus mid term of lowering the harvest volume in proportion (-10.0%) to the harvest area change. This is because existing old growth stands are assumed to be neither adding nor losing volume through time. Once second growth becomes an appreciable component of the harvest profile, harvest age and DBHq are higher (longer rotation) with the result that stand volumes per hectare at harvest are higher as well. This tends to compensate for the loss of area harvested such that the overall volume harvest is somewhat less affected in the longer term (-9.2%) (Appendix V-B, Table 12) and near the end of the simulation (-4 to -7%).

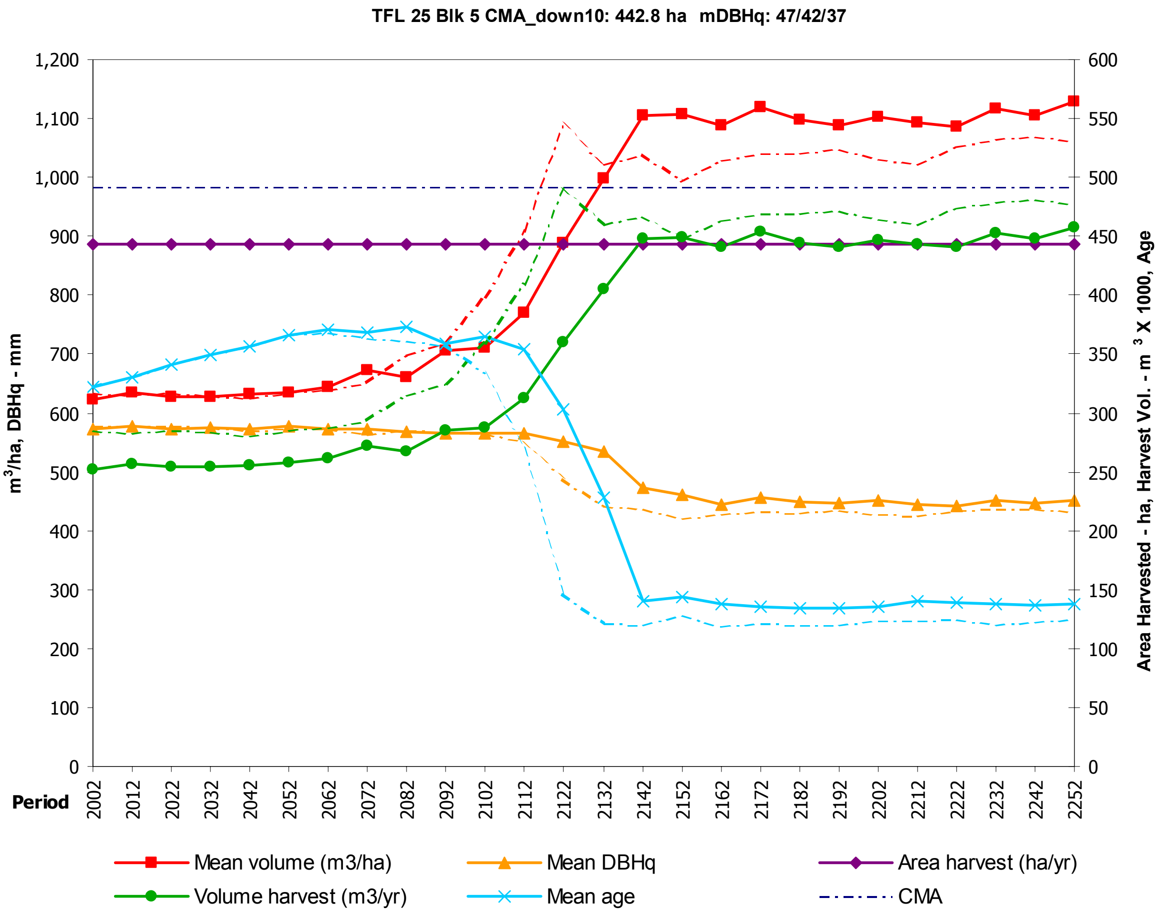

Figure 34. Block 5 harvest statistics[20] through 250 years for current management area harvest less 10%

6.3 Sensitivity Analyses

Harvest output statistics for all sensitivity runs are presented in Appendix V-A. In the harvest output graphs, decreases in area harvest relative to the base case are presented both unadjusted and as a new flat line. For increases in area harvest, a new, higher, flat-line harvest level was established. Flat-line flows were established by increasing area harvest requested until a deficit occurred, and then dropping back to the nearest whole number where the deficit disappears. Appendix V-B (p.103) summarizes changes in area (Table 10, Table 11) and near, mid, and long term volume (Table 12).

Table 5 presents the area results of sensitivity analyses for Block 5.

Table 5. Block 5 Sensitivity results

				CMA-PA			
	Harvest	Change		Harvest	Change		Description
Run ID	(ha)	(ha)	%	(ha)	(ha)	%	
CMA	492	-	-	364	-128	-26.0	Area-based current management option
+Oe	511	19	3.9	-			Include Oce and Ohe polygons in THLB (4.7 % of THLB)
-Oh	404	-88	-17.9	-			Remove helicopter operable polygons (18.0% of THLB)
-SI3m	434	-58	-11.8	323	-41	-11.3	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	559	67	13.6	409	45	12.4	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	448	-44	-8.9	336	-28	-7.7	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	483	-9	-1.8	358	-6	-1.6	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to mDBHq)
-PA	364	-128	-26.0	-			Remove protected area candidates as identified in April, 2001 announcement
-PA-OA	206	-286	-58.1	-			As above and also remove Option Areas identified in April, 2001 announcement
-midVQ	477	-15	-3.0	349	-15	-4.1	Use mid range disturbance target
+BEO	492	0	0.0	364	0	0.0	Apply specific BEOs to draft or legislated landscape units where not included in CM0
-SsSIest	469	-23	-4.7	347	-17	-4.7	Adjust SI so that Good site Spruce SI=34m instead of 39m - Piece size remains 47-42-37

Removal of the Candidate Protected Areas identified in the April, 2001 agreement will result in a 26% reduction of area harvest. Additional removal of the Option Areas identified at that time would result in a total area harvest reduction of 58% or 286 ha.

Land base reductions aside, Block 5 is most sensitive to changes that alter the minimum harvest age (-SI3m, +/- age). Removing the area operable only by helicopter has an impact proportional to the THLB excluded from the simulation.

Visual quality is an important issue along the Inside Passage and further reducing the allowable disturbance in this area had an impact of –3.0%.

7.0 Block 6 Analysis (Haida Gwaii)

7.1 Current Management - 254 ha/year

Figure 35 summarizes for the current management or "base case" simulation, the trends for harvest variables including timber volume, harvest age, mean stand diameter (DBHq), and proportion of helicopter harvesting.

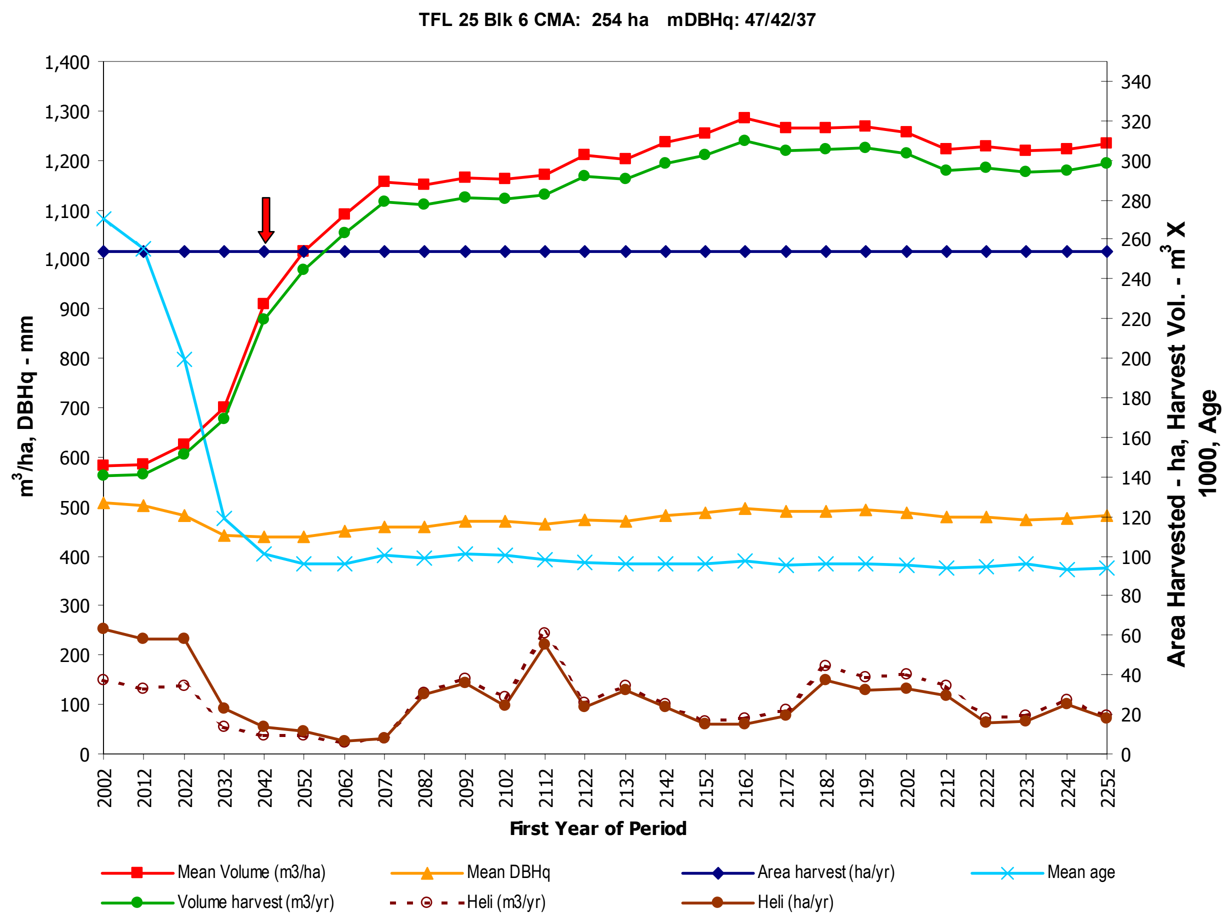

Figure 35. Block 6 Current Management harvest statistics through 250 years[21]

In this Block the transition to second growth is expected within the next few decades. As this occurs, average age of harvested stands declines abruptly until the transition is complete. Average DBHq at harvest declines from around 51 cm at present to 44 cm after 30 years and rebuilds to 47-50 cm in the long term. Within twenty years average merchantable stand volumes at harvest start to increase from current levels of under 600 m^3/ha and rapidly rise to in excess of 1,100 m^3/ha within 70 years. This effect is related to maturing second growth becoming available for harvest. Current AAC has been significantly depressed due to the age class imbalance created by the 1988 withdrawal of Gwaii Haanas reserve from forest management. Expected gains from current silviculture practices add to the second growth fall up[11] later in the simulation. As the area harvest is constant, annual harvest volumes increase in tandem with the increasing stand volumes. In the long term, ages at harvest average 93-98 years and average harvest diameters are around 47-50 cm (individual stands ranging 37-70+ cm).

In this Block the indicated harvest level is less than the LRSA and mLRSA calculations (Table 1, p.6), suggesting that throughout the simulation and even at the pinch point circa 2042 stands are on average harvested well beyond culmination of mean annual increment and the threshold minimum harvest age needed to ensure profitability.

Harvesting in helicopter-operable polygons makes up about 60 ha annually in the short term, but on average 11% or 28 ha per year of the annual harvest is from helicopter polygons. In the current model set-up there is no satisfactory method to regulate the helicopter portion within the overall area regulation so the short term heli-portion may be overstated. The appropriate level of harvesting from helicopter-operable polygons is discussed further in section 7.3.

Age class distributions are examined in Figure 38. On the THLB, the 21-60 age classes initially decline from current levels (which reflect a larger pre-1988 AAC and the concentration of early harvesting on the northern portion of Moresby Island) and then stabilize through the remainder of the simulation. Older (61- to 120-year-old) second growth age classes increase significantly in the first 50-year period and then stabilize. 121- to 250-year-old stands remain present in low abundance throughout the simulation. On the THLB the oldest stands decline in the first 50 years from 6,000 ha to 200 ha as the transition to second growth harvesting is completed.

[21] Red arrow indicates point where an area harvest deficit occurs if harvest request is increased by 1 ha.

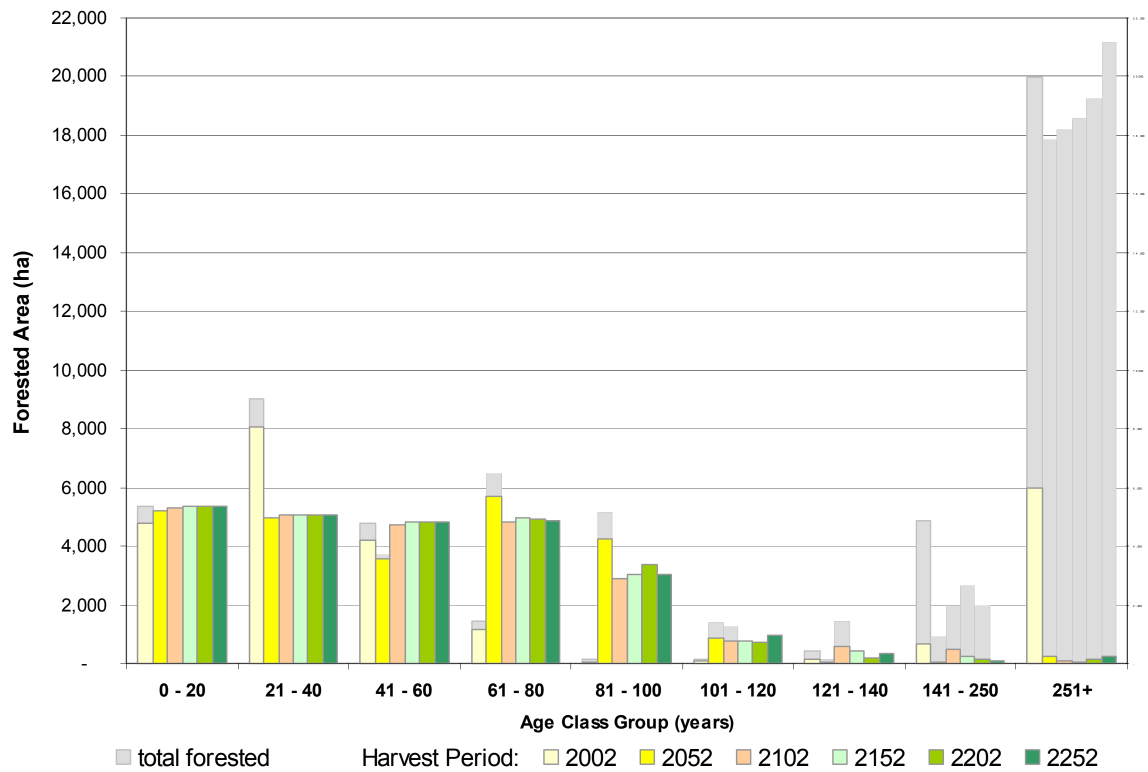

Figure 36. Age class progression on Block 6 THLB (+ total forested) for current management through 250 years

On the total forest land base, forest greater than 250 years old declines from the current level of just under 20,000 ha to about 18,000 ha and then rebuilds to above the 21,000 ha level as 141- to 250-year-old stands are recruited into the oldest age class. In this landscape, the future proportion of old forest remains essentially unaltered from current conditions.

Figure 37 illustrates gross growing stock levels for the total land base. Initially levels are about 17.5 million m^3 and rise above 25 million m^3 in the longer term. The proportion of older forest drops initially from the current level of about 12.5 million m^3 to about 9 million m^3 and then stabilizes near 12 million m^3 in the long term. This building standing inventory of wood permanently provides the basis for sustainable timber flow in the long term and provides substantial habitat and other environmental benefits to supplement values in the adjacent Gwaii Haanas reserve (148,500 ha). The proportion of younger growing stock increases initially and then stabilizes at about 24% of total growing stock. The 71- to 140-year-old growing stock provides the primary source of sustainable timber production through the simulation and increases from near nil initially to 28% in the long term.

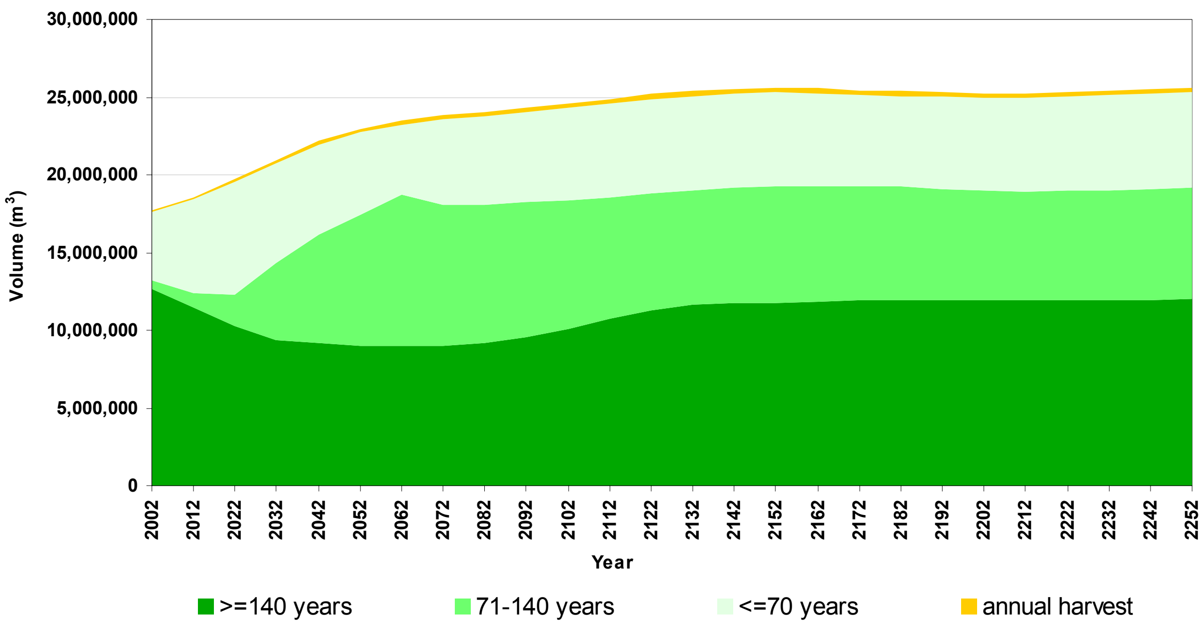

Figure 37. Merchantable growing stock on total Block 6 land base through 250 years

The older growing stock is for the most part, but not entirely, in reserves or area projected to be unavailable for timber harvest. Figure 38 displays growing stock through time for the THLB only. For non-timber or scheduling reasons, some timber is held significantly beyond normal rotation ages and reaches ages in excess of 140 years before other stands become equally or more suitable for satisfying non-timber objective(s). When this timber is released, its harvest could provide a small but ongoing supply of older stems possibly suitable for specialty manufacturing or cultural purposes.

Figure 39 is as per Figure 37 except data is presented on an area basis rather than a volume basis and simplifies the age class data presented in Figure 36.

Initially the area of old growth declines, the area of maturing stands increases, and the area of younger stands expands and then contracts. Contrary to popular opinion, as the transition from old growth progresses, at the landscape level old

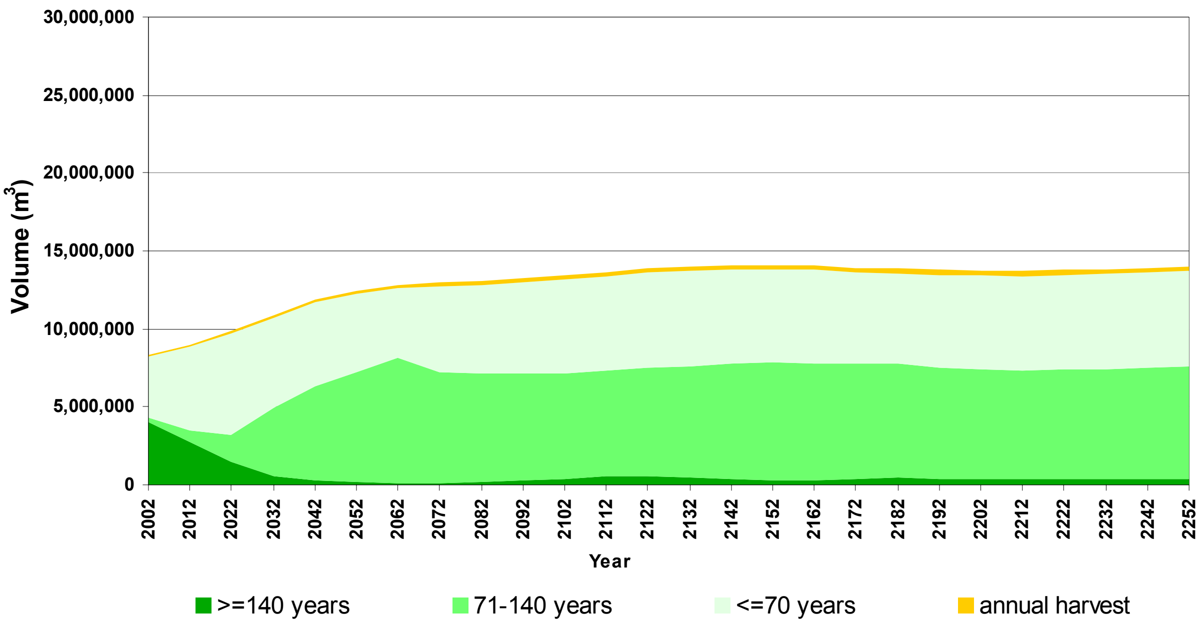

Figure 38. Merchantable growing stock on Block 6 THLB through 250 years

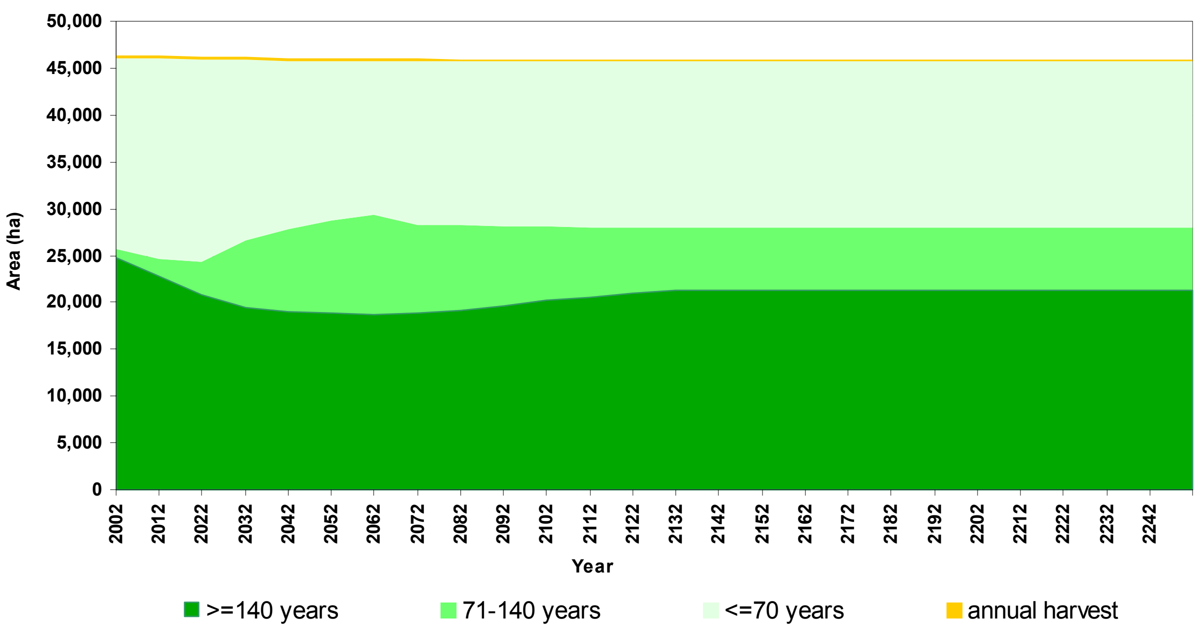

Figure 39. Age-group areas for Block 6 total land base through 250 years

growth area is replaced less by clearcut area and more by 71- to 140-year-old stands. A century into the future under the current management regime, young stands will occur less frequently than they do today.

Figure 39 also clearly demonstrates that the age class distribution is already much different than the natural disturbance type (NDT1) or recent historical range of natural variability for the area would dictate. Clearly any attempt to impose or return to an age class distribution representative of infrequent disturbances would be difficult, as well as economically devastating.

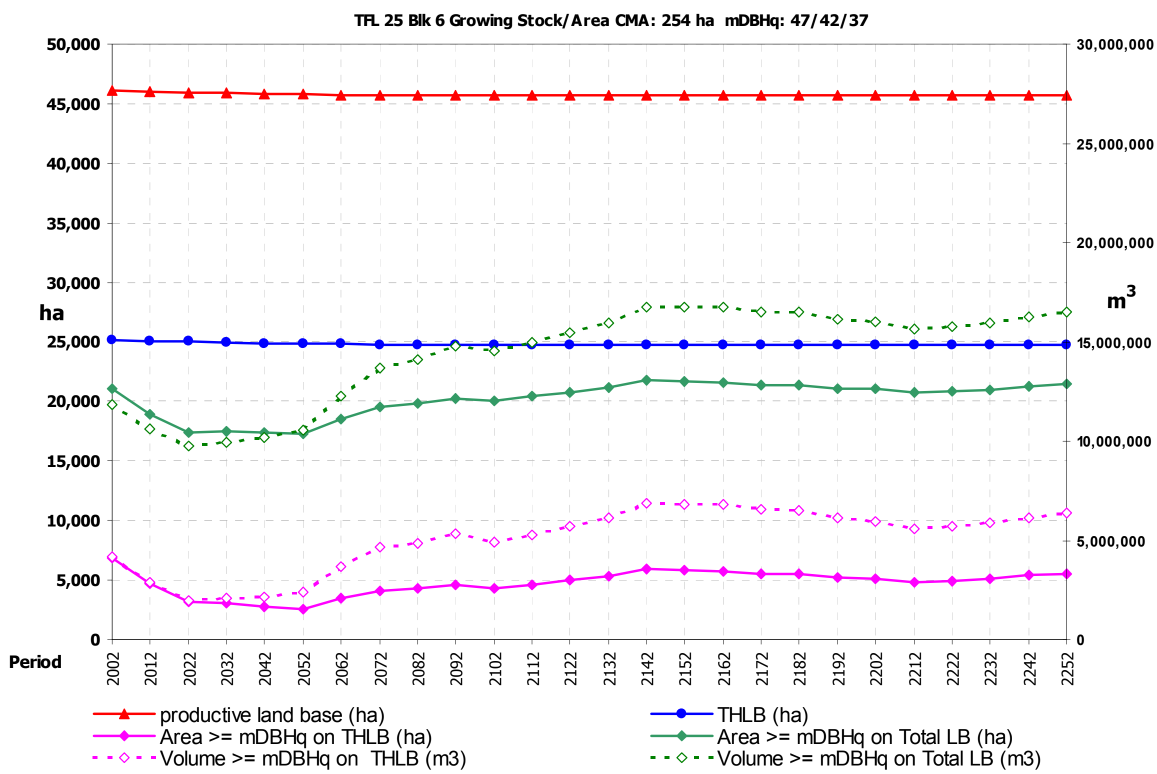

Figure 40. Merchantable growing stock in harvestable (>mDBHq) stands through 250 years for Block 6.

Figure 40 presents growing stock in terms of merchantable volume and area that is larger than the minimum harvestable[12] DBHq.

Roughly 20,900 ha or 46% of the productive land base is unavailable for harvesting for the long term. Because the locations of future Wildlife Tree Patches and partial retention along streams could not be easily predicted, they were modelled as a yield curve volume net down. Consequently these net downs are not represented in any of the aforementioned Figures and the actual volume and/or hectares illustrated understate the old forest reserved from harvest by about 5% of THLB area or volume.

On the THLB, harvestable stands become less available until the transition to second growth is complete and at the lowest point 2,557 ha are of harvestable size. This represents ten years worth of harvesting at the indicated harvest level. Operational flexibility in the selection of harvest locations can be expected to be most limited during the coming decades from 2012 through 2071.

A strategic focus for silviculture treatments could be to increase the harvestability of stands through the 2012-2071 period where area available for harvesting is projected to be lowest. However, there is expected to be ample volume available through the latter half of this period. Silviculture treatments which increase the future volume, merchantability or quality of stands beyond 2072 may be more or less equal in terms of strategic importance and should therefore be ranked using stand-level financial analysis.

7.2 Alternate Harvest Levels

7.2.1 10% Increase

Figure 41 shows that a higher area harvest request induces area and volume shortfalls at the transition to second growth. Note that the volume trough created at 2032 is about equal to the volume harvest levels from 2002-2031. Average harvest age and DBHq decline somewhat sooner but are notably lower in the long term. Average volume per hectare is lower in the long term as stands are harvested earlier than in the CMA simulation. Relative to the current management simulation, this run produces more volume (2,104,640 m^3 or 8,400 m^3 annually on average) through 250 years (see Appendix V-B). In the short term volume harvest is 9.9% higher but in the long term the volume harvest increases only 3.0%.

