A REVIEW OF THE SUSTAINABLE YIELD ISSUES IN THE WOMBAT STATE FOREST

Consultants' Report

by

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EXECUTIVE SUMMARY

The Victorian Regional Forest Agreement Steering Committee has requested a review of the issues raised by the Wombat Forest Society concerning the sustainable yield rate for the Midlands Forest Management Area. We have reviewed the critique prepared by Mr Tim Anderson of the Wombat Forest Society and have met with him, representatives of the Victorian Association of Forest Industries and the Construction, Forestry, Mining and Energy Union, and technical staff of the Department of Natural Resources and Environment. We have not done a full evaluation of the sustainable yield system since this was done by Turner in 1995 and then by the Department staff in 1995. Rather we have concentrated on the issues raised by Mr Anderson in his critique, and after taking into account the comments of Victorian Department of Natural Resources and Environment (NRE) staff we have attempted to make a judgement as to the validity of the issue and what might be done to correct any possible deficiencies.

We have identified 10 specific issues from Mr Anderson's critique; these are indicated in Italics, followed by some brief comment on our evaluation of each.

1: Protection of catchment values in calculation of the sustainable yield. Constraints on the future proportional distribution of age classes are imposed. We cannot comment on whether this is adequate protection of catchment values.

2: 75% of the Wombat has had at least the first shelterwood harvest applied since 1974. We believe that the actual percentage is somewhat lower than this, but point out that the optimum strategy for the Midlands Forest Management Area may be to harvest the shelterwood-available area of the Wombat State Forest first and then to harvest remaining less productive areas outside of the Wombat State Forest.

3: Basal Area retention for the first shelterwood cut was changed from 9-11 m^2/ha to 5-7 m^2/ha and the consequence of this will be a reduction in sawlog yield from the second shelterwood harvest. NRE staff advise us that harvesting prescriptions have not been changed from retention of about 9-11 m^2/ha basal area.

4: Midlands Forest Management Area Strategic Harvest Schedule for Existing Forest Stands shows an obvious shortfall in the supply of logs. The current model shows the next shelterwood rotation to be between 50 and 60 years. We find no evidence of a future shortfall or short shelterwood rotation. The minimum future shelterwood rotation length is set at 75 years.

5: With predicted rotations of less than sixty years, delays of even five to ten years in achieving adequate regeneration, must severely compromise the possibility of meeting the model's necessary growth rates. NRE staff advise that regeneration under the shelterwood system is generally successful and that remedial action is taken where it isn't, well within the decade.

6: Yield expectations are unrealistically high for the two shelterwood cuts. The data we have been able to gather on current harvesting is conflicting, but we find no clear evidence that yields are being over-optimistically estimated. It does not appear to us that future predicted yields are too high, given the likely growth of the forest.

7: Yield expectations for clearfall are also unrealistically high. Again we find no clear evidence of this. Yields from the low site quality areas outside of the Wombat State Forest recently harvested have been very low apparently, but logging of these areas has now ceased.

8: Regeneration and fuel reduction burns are reducing the quality of the timber obtainable from the forest. NRE staff advise us that fuel reduction burns do not significantly reduce future timber quality and that there does not appear to be a degrade of logs in the second shelterwood cut following regeneration burns 10-15 years before.

9: Volumes of B+ sawlogs can not be sustained in the short run. NRE has no requirement to maintain proportion of high-grade logs. Although the proportion of these has decreased over the last decade, it has been relatively constant at about 25% over the last five years.

10: NRE should make maps of scheduled coupes up to say the year 2060 available to the interested public by say 5 year time steps. Longterm planning is at the analysis area level, not at the coupe level but strategic level planning maps can be made available.

We suggest that NRE staff communicate directly with Mr Anderson where there is continuing uncertainty that might be clarified by further analysis of existing data. Other issues, particularly those related to current and future yields may be clarified when results of the Statewide Forest Resource Inventory are available. However we strongly recommend that NRE puts into operation a systematic procedure that relates estimated and actual harvests on coupes and calibrates estimates against realised volumes. We suggest that in the longer term that research be conducted on improved methods for estimating harvestable volumes on a coupe basis.

In view of the recent Timber Resource Analysis conducted for the Midlands under the West Victoria Regional Forest Agreement process, we have indicated where the Review has addressed issues raised by Mr Anderson and which issues remain to be addressed prior to the 2001 sustainable yield review. We suggest that the difference in calculated sustainable yield between the 1995 estimate and that estimated in 2000 is due to changes in technology, changes in attitude to risk and changes due to the draft new reserve system, of approximately one third each.

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INTRODUCTION

Context

Under the Victorian Forests Act of 1958 there is a requirement that the sustainable yield rate of each Forest Management Area be reviewed at least every five years from July 1991. In that year the sustainable yield rate for the Midlands FMA was set at 70 000 cubic metres per year of C grade and higher (C+) sawlogs. In 1996 following an independent review of the methodology for calculating the sustainable yield, an internal review report (DCNR, 1995) and the compilation of a new Management Plan (DCNR, 1996), the sustainable yield rate was reduced to 58 000 cubic metres per year of D+ logs.

