Forest Management Plan 2004-2013

Mid-term audit of performance report

Supplemental advice to the Conservation Commission concerning the causes for the higher levels of karri other bole volume production during 2004-2007

Forest Management Branch
Department of Environment and Conservation
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Contents

Summary

Karri other bole volume (KOBV) is defined as the volume of all wood within the tree bole (i.e. below crown break) that is not of sawlog quality. The annual level of production of KOBV during the period 2004–2007 has exceeded the upper limit of 117,000 cubic metres specified in the Forest Management Plan 2004-2013 (FMP). Approximately 70% of the annual production arises from first thinning operations in regrowth karri stands, with the remainder sourced from clearfelling operations in mature two-tiered stands.

The higher-than-forecast production levels arose from a combination of factors affecting the yields realised from both regrowth and two-tiered operations. In order of magnitude, these include:

- higher yields of KOBV realised from the thinned regrowth stands due to a higher proportion of karri in the karri/marri mix than was forecast;
- higher yields of KOBV realised from the thinned regrowth stands is likely due to higher site quality areas being thinned than was forecast;
- higher yields of KOBV realised from the two-tiered stands due to a larger area cut over than forecast;
- an increase in the minimum size of sawlogs accepted from first thinnings in regrowth stands which meant that some material forecast to be yielded as sawlog has instead been yielded as KOBV;
- inclusion of some crown-wood in the recorded level of KOBV production; and
- inclusion of some regrowth marri in the recorded level of KOBV production.

Detailed analysis of the areas cut over, silvicultural outcomes and yields achieved during 2004-2007 indicate that the annual area thinned, the net area thinned within coupes, the standard of application of the silviculture guidelines and the yields per hectare of KOBV generated from the two-tiered stands were consistent with the sustained yield calculations for the FMP. Therefore it is concluded that these factors did not contribute to the higher than forecast production levels of KOBV.

Continuation of the regrowth thinning program at the area rate consistent with the FMP will generate levels of KOBV during 2008-2013 which exceed the annual upper limit of 117,000 cubic metres. Depending on the mix of site quality accessed within regrowth stands, annual production could range up to approximately 170,000 cubic metres. Such elevated levels of KOBV production impact positively on future karri sawlog supply.

It is recommended that a revised upper limit of 170,000 cubic metres per annum for the production of KOBV would be consistent with the settings and intent of the FMP, while also providing for the fluctuations in production that accompany the mix of forest characteristics on annual harvest plans.

Introduction

The purpose of Key Performance Indicator (KPI) 5 in the Forest Management Plan 2004-2013 (FMP) is to monitor and report on the level of timber products extracted from State forest relative to the sustained yield. Data collated for this KPI and reported in the mid-term audit of the FMP indicates that the annual removals of karri other bole volume (KOBV) has exceeded the upper limit specified in the FMP of 117,000 cubic metres per year by between 23 per cent and 46 per cent during the period 2004 to 2007. The Conservation Commission has requested a detailed analysis be undertaken of the causes for the greater volumes being produced. This report constitutes the supplemental advice to the Conservation Commission on the reasons for the elevated level of production of karri other bole volume.

The first section of the report provides background information on the assumptions underpinning the forecast level of KOBV production during the FMP. The approach adopted is to identify and describe the factors that may contribute to the elevated level of production of KOBV, followed by the results of the analyses. The factors giving rise to the higher production are summarised and the implications of the findings for the level of production of KOBV, marri bole volume during the period 2008-2013 and karri sawlog production during the next forest management plan are discussed.

Background

Level of production of KOBV during 2004-2007 compared to forecast 2004-2013 levels

Karri other bole volume (KOBV) is a generic term for all non-sawlog quality products within the tree bole (i.e. below crown break). KOBV is sourced from clearfelling operations in two-tiered stands and older regrowth stands, and thinning operations in younger regrowth karri stands. Table 1 (reproduced from the report on KPI 5 in the mid-term audit report) summarises the level of production of KOBV during the period 2004-2007 relative to the upper limit determined during the calculation of sustained yield for the FMP.

Table 1. Removals of karri other bole volume from State forest during the period 2004 – 2007.

Karri other volume (cubic metres)					
Year	**Annual removals**	**FMP upper limit**	**Cumulative total removals**	**FMP cumulative limit**	**Cumulative variation (Actual – FMP)**
2004	143,504	117,000	143,504	117,000	+ 26,504
2005	147,252	117,000	290,756	234,000	+ 56,756
2006	170,249	117,000	461,005	351,000	+ 110,005
2007	148,727*	117,000	609,732	468,000	+ 141,732

* Figure incorporates an adjustment to the raw delivery data to reflect a change in the minimum sawlog size (and hence an increase in the proportion sold as other bole volume) that was accepted by FPC customers in 2007.