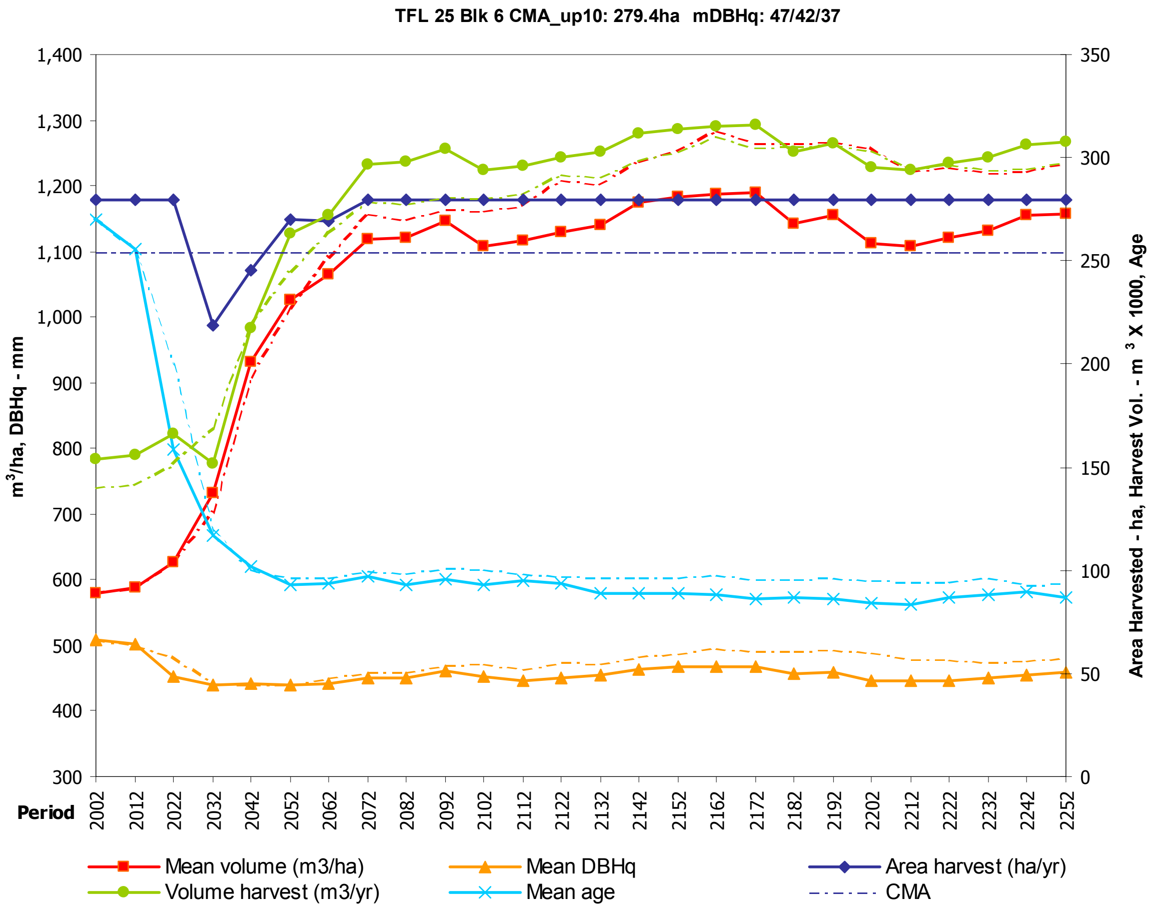

Figure 41. Block 6 harvest statistics[22] through 250 years for current management area harvest plus 10%

7.2.2 10% Decrease

Lowering the harvest request level by 10% (Figure 42) has the effect in the short term of lowering the harvest volume in proportion (-10.3%) to the harvest area change. This is because existing old growth stands are assumed to be neither adding nor losing volume through time. Once second growth becomes an appreciable component of the harvest profile, harvest age and DBHq are higher (longer rotation) with the result that stand volumes per hectare at harvest become higher as well. The higher volume per hectare tends to compensate for the loss of area harvested such that the overall volume harvest is less affected in the longer term (-4.6%) (Appendix V-B).

[22] Dashed lines in background represent current management statistics.

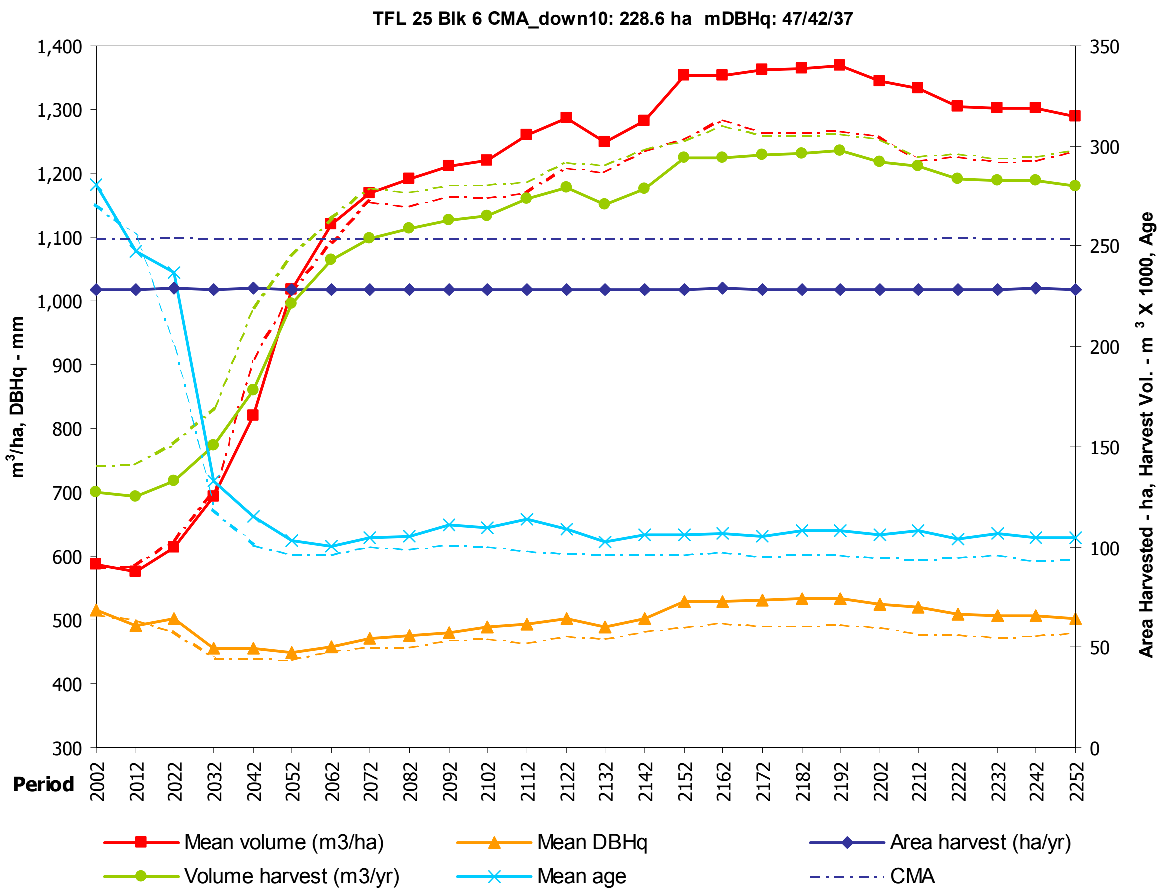

Figure 42. Block 6 harvest statistics[23] through 250 years for current management area harvest less 10%

7.3 Sensitivity Analyses

Harvest output statistics for all sensitivity runs are presented in Appendix V-A. In the harvest output graphs, decreases in area harvest relative to the base case are presented both unadjusted and as a new flat line. For increases in area harvest, a new, higher, flat-line harvest level was established. Flat-line flows were established by increasing area harvest requested until a deficit occurred, and then dropping back to the nearest whole number where the deficit disappears. Appendix V-B (p.103) summarizes changes in area (Table 10, Table 11) and near, mid, and long term volume (Table 12).

Table 6 presents the area results of sensitivity analyses for Block 6.

[23] Dashed lines in background represent current management statistics.

Table 6. Block 6 Sensitivity results

Run ID	Harvest (ha)	Change (ha)	Change %	Description
CMA	254	-	-	Area-based current management option
+Oe	262	8.0	3.1	Include Oce and Ohe polygons in THLB (2.9% of THLB)
-Oh	215	-39.0	-15.4	Remove helicopter operable polygons (10.8% of THLB)
-SI3m	176	-78.0	-30.7	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	283	29.0	11.4	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	200	-54.0	-21.3	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	229	-25.0	-9.8	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to mDBHq)
-midVQ	239	-15.0	-5.9	Use mid range disturbance target
-Oc	30	-224.0	-88.2	Simulation on THLB accessible by helicopter only to estimate flat line portion of harvest attributable to helicopter harvesting.
UnCon	297	43.0	16.9	Remove all non-timber land base and volume constraints to simulate timber potential.
-Dr	234	-20.0	-7.9	Remove alder leading stands from the harvest flow permanently (no long term succession to conifers).

Block 6 is most sensitive to changes that increase the minimum harvest age (-SI3m, +age) or reduce THLB (-Oh).

As was the case in Block 1, the +/-age sensitivities are not proportional to one and other.

Reducing the THLB by 11% by removing helicopter-operable area has a disproportionate negative impact that may be an artefact caused by the unregulated peak of helicopter activity inherent in the CMA simulation (Figure 35) immediately prior to the pinch point. However the volume/year vs area/year for the first three decades indicates that the short term helicopter harvest is old growth dependent and a higher short term helicopter harvest is important. Simulations of the harvesting on the conventional land base only (-Oh) indicate a harvest level of 215 ha, suggesting that no more than 39 ha of helicopter harvesting is needed annually in the short term to sustain the current management harvest level. Adding the –Oc and –Oh runs suggests a harvest level of 245 ha, or 9 ha less than the base case. Therefore the combination of conventional and helicopter harvesting is synergistic. Cumulative harvesting from helicopter-operable polygons should exceed 150 ha within the forthcoming five years (at least 75% of –Oh change and equal to –Oc result) to ensure future harvest flow is not disrupted and adjustments, if needed as suggested by the next TSR, will not be severe.

The flow of red alder volume from the base case simulation and the –Dr simulation indicate that alder needs to be a significant proportion of the harvest profile in the short term. The annual volume harvest from stands with an alder component should be at least 15,000 m^3/year[24] in the short term and build to higher levels thereafter as the transition to second growth proceeds.

[24] For operational implementation the minimum is stated in terms of volume, rather than area, because alder generally comes from mixed stands that cannot be easily stated on an area basis.

8.0 Analysis of Combined Blocks

All blocks were combined into one management unit to test the effect of age class or other synergies among blocks. Combining the blocks resulted in a 24 ha or 2% increase[25] in annual harvest area, suggesting that some synergies between blocks may be present.

From an operational perspective, a logical block combination could be Blocks 2 and 3 which are in the same geographic vicinity, have relatively small AACs, and are at remote locations both serviced from east Vancouver Island. However, a run combining these blocks actually resulted in a harvest level somewhat below the combined harvest levels suggested earlier. The model seems to harvest exclusively in each block for extended periods thus creating adjacency and other bottlenecks. Further investigation is needed to reconfigure the model to prevent this artefact and properly investigate any potential synergy among Blocks 2 and 3.

9.0 Marginally Economic Opportunity

As part of operability mapping, a significant area of timber was identified as being "marginally economic". In other words, it is not economically viable to harvest these stands during average market conditions as cost estimates exceed expected revenues. This area is assumed inoperable for the purposes of this timber supply analysis.

However, during market cycle peaks, stand values would exceed costs so that such stands could be harvested at a profit. The AAC Determination generally does not consider this opportunity wood. Even when markets peak and such stands become profitable, they are seldom the focus of harvesting as other stands within the regular AAC indicate a higher profit margin.

To realize this opportunity, a regulation mechanism needs to allow a periodic harvest of marginally economic stands over and above regular AAC. While a

[25] These results were based on preliminary modelling. Subsequently input files were corrected for a minor input error but were not recompiled for this combined run as creation of the combined file was onerous. Results would not be expected to change significantly.

partitioned harvest could accomplish this, harvesting would not be expected for perhaps many years in succession. If a partition were stated in terms of an annual allowable harvest there could be a perceived underharvest of the partition for many years, and then an apparent over harvest once every five to ten years. A periodic allowable harvest more in sync with market cycles would be the preferred approach.

For example, the +Oe sensitivity run suggests that the following (Table 7) periodic harvests could be acceptable.

Table 7. Potential Periodic Harvests of Marginally-Inoperable Polygons

TFL Block	+Oe result (ha/yr)	Periodic Harvest (m^3/period)	
		within 5 year period	within 10 year period
1	2	10	20
2	2	10	20
3	2	10	20
5	19	95	190
6	8	40	80

10.0 Cultural Cedar Supply

The normal harvest profiles will contain significant amounts of cedar suitable for cultural purposes such as bark stripping, small dugouts, poles, carving, or root collection. Figure 43 presents the projected cedar volume harvest for each block of the TFL through the next 250 years.

Figure 44 shows the cedar growing stock present through the simulation. Although there is a modest decline, at no point does the growing stock fall below 82% of current levels.

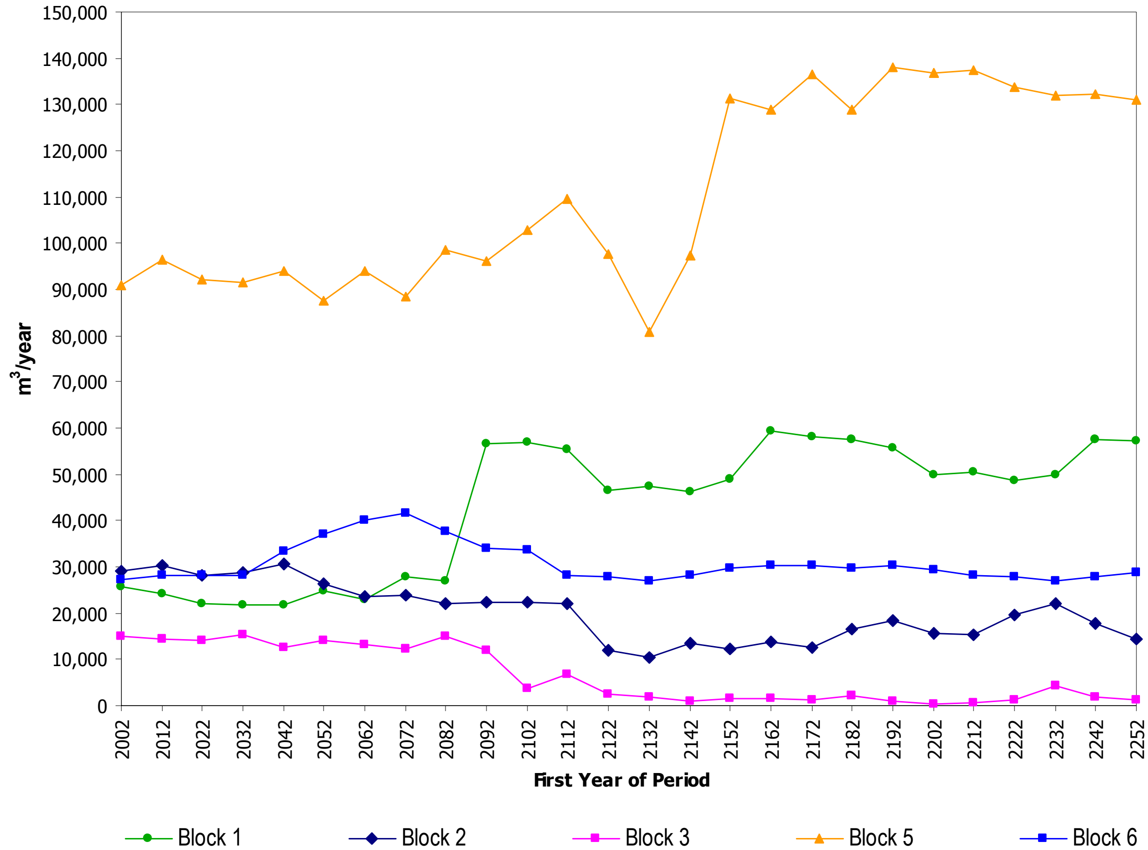

Figure 43. Projected cedar harvest by block through 250 years.

A small but continuous supply of monumental cedar (suitable for large dugouts, very large poles, split beams and planks) can be expected to be available from reserved areas including riparian reserves, old-growth management areas, and other inoperable forests. Wildlife tree patches and other trees retained within blocks were not included in this analysis and hence cedar retention estimates herein are underestimated by up to 5-8%.

A crude model was developed to estimate the availability through time of larger or "monumental" cedar trees suitable for special cultural purposes such as pole carving and dugout canoe construction. The model is described and discussed in more detail in Appendix V-D. Table 8 indicates the minimum and average number of larger diameter (≥70cm) trees predicted through the simulation for each Block. Although there is variation throughout the simulation, considerable numbers of larger cedar trees are forecast and contrary to some speculations such trees do not disappear.

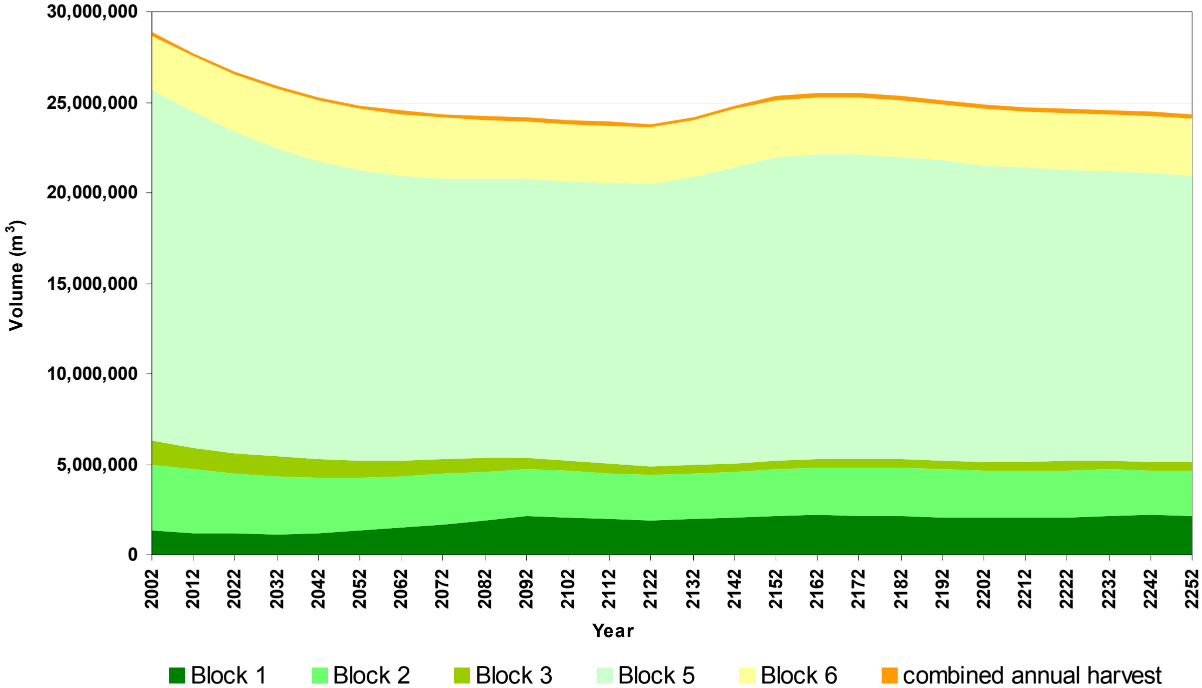

Figure 44. Cedar growing stock and annual harvest volumes through 250 years.

Table 8. Estimated larger diameter (≥ 70 cm) cedar trees available through 2252

Block	Minimum	Average
1	64,819	86,878
2	210,281	231,430
3	46,817	63,946
5	1,296,297	1,567,810
6	339,366	375,696
Total	1,957,580	2,325,760

11.0 Uncertainties

In the course of preparing for, and developing this analysis, a number of uncertainties in the underlying data and assumptions have become evident. These are listed below in order of perceived potential impact on timber supply and the direction (area harvest increase/decrease) of the potential change.

+/-	The 3.25% volume allowance for future Wildlife Tree Patches needs to be verified against actual area withdrawals from the timber harvesting land base for WTP designations. Under area-based regulation, including WTP/THLB overlap area as part of the cut[1] should allow accurate tracking of the proportion of WTPs that would otherwise be THLB. This should facilitate simulation of WTPs as THLB area withdrawals (rather than as volume net downs) for future analyses.
-/--	Ecosystem Based Management is an evolving concept that WFP has agreed to test and where feasible implement in parts of the TFL. It is expected to include increased reserve areas and use of partial retention silviculture systems[28] and at the same time it is to maintain or enhance the economic feasibility of forestry. Modelling forest re-growth in response to dispersed, stand-level partial retention/harvesting remains problematic and has not been attempted for this analysis. Intuitively, shading, scarring, and mistletoe effects on regeneration and productivity seem likely, yet some proponents of selection and other partial harvest systems suggest productivity is actually improved by advanced regeneration and efficient capture of photosynthetic energy. Field studies, calibration of uneven-aged growth models for coastal use, and development of ecological process models are needed to forecast the outcomes of heretofore-unknown silvicultural practices. However, to determine an area-based harvesting level in an increasingly uneven-aged modelling environment, mDBHq lessens in modelling importance. Perhaps

then, such modelling is only important for those interested in volume flows and is of little consequence to determining an area-based harvest level[26].

-/(+)	For Blocks 2, 3, and 5 site indices for managed and unmanaged second growth stands were based on Provincial SIBEC averages. These estimates have been recently updated but the updates were not used in this analysis. Site indices for these blocks need to be field checked and re-determined based on local field sampling. Sensitivity analysis results suggest that changes in site indices may profoundly influence area harvest levels through their influence on mDBHq at critical second growth pinch points.
+/-	For Blocks 2 and 3, and less so for Block 5, estimates of remaining old growth inventory volumes need to be confirmed in light of recent harvesting and withdrawals from the timber harvesting land base. A Vegetation Resource Inventory is in progress for Block 2 and 3. Re-inventory is not planned for Block 5 given current land use uncertainties. The existing Block 5 inventory is less than 20 years old. In Blocks 1 and 6 VRI has been completed and adjustments to timber volumes have been positive in both cases.
+/(-)	In Block 5, the procedure used to estimate site index tended to underestimate site indices for poor sites and overestimate site index for better sites. As poorer sites are more common, this may have lead to underestimation of overall yields. Completion of ecosystem mapping and VRI sampling would improve site index estimates substantially. However the harvest profile in this block is dominated by old forests for the next century or more, so second growth yields are relatively less important for setting current harvest level.

[26] In a pure, selection system landscape, harvest regulation becomes neither area- or volume-based; instead a stand level BA regulation of growing stock is the preferred approach.

+/-	Operational adjustment factors for managed stands were TIPSY defaults. Field estimates for the more common stand types would improve estimates of mid to long term yield. Anecdotally OAF1 net downs may be underestimated for Block 5 where brush problems abound and herbicide use is restricted and may be overestimated in Blocks 1, 3, and 6 where stocking tends to be very good.
+	Historic spacing and fertilization treatments need to be digitized, entered into the GIS, and appropriately modeled. As the mDBHq criterion is critical to this analysis, these treatments may have an important positive impact at the area-based pinch point by effectively reducing rotation age.
-	As retention and partial harvesting systems become more common both in riparian management and more widely, yield adjustments to reflect increased shading of crop trees and harvest damage of residual crop trees will be needed. Long term estimates of retention and its nature are as yet unreliable due to the short period of application and variability of implementation strategies to date.
+	Commercial thinning[27,28] is proven in Douglas-fir stands in the drier variants of the Coastal Western Hemlock Zone and may be used in future to alleviate timber supply shortfalls. Further analyses are warranted for Block 1, although recently CT has proven uneconomic where hemlock is a significant stand component.

[27] For cut control of commercial thinning we suggest that an equivalent clearcut area (ECCA) be calculated to go against area AAC. ECCA would be calculated based on the expected volume opportunity lost at final harvest as follows:

$ECCA_{CT}$ (ha) = CT (ha) X (BAiptc – BA_{Ct}aiptc) / BAi where,

BAi = initial BA
BAiptc = initial BA projected to culmination (or for 20 years if culmination is less than 20 years away.)
BA_{CT}aiptc = post-CT BA projected to age of BAiptc

[28] For cut control of partial cutting in older, less responsive stands we suggest that ECCA be simply harvest area X (BA removed / BAi)

+	The capability to model future cultural cedar tree availability would be improved by improving growth and yield data and modelling of 2nd growth cedar. Samples of older second growth cedar are uncommon and diameter distributions projected from current models may be unreliable at older ages. Timber supply modelling assumptions for regeneration strategies need to be refined to better reflect current species-specific reforestation practices for western red cedar and yellow cypress.
-/+	Land base reductions and/or volume net downs for future riparian management need to be confirmed in light of evolving practices, shifting expectations, and the relatively short implementation experience so far. Although no-harvest zones had dominated earlier management thinking, more recently there has been a move to more active intervention and flexibility around streams. If a “disturbed area” model is to be used for cut control, there will be a need to model partial cut area and basal area removal.
+	Future tree improvement gains are expected to be larger than modelled herein. Where the gains are not realized until beyond pinch points they are expected to have little influence under a flat line area-regulation scenario.
+/-	Higher elevation site index estimates are less certain than for lower elevation ecosystems where older second growth is common and site index estimates are more reliable.
+/-	These simulations are not optimized for harvest sequencing (model follows inherent stand database or model priority order) although variations in harvest sequence may yield higher harvest levels. This would however be a time consuming exercise in the current modelling environment. In any case operational forest development is not inherently optimized either.

12.0 Recommendations

- Area-regulated harvest level for TFL 25 should be set at 1,250 ha less 8 ha of non-recoverable losses. This level will ensure that both the timber harvested for human use and the growing stock performing environmental services increases for future generations.

- Should economic conditions become favourable, efforts to prove the feasibility of harvesting in forest types deemed marginally uneconomic (not included in base case analyses) are to be encouraged. Such harvests should not be charged against AAC and should be permitted to occur periodically when conditions allow. We recommend that a marginally economic area allocation[29] be allowed to accumulate for a rolling or “evergreen” 10-year period and be harvestable at the Licensee’s discretion when economic conditions permit. Based on “+Oe” runs, recommended annual accumulations for Blocks 1, 2, 3, 5, and 6 respectively are: 2, 2, 2, 19, and 8 ha. Therefore within the upcoming 5-year cut control period, harvests by Block could not exceed 10, 10, 10, 95, and 40 ha respectively.

- A strategic silviculture analysis, if funded, would identify future timber and habitat shortfalls and devise strategies to alleviate these. As well the analysis should investigate opportunities for fertilization, thinning, or other interventions that may lower minimum profitable harvest ages at critical pinch points, and analyse the outcome of such strategies in terms of habitat availability, timber volume and quality, and return-on-investment.

- The Licensee should ensure that for the next 5-year cut control period the area harvested from polygons accessible only by helicopter exceeds the following (~75% of “-Oh” area change times 5 years) for each Block:
    - Block 1: 23 ha
    - Block 2: 86 ha

[29] Small incidental harvests of marginally uneconomic area would go against AAC, and the exemption would be activated for area sums greater than 2 ha by TFL Block.

- Block 3: 30 ha
- Block 5: 330 ha
- Block 6: 150 ha

- Government to Licensee discussions should be continued to explore administrative and policy changes associated with area-regulation that may reduce costs to government and increase Licensee profitability. Reforms may be possible with respect to, but not limited to, the following:
    - elimination of waste and residue sampling and billing programs.
    - area-based cut control and SBFEP allocations.
    - area-based stumpage ($/ha harvested) or an “all found” annual tenure rental.

Appendix V-A
Harvest Statistics for Simulation Runs

In the graphs following, The solid coloured trend lines presented are the output variables for the sensitivity's flat line flow. Dashed lines of the same colour represent the current management (CMA) or base case statistics for comparison purposes. A flat dashed line represents the CMA flat line flow and the unadjusted deficit flow, where it occurs, is presented as a dashed line below CMA.

Run naming conventions and descriptions of each run are presented in Appendix V-C.