The annual removals have exceeded the upper limit of 117,000 cubic metres per year determined in the sustained yield calculations by between 23 per cent and 46 per cent each year.

Basis of the FMP forecast level of 117,000 cubic metres for period 2004-2013

The upper limit of 117,000 cubic metres per year was based on the projected woodflow arising from harvesting two-tiered and regrowth stands in accordance with the Karri Silviculture Guideline (Department of Conservation and Land Management 2005).

Harvesting operations in two-tiered karri stands

The projected woodflow from harvesting operations in two-tiered karri stands assumed approximately 365 hectares per annum would be cut over, with yields of KOBV varying according to location, previous cutting history and silvicultural intent. The projected KOBV yields ranged from 35 – 81 cubic metres per hectare, and were derived from inventory of the standing volume conducted during 2002.

Thinning operations in regrowth karri stands

The forecast woodflows from the thinning operations in regrowth karri stands assumed first thinning operations were conducted each year in up to 1,260 hectares of stands regenerated since 1967. These stands vary in their site quality (productive capacity), species composition (karri/marri/jarrah), and method of regeneration (planted or naturally seeded).

The FMP assumed that stands would be thinned according to the standards specified in Silviculture Specification 1/92 (Department of Conservation and Land Management 1992), assumed broad strata of site quality and stand condition, and provisionally scheduled stands for thinning within aggregated five year periods. Detailed stratification of the forest estate into these categories was not available for the younger regrowth, and average site qualities were assigned to areas.

The yield regimes projected a small quantity per hectare of sawlog would be generated from the first thinnings in the older regrowth stands.

Method

The various assumptions inherent in the projections were examined to identify the causes for the significant over-production of KOBV.

A systematic analysis was undertaken of those factors potentially contributing to a variation between the forecast and realised yield levels. This involved a critical review of data on the total areas cut over, the characteristics of the stands, the standard of thinning achieved, and the volumes realised. These analyses used data extracted from a number of Department of Environment and Conservation (DEC) and Forest Products Commission (FPC) databases and systems, including the:

- Forest Management Information System (FMIS);
- Silvicultural Recording System (SILREC);
- Logging Operations Information System (LOIS); and

- Forest Scheduler (FORSCHED).

Additional investigation was initiated to review the degree of consistency between actual and projected retained density in regrowth stands and the area of extraction tracks and landings arising from thinning operations.

The results of these investigations are presented in the following section. The area and characteristics of stands cut over during 2004-2007 are compared to the FMP projections, followed by an evaluation of the standard of thinning achieved relative to the silvicultural guideline and yield regimes. The volume of KOBV realised from the two-tiered and regrowth stands is then compared to the FMP forecasts, and a summary presented of the factors giving rise to the higher levels of KOBV produced during 2004-2007.

Results and Discussion

Areas cut over during 2004-2007 compared to the FMP projections

Total area

Data for KPI 6 (refer Appendix 1) indicate that a cumulative area of 1,860 hectares of two-tiered karri forest was cut over during the period 2004-2007. The FMP strategic scheduling forecast that approximately 400 hectares less (1,460 hectares) would be cut over during this period. The additional area of karri two-tiered forest that was cut over has arisen from a short-term deferral on annual harvest plans of the scheduled clearfell of up to 240 hectares of older regrowth stands. The FMP provides for the clearfell of regrowth stands older than 75 years, provisionally scheduled to commence from 2006. The commencement of these operations was delayed while refinements to forest stratification defined the operational boundaries for these stands. This short-term adjustment is of no consequence over the period of the FMP, because as the regrowth areas are incorporated into the annual harvest plans during 2009–2013 there will be a corresponding reduction in the area of two-tiered forest that will be cut over. The two-tiered stands realise a higher proportion of KOBV per unit of sawlog compared to the harvest of older regrowth, which are also forecast to yield much higher volumes of sawlog per hectare. Consequently, a contributing factor to the higher level of KOBV produced during 2006 and 2007 was the additional area of two-tiered forest cut over in this period.

Data for KPI 12 (refer Appendix 2) indicate that a cumulative area of 4,180 hectares of regrowth karri was thinned during the period 2004–2007. The FMP notionally scheduled 3,555 hectares during this period, but provided for an overall total of up to 1,260 hectares per annum averaged over the ten years of the FMP. The actual area of regrowth karri forest that was thinned is therefore within forecast levels. The higher level of KOBV production has consequently not arisen from a substantial increase in the area of regrowth karri forest thinned during this period.