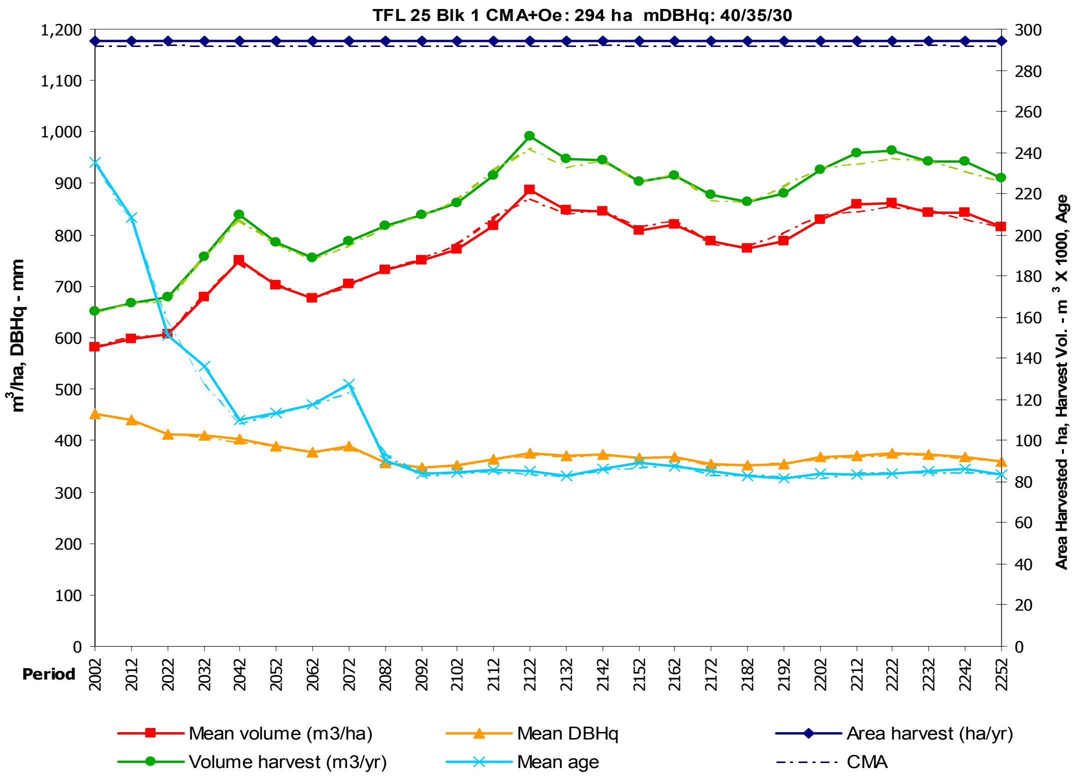

Figure 45. Block 1 CMA +Oe

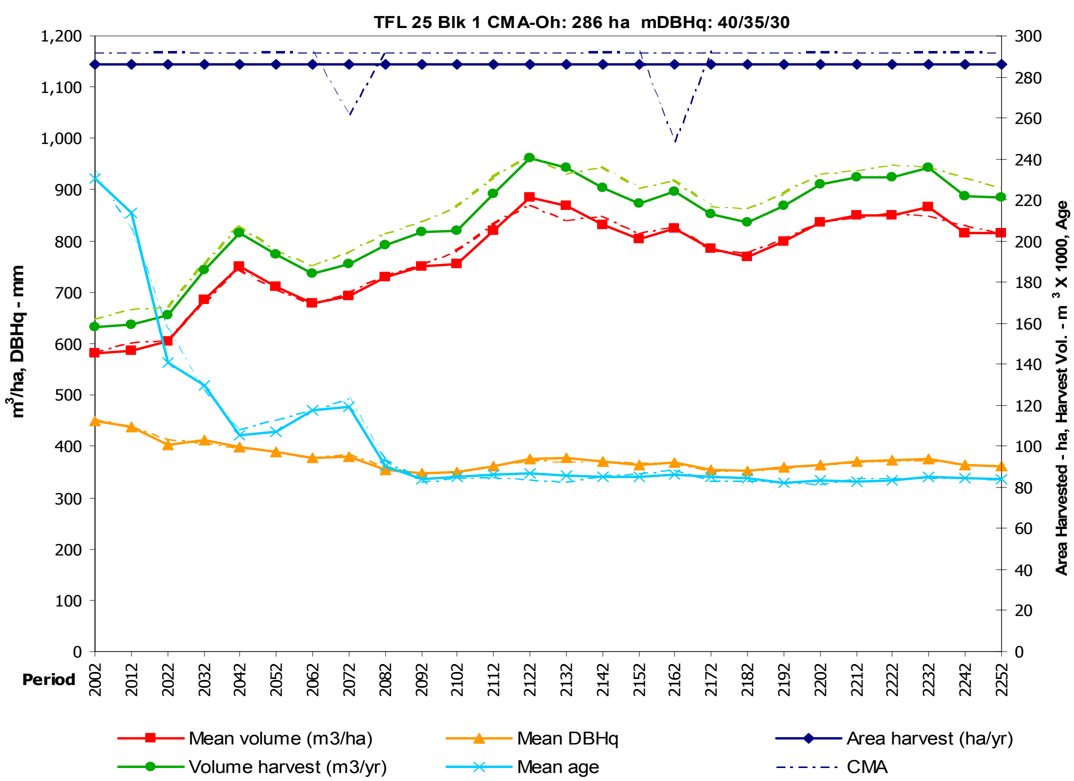

Figure 46. Block 1 CMA –Oh

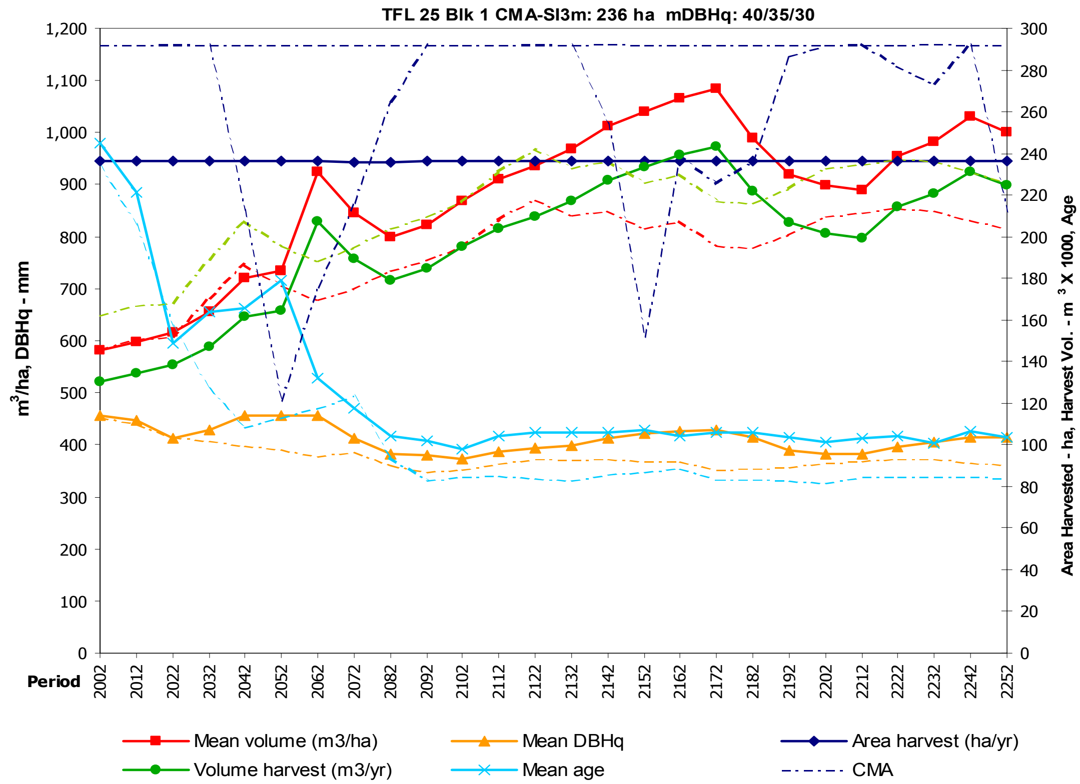

Figure 47. Block 1 CMA –SI3m

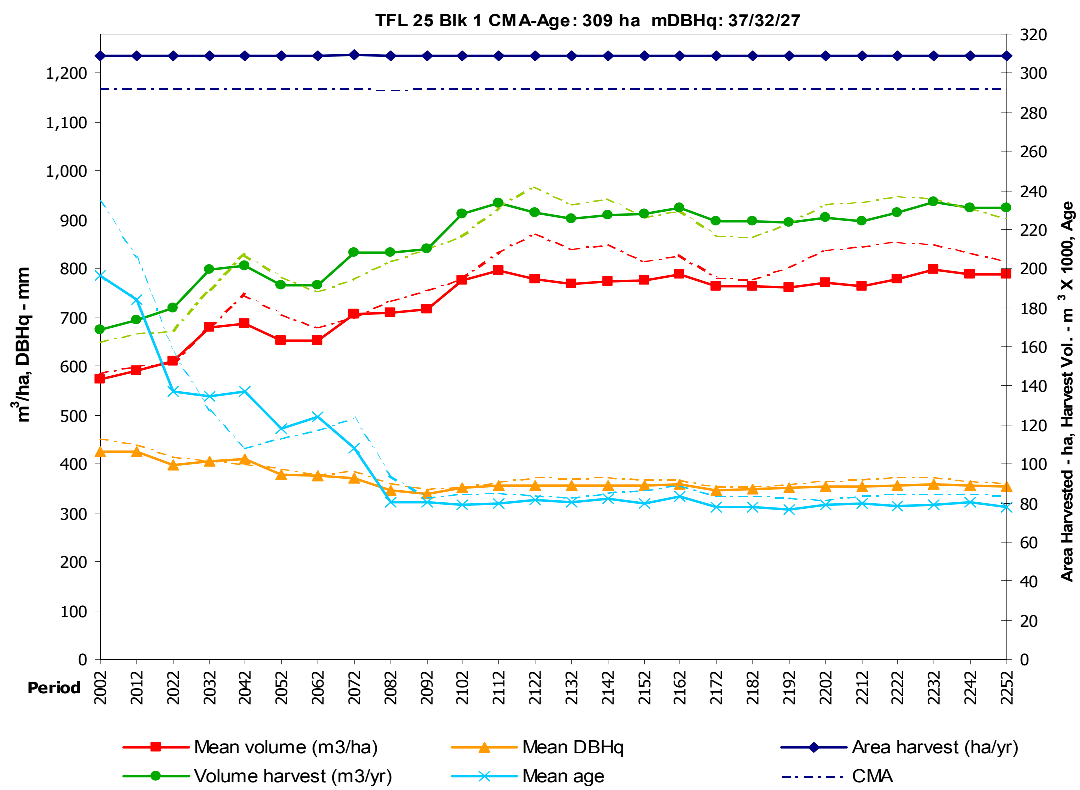

Figure 48. Block 1 CMA -age

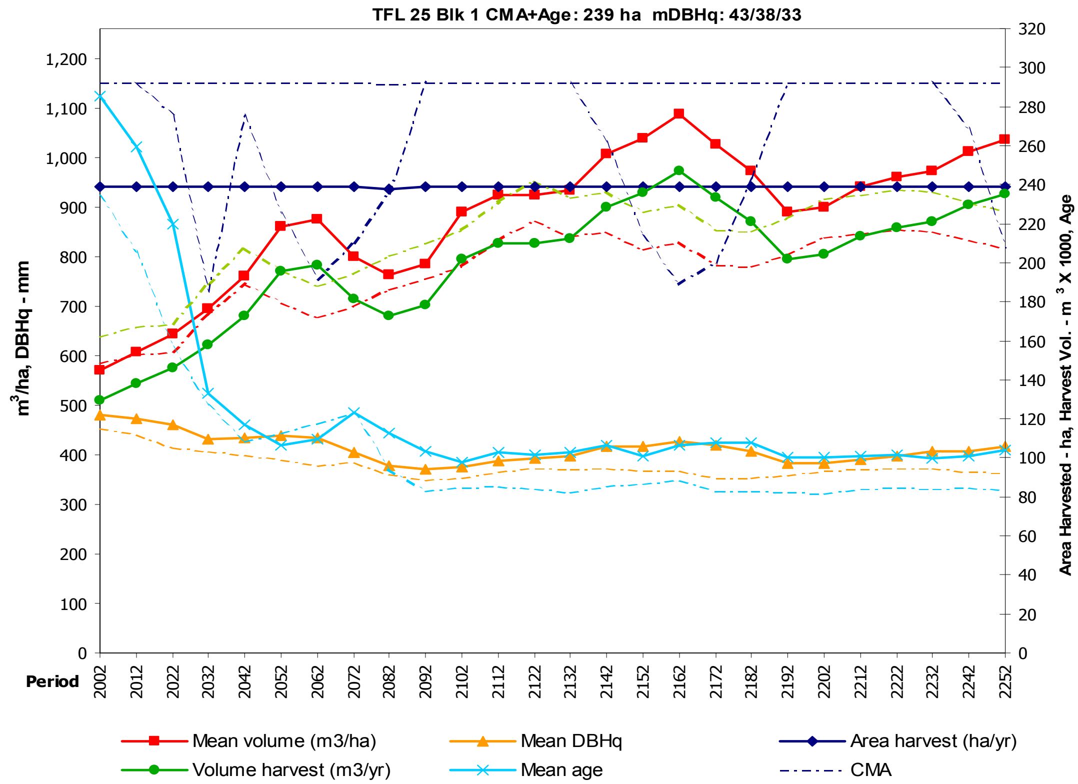

Figure 49. Block 1 CMA +age

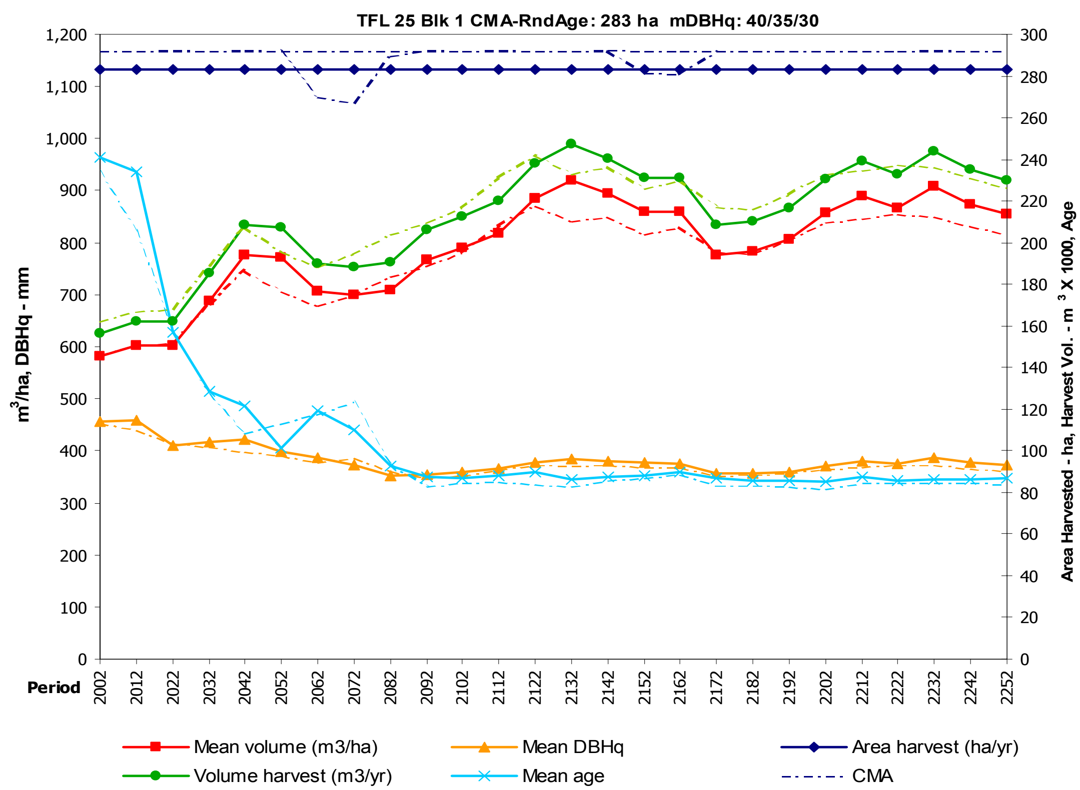

Figure 50. Block 1 CMA –RndAge

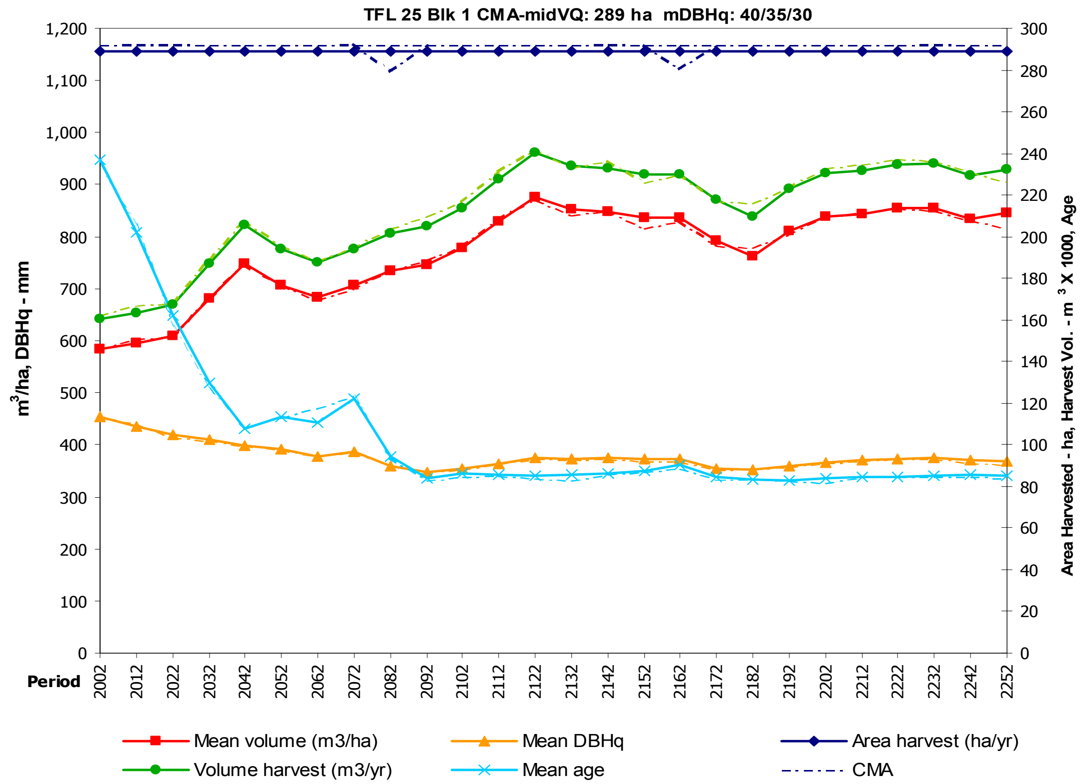

Figure 51. Block 1 CMA-midVQ

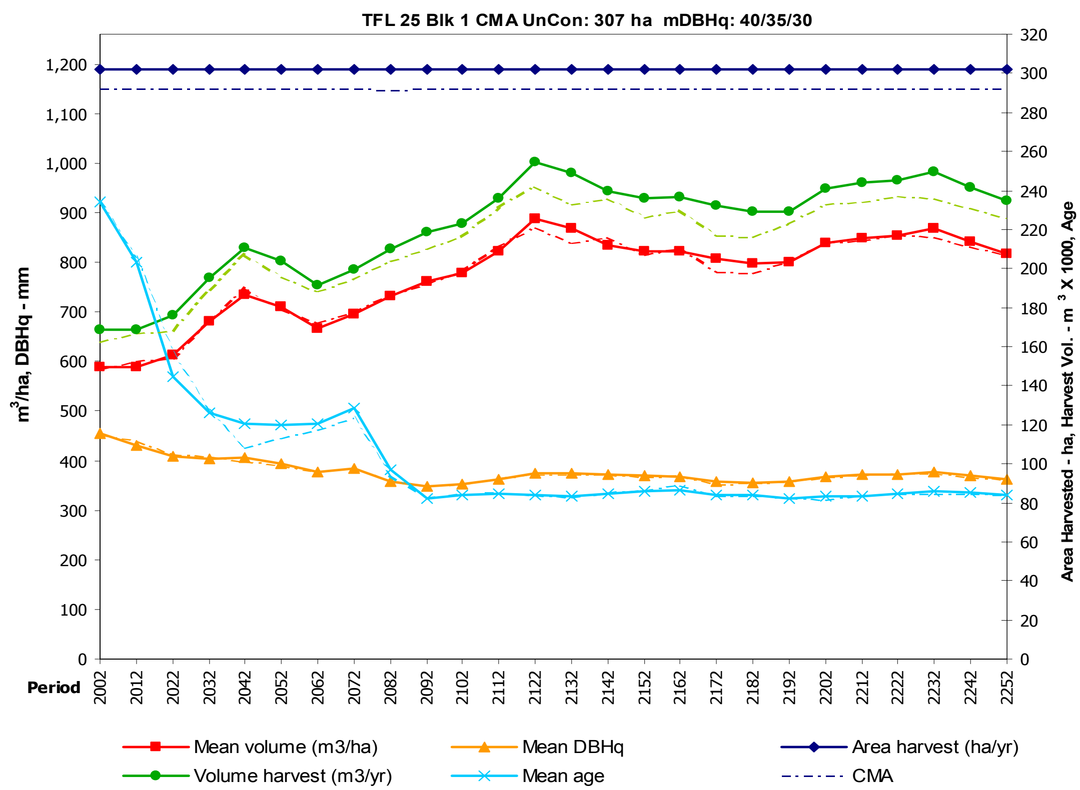

Figure 52. Block 1 CMA UnCon

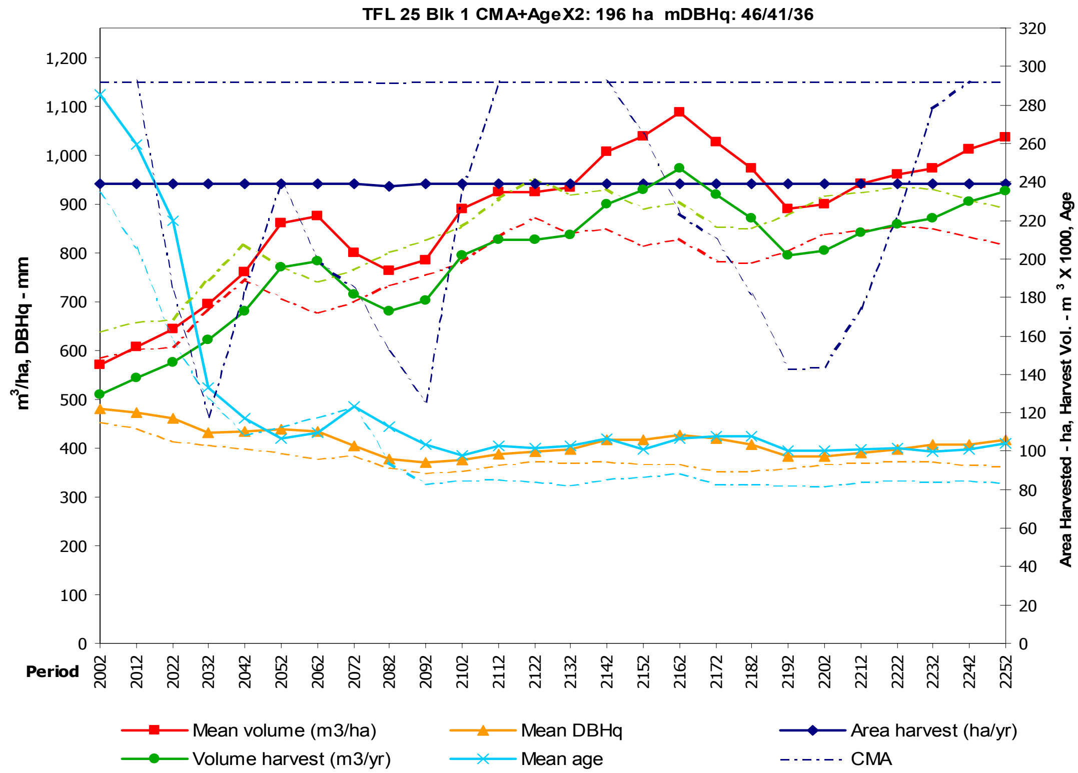

Figure 53. Block 1 CMA +ageX2

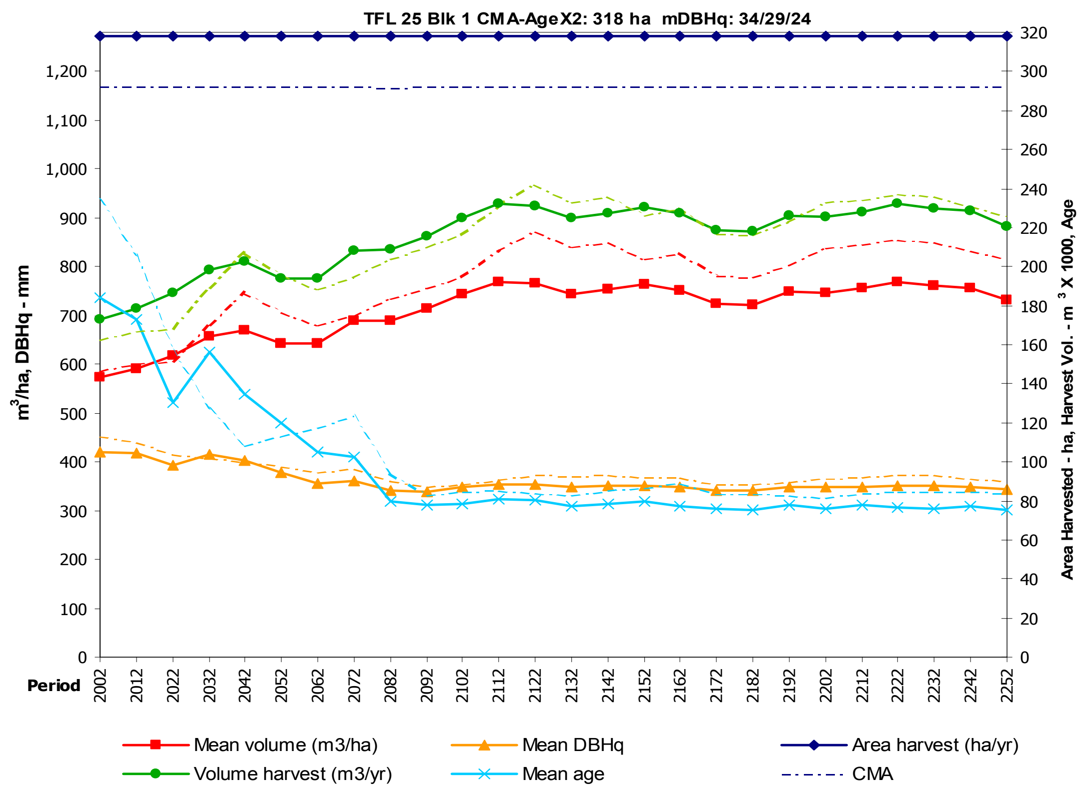

Figure 54. Block 1 CMA –ageX2

TFL 25 Blk 1 CMV: 185,000 m3 mDBHq: 40/35/30

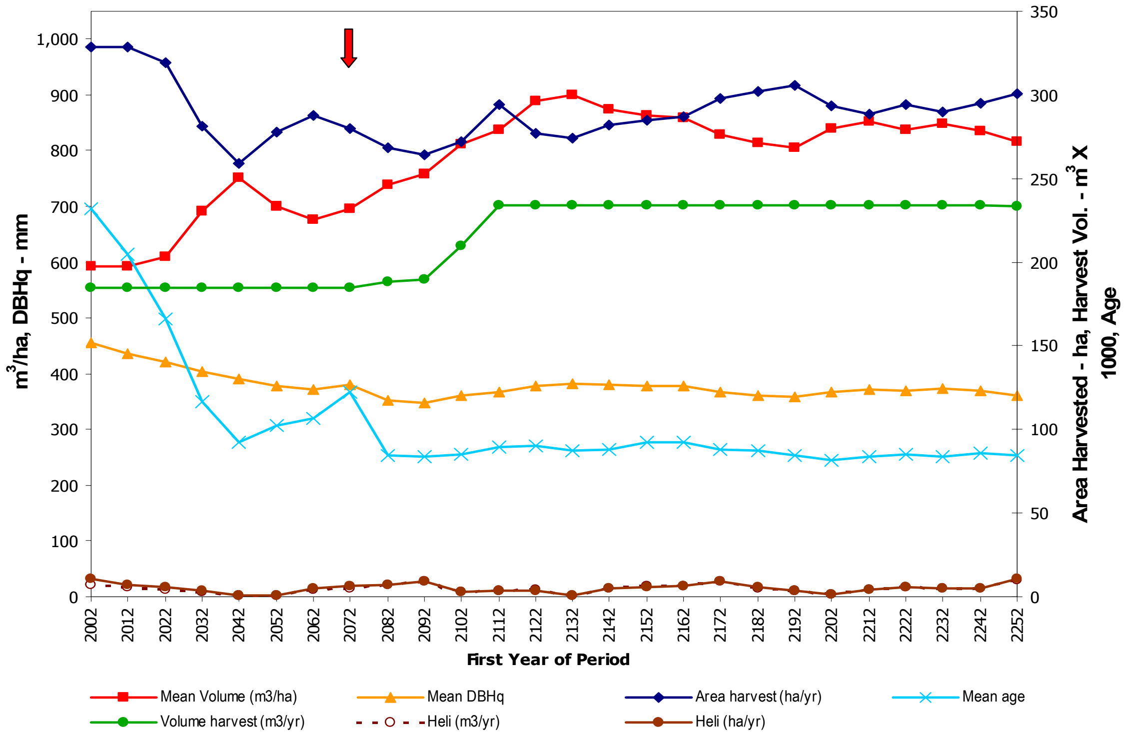

Figure 55. Block 1 CMV (Volume Regulated)