Net area thinned within coupes

Assumptions concerning the net area within a regrowth coupe that would be operationally thinned were incorporated in the woodflow scheduling for the FMP. The gross area for each regrowth stratum was reduced by 10.5 per cent to 15.9 per cent to account for unstocked areas outside of informal reserves which arise from cleared landings, major tracks or low stocked areas. This figure was derived from a detailed analysis in 2002 of a broad sample of regrowth coupes and previous

stratification datasets. Analysis of SILREC aerial photography of coupes thinned to 2007 indicated that this adjustment was robust. Consequently, the higher level of KOBV production has not been contributed to by a consistently higher proportion of the area within coupes being fully stocked and available for thinning.

Characteristics of regrowth stands

A key factor influencing the level of agreement between realised (actual) yields and forecast (modelled) yields is the level of consistency between the actual and forecast characteristics of the regrowth stands that are thinned during a period. Characteristics of the stands that influence yields include the method of regeneration, the site quality and the species composition. This is because naturally regenerated (cf. planted) stands have a higher initial stocking which generally results in higher yields at first thinning, the higher quality sites generate higher yields at a given age, and pure karri stands generate higher karri yields than mixed karri / marri stands. Table 2 summarises the proportion of the annual area cut over by the stand origin (method of regeneration), site quality, and dominant species.

Table 2. The proportion (per cent) of total regrowth karri area thinned each year classified by method of regeneration, site quality, and the dominant species mix of the forest prior to regeneration.

Stand characteristic	**2004**	**2005**	**2006**	**2007**
Total area thinned (ha) (ex KPI 6)	930	1,090	1,160	1,000
Method of regeneration				
Planted stands	11	30	51	55
Naturally regenerated (including direct seeded)	89	70	49	45
Site quality class				
SQ1	23	11	23	9
SQ3	23	12	12	19
SQ5	23	36	28	18
Not Stratified / Stratification not available	31	41	37	54
Original dominant species (API)				
Karri	97	100	100	99
Karri/other species mix	3			1

The majority of the areas thinned in 2004 and 2005 were naturally regenerated, while in 2006 and 2007 approximately half the areas were planted and half of natural origin. This contrasts with the broad assumption applied in the strategic woodflow scheduling for the FMP that approximately 30 per cent planted : 70 per cent naturally regenerated stands would be thinned each year.

The distribution of stands across site quality classes suggests a higher proportion of stands with lower productive capacity (Site SQ5) were thinned during this period than the FMP modelling forecast. However, the absence of site stratification for at least a third of the areas thinned means that it is not possible to conclude a higher proportion of stands with lower productive capacity were thinned during this period.

Additionally, the high proportion of pure karri areas accessed during the period suggests that the majority of stands that were not stratified were of higher site quality, because the lower site qualities are generally associated with mixed species stands.

The original forest composition of areas thinned during 2004 to 2007 has been almost completely pure karri. This suggests a low proportion of marri would be expected to have been present in the regenerated stands.

Overall, this information suggests there has been substantial variation between the broad mix of site quality and species composition of the areas actually thinned compared to that assumed in the FMP woodflow modelling. Although the absence of complete site quality stratification for all thinned stands prevents precise comparisons, it is likely that the elevated level of KOBV production has been contributed to by a concentration of thinning in the higher site quality stands in the initial years of the plan.

Standard of thinning achieved relative to silvicultural guideline and projected yield regimes

The yield regimes applied in the FMP woodflow modelling assumed that the timing and intensity of thinning in the regrowth stands was conducted in accordance with Silviculture Specification 1/92 (Department of Conservation and Land Management 1992). This Specification provides for a stand of a given top height to be thinned to a target basal area. Thinning is within an acceptable range of basal area if the retained basal area of the stand is within approximately ± 2 m^2 per hectare of the target. Conformance with this standard is routinely monitored during operations by FPC personnel sampling 10 points per 2 hectares to compile a post-thinning stand density report.

A representative sample of post-thinning stand density reports (randomly selected within coupes across the years and method of regeneration depicted in Table 2) were examined to determine if the higher level of KOBV could have been contributed to by the systematic over-thinning of stands. In such circumstances, stands would have been thinned to residual densities lower than the target specified in the Silviculture Specification 1/92 (Department of Conservation and Land Management 1992) for stands of that particular top height. Table 3 summarises the results of this investigation.

Table 3. Conformance statistics for a sample of 433 post-thinning stand density reports sampling 866 hectares within coupes thinned during the period 2004 to 2007. The total number of sample points checked within the reports is 4,330.

Year	No. Stand density reports * checked	Per cent of reports in acceptable residual density range	Per cent of sample points within acceptable reports below target density	Per cent of sample points within acceptable reports at target density	Per cent of sample points within acceptable reports above target density
Planted stands					
2004	20	100	54	39	7
2005	32	97	50	10	40
2006	100	100	31	32	37
2007	40	95	29	25	46
Sub total	***192***	***98***	***36***	***28***	***36***
Naturally regenerated stands					
2004	40	88	49	3	47
2005	40	98	36	23	40
2004/05	60	98	30	37	33
2005/06	20	100	54	15	31
2006	60	98	26	19	55
2007	21	90	44	13	43
Sub total	***241***	***96***	***36***	***21***	***43***
Grand total	**433**	**97**	**36**	**24**	**40**

* Within an individual report sampling 2 hectares, a total of 10 sample points are recorded.