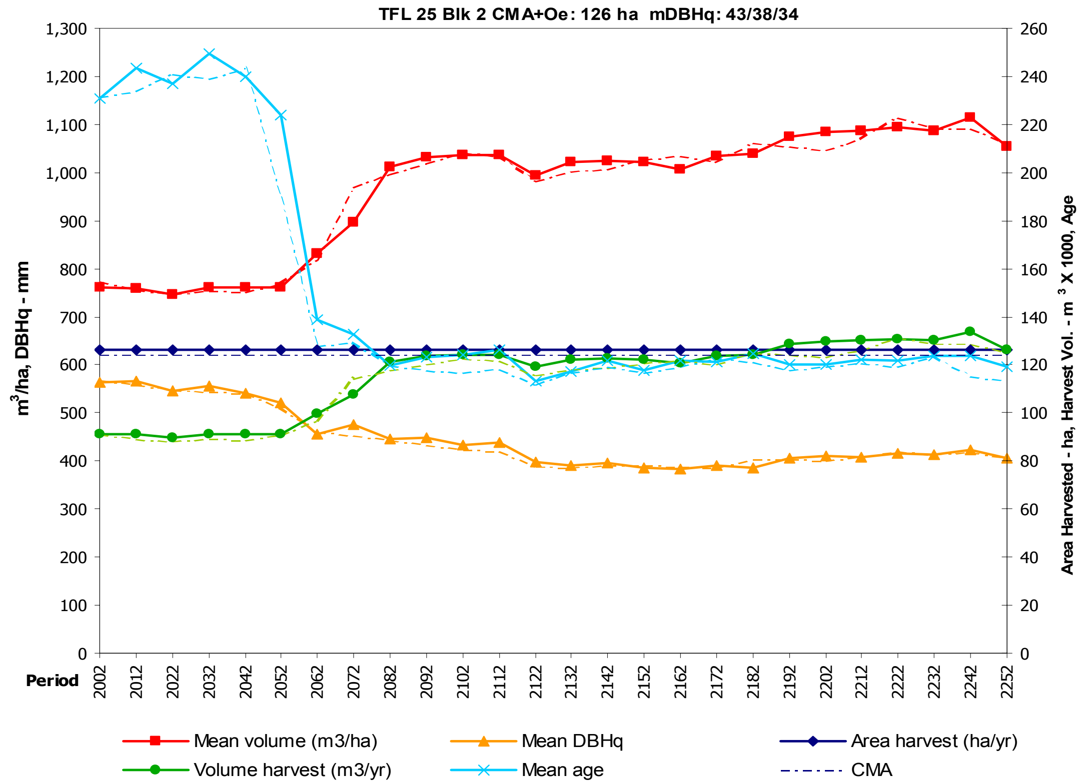

Figure 56. Block 2 CMA +Oe

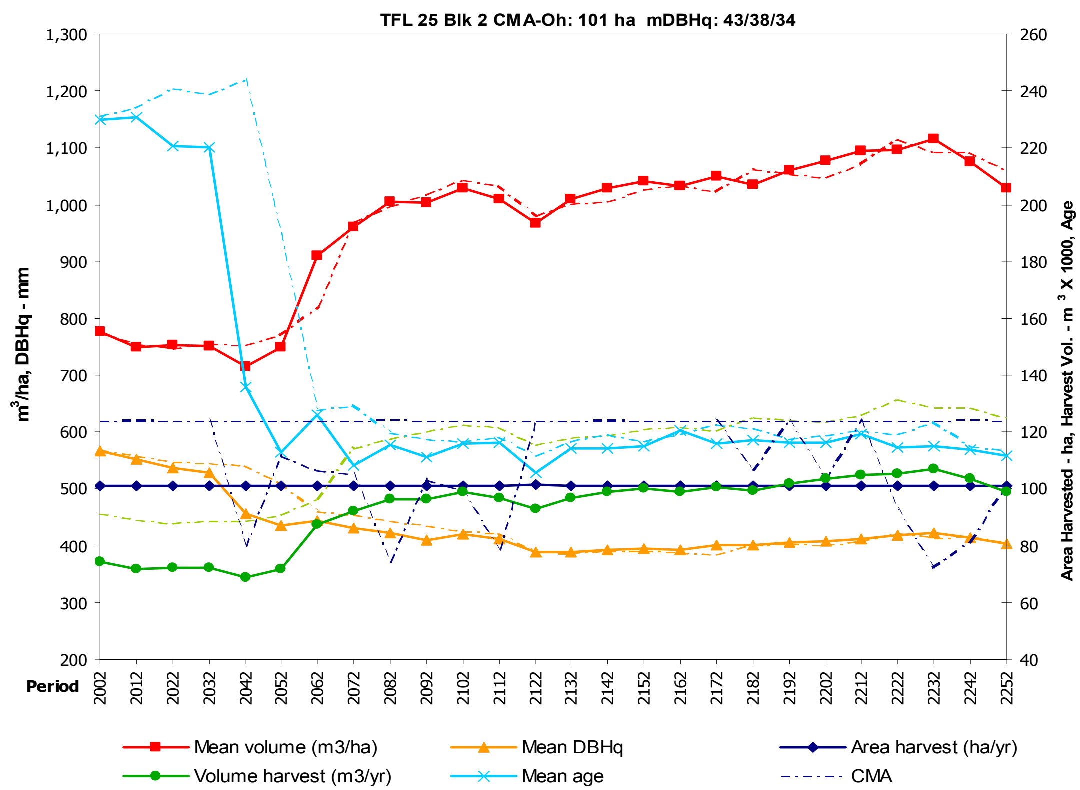

Figure 57. Block 2 CMA -Oh

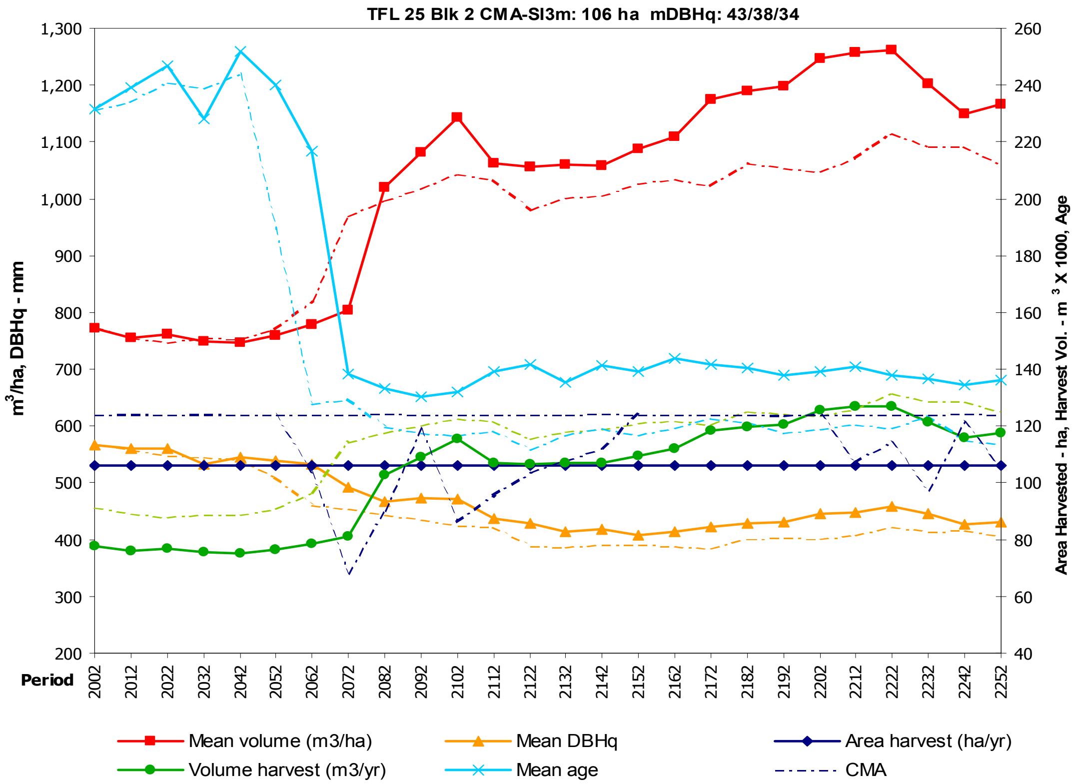

Figure 58. Block 2 CMA –SI3m

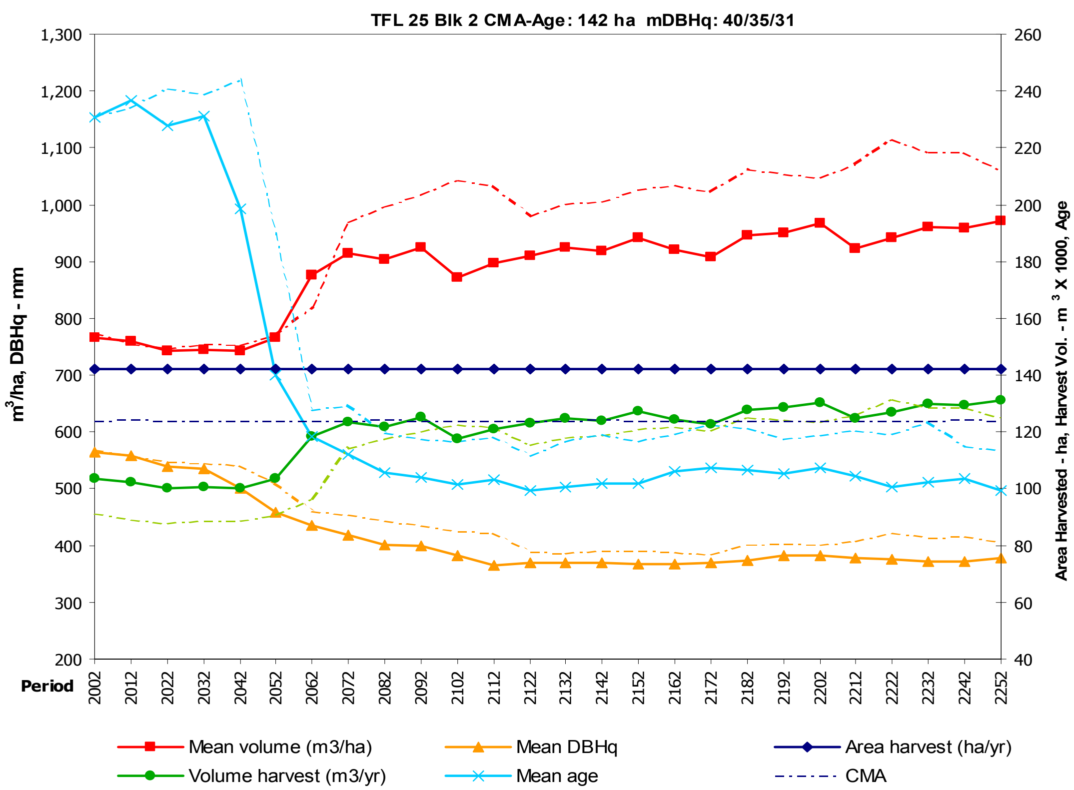

Figure 59. Block 2 CMA -age

WFP

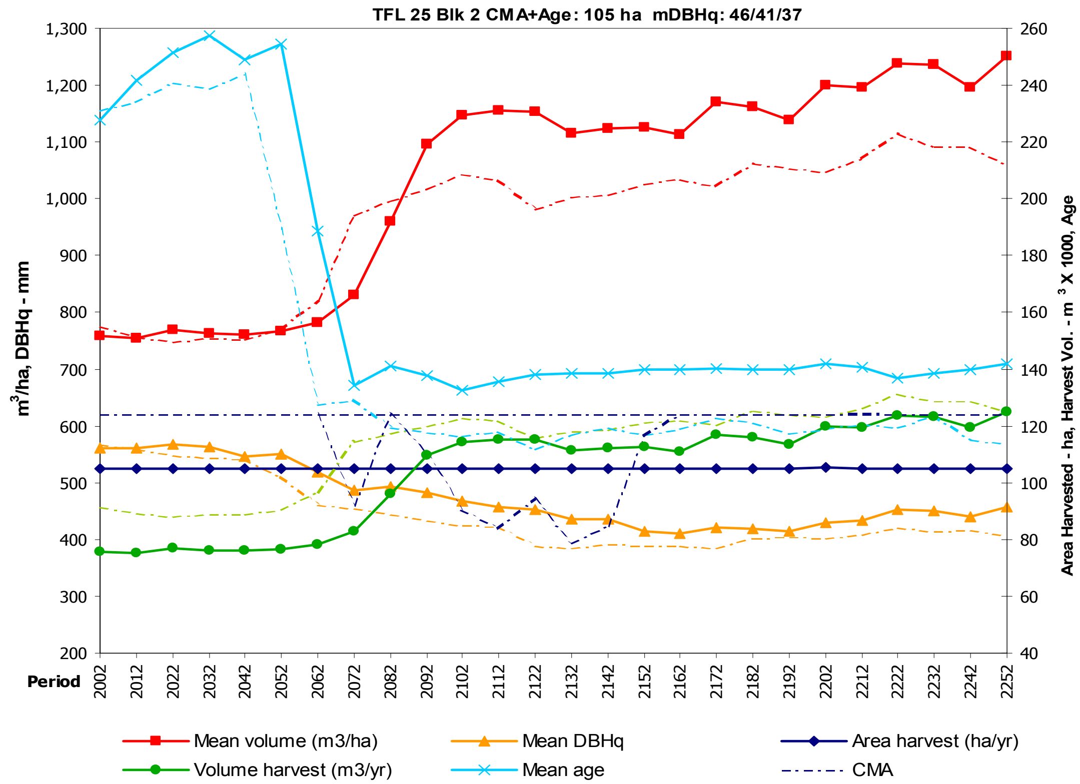

Figure 60. Block 2 CMA +age

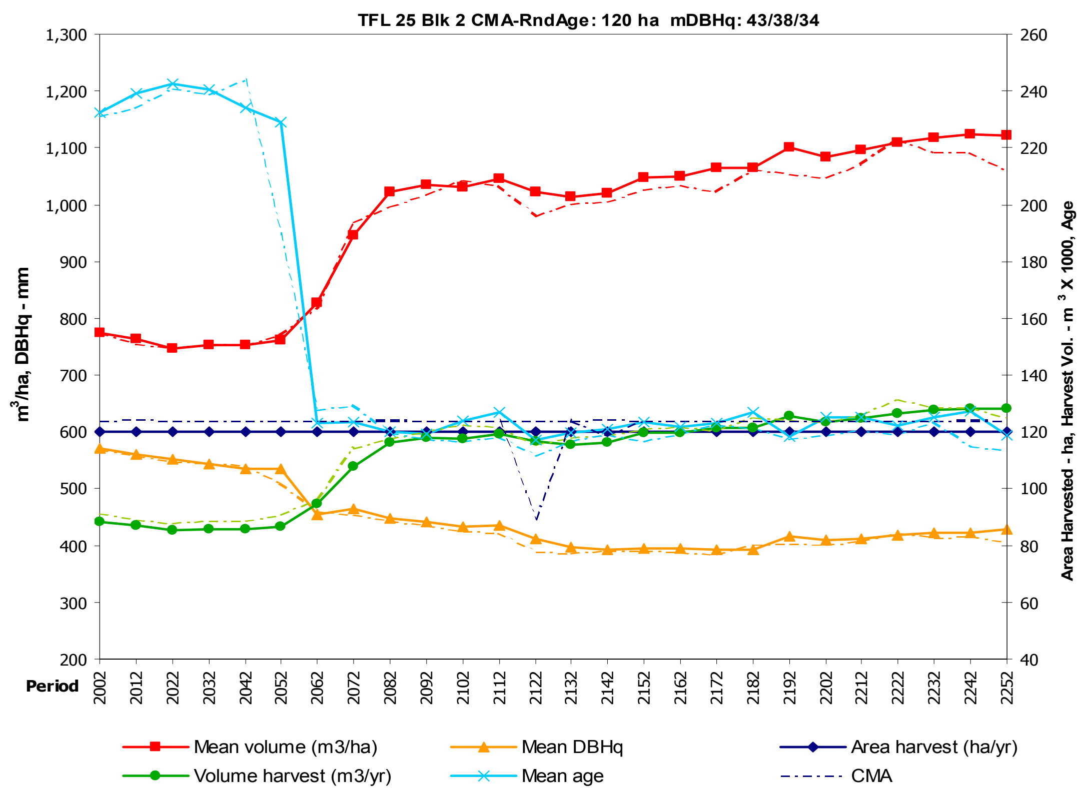

Figure 61. Block 2 CMA -RndAge

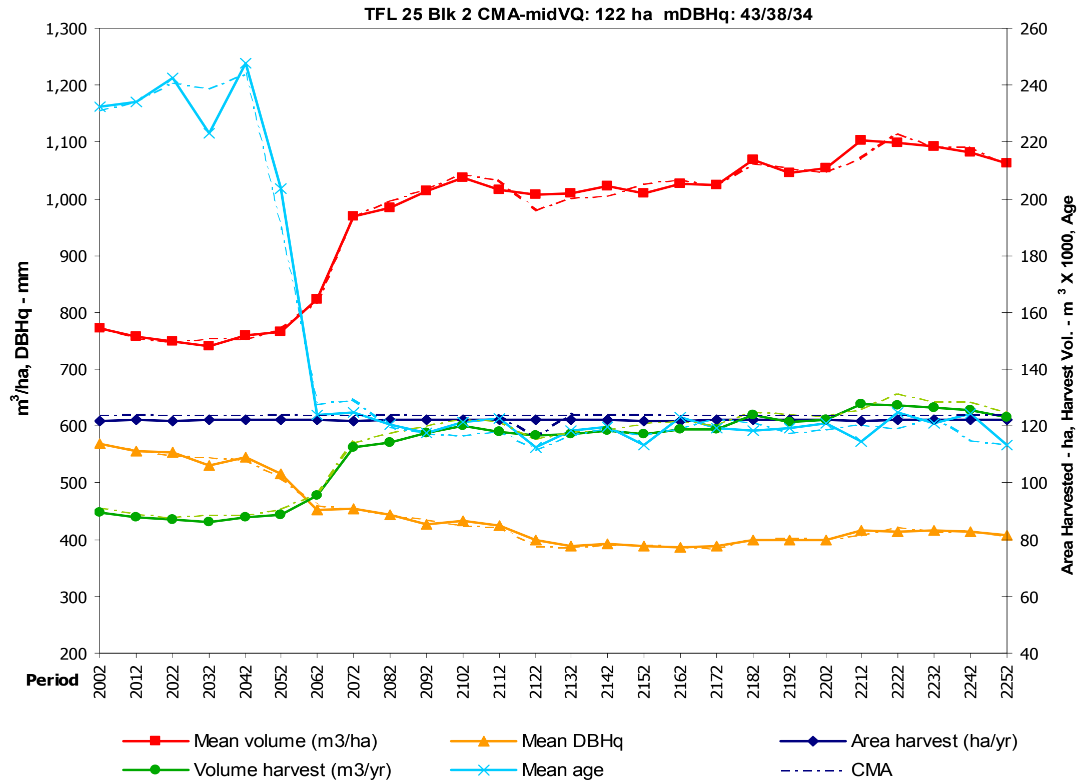

Figure 62. Block 2 CMA -midVQ

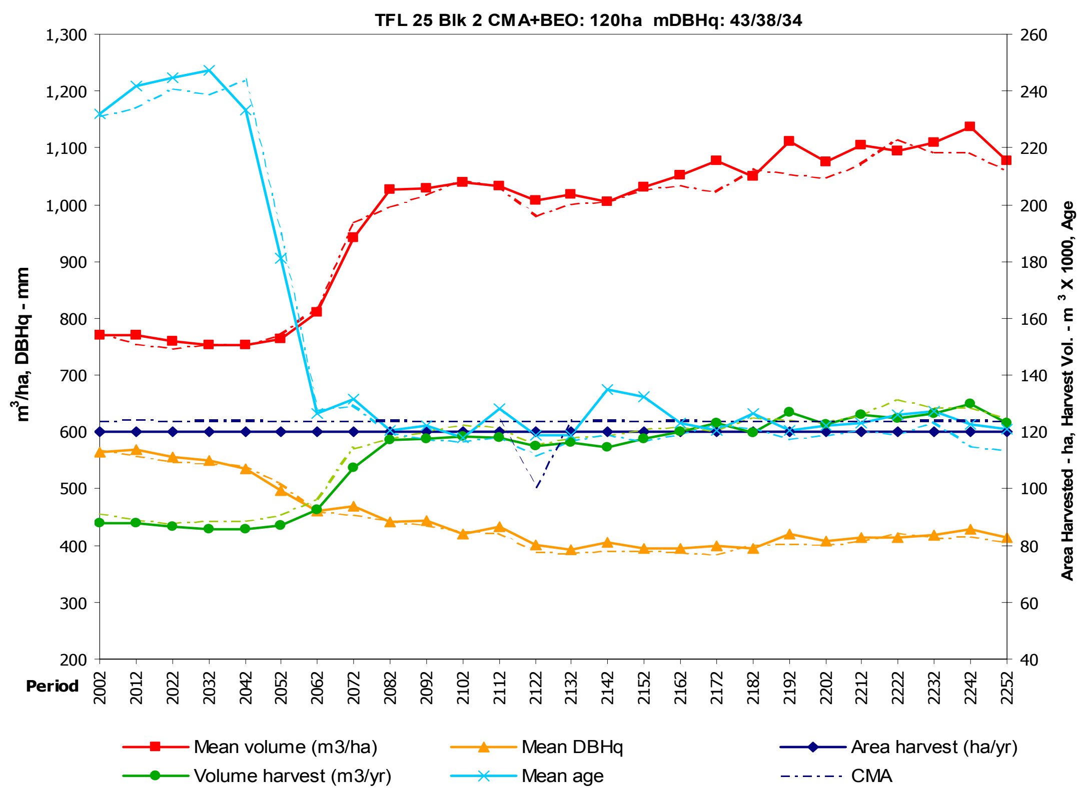

Figure 63. Block 2 CMA +BEO

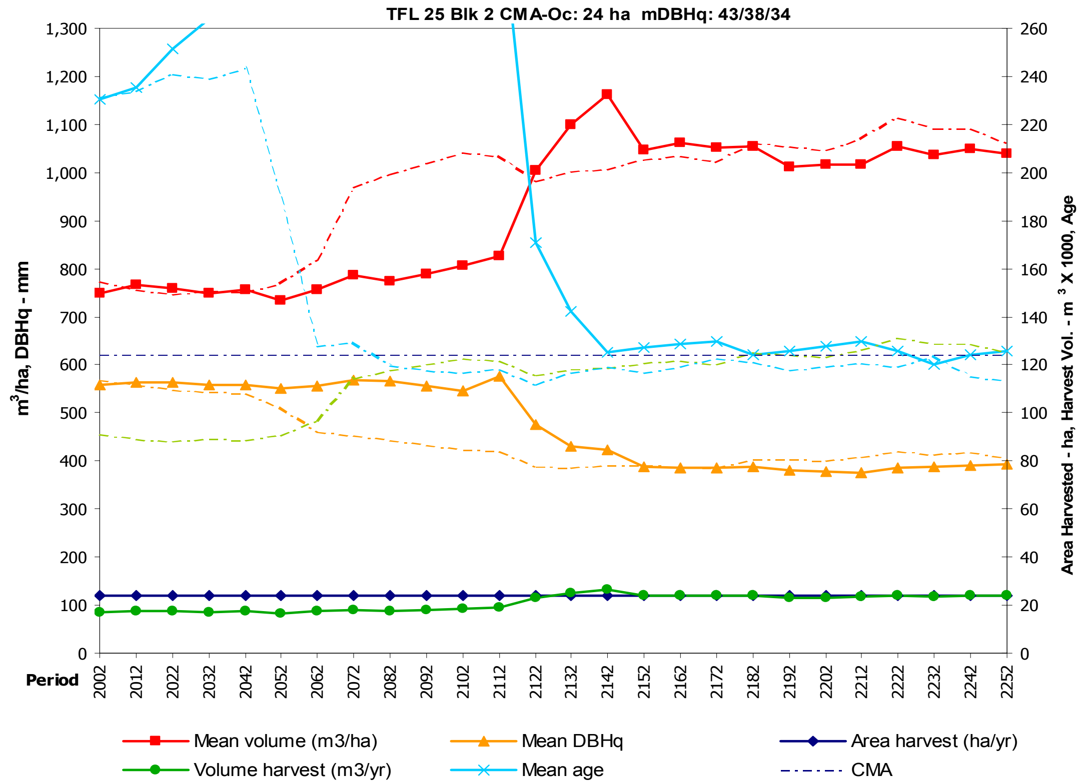

Figure 64. Block 2 CMA -Oc

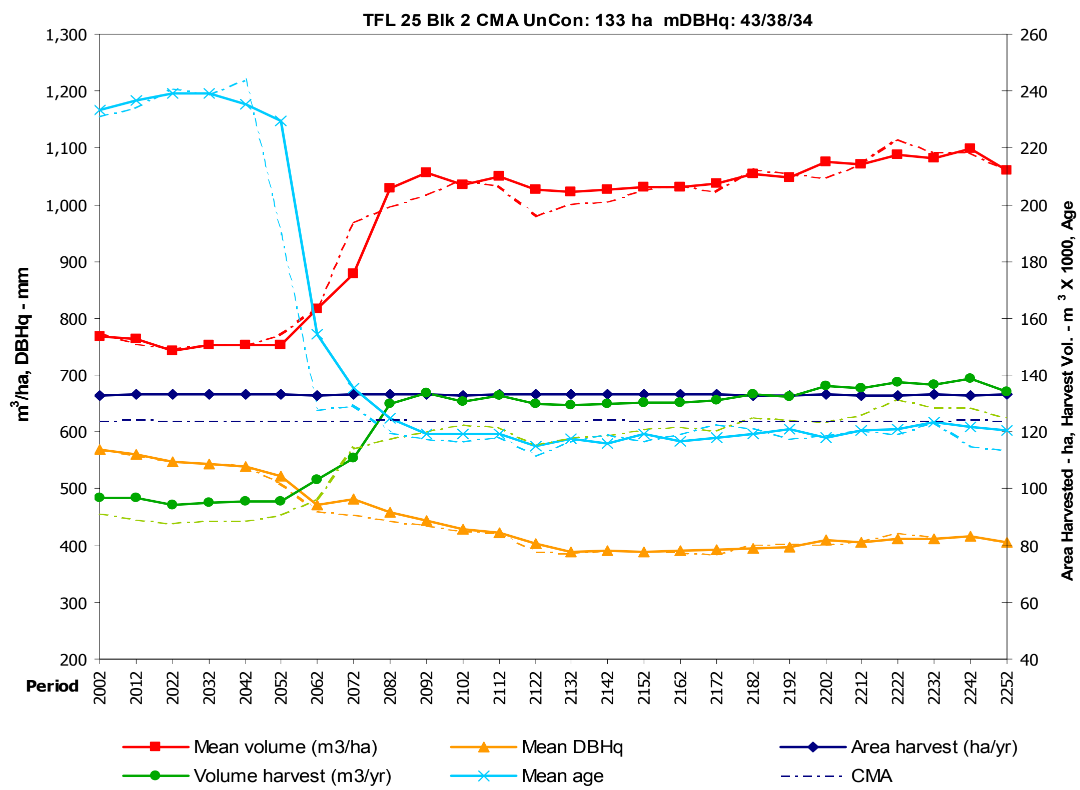

Figure 65. Block 2 CMA UnCon

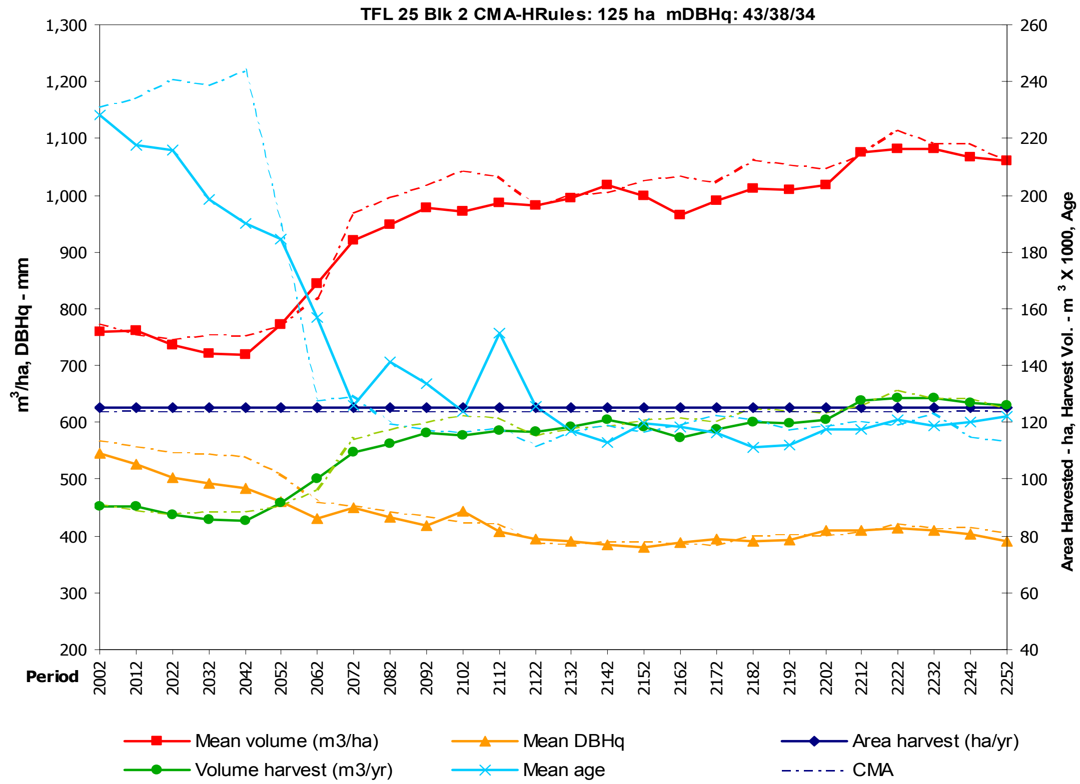

Figure 66. Block 2 CMA -HRules

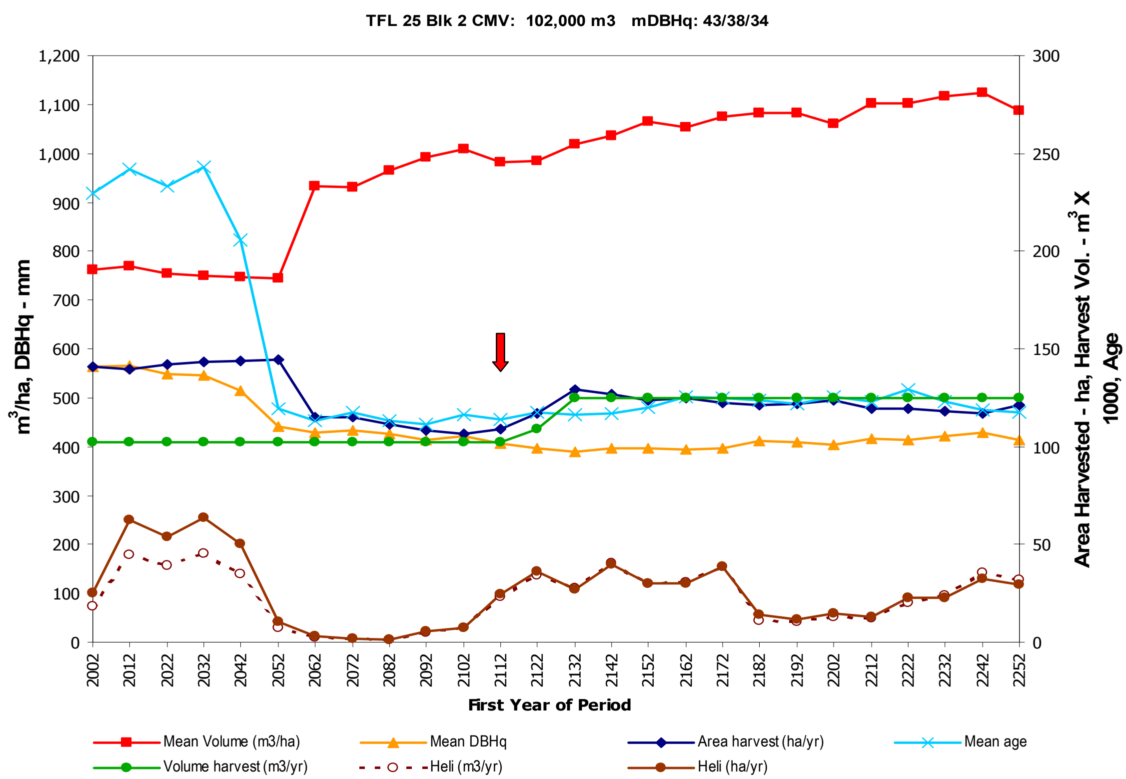

Figure 67. Block 2 CMV (Volume Regulated)

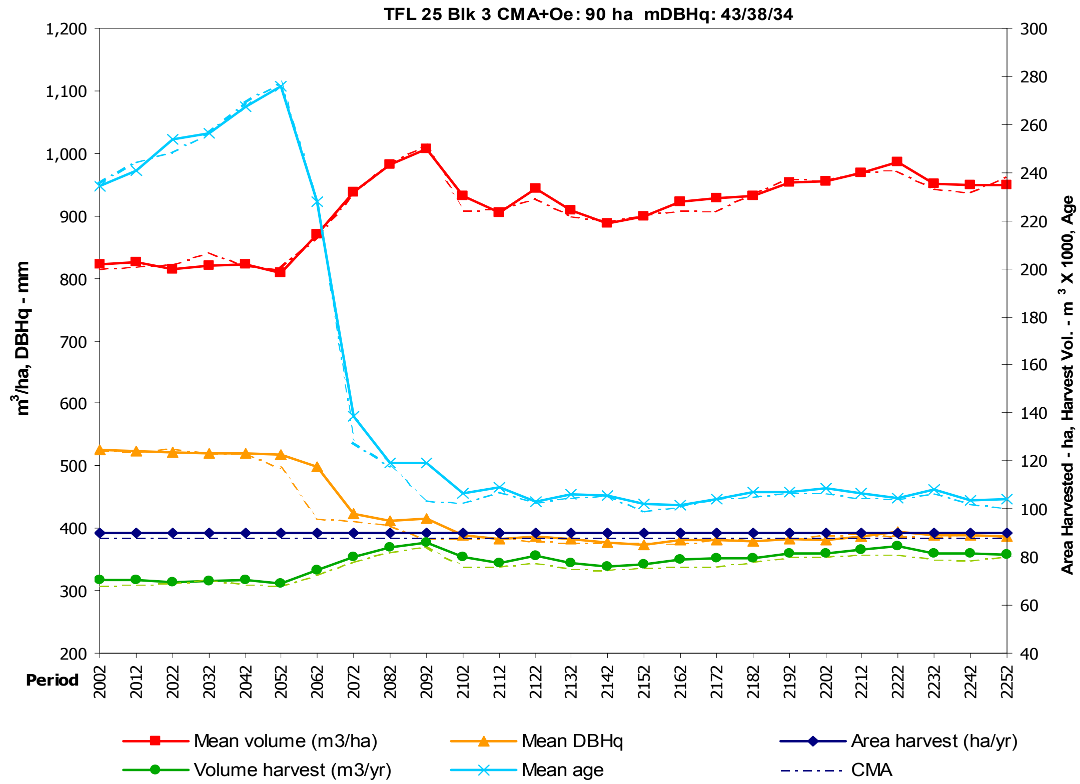

Figure 68. Block 3 CMA +Oe

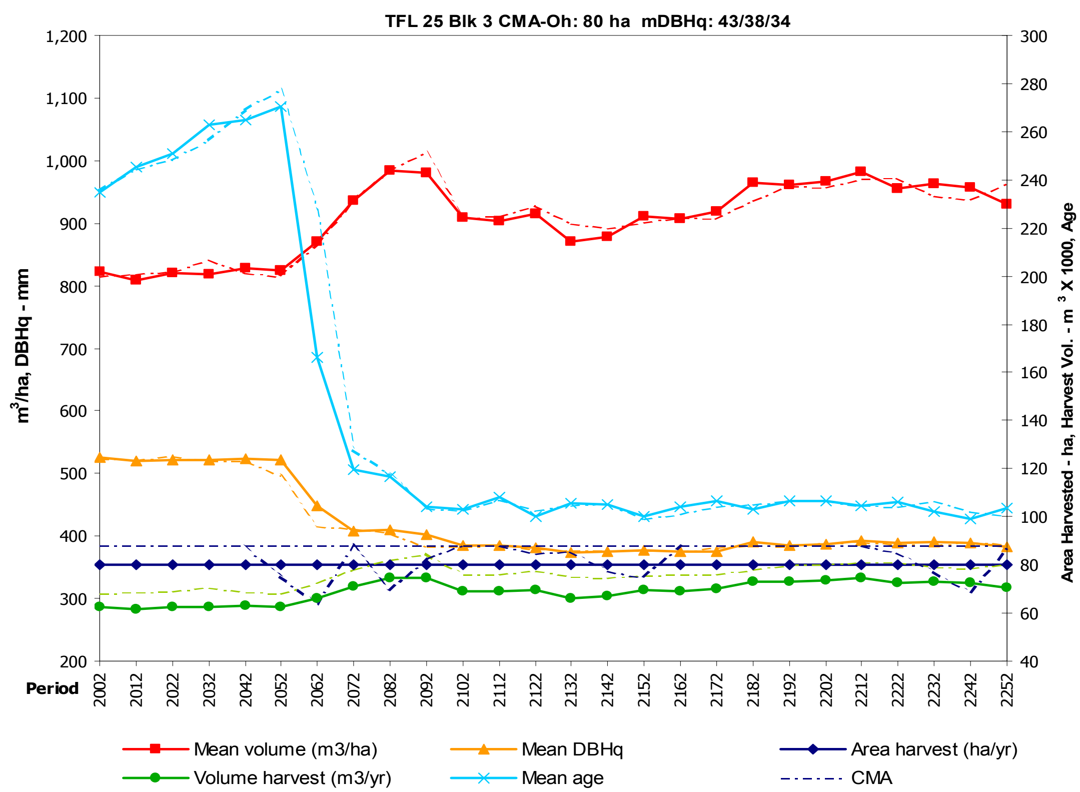

Figure 69. Block 3 CMA -Oh

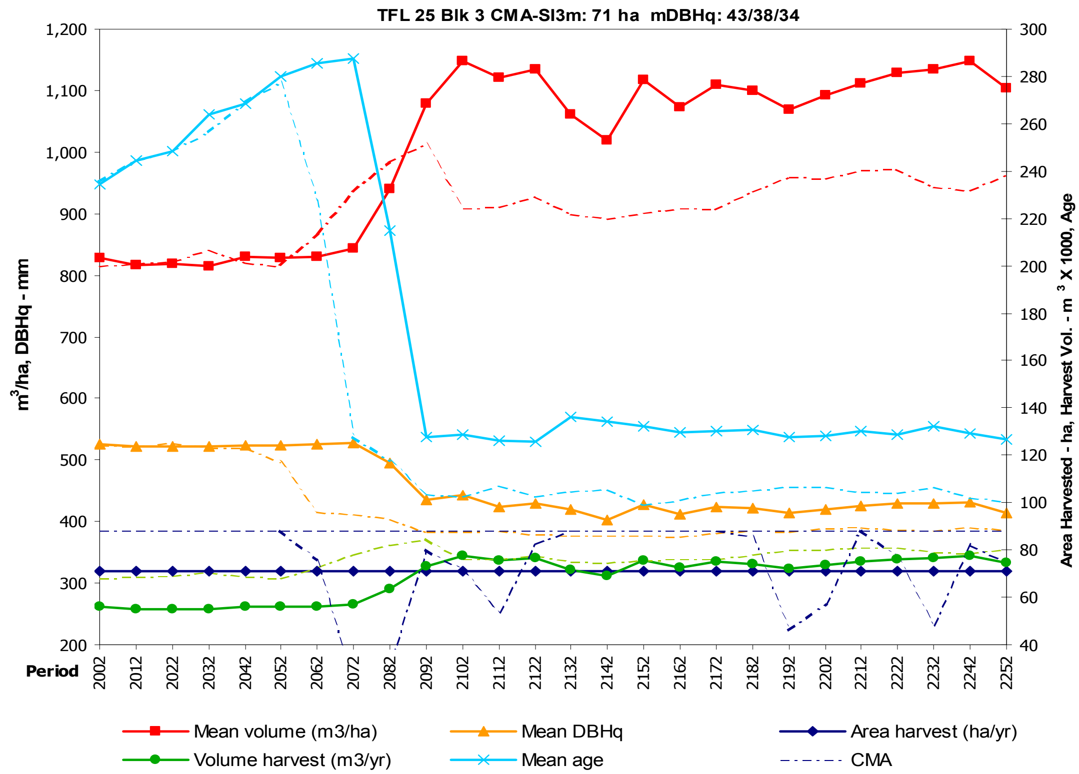

Figure 70. Block 3 CMA –SI3m

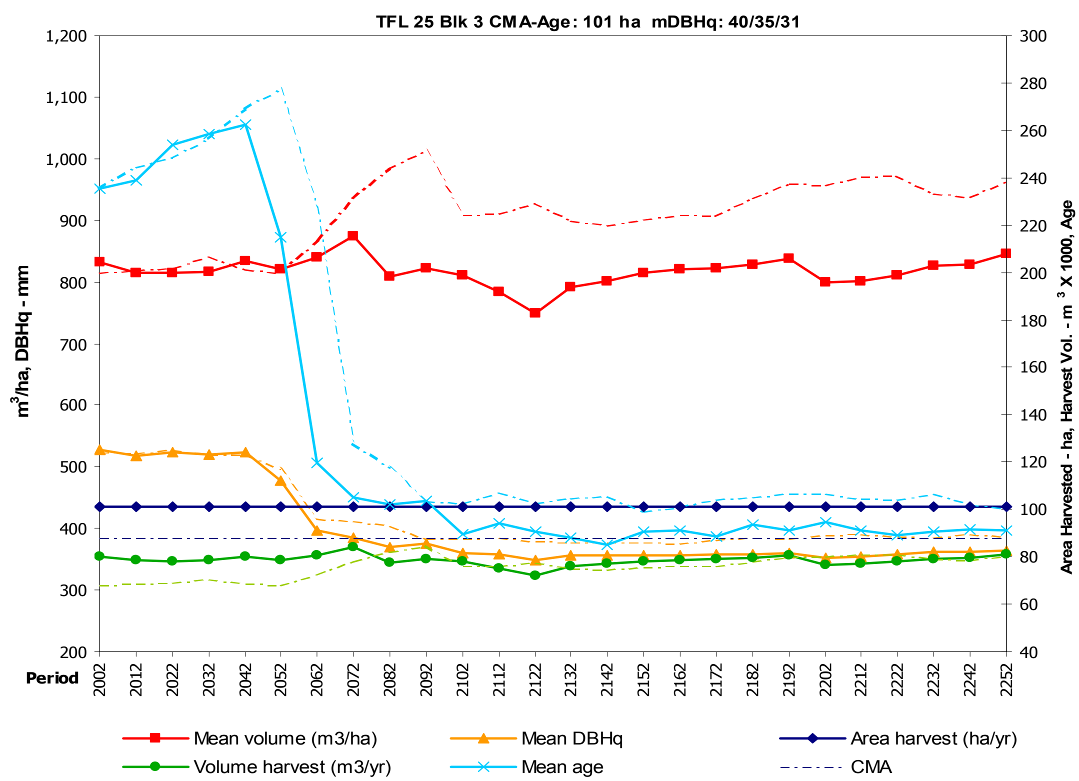

Figure 71. Block 3 CMA -age

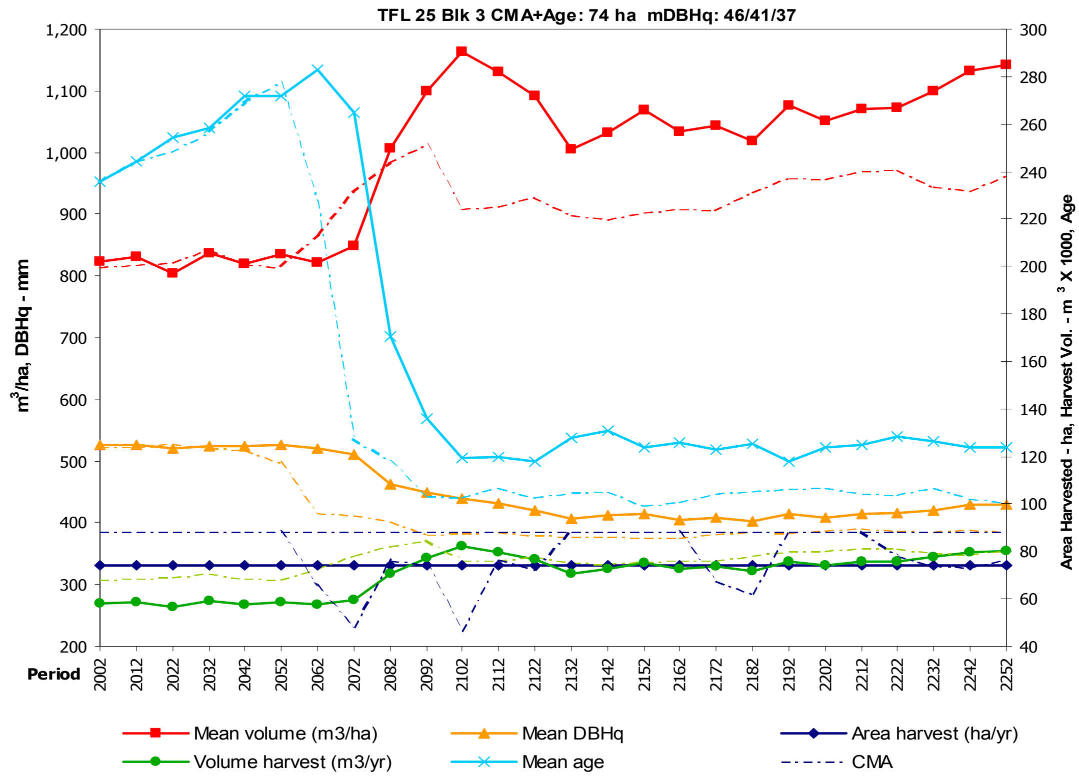

Figure 72. Block 3 CMA +age

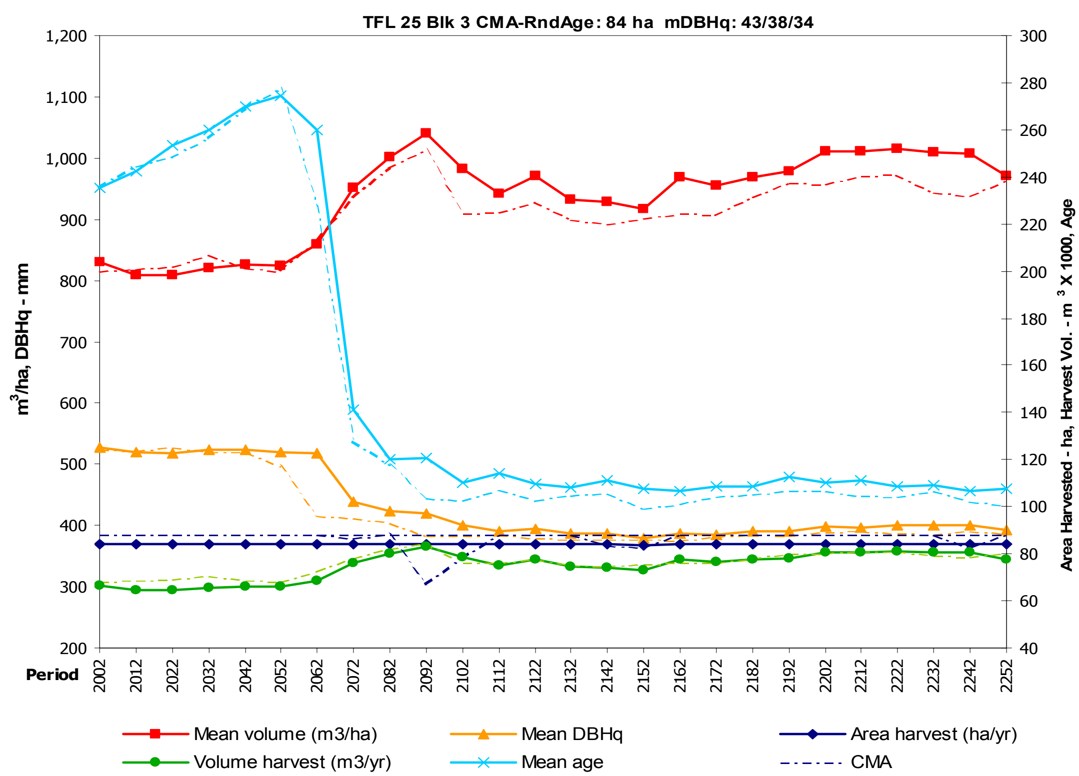

Figure 73. Block 3 CMA -RndAge

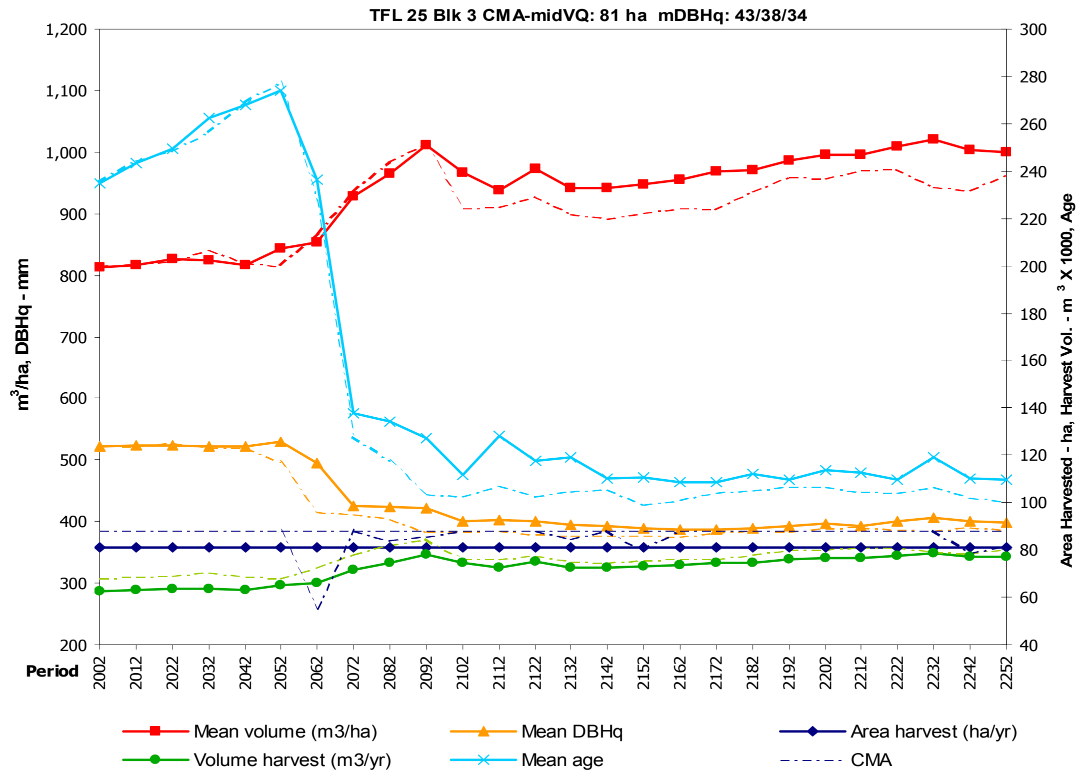

Figure 74. Block 3 CMA -midVQ

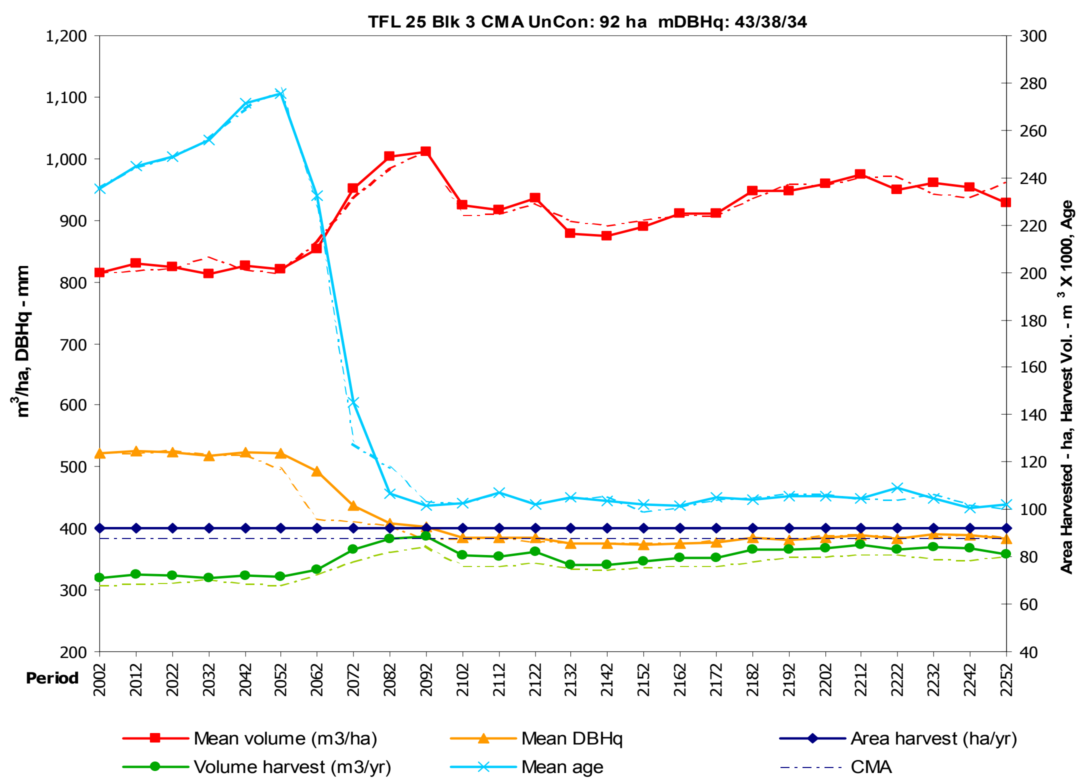

Figure 75. Block 3 CMA UnCon

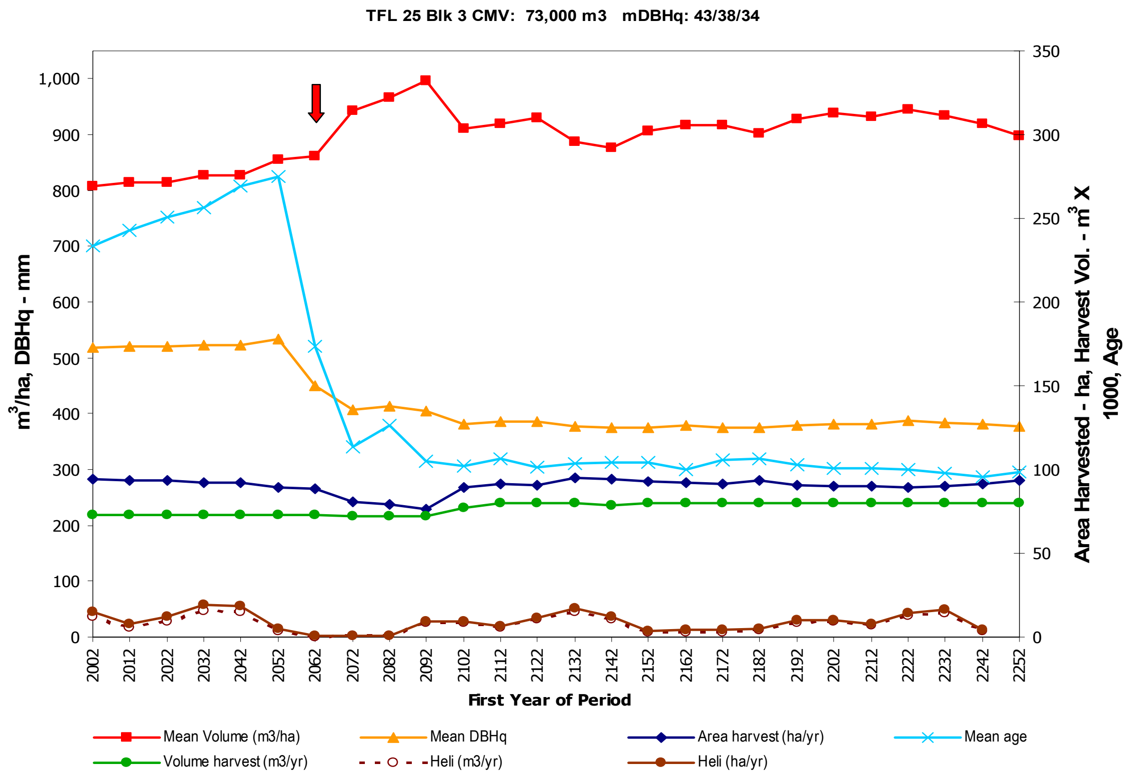

Figure 76. Block 3 CMV (Volume Regulated)