Within this sample, 97 per cent of the locations were thinned to a residual density within the acceptable range. There was no difference in standards achieved between planted or naturally regenerated stands. Similarly, there was no trend of a systematic bias toward over or under thinning, with approximately 36 per cent of the sample points below target density and 40 per cent above.

Consequently, there was no evidence that systematic over-thinning was a factor contributing to the higher levels of KOBV realised during 2004-2007.

Comparison of volumes of KOBV realised from operations relative to forecasts

Two-tiered karri stands

An average of approximately 460 hectares per annum has been harvested from two-tiered karri forest (KPI 6 – see Appendix 1). Within the total area harvested during 2004-2007 fourteen monitoring plots were available to compare realised volumes with those predicted during clearfell operations in the two-tiered stands. The ratio of realised/forecast gross bole volume (sawlog plus non-sawlog combined) within each plot provides a measure of the consistency between the realised and forecast yields: a ratio of 1.0 indicates perfect agreement.

The mean ratio across all plots was 1.02, suggesting that on average the realised gross bole volume from the sample plots was 2 per cent greater than was forecast (Table 4). While this is a small sample size with wide variation evident, the data suggest the KOBV forecasts for the two-tiered stands are robust and were not a factor contributing to the overall elevated level of KOBV during 2004-2007.

Table 4. Ratio of karri gross bole volume realised/forecast within 14 inventory plots monitoring utilisation in two-tiered karri operations during 2004 – 2007.

	Minimum	**Mean**	**Maximum**
Ratio of karri gross bole volume realised/forecast	0.19*	1.02	1.92

*Observation constitutes an outlier due to the plot being in a mixed jarrah/karri stand with jarrah dominant.

The recovery of additional product from the crowns of the trees felled in two-tiered operations is another factor that was investigated as a contribution to the higher realised yields of KOBV from these plots. Such crown-wood volume was not included in the 117,000 upper limit. However, logs recovered from the crowns are not separately recorded in LOIS and therefore the KOBV figure (Table 1) will include an unquantified component of volume sourced from tree crowns. Estimates compiled during the calculation of sustained yields for the FMP suggest the additional volume in the crown can be as high as 10 per cent of the bole volume in large karri trees. Because two-tiered operations contribute around 30 per cent of the annual production of KOBV, it is likely that less than 3 per cent of the total annual KOBV production would have been sourced from crownwood in two-tiered stands.

Regrowth karri stands

Utilisation was monitored in fourteen plots that were available for analysis within regrowth karri stands thinned during 2004-2008. These plots were located in stands regenerated prior to 1980, and sampled the range of site quality in both planted and naturally regenerated stands (Table 5).

Table 5. Stand characteristics of 14 inventory utilisation sample plots in regrowth karri stands thinned during 2004-2008. Some plots finalised in 2008 are included because they were commenced or partially completed in 2007 and are considered representative of operations to December 2007.

Characteristic	**Minimum**	**Mean**	**Maximum**
Site index (m)	31	42	50
Site Quality Class	SQ5 (8 plots)	SQ3 (3 plots)	SQ1 (3 plots)
Stand top height (m)	27	34	52
Age at thinning (yrs)	25	31	57
Gross bole volume (m^3/ha) before thinning	77	213	400

The ratio of karri gross bole volume realised/forecast within the plots (Table 6) indicates that on average the karri gross bole volume realised from the plots was 34 per cent greater than forecast, while the total gross bole volume realised (including marri) was only 7 per cent greater than forecast. The sample size is too small to undertake detailed comparisons between realised and forecast yields for combinations of site quality, thinning regime and geographic location.

Table 6. Ratio of karri gross bole volume realised/forecast within 14 inventory plots monitoring utilisation in regrowth karri thinning operations during 2004-2007.

	Minimum	**Mean**	**Maximum**
Ratio of karri gross bole volume realised/forecast	0.38*	1.34	2.85
Ratio of karri and marri gross bole volume realised/forecast	0.41*	1.07	1.90

*Observation constitutes an outlier with a very low site quality.

The results from this sample of plots suggests the primary reason for the elevated level of KOBV production relative to the FMP upper limit is the low frequency of marri in the regrowth stands thinned during 2004-2007, relative to the yield regimes used in compiling the FMP forecasts. Thus, while the growth models performed well in predicting *total* site thinning yields, the proportion of the total stand stocking that was assumed to be marri led to under-estimation of karri yields. The yield regimes assumed that marri regrowth stems would comprise an increasing proportion of the total first thinning yield as site quality decreased, ranging from 9 to 40 percent of the yield as the karri site quality declined. In practice, the proportion of marri volume realised within the stands thinned to 2007 has been much lower or negligible, giving rise to an under-estimate of the karri volume produced from the first thinnings and an over-estimate of marri.

There were insufficient plots to compare the total volumes removed from naturally regenerated and planted stands of similar age and site quality. The planted stands were forecast in the FMP scheduling to generate a higher (by 7 to 22 per cent) yield of KOBV at first thinning. The higher KOBV yield was based on spacing trials that had indicated a reduced bole length, and hence a reduced proportion of sawlog in the bole volume, for stands planted at the stocking density that applied until 1990. If the planted stands have generated a higher proportion of KOBV, then the increased proportion of planted stands thinned during 2004-2007 relative to the FMP forecasts would be another factor contributing to the elevated level of KOBV production to 2007.

At the operational scale, the magnitude of the under-estimation of karri gross and other bole volume is also evident in the product removals recorded through LOIS (Table 7). Data is not available for individual site quality and age categories because removals are recorded on a coupe basis, which comprise a mixture of these attributes. Consequently, data was extracted from LOIS and SILREC for aggregates of these classes, providing broad indicative information within aggregated areas exceeding 50 hectares.

Table 7. Volume of sawlog and other bole volume (m^3/ha) realised and forecast from an aggregated sample of 3,682 ha of regrowth areas thinned during 2004-2007. The forecast figure was derived by combining areas of differing site quality and condition.

Component of yield	Realised	Forecast	Ratio
Karri sawlog volume (m^3/ha)	4.5	9.8	0.5
Karri other bole volume (m^3/ha)	113.4	59.7	1.9
Marri bole volume (m^3/ha)	0	18.0	-
Total volume (m^3/ha)	117.9	87.5	1.3

The method of derivation of the forecasts (by combining varying proportions of site quality within the operations) means that the data in Table 7 can only be interpreted for broad trends rather than absolute differences. The average KOBV realised per hectare was almost double the forecast yield for this aggregated sample. No marri bole volume was recorded as removals from these thinnings, in contrast to the forecast average marri volume of 18 cubic metres per hectare. The total volume (karri plus marri) realised was closer to, but still substantially higher than the forecast volume.

The lack of marri bole volume recorded as removals from the first thinning operations is partly a function of the recording in LOIS. The FPC has confirmed that minor volumes of regrowth marri are likely to have been included in loads recorded as karri, due to the operational difficulty of segregating small quantities of this species in the forest.

The average quantity of karri sawlog realised from the first thinning operations was also substantially less than forecasts, although in absolute terms (cubic metres per hectare) the figures are small relative to KOBV and total volume. However, the plot level data did not confirm this trend: the ratio of karri sawlog volume realised to forecast in the 14 plots averaged 1.0.

In early 2007 changes were made to the karri sawlog size and quality specifications delivered from the first thinnings. The minimum small end diameter of sawlog accepted from first thinnings was increased from 200 mm to 350 mm. This resulted in less sawlog volume being produced and a consequent increase in the production of KOBV. An estimated additional 9,900 cubic metres of KOBV was recorded in 2007 as a consequence. This effect was reflected in both the KOBV and karri sawlog production figures reported in Table 4 of KPI 5.

Summary of factors giving rise to the higher levels of KOBV produced 2004-2007 relative to the FMP forecasts

A combination of factors has contributed to varying degrees to the higher levels of KOBV than was forecast in the modelling for the FMP. In descending order of importance, these factors are:

- A higher proportion of karri in the thinned regrowth stands has generated higher yields of KOBV and less marri other bole volume than was forecast. Higher total volumes per hectare have been realised compared to forecasts for stands thinned to 2007;

- The realised mix of site quality, species composition and method of regeneration for the regrowth stands thinned to 2007 has not closely matched the mix of stands forecast to be thinned. There are valid operational reasons for such variations between strategic scheduling and the annual harvest plans. It is likely that a larger proportion of higher site quality areas have been thinned with a corresponding higher volume of KOBV generated;
- The area of two-tiered karri forest cut over has been higher than the FMP forecast, which assumed a lesser quantity of KOBV would accrue from the clearfell of older regrowth stands during this period;
- An increase to the minimum acceptable size of karri sawlogs from first thinnings has lead to volumes of the smallest sawlog size (between 200–350 mm small end diameter) being removed as other bole volume;
- Extra wood sourced from the crowns of felled trees in the two-tiered stands has been recorded as KOBV, rather than separately accounting for the crown-wood volume; and
- An unquantified proportion of regrowth marri stems thinned in the regrowth karri operations are included as karri in the recorded KOBV statistics.