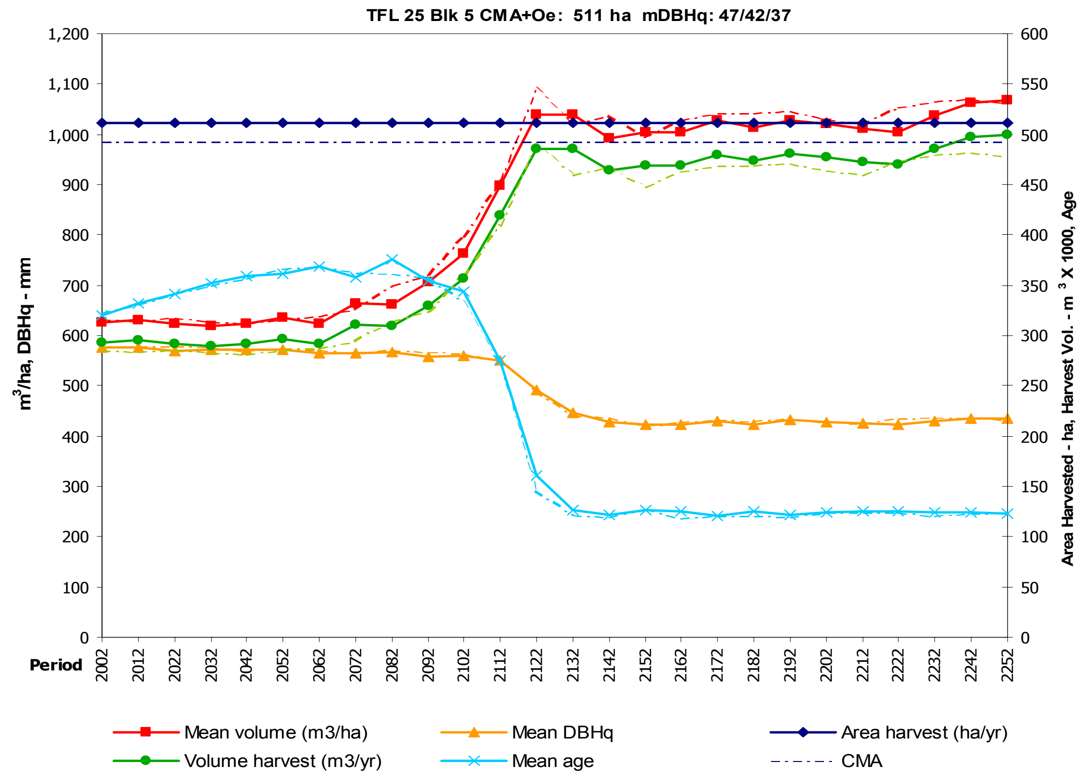

Figure 77. Block 5 CMA +Oe

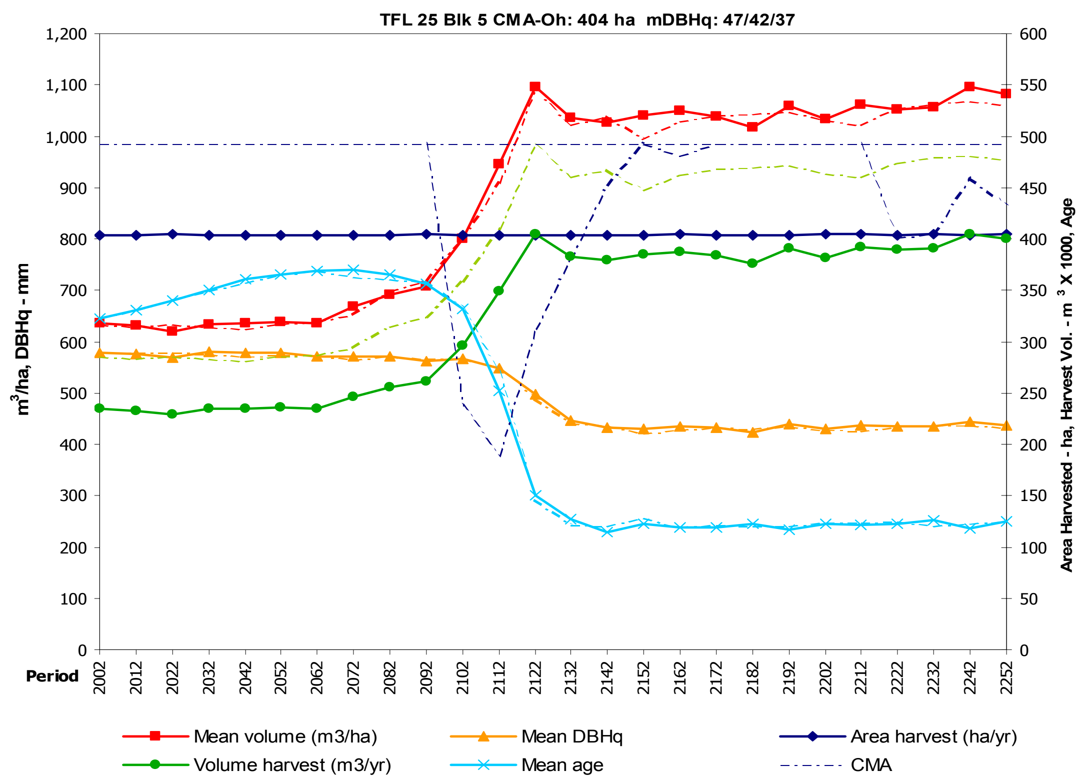

Figure 78. Block 5 CMA -Oh

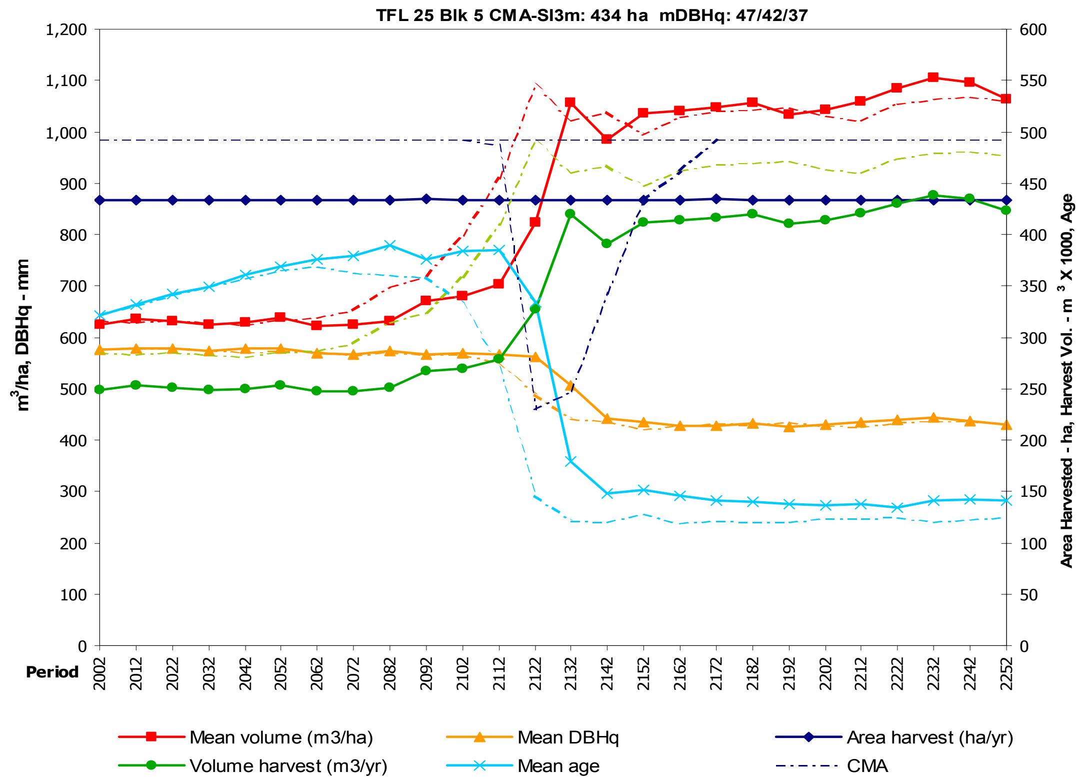

Figure 79. Block 5 CMA –SI3m

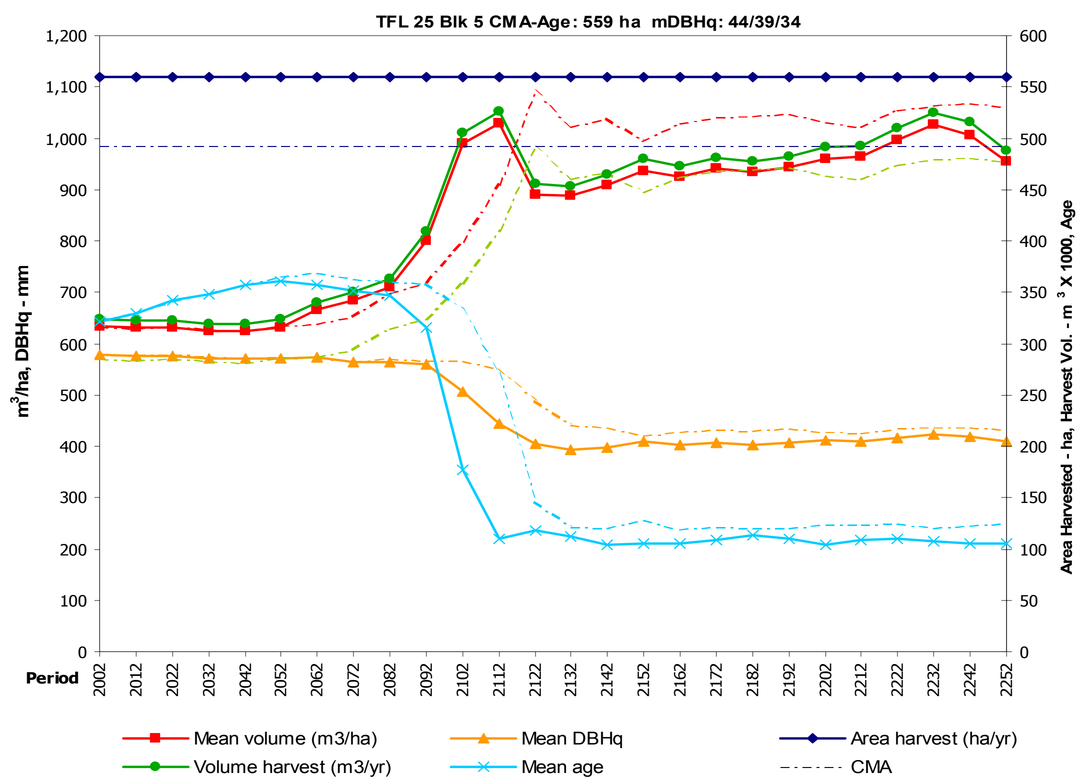

Figure 80. Block 5 CMA -age

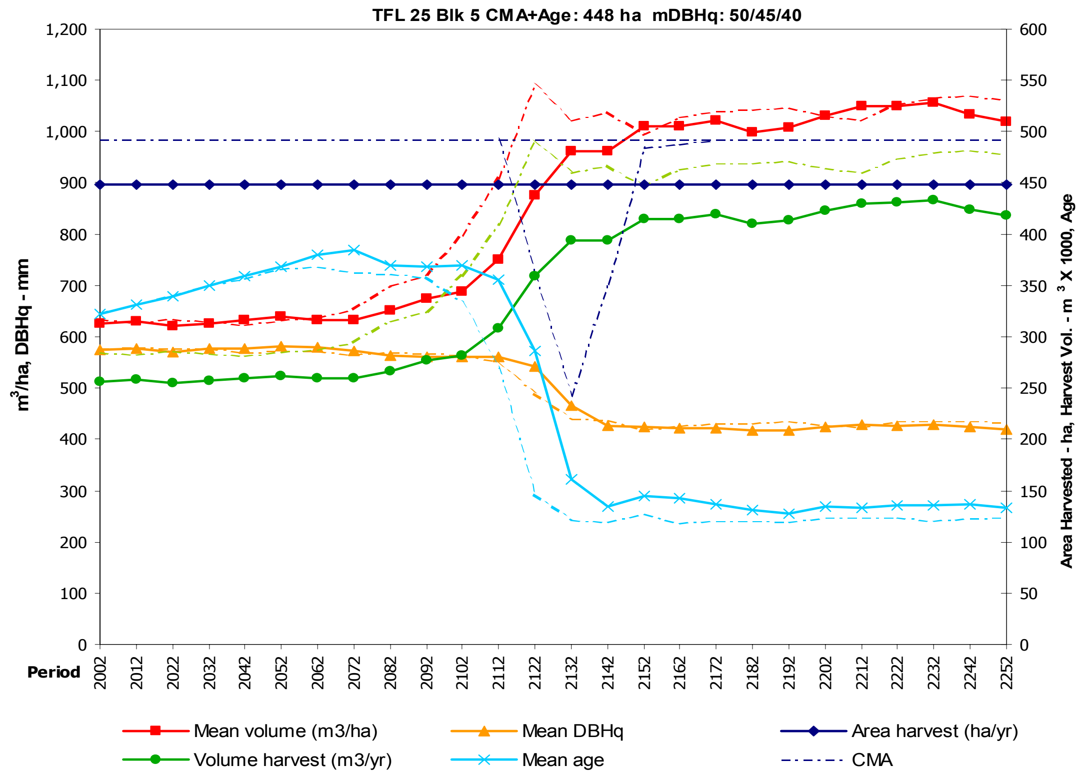

Figure 81. Block 5 CMA +age

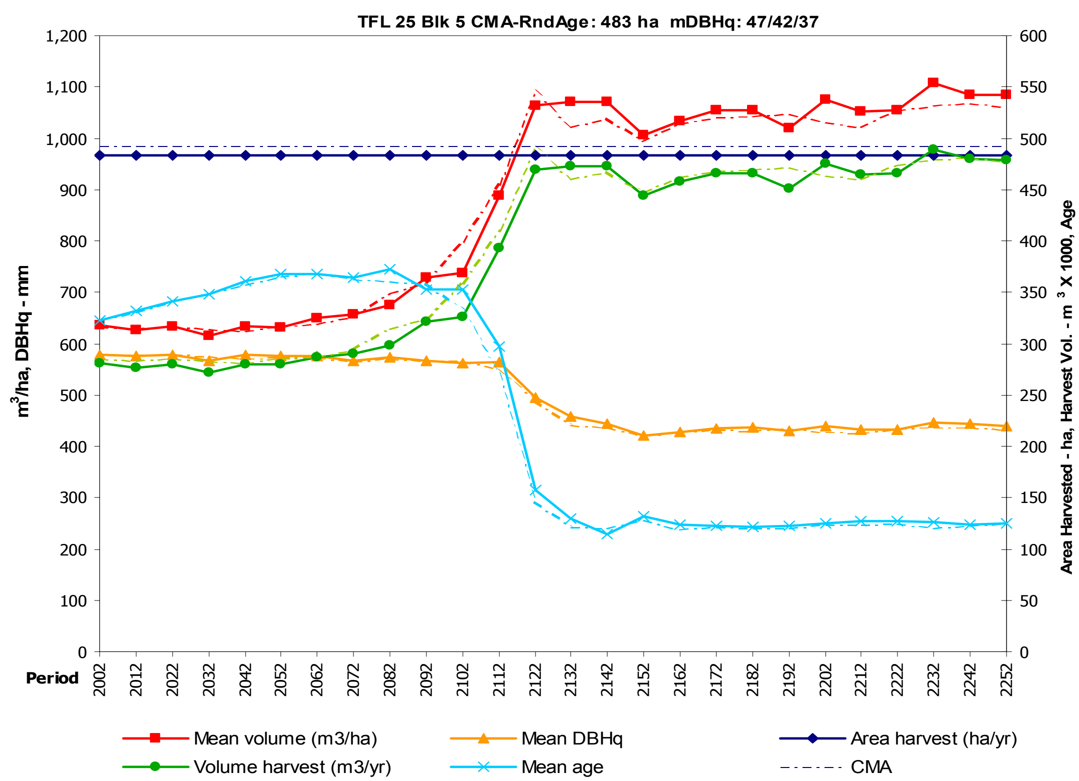

Figure 82. Block 5 CMA -RndAge

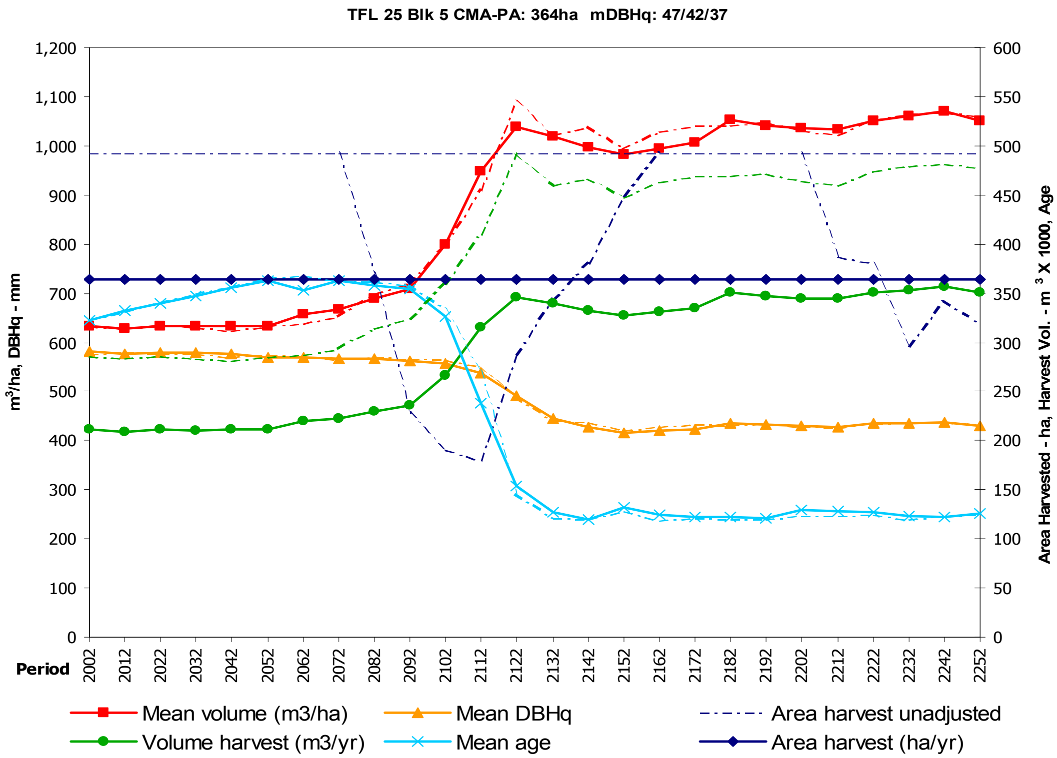

Figure 83. Block 5 CMA -PA

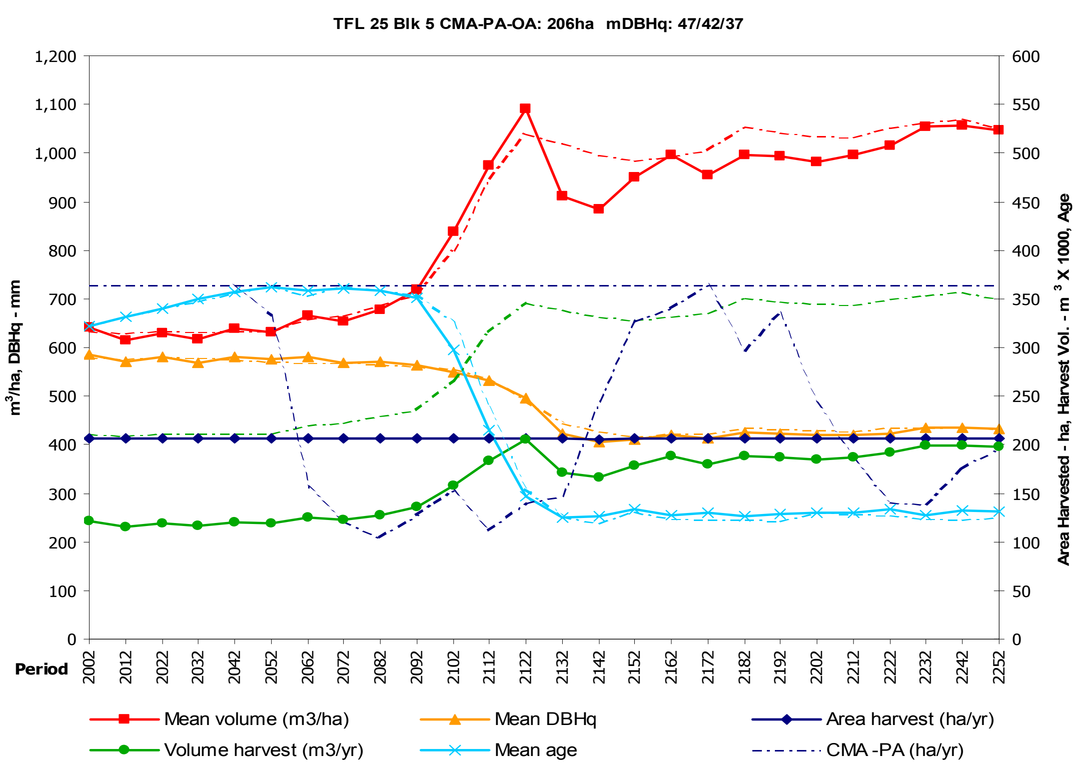

Figure 84. Block 5 CMA -PA -OA

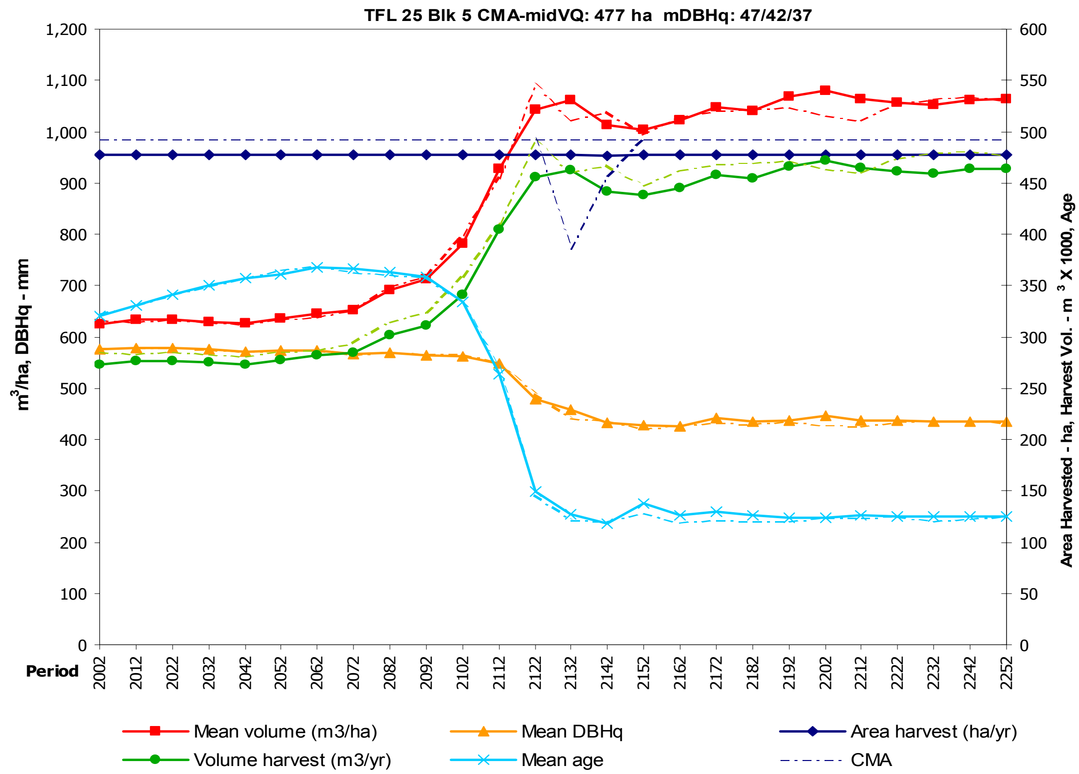

Figure 85. Block 5 CMA -midVQ

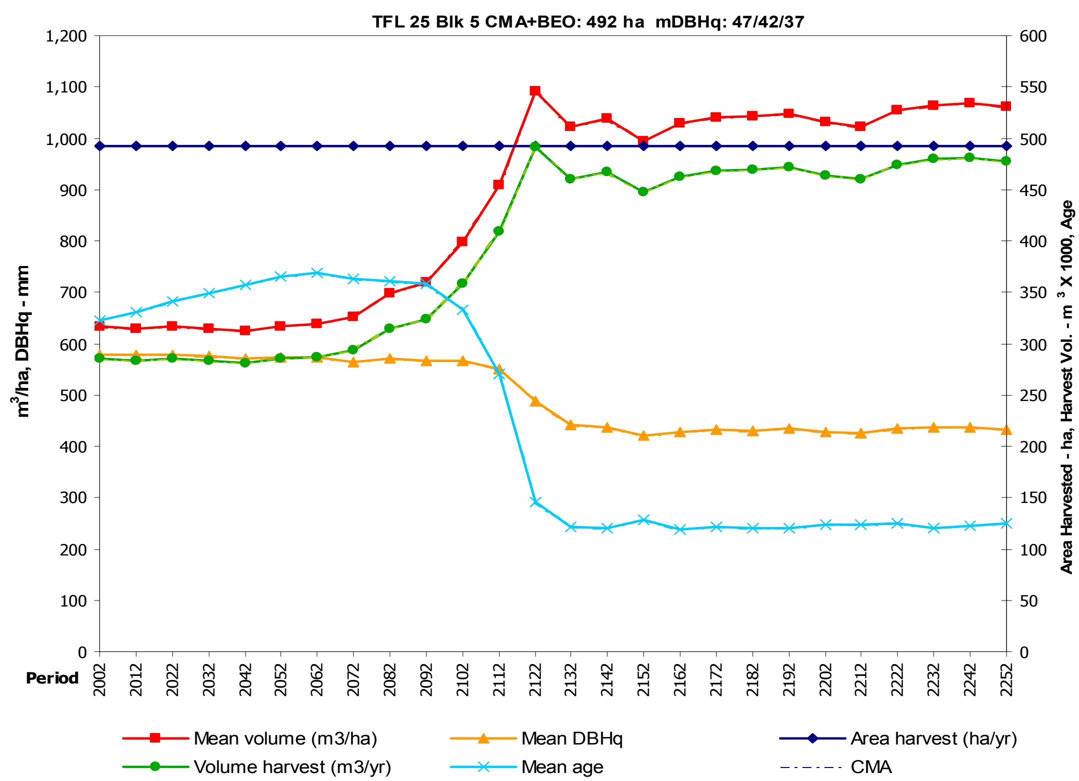

Figure 86. Block 5 CMA +BEO

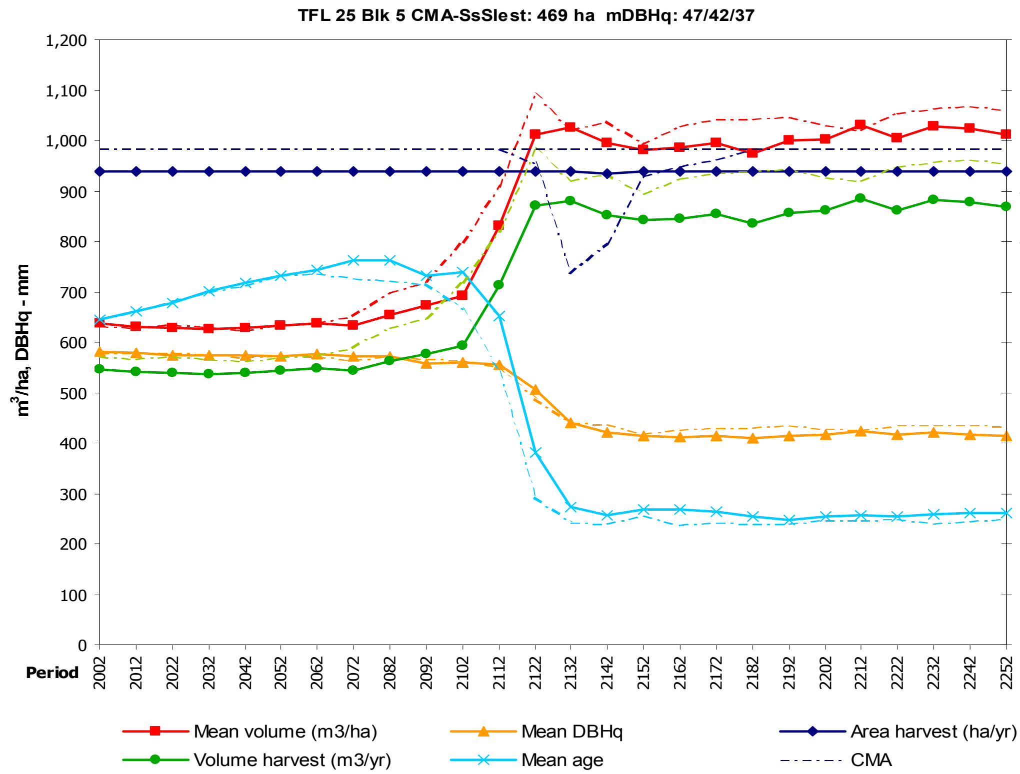