Factors determined not to have contributed to the elevated levels of KOBV production during 2004-2007 are the area of regrowth thinned each year; the net area thinned within each coupe; the standard of application of the silviculture guidelines; and the yields per hectare realised from the two-tiered stands.

Implications

Implications for KOBV production during 2008-2013

KOBV production during the period 2008-2013 will be sourced from a combination of two-tiered operations, clearfelling of older regrowth stands, and regrowth thinning.

The karri sawlog sustained yield determines the annual area of two-tiered forest cut over and hence the volume of KOBV produced as a consequence of the sawlog cut. Production of KOBV from two-tiered operations will reduce as the area of older regrowth stands scheduled for clearfelling increases, as a consequence of the lower volume of KOBV in older regrowth stands. Combined, however, these two sources are likely to still contribute around 30 per cent of the annual KOBV production.

In regrowth stands the requirement to only thin stands that have achieved a minimum top height of 30 metres provides an overall constraint on the level of KOBV produced from these stands. The production of KOBV from thinning operations will reflect the composition of site quality, species mix and age class of stands thinned during 2008-2013. The preparation of a three-year harvest plan for 2010 to 2012 is well advanced and the provisional plan schedules regrowth karri areas of similar stand characteristics to the areas thinned during 2004-2007. Provision has been made to maintain the rate of thinning up to the 1,260 hectares per annum. Consequently, the annual production of KOBV from all sources during the period 2008-2013 is anticipated to exceed the FMP upper limit of 117,000 cubic metres per annum, unless the area of regrowth karri thinned each year is significantly reduced. The FPC has advised that a temporary reduction in thinning operations for 2009 has recently occurred due to market conditions. A substantial scaling back of regrowth thinning operations would have commercial implications for the FPC, impact the future sustained yield of karri sawlogs, potentially lead to adverse outcomes on future stand

productivity under a drier climate, and may delay the reintroduction of prescribed fire into the younger regrowth stands.

The annual production of KOBV from all sources could range as high as 170,000 cubic metres during 2008-2013, assuming the areas cut over are consistent with the FMP and the projected productivity of stands and current operational practices (including the increased minimum size of sawlog accepted from first thinnings) are maintained. The production of KOBV will fluctuate annually in response to a number of operational factors, but a revised upper limit of 170,000 cubic metres per annum should be consistent with other FMP settings such as providing for the sawlog sustained yield.

Implications for marri other bole volume production during 2008-2013

The under-production of marri bole volume realised from first thinnings in the regrowth karri stands thinned to date relative to forecast volumes has implications for the level of marri bole volume forecast to be available during this FMP. An annual limit of 196,000 cubic metres of marri bole logs was set for the FMP, and included in this figure was a projected resource arising from first thinnings in regrowth karri stands.

Depending on the relative species composition of stands thinned during 2008-2013, less marri bole volume will be generated than previously forecast. However, revision of the FMP 196,000 upper limit is not considered necessary because:

- The FMP upper limit is averaged over the ten years of the plan, and data reported in KPI 5 for the removals of marri bole volume during the first four years indicate low annual volumes have been taken to date; and
- The level of marri production was not set as a non-declining yield, but rather as a forecast level of production as a consequence of harvest operations in jarrah and karri stands.

Implications for future karri sawlog production

The total area of regrowth thinned has been consistent with the woodflow scheduling averages for the period of the current FMP. The stands are being thinned to the target basal areas specified in Silviculture Specification 1/92 (Department of Conservation and Land Management 1992). Consequently, a continuation of the elevated level of production of KOBV will impact positively on future sawlog production.

The mix of site quality, species composition and method of regeneration of regrowth stands thinned to 2007 has differed from the FMP forecasts, and will likely vary for the remainder of the FMP. It is possible higher sawlog yields (to FMP specifications) in second and subsequent thinnings than originally forecast may be achieved from regrowth stands given the higher site quality and lower proportion of marri regrowth present in stands thinned to date.

Recommendations

It is recommended that a revised upper limit of 170,000 cubic metres per annum for the production of KOBV would be consistent with the settings and intent of the FMP, while also providing for the fluctuations in production that accompany the mix of forest characteristics on annual harvest plans.

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Appendices

Appendix 1. Key Performance Indicator 6 (reproduced from the Mid-term Audit Report of the Forest Management Plan)

KPI 6: Area of forest cut over annually

Performance measure	*Annual area of each forest type harvested according to each silvicultural objective.*
Performance target(s)	*Not possible to set a realistic target for area cut over.*
Reporting	*Annual publication of areas cut over.*
Response to reporting	*The Conservation Commission to evaluate the need for revision of management practices in the context of its assessment and auditing function, in consultation with the Forest Products Commission and the Department.*

Objective of the KPI

The objective of KPI 6 is to assess the success of the implementation of the Forest Management Plan by reporting trends in the total area harvested for each silvicultural objective in the context of the total forest area available for timber production.