Figure 87. Block 5 CMA –SsSlest

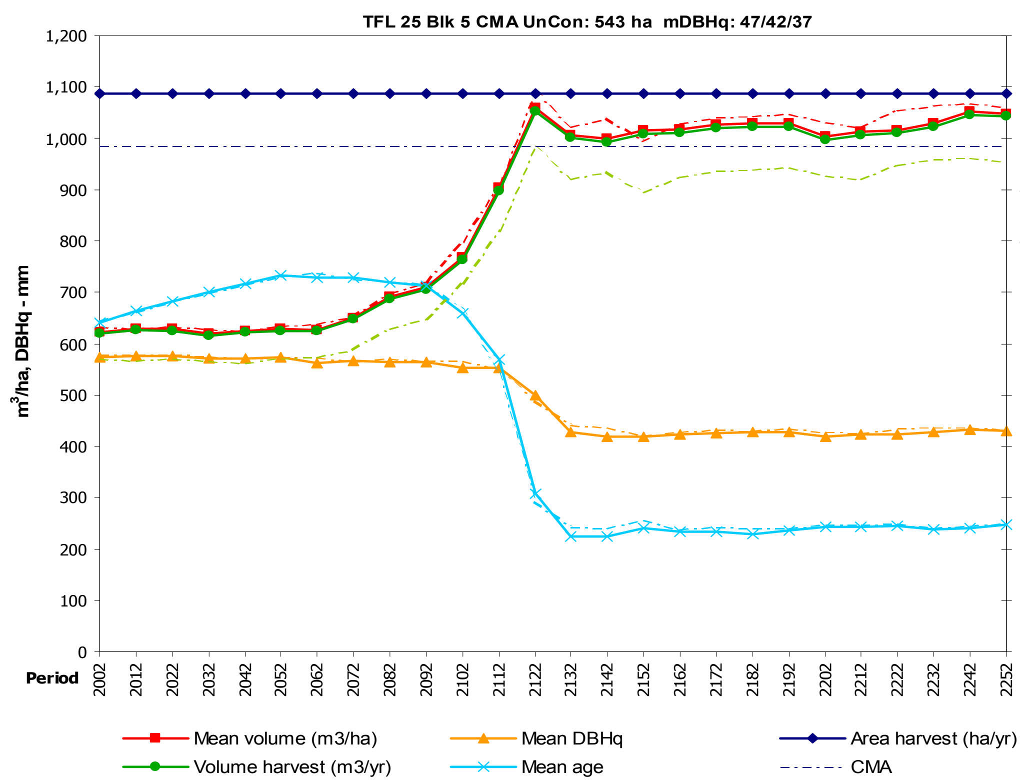

Figure 88. Block 5 CMA UnCon

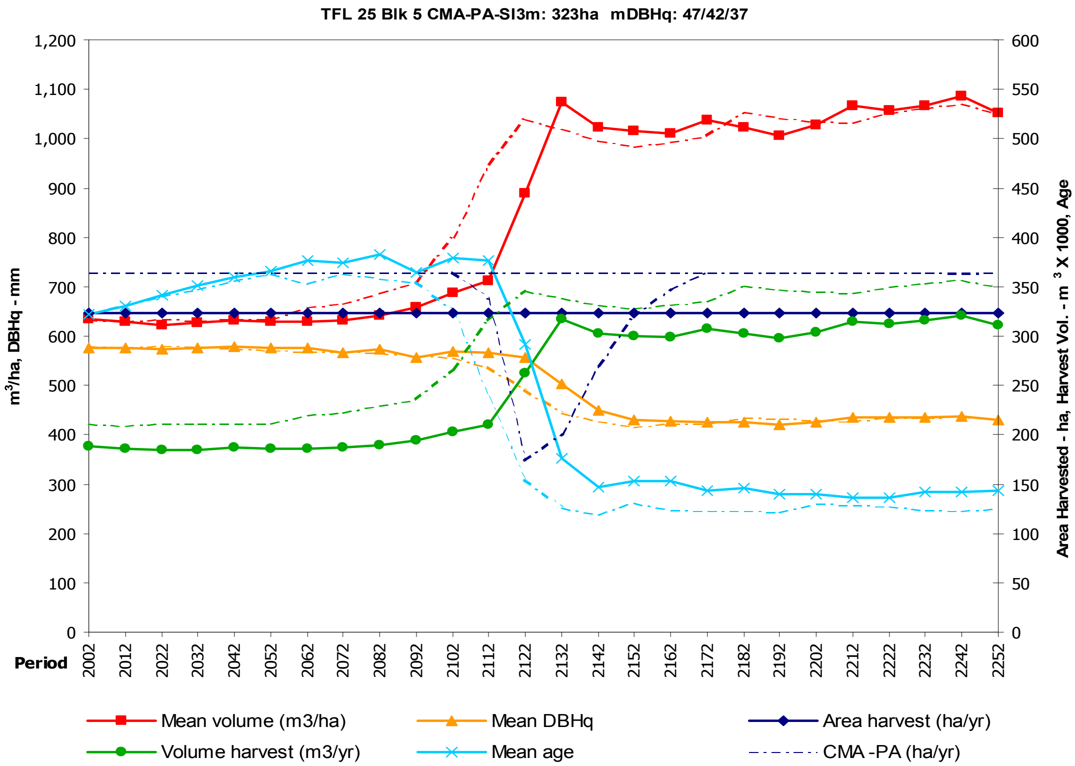

Figure 89. Block 5 CMA –PA –SI3m

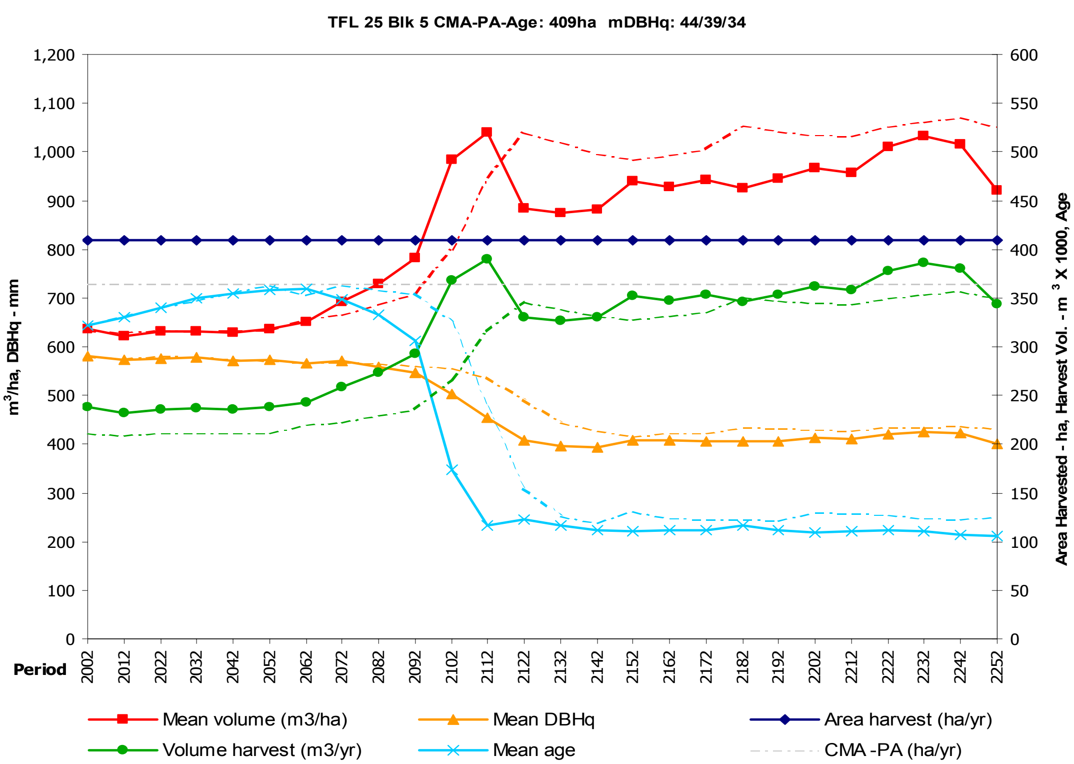

Figure 90. Block 5 CMA –PA –age

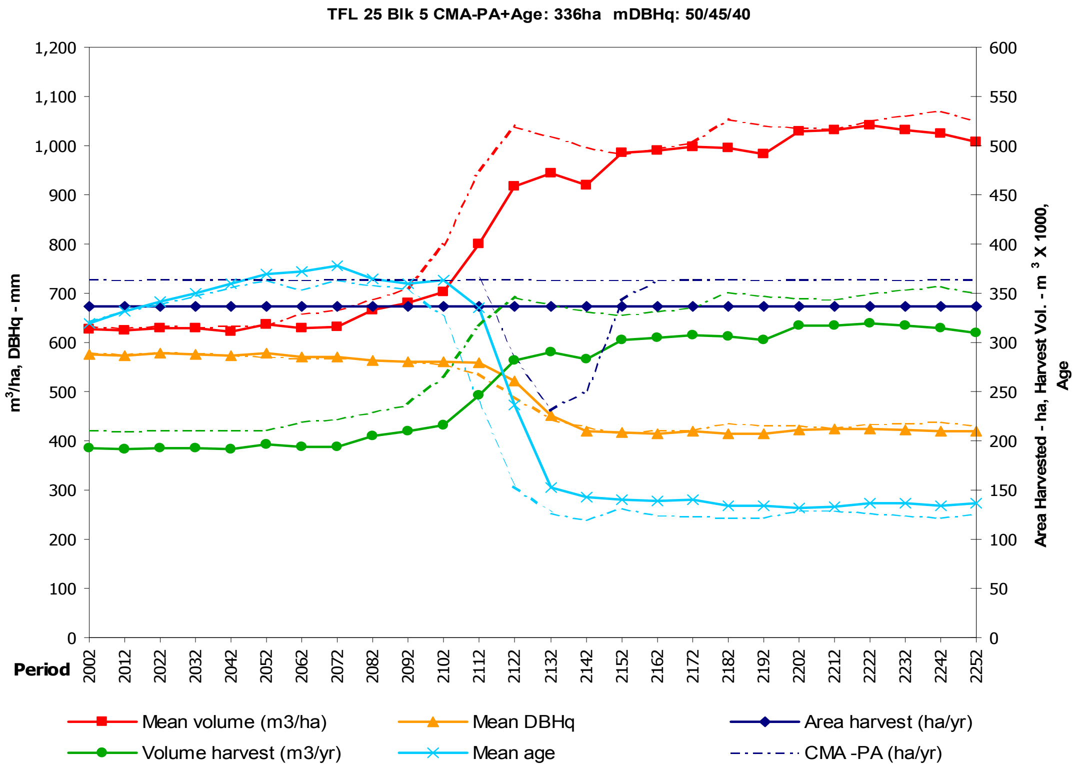

Figure 91. Block 5 CMA –PA +age

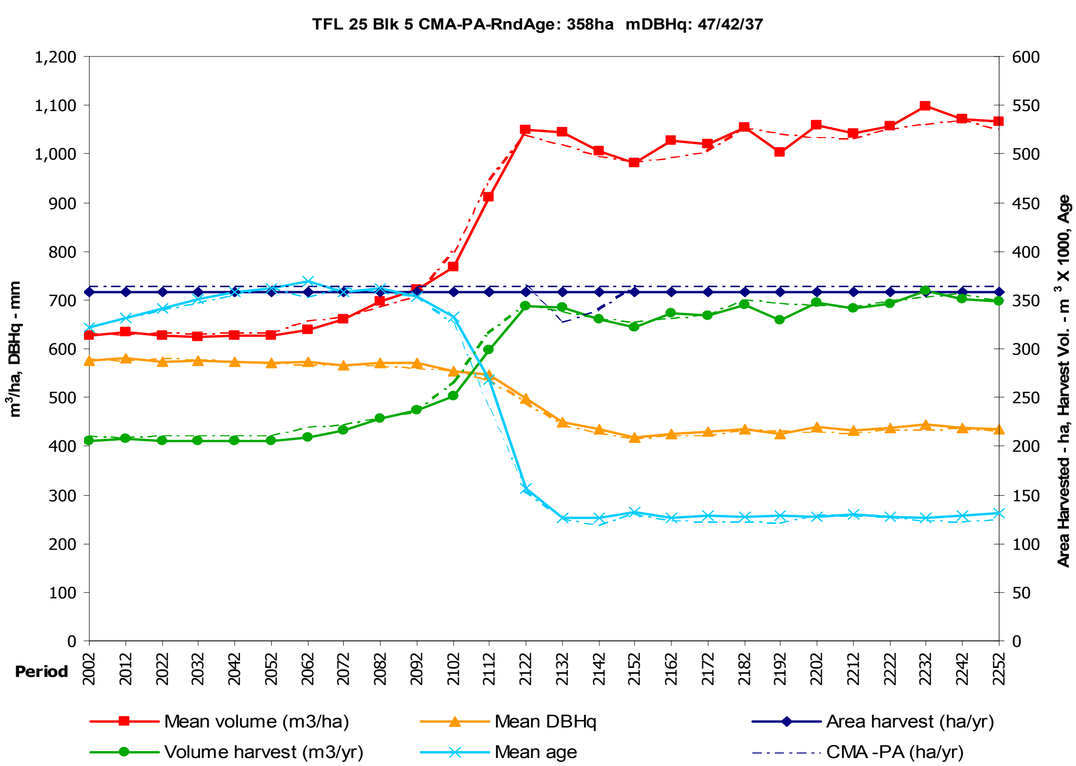

Figure 92. Block 5 CMA –PA –RndAge

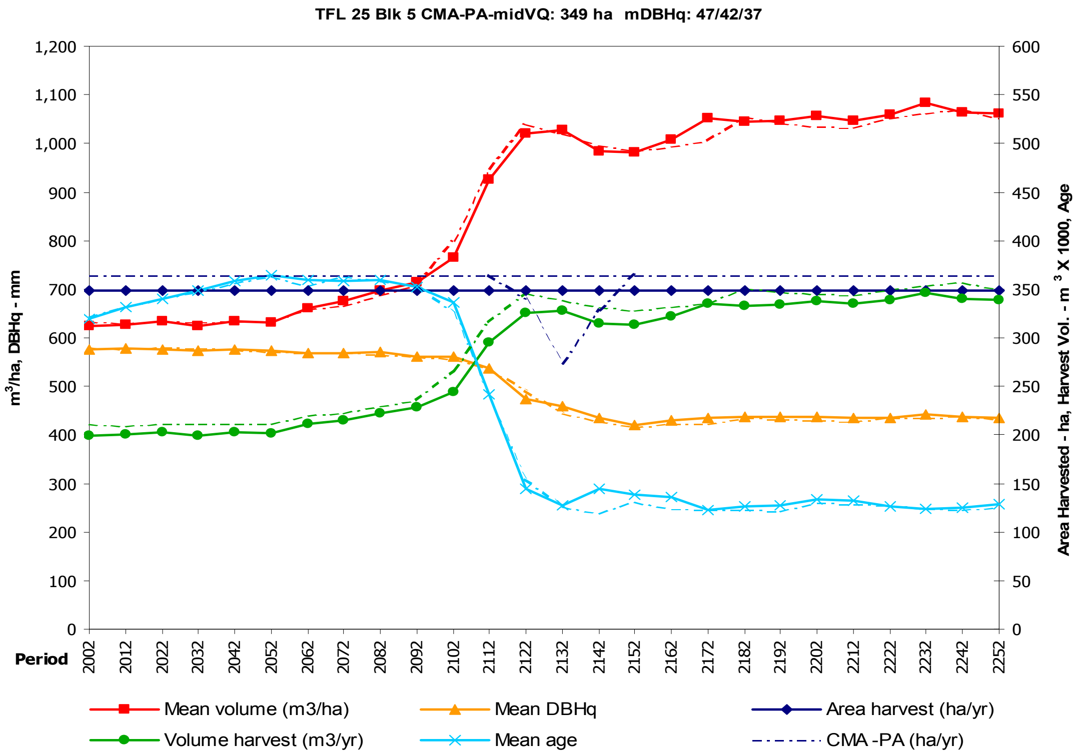

Figure 93. Block 5 CMA –PA –midVQ

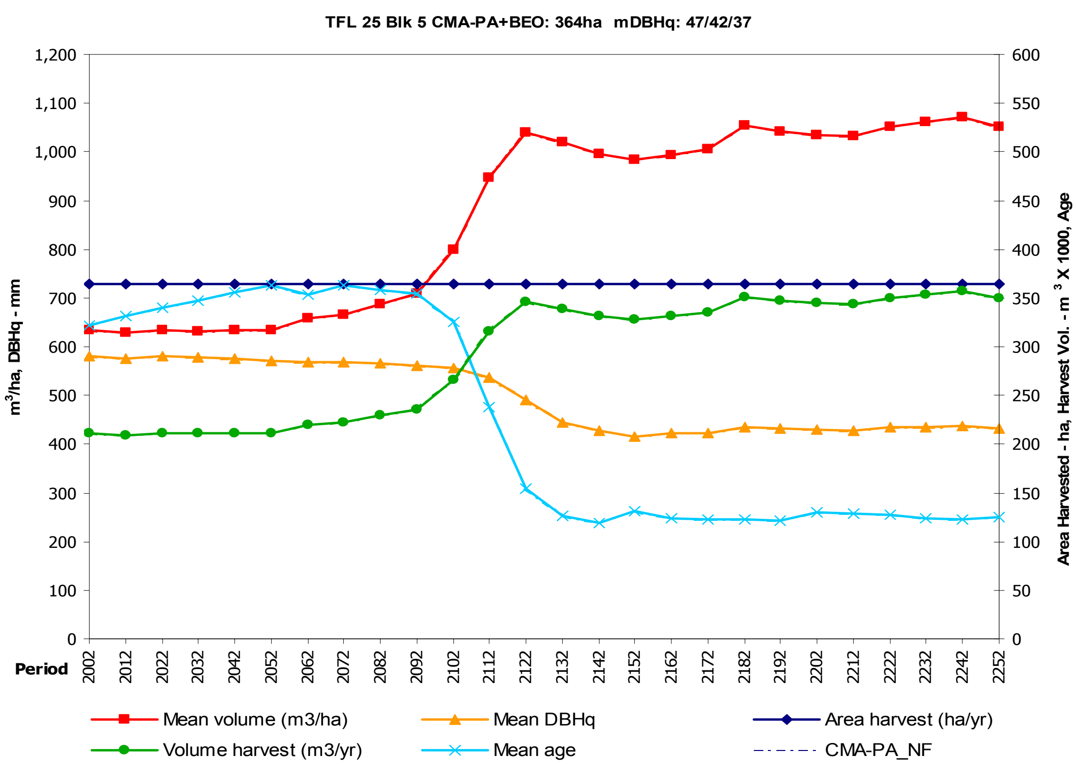

Figure 94. Block 5 CMA –PA +BEO

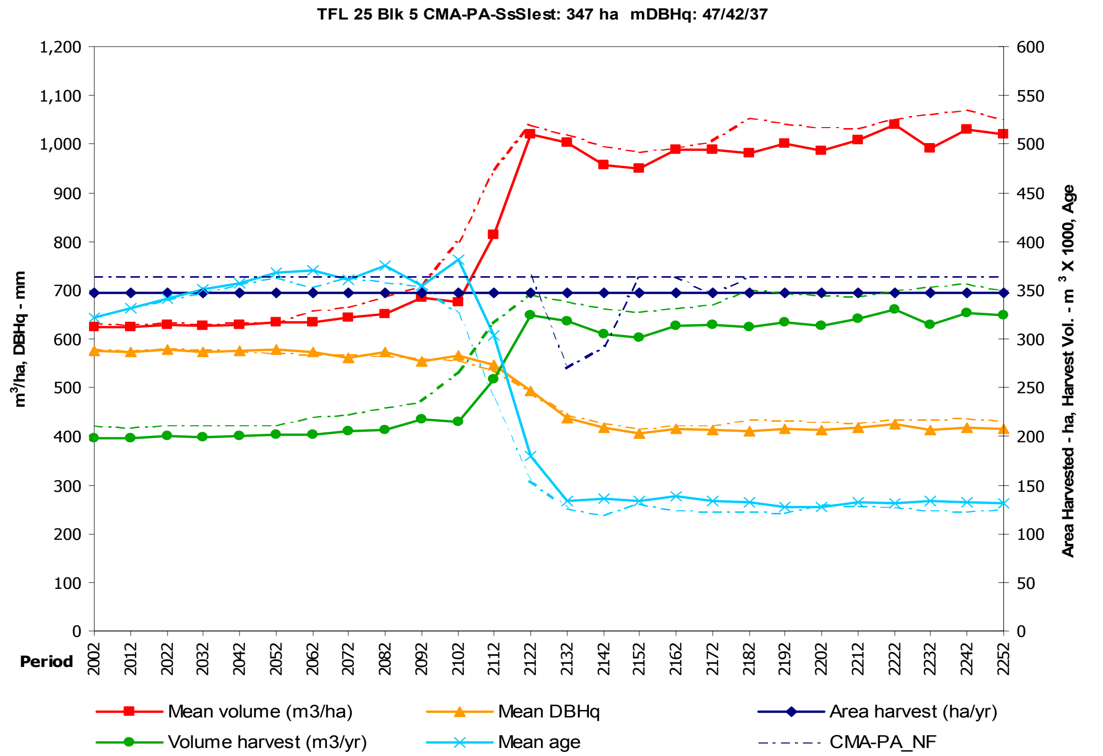

Figure 95. Block 5 CMA –PA –SsSlest

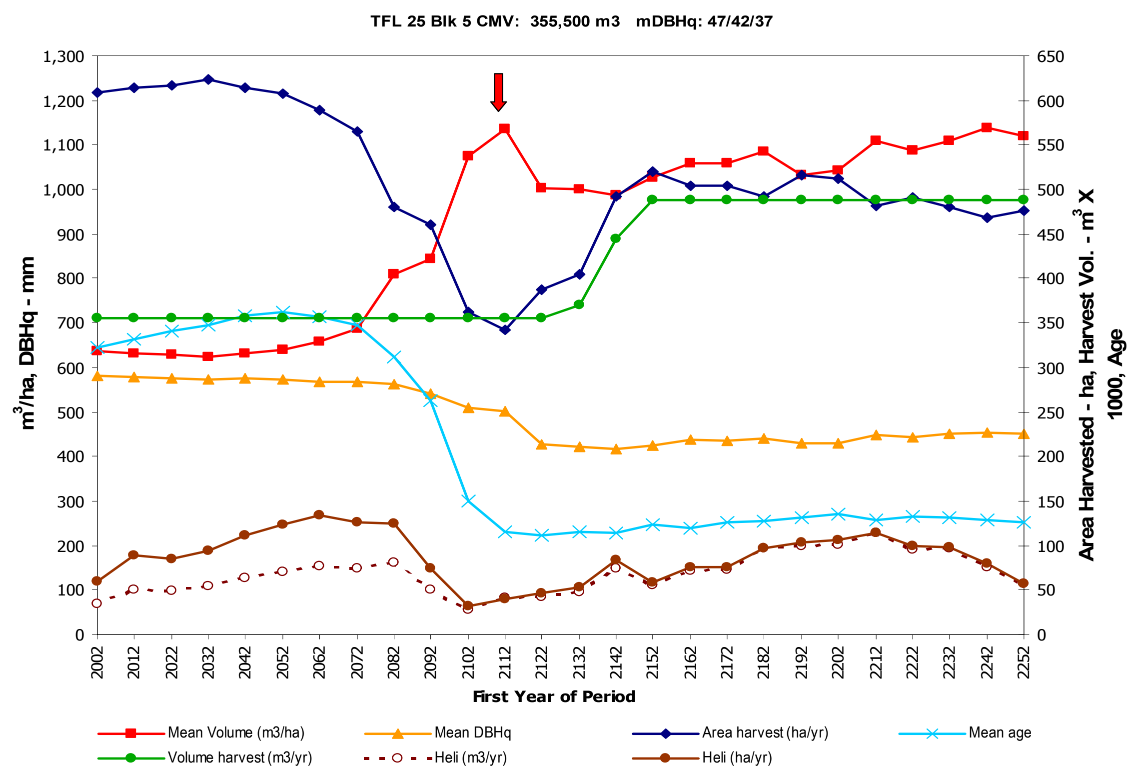

Figure 96. Block 5 CMV (Volume Regulated)