Background and context

The native forest available for timber production comprises a broad range of forest structure and composition, on sites of varying productivity. Consequently, when areas are cut over, the silvicultural guidelines seek different silvicultural objectives according to the existing stand structure and condition. For example, where there is a predominance of vigorously growing trees, the stand may be thinned to promote growth on the retained trees whilst providing a yield of log products; where this is not the case, the stands are harvested with the object of regenerating them.

The total area that is cut over each year to the various silvicultural objectives provides a general indication of the rate of harvest across that portion of the forest that is available for timber production. Changes in the relative proportion of area cut over to the different objectives will reflect variations in the structure and composition of the forest made available on an annual harvest plan, as well as the degree of consistency in the application of the Silviculture Guidelines.

Annual targets for the area cut over to each objective have not been set. This is for several reasons. The placement of coupes onto an annual harvest plan is influenced by a number of operational and planning factors aside from the structure and composition of the forest, including the seasonal prescribed burning program and the need for geographic spread across timber supply zones. Annual fluctuations in the areas cut over to each silvicultural objective are therefore expected due to the variation inherent in the mix of forest in coupes in annual and three-year harvest plans. The month of harvest completion can also influence the year for which figures are recorded, with apparent spikes in the total area for one year sometimes being partly an artifact of the size of the coupes and lengthy period that harvest operations may have taken to completion.

Results and explanatory notes

During the period 2004 to 2007, the total area of native forest cut over each year averaged 9,582 ha, or 1.1 per cent of the total area of 848,380 ha of native forest available for timber production under the FMP. Most of this area was jarrah (average of 7,972 ha per year or 1.1 per cent of available 751,910 ha), followed by karri (average of 1,510 ha per year or 2.5 per cent of available 60,000 ha), with small areas of wandoo (average of 100 ha per year or 0.3 per cent of available 36,470 ha). Note that the annual area cut over relative to the total area

available for timber production does not infer a rotation length for the species, due to the inclusion of thinnings and partial cutting objectives in the area cut over.

While the total area of jarrah and karri cut over has been relatively consistent each year, the proportion cut to each silvicultural objective has fluctuated across the reporting period (Table A12).

Table A12. Annual area (hectares) of native forest cut over to each silvicultural objective.

Forest type	Silvicultural objective	Area cut over#^ (ha)			
		2004	2005	2006	2007
Jarrah	Promote growth on retained trees (thinning)	470	410	1,020	360
	Release regeneration (gap)	480	230	680	410
	Establish regeneration-eastern jarrah (shelterwood)	770	720	1,090	500
	Establish regeneration-western jarrah (shelterwood)	3,040	2,160	1,710	2,540
	Single tree selection (retention in dieback areas)	1,420	1,810	2,230	2,200
	Selective*	1,460	520	1,070	1,190
	Other (mining and clearing for utilities)	910	920	650	920
	Jarrah total	**8,550**	**6,770**	**8,450**	**8,120**
Karri	Establish jarrah/karri regeneration	80	30	60	20
	Establish regeneration (clearfall karri)	170	480	350	440
	Establish regeneration (partial karri clearfall)	120	10	0	100
	Promote growth on retained trees (thinning)	930	1,090	1,160	1,000
	Karri total	**1,300**	**1,610**	**1,570**	**1,560**
Wandoo	Establish regeneration	0	0	90	20
	Promote growth on retained trees (thinning)	0	30	220	40
	Wandoo total	**0**	**30**	**310**	**60**

* Stands that have been cut over and retain a high proportion of cull (unmerchantable trees), and in which limited silvicultural treatments have been applied.
# These statistics will vary slightly from figures published in previous DEC and FPC Annual Reports due to the subsequent updating of some objectives following later silvicultural treatments.
^ The areas reported are the net area cut over, which is equal to the entire coupe area LESS the area of informal reserves and other uncut patches within the coupe.

Over half of the area of jarrah forest cut over each year was cut to shelterwood or single tree selection (dieback) objectives. Cutting to release regeneration (gap) or thinning to promote growth on retained trees were the smallest proportion of the area cut over each year. In contrast, the thinning objective was sought in over two-thirds of the total area of karri cut over each year. These are principally first thinnings in regrowth karri stands aged less than 30 years.