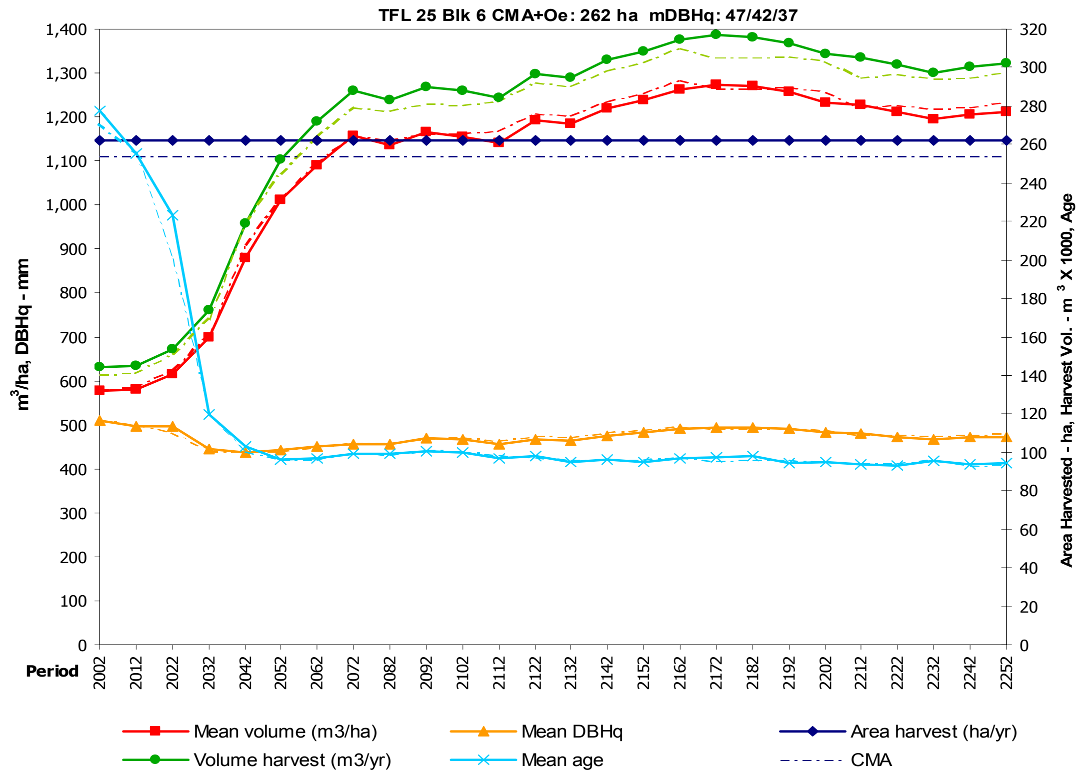

Figure 97. Block 6 CMA +Oe

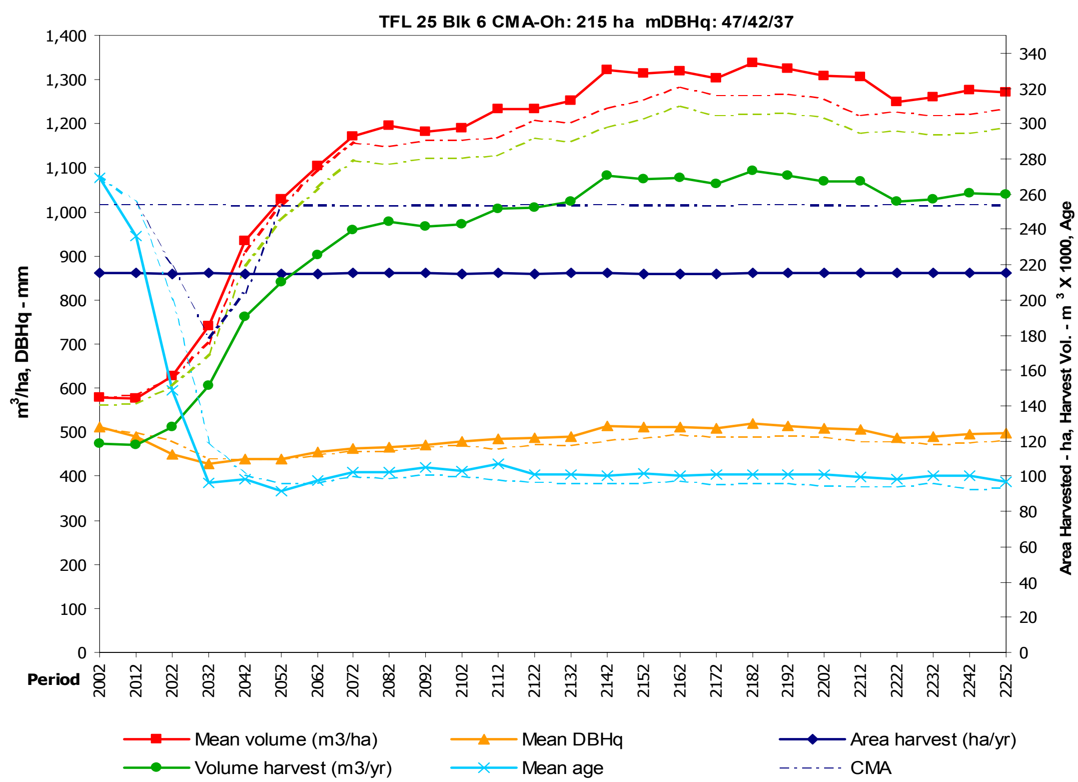

Figure 98. Block 6 CMA -Oh

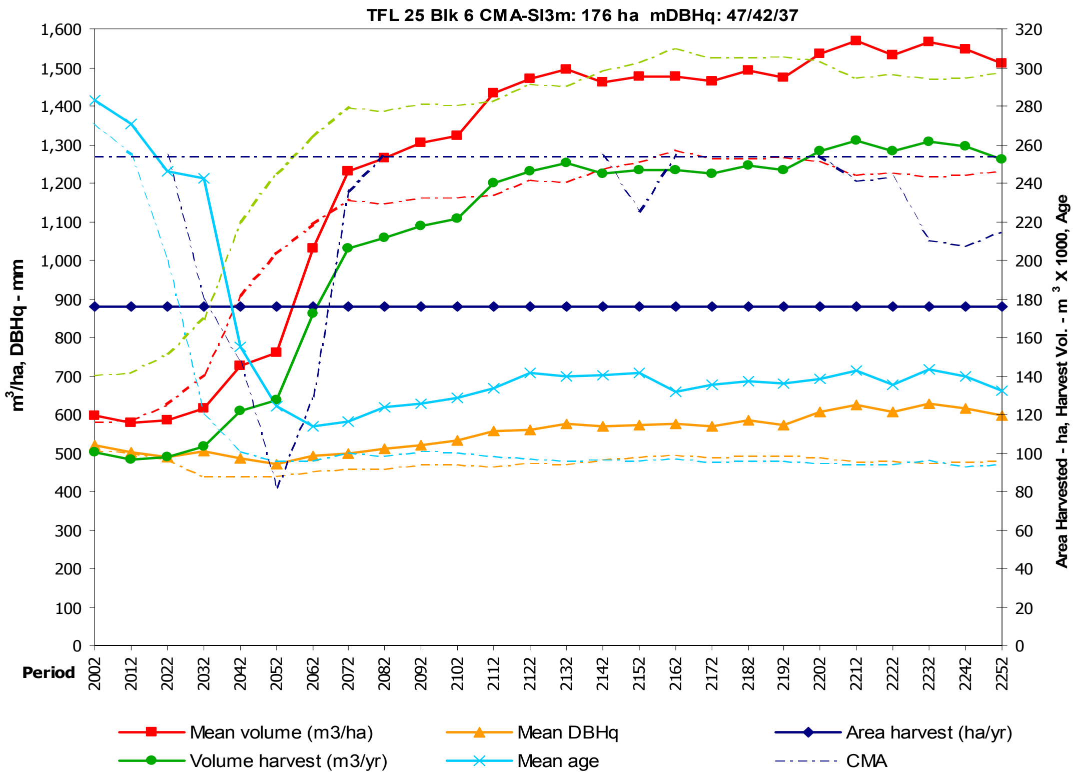

Figure 99. Block 6 CMA –SI3m

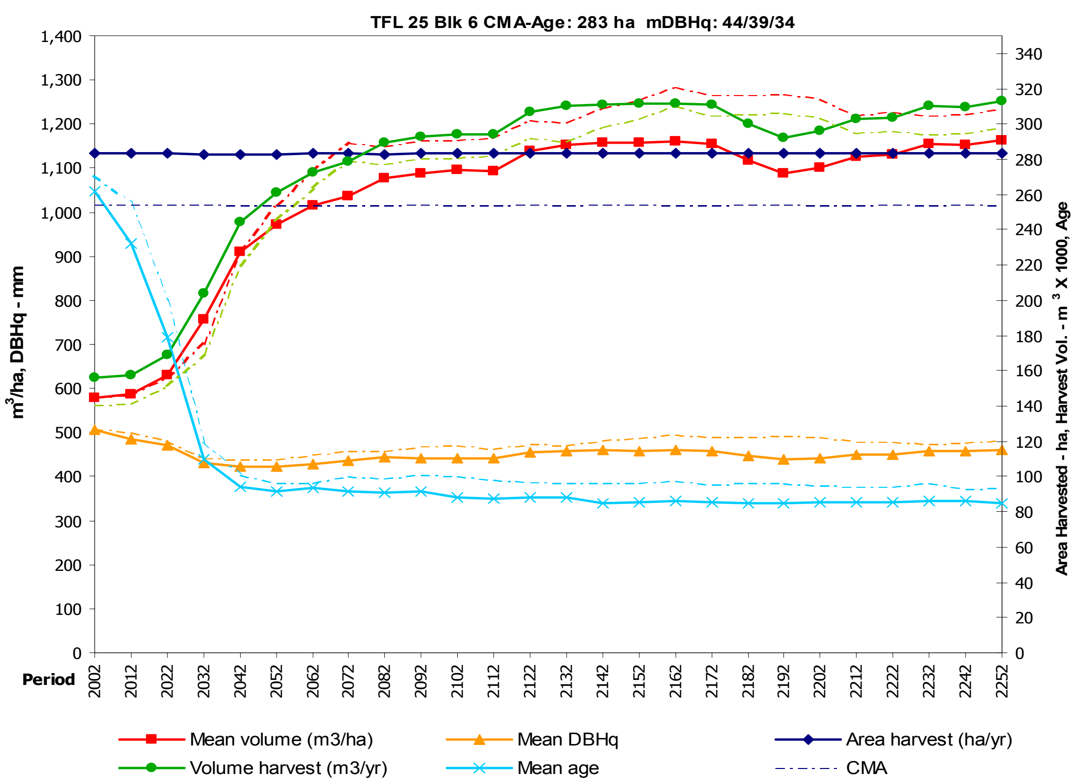

Figure 100. Block 6 CMA -age

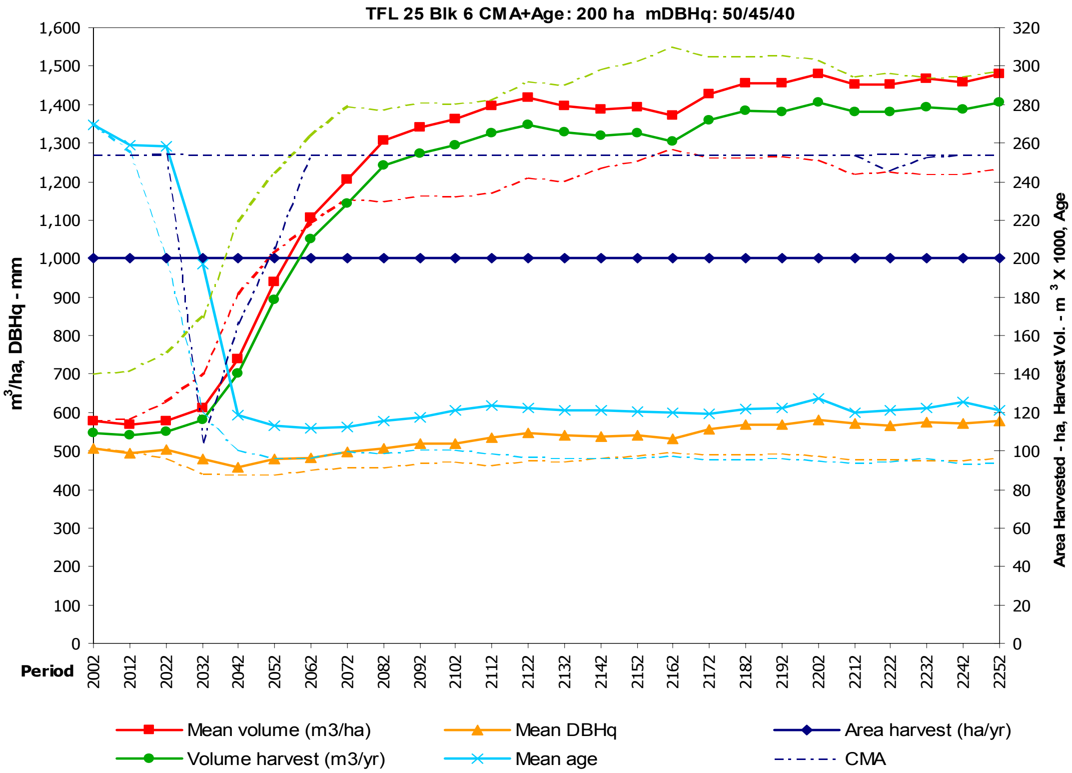

Figure 101. Block 6 CMA +age

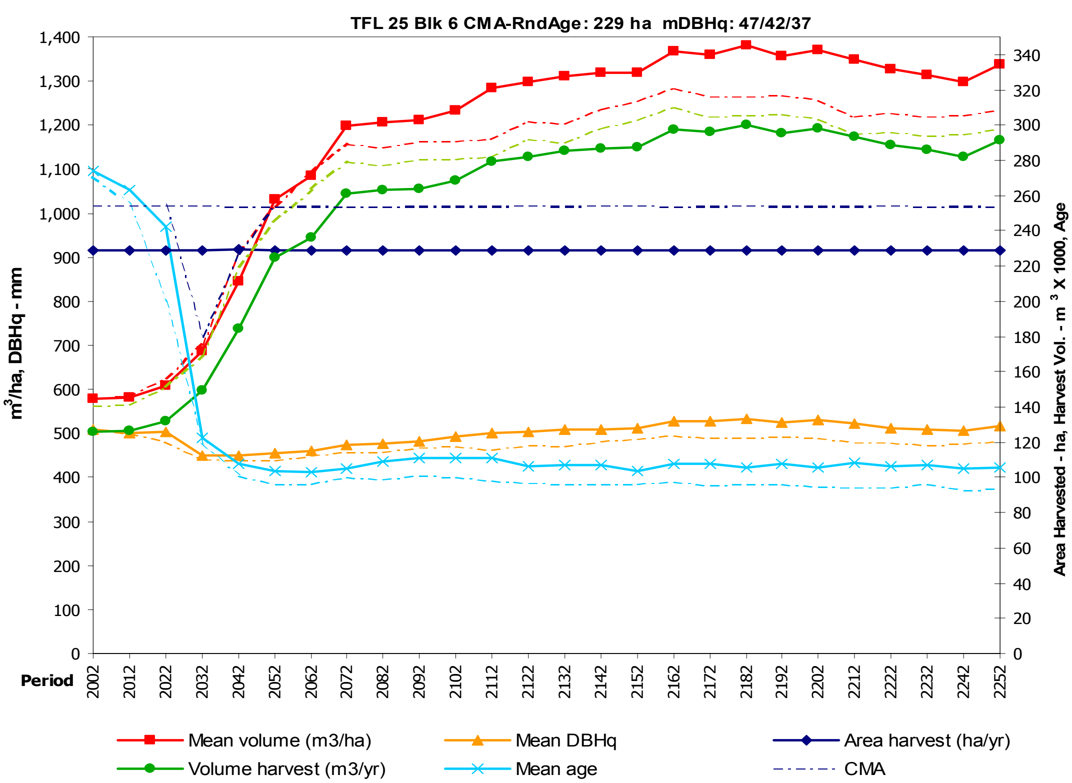

Figure 102. Block 6 CMA -RndAge

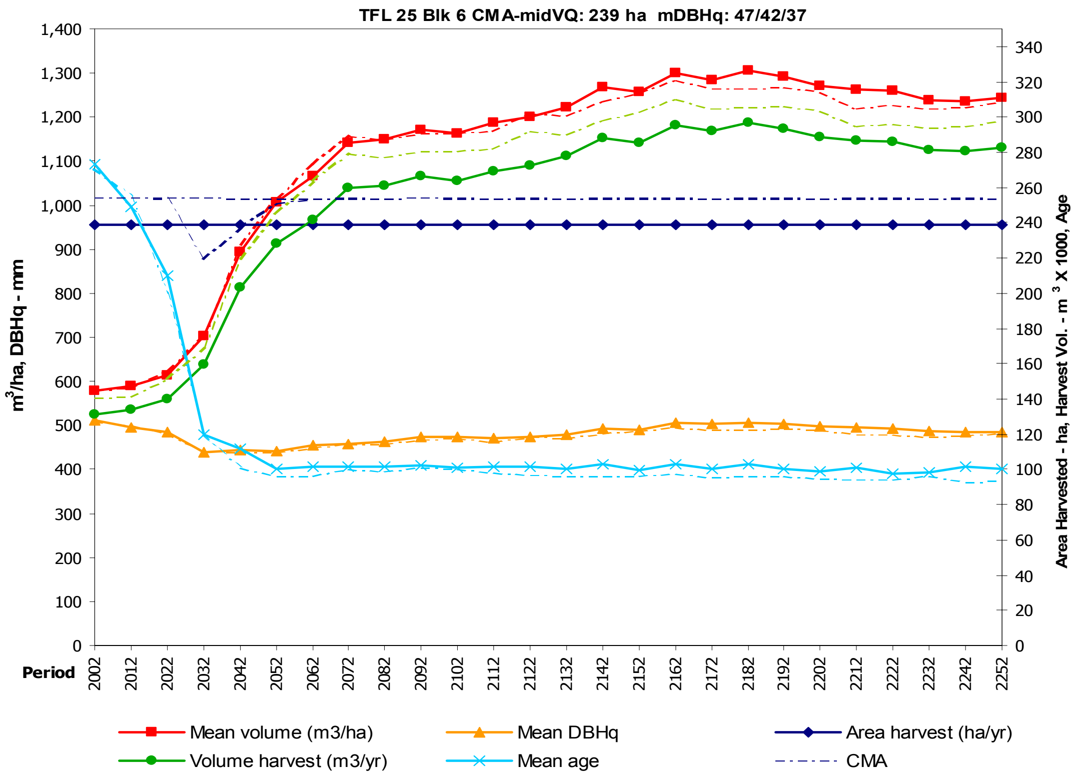

Figure 103. Block 6 CMA -midVQ

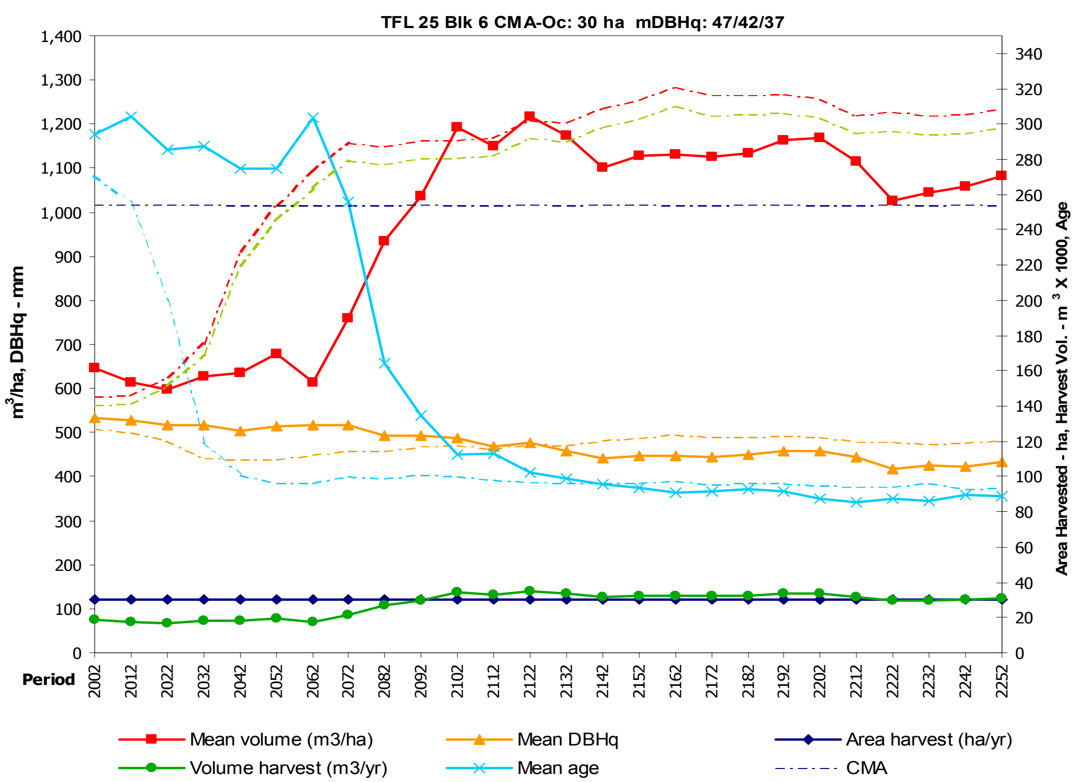

Figure 104. Block 6 CMA -Oc

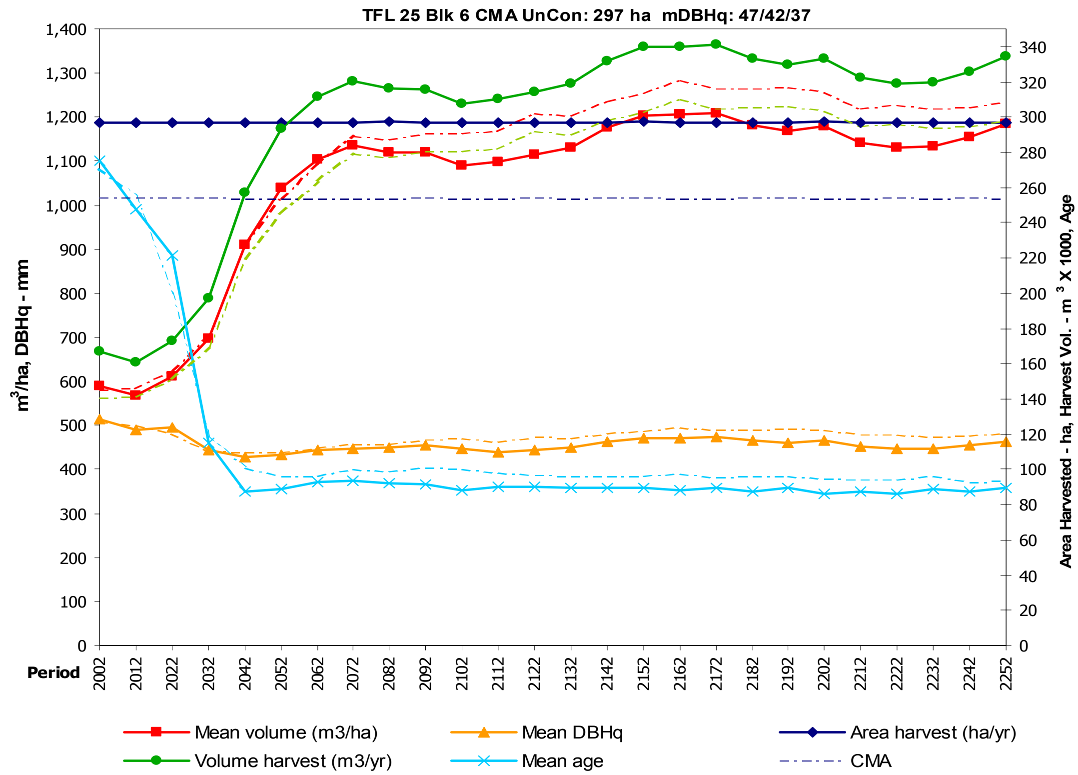

Figure 105. Block 6 CMA UnCon

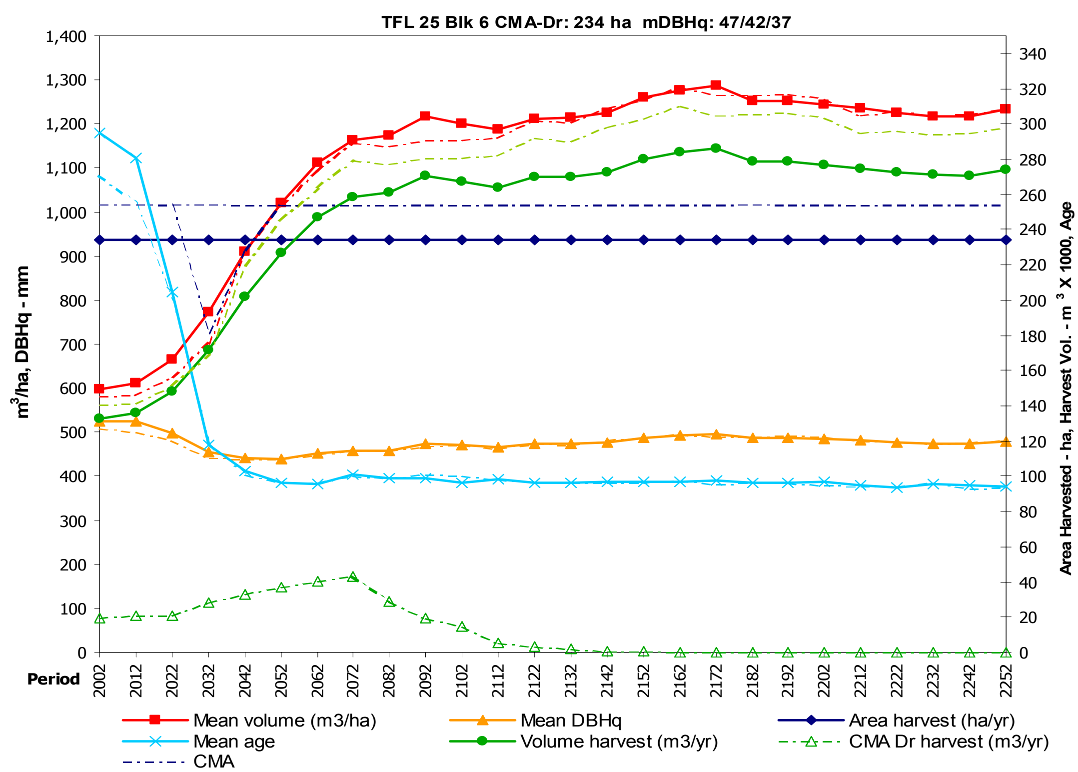

Figure 106. Block 6 CMA -Dr

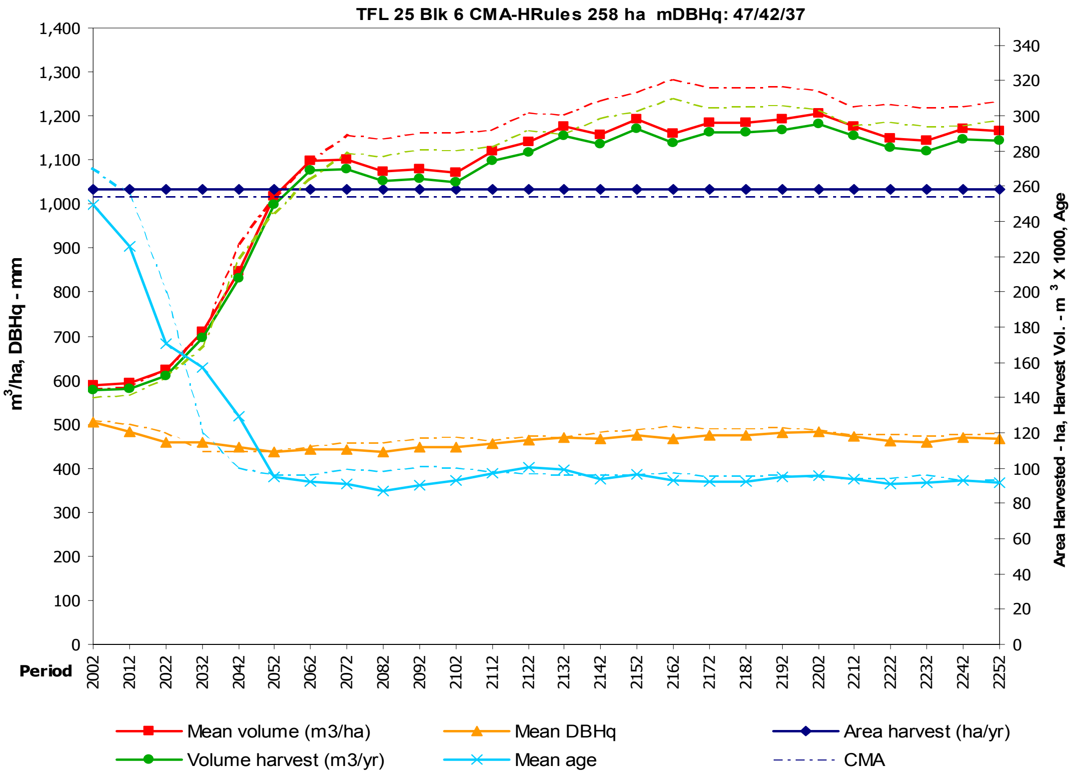

Figure 107. Block 6 -HRules

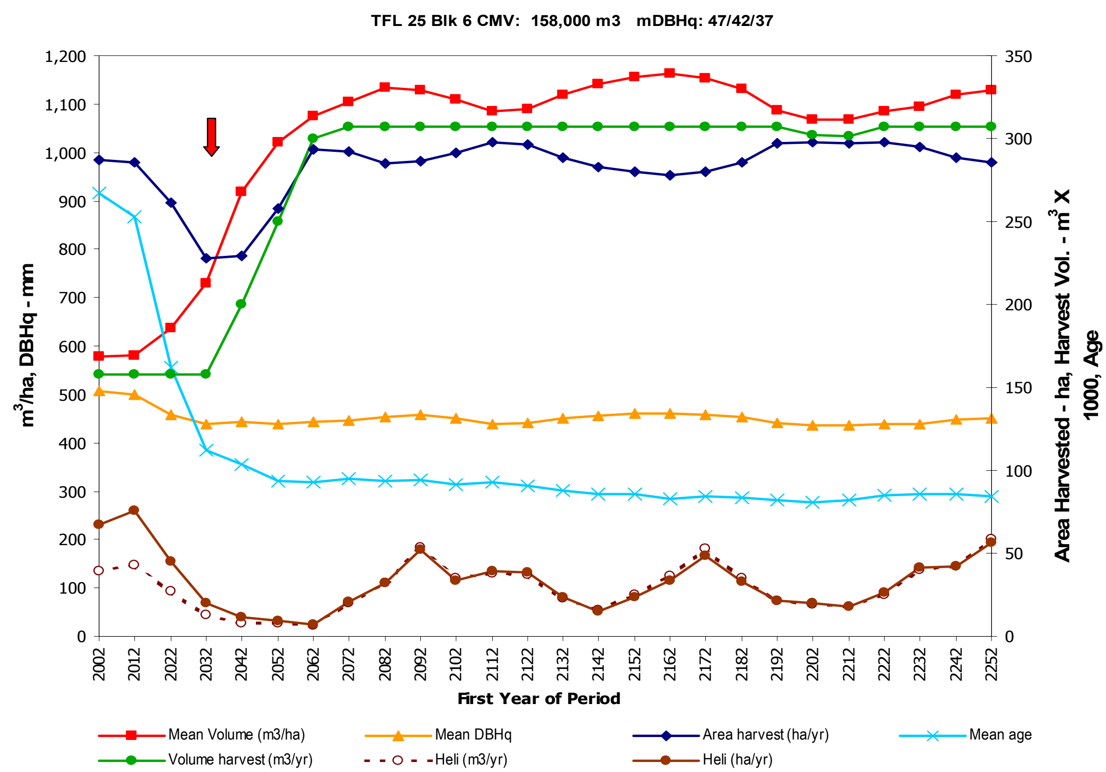

Figure 108. Block 6 CMV (Volume Regulated)

Appendix V-B
Change Summaries for Simulation Runs
Relative to CM

Table 9. Annual Area Harvest Summary

Harvest (ha)	Block					
Run ID	1	2	3	5	5-PA	6
CMA	292	124	88	492	364	254
_up10	321.2	136.4	96.8	541.2		279.4
_down10	262.8	111.6	79.2	442.8		228.6
+Oe	294	126	90	511		262
-Oh	286	101	80	404		215
-SI3m	236	106	71	434	323	176
-age	309	142	101	559	409	283
+age	239	105	74	448	336	200
-RndAge	283	120	84	483	358	229
-PA				364		
-PA-OA				206		
-midVQ	289	122	81	477	349	239
+BEO		120		492	364	
-SsSlest				469	347	
-Oc		24				30
UnCon	307	133	92	543		297
-Dr						234
-HRules		125				258
+ageX2	196					
-ageX2	318					

Table 10. Change in Annual Area Harvest Summary

Change (ha)	Block					
Run ID	**1**	**2**	**3**	**5**	**5-PA**	**6**
CMA	292	124	88	492	364	254
_up10	29	12	9	49		25
_down10	-29	-12	-9	-49		-25
+Oe	2	2	2	19		8
-Oh	-6	-23	-8	-88		-39
-SI3m	-56	-18	-17	-58	-41	-78
-age	17	18	13	67	45	29
+age	-53	-19	-14	-44	-28	-54
-RndAge	-9	-4	-4	-9	-6	-25
-PA				-128		
-PA-OA				-286		
-midVQ	-3	-2	-7	-15	-15	-15
+BEO		-4		0	0	
-SsSlest				-23	-17	
-Oc		-100				-224
UnCon	15	9	4	51		43
-Dr						-20
-HRules		1				4
+ageX2	-96					
-ageX2	26					

Table 11. Percentage Change in Annual Area Harvest Summary

Change (%)	Block					
Run ID	**1**	**2**	**3**	**5**	**5-PA**	**6**
CMA	292	124	88	492	364	254
_up10	10.0	10.0	10.0	10.0		10.0
_down10	-10.0	-10.0	-10.0	-10.0		-10.0
+Oe	0.7	1.6	2.3	3.9		3.1
-Oh	-2.1	-18.5	-9.1	-17.9		-15.4
-SI3m	-19.2	-14.5	-19.3	-11.8	-11.3	-30.7
-age	5.8	14.5	14.8	13.6	12.4	11.4
+age	-18.2	-15.3	-15.9	-8.9	-7.7	-21.3
-RndAge	-3.1	-3.2	-4.5	-1.8	-1.6	-9.8
-PA				-26.0		
-PA-OA				-58.1		
-midVQ	-1.0	-1.6	-8.0	-3.0	-4.1	-5.9
+BEO		-3.2		0.0	0.0	
-SsSIest				-4.7	-4.7	
-Oc		-80.6				-88.2
UnCon	5.1	7.3	4.5	10.4		16.9
-Dr						-7.9
-HRules		0.8				1.6
+ageX2	-32.9					
-ageX2	8.9					

Table 12. Volume Harvest Summary[30]

Volume Changes		Block						Totals	
Run ID		1	2	3	5	5-PA	6		-PA
CMA	Near	*3,290,689*	*1,804,675*	*1,366,849*	*5,685,158*	*4,202,677*	*2,817,458*	*14,964,829*	*13,482,348*
	Mid	*9,485,043*	*4,529,882*	*3,486,836*	*14,224,787*	*10,631,840*	*10,477,782*	*42,204,329*	*38,611,383*
	Long	*40,497,623*	*22,003,138*	*14,110,692*	*77,965,375*	*57,282,168*	*52,937,604*	*207,514,432*	*186,831,225*
	total	***53,273,355***	***28,337,695***	***18,964,377***	***97,875,320***	***72,116,686***	***66,232,844***	***264,683,590***	***238,924,956***
_up10	Near	295,286	161,777	149,366	606,013		280,090	1,492,532	
	Mid	210,996	546,603	91,613	1,455,009		231,007	2,535,228	
	Long	119,066	-221,025	26,543	3,728,089		1,593,543	5,246,217	
	total	**625,348**	**487,356**	**267,522**	**5,789,110**	**0**	**2,104,640**	**9,273,977**	**0**
_down10	Near	-331,979	-186,512	-118,184	-592,618		-290,416	-1,519,709	
	Mid	-850,346	-464,403	-387,890	-1,394,214		-1,211,057	-4,307,909	
	Long	-2,276,797	-1,094,557	-358,527	-6,994,001		-2,413,468	-13,137,351	
	total	**-3,459,122**	**-1,745,471**	**-864,601**	**-8,980,833**	**0**	**-3,914,942**	**-18,964,969**	**0**
+Oe	Near	5,881	18,121	44,461	195,718		70,613	334,794	
	Mid	50,784	98,774	54,386	383,054		223,140	810,138	
	Long	204,829	397,782	403,834	1,395,432		1,139,030	3,540,907	
	total	**261,494**	**514,677**	**502,681**	**1,974,204**	**0**	**1,432,784**	**4,685,840**	**0**
-Oh	Near	-113,792	-341,175	-125,560	-1,007,168		-456,765	-2,044,460	
	Mid	-168,064	-805,616	-320,814	-2,531,151		-1,424,607	-5,250,252	
	Long	-995,535	-4,052,905	-1,284,923	-13,381,738		-6,402,669	-26,117,769	
	total	**-1,277,392**	**-5,199,695**	**-1,731,297**	**-16,920,057**	**0**	**-8,284,041**	**-33,412,481**	**0**
-SI3m	Near	-646,329	-264,691	-256,024	-674,991	-466,242	-848,975	-2,691,010	-2,482,261
	Mid	-1,290,332	-703,709	-704,861	-1,736,730	-1,354,326	-4,251,409	-8,687,042	-8,304,638
	Long	-2,332,405	-1,675,352	-993,693	-11,353,601	-7,890,131	-9,248,464	-25,603,514	-22,140,045
	total	**-4,269,066**	**-2,643,752**	**-1,954,578**	**-13,765,322**	**-9,710,700**	**-14,348,848**	**-36,981,566**	**-32,926,944**
-age	Near	131,295	252,886	215,696	779,472	501,442	318,744	1,698,093	1,420,063
	Mid	150,460	698,426	474,796	2,026,703	1,266,600	1,038,259	4,388,645	3,628,542
	Long	-44,262	519,351	-59,956	6,594,617	4,591,111	1,324,443	8,334,193	6,330,686
	total	**237,493**	**1,470,663**	**630,536**	**9,400,793**	**6,359,153**	**2,681,446**	**14,420,930**	**11,379,291**
+age	Near	-614,724	-295,108	-201,921	-535,572	-358,268	-640,327	-2,287,652	-2,110,349
	Mid	-776,149	-693,513	-588,626	-1,305,648	-963,409	-2,932,219	-6,296,154	-5,953,915
	Long	-2,302,275	-1,675,794	-705,531	-10,459,084	-6,960,139	-5,004,809	-20,147,492	-16,648,548
	total	**-3,693,148**	**-2,664,415**	**-1,496,077**	**-12,300,303**	**-8,281,817**	**-8,577,356**	**-28,731,298**	**-24,712,812**
-RndAge	Near	-101,964	-49,920	-56,918	-112,573	-70,187	-291,307	-612,681	-570,296
	Mid	44,484	-147,413	-181,702	-249,000	-332,354	-1,209,512	-1,743,143	-1,826,497
	Long	-275,867	-334,777	-62,507	-942,316	-684,677	-1,792,302	-3,407,768	-3,150,130
	total	**-333,346**	**-532,110**	**-301,127**	**-1,303,889**	**-1,087,219**	**-3,293,121**	**-5,763,593**	**-5,546,923**
-PA	Near				-1,482,481				
	Mid				-3,592,946				
	Long				-20,683,207				
	total	**0**	**0**	**0**	**-25,758,634**	**0**	**0**	**0**	**0**
-PA-OA	Near				-3,318,322	-1,835,841			
	Mid				-8,223,637	-4,630,691			
	Long				-46,412,503	-25,729,296			
	total	**0**	**0**	**0**	**-57,954,462**	**-32,195,827**	**0**	**0**	**0**

30 "Near" refers to first two decades; "Mid" to next five decades; "Long" to decade 8 and beyond.

Volume Changes		Block						Totals	
Run ID		1	2	3	5	5-PA	6		-PA
-midVQ	Near	-51,139	-30,844	-113,352	-191,526	-201,782	-164,816	-551,677	-561,933
	Mid	-64,649	-78,783	-277,738	-377,468	-461,055	-749,954	-1,548,592	-1,632,179
	Long	-297,555	-352,932	-612,421	-2,121,303	-2,203,528	-2,482,001	-5,866,213	-5,948,437
	total	**-413,343**	**-462,560**	**-1,003,511**	**-2,690,298**	**-2,866,365**	**-3,396,771**	**-7,966,482**	**-8,142,550**
+BEO	Near		-46,983		0	0			
	Mid		-149,357		0	0			
	Long		-387,443		0	0			
	total	**0**	**-583,784**	**0**	**0**	**0**	**0**	**0**	**0**
-SsSlest	Near				-240,880	-240,221			
	Mid				-688,840	-616,604			
	Long				-7,001,528	-5,138,009			
	total	**0**	**0**	**0**	**-7,931,248**	**-5,994,834**	**0**	**0**	**0**
-Oc	Near		-1,458,314				-2,456,582		
	Mid		-3,670,563				-9,574,542		
	Long		-17,961,127				-47,309,926		
	total	**0**	**-23,090,004**	**0**	**0**	**0**	**-59,341,050**	**0**	**0**
UnCon	Near	85,147	130,858	71,172	538,208		456,414	1,281,798	
	Mid	290,445	302,657	130,936	1,321,438		1,845,719	3,891,194	
	Long	1,653,518	1,688,789	670,334	6,569,146		5,471,160	16,052,948	
	total	**2,029,110**	**2,122,304**	**872,442**	**8,428,792**	**0**	**7,773,294**	**21,225,941**	**0**
-Dr	Near						-128,155		
	Mid						-521,853		
	Long						-3,875,219		
	total	**0**	**0**	**0**	**0**	**0**	**-4,525,228**	**0**	**0**
-HRules	Near		5,082				77,988		
	Mid		-21,029				44,865		
	Long		-499,888				-2,246,364		
	total	**0**	**-515,835**	**0**	**0**	**0**	**-2,123,511**	**0**	**0**
+ageX2	Near	-614,724							
	Mid	-776,149							
	Long	-2,302,275							
	total	**-3,693,148**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
-ageX2	Near	224,191							
	Mid	272,761							
	Long	-113,328							
	total	**383,624**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Appendix V-C
Description of Simulation Runs

Run naming conventions

CMA	means current management area-based (base case)
CMV	means current management volume-based
CMA_	means change in harvest flow
_NF	means “no flow”. I.e. original flow is requested but not maintained
40/35/30	means minimum harvestable quadratic mean stand diameter (mDBHq) in centimeters (cm) for Good/Medium/Poor sites respectively.
+	means factor added for sensitivity analysis
–	means factor removed for sensitivity analysis

Table 13. Simulation Run Labels and Descriptions

Run ID	Description
CMA	Area-based current management option
_up10	Alternate flatline request up 10% of CMA
_down10	Alternate flatline 90% of CMA
+Oe	Include Oce and Ohe polygons in THLB
-Oh	Remove helicopter operable polygons
-SI3m	Reduce SI estimates for age class 1-2 and future stands by 3m
-age	Lower minimum harvest age by decreasing mDBHq by 3 cm
+age	Increase minimum harvest age by increasing mDBHq by 3 cm
-RndAge	Uses the mDBHq ages rounded up to the nearest 10th year (effectively adds 5 years to
-PA	Remove protected area candidates as identified in April, 2001 announcement
-PA-OA	As above and also remove Option Areas identified in April, 2001 announcement
-midVQ	Use mid range disturbance target
+BEO	Apply specific BEOs to draft or legislated landscape units where not included in CM0
-SsSIest	Adjust SI so that Good site Spruce SI=34m instead of 39m - Piece size remains 47-42-37
CM12356	Combine all blocks as one to test for age class and constraint complement potentials
CM23	Combine Blocks 2 and 3 to test for complementary age class structures
-Oc	Simulation on THLB accessible by helicopter only to estimate flat line portion of harvest attributable to helicopter harvesting.
UnCon	Remove all non-timber land base and volume constraints to simulate timber potential.
-Dr	Remove alder leading stands from the harvest flow permanently (no long term succession to conifers).
-HRules	turn off oldest first and minimize growth loss harvest rules.
+ageX2	Increase minimum harvest age by increasing mDBHq by 3X2=6cm
-ageX2	Decrease minimum harvest age by decreasing mDBHq by 3X2=6cm

Appendix V-D
Modeling for Cultural Cedar

As there is interest in the sustainability of cedar harvesting, a preliminary model was developed to predict cedar availability into the future. WFP cruise information from TFL 25 and the adjacent Timber Supply Areas was analysed to develop a cedar diameter class distribution for old growth stands and TIPSY was used to generate distributions for second growth at various stand ages. These distributions were used, based on inventory or estimated future stand species composition and simulation age, to forecast the cedar component of harvests and growing stock through the 250-year simulation.

There are a number of difficulties with such a model:

- Although TIPSY does produce a diameter distribution, it does not report diameters beyond 90 cm DBH.
- TIPSY is calibrated for predicting second growth volumes and may not reliably predict diameter distributions at older stand ages that are approaching and beyond the ages within the calibration data set.
- The western redcedar data set on which TIPSY is calibrated is much smaller than for other coastal species and therefore predictions are less certain. There is no data for yellow cedar hence it is assumed to mimic western redcedar in its growth and yield habits.
- “Monumental” and cultural cedar is not easily defined. Tree sizes and quality needed for cultural purposes likely vary considerably depending on the use. For example, large totem poles, canoes, and buildings would need large, sound trees. Large decayed trees could provide split planks and carving blocks. Sound but smaller trees may provide for smaller canoes, poles, roundwood posts and beams, and sawn planks/blocks. Trees of almost any

size could provide bark for stripping if a section of clear bole is present. Perhaps smaller or more vigorous cedars provide good roots. Clearly guidance is needed from First Nations to better define the characteristics of various types of cultural cedars.

- Cruise data was used to estimate cedar diameter distributions in old growth forests, but associated decay-indicator data was not felt suitable for predicting the percentage of old growth trees that are sound and suitable for monumental purposes. Again guidance is needed from First Nations to estimate the proportion of larger trees actually suitable.

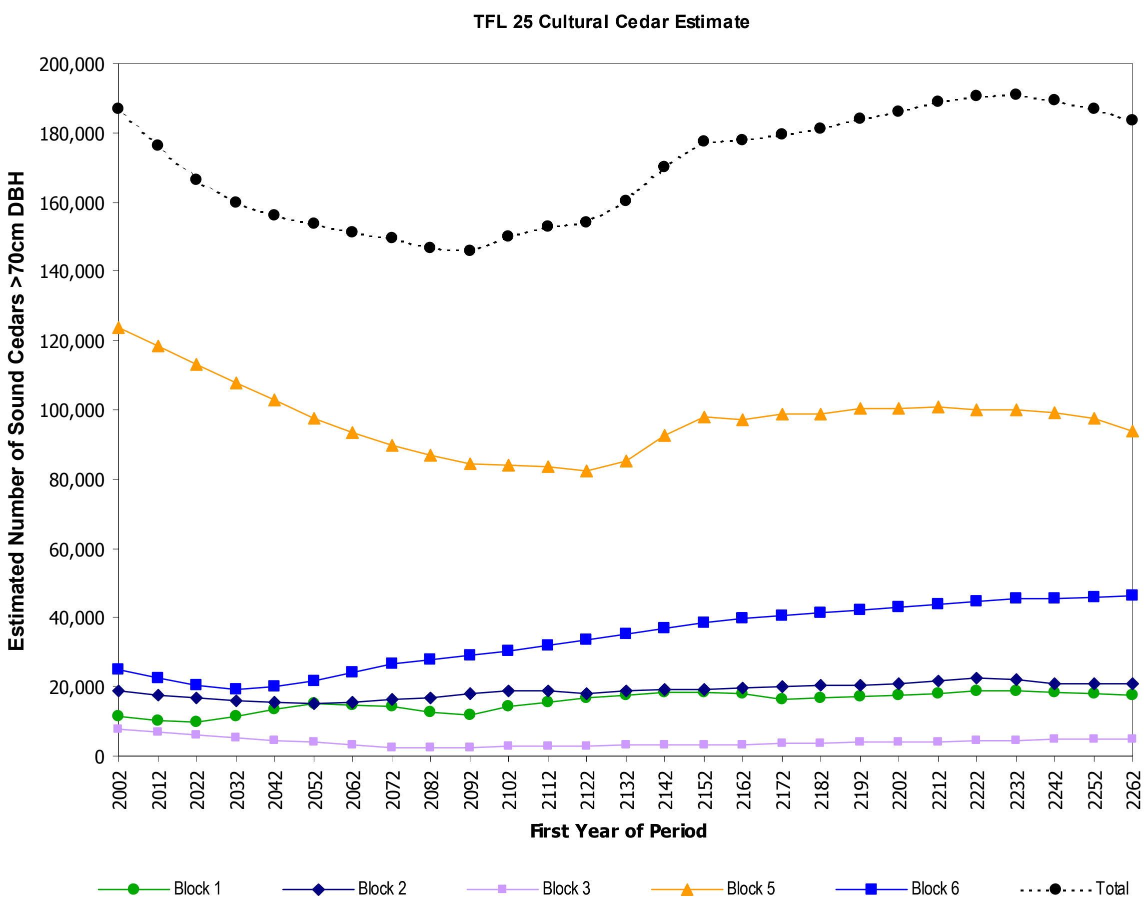

Figure 109. Test Estimate of Cultural Cedar Availability for TFL 25 through 250 years.

Figure 109 presents the results of a model test for each TFL Block using the assumptions that one in twenty large diameter old growth cedars (likely many centuries old) is sound and that most second growth cedars (<200-years-old) are sound. The data indicates the estimated number of larger, sound cedar trees occurring on the land base through time. In all blocks there is an initial decline until harvesting shifts to second growth forests and most blocks recover in the long term. In Block 5 the decline is 34% but much extended as old forest is the primary source of timber for the next century. Block 5 dwarfs the other management units due to its large land area and high percentage of timber reserved from harvest for operability or environmental reasons.

For the TFL as a whole, estimated availability of larger cedars declines 22% through the middle of the simulation but recovers in the long term to current levels.