The figures in Table A12 are the aggregated area recorded as cut to the particular objective. They do not directly indicate whether a particular silvicultural objective as applied in the field was the most appropriate choice for the stand structure and composition. Field monitoring suggests that during the period 2004 to 2006 there was considerable variation in the scale (i.e. minimum patch size) at which the jarrah silvicultural objectives were defined in the field, and in the consistency of treemarking. Moreover, some of the jarrah objectives may not be achieved unless appropriate treatments are applied following harvesting to attain the necessary stand density. While the extent of the silvicultural treatments is recorded by the Forest Products Commission, supplementary data on the outcome achieved are not recorded post-treatment. The Department will progress improved reporting of silvicultural outcomes with the Forest Products Commission.

Appendix 2. Key Performance Indicator 12 (reproduced from the Mid-term Audit Report of the Forest Management Plan)

KPI 12 – The achievement of early thinning schedules that underpin future yield

Performance measure	*Achieved thinning versus that prescribed in silviculture schedules.*
Performance target(s)	*All stands thinned at the prescribed stand development stage.*
Reporting	*Two years after commencement of the plan and each two years thereafter.*
Response to target shortfall	*The Forest Products Commission and the Department to investigate the cause and report to the Conservation Commission. The Conservation Commission to evaluate the need for revision of management practices in the context of its assessment and auditing function in consultation with the Department.*

Objective of KPI 12

The objective of KPI 12 is to assess the implementation of the FMP through tracking the area of regrowth jarrah and karri forests that have received a first thinning, relative to the area provisionally scheduled in the calculation of sustained yields.

Context

The sustained yields in the FMP assume that regrowth jarrah and karri stands are periodically thinned to promote sawlog growth. The timing and intensity of thinnings are prescribed in the Silviculture Guidelines. Depending on the site quality (productivity), stage of stand development and the stand density, areas of forest are provisionally scheduled for future thinnings. Detailed stratification of the forest estate into these categories assists the scheduling of thinning operations, but such stratification is only progressed as resources permit, and is still being refined for jarrah stands. Such stratification work would be an important refinement to the calculation of sustained yields for the next FMP, but the extent of such work will need to be weighed against other priorities.

The achievement of early (first) thinnings is particularly important because extended delays over years can, in jarrah stands, lead to an overstocked condition and markedly slower growth rates. This KPI therefore aims to monitor progress toward achieving the provisionally scheduled level of thinning in the regrowth jarrah and karri forests.

The woodflow projections for the sustained yields adopted broad strata of site quality and stand condition, and provisionally scheduled stands for thinning within aggregated five-year periods. Field inspection associated with the preparation of three-year harvest plans is used to refine the scheduling, which may include the deferral of thinning into the next period depending on the stage of stand development.

Results and explanatory notes

Karri

The total area of karri regrowth provisionally scheduled to be thinned during the period of the FMP comprised a base set of schedules and, given the strong commercial market for the regrowth wood and the availability of detailed stand stratification, provision was made for an expanded program up to a level that would not impact on the sawlog sustained yield. The total area provisionally scheduled for thinning averaged up to 1,260 hectares per annum (2,520 ha per biennium) over the period of the FMP, with a higher proportion of the area scheduled to be thinned in the latter period of the plan (2009-2013).

The area of regrowth karri thinned to December 2007 relative to the scheduling indicates that the thinning program is progressing ahead of the schedule (Table A21), but is within the overall average for the entire FMP.

Table A21. Area (hectares) of regrowth karri provisionally scheduled and actually thinned during the period 2004 to 2007. The figure for the area scheduled includes provision for an expanded first thinnings program as provided for in the FMP.

Operation period	Area provisionally scheduled for first thinning (ha)	Area thinned (ha)	Variation (ha)
2004 – 2005	1,452	2,020	+ 568
2006 – 2007	2,103	2,160	+ 57

The faster rate of thinning will not impact future sawlog sustained yields (refer to KPI 11 for further information), and is considered by the Department to facilitate the re-introduction of strategic prescribed burning into these younger stands.

Jarrah

First thinning operations in regrowth jarrah were nominally scheduled to commence in 2006 in stands in the Warren Region that had been regenerated between 1974 and 1984. A program of approximately 450 hectares per annum was provisionally scheduled, based on broad site quality and stand age strata.

To October 2008, thinning in these stands has not commenced. Preliminary field inspection of some of the scheduled stands has indicated that refinement of the site stratification will be necessary to reschedule many areas, as they are not yet ready for thinning due to variable stocking and slower growth rates. The current absence of a market for the small residue jarrah and marri logs has delayed these operations, as non-commercial thinning will require significant funds and potentially complicate fire protection in these stands. The Forest Products Commission has been investigating markets and suitable harvesting equipment for these operations.

While a delay of several years in conducting thinning operations in these stands is not significant, lengthy delays will generate large backlogs and require alternate yield regimes to be adopted into the next FMP.

The causes of the delay in commencing first thinning operations in the regrowth jarrah stands and the consequences for sustained yield will be reported to the Conservation Commission by the Department and the Forest Products Commission.