For some time (certainly prior to 1995) there have been protests from local conservationists that the sustainable yield rate has been set at a higher-than-sustainable level. In the forefront of this campaign has been the Wombat Forest Society in which Mr Tim Anderson has been active in collecting and analysing the data made available to him by the Department of Natural Resources and Environment (NRE) and from other sources. The Wombat Forest Society has prepared a critique of the Midlands Forest Management Area Sustainable Yield, and the model used by the NRE to derive the sustainable yield rate for the Forest Management Area. The Wombat Forest Society document is entitled 'Midlands Forest Management Area Sustainable Sawlog Yield Model Analysis and Critique' published in May 1999 (Anderson, 1999).

The Victorian Regional Forest Agreement Steering Committee is seeking a review of the issues raised by the Wombat Forest Society concerning the sustainable yield rate for the Midlands Forest Management Area.

Terms of Reference

The Steering Committee indicated in the Terms of Reference for this consultancy that it was seeking a report on:

1. The methods used by NRE and the Wombat Forest Society to develop the respective sustainable yield estimates; and

2. The issues raised by the Wombat Forest Society concerning the sustainable yield rate in the Wombat State Forest.

The committee further indicated that the consultants should:

- investigate and comment on the differences between the Wombat Forest Society resource estimates and the legislated yield rate; and

- identify significant issues that should be considered in a review of the sustainable yield rate for the Midlands Forest Management Area due in 2001.

Form of the Review

The consultants met with Commonwealth AFFA and Victorian Department of Natural Resources and Environment (NRE) staff, and with Mr Anderson, President of the Wombat Forest Society, Mr Jon Drohan of the Victorian Association of Forest Industries and Mr Michael O'Connor of the Construction, Forestry, Mining and Energy Union to seek input to the review.

An evaluative review was conducted of the appropriateness of the datasets, models, systems and methodology used in the calculations of the sustainable yield of sawlogs for the Wombat State Forest (as part of the Midlands Forest Management Area). This was done through review of documents including the Wombat Forest Society critique and presentations by and interviews with those responsible for making the yield calculations in NRE and the author of the critique.

Previous Review

In September 1995 the Department of Conservation and Natural Resources (DCNR) commissioned the first author of this report to "review the procedures being used by the DCNR in forecasting sustainable timber yields for the Midlands FMA". This unpublished report is presented here as Appendix A. The report briefly evaluates the overall concepts and tools used, stratification of the forest, current growing stock statistics by strata, yield prediction by strata, management options considered, sources of error and risk and procedures taken to reduce them, and recommendations for future R&D.

In his report, Turner found that the methodology being used by DCNR to calculate sustainable yields for the Midlands at that time was "appropriate" and "consistent with best international practice". However some concerns were expressed about the "estimation of future growth" and "the simplicity with which the development of the residual and regenerating stands are modelled in the so-called shelterwood cuts, and with the handling of site variation". Also recommended was that "a clear mechanism for monitoring the yield predictions should be established so that actual removals and growth are routinely compared with predictions."

COMPARISON OF METHODS USED BY NRE AND WOMBAT FOREST SOCIETY

Methods used by NRE

The current legislated level of sustainable yield for the Midlands is the result of a review conducted in 1995 by the then Department of Conservation and Natural Resources. Following the review of the procedures by Turner, the methodology was published in a technical report entitled 'Review of Sustainable Sawlog Yield: Midlands Forest Management Area' (DCNR, 1995). In that report are described the methods used to determine the land base for timber production, the use of a continuous forest inventory system established 30 years earlier to determine current timber resources and their growth rates, the models used to project timber volumes into the future under the various silvicultural systems then being used or proposed, and the use of the Integrated Forest Planning System incorporating FORPLAN to examine constrained scenarios to estimate sustainable yields. The report also quotes the conclusion of the unpublished review by Turner; in part: "My review of the procedures being used to calculate sustainable yields for the Midlands Management Area indicates that an appropriate methodology consistent with best international practice is being used" (DCNR, 1995, p.24). The DCNR report also acknowledges that "Dr Turner also indicated several areas where there is room for improvement, in particular the estimation of future growth, the Shelterwood model and site variation" and then proceeds to indicate that work on these aspects was either under way (site variation) or acknowledged as being needed.

In view of this published report and the earlier review by one of the present consultants, it does not seem fruitful to do another detailed review at this time. Furthermore, since 1995 the Statewide Forest Resource Inventory has been set up to collect consistent and well-controlled inventory and growth data over the whole state at the strategic level. This project has been well reviewed (including in the design stage by the authors of this report) and documented (e.g., DNRE, 1997; Hamilton *et al.*, 1999 and Hamilton and Brack, 1999). At least some of the improvements suggested by Turner will be addressed by these data when they become available for the Midlands Forest Management Area. Remaining issues will be addressed at the end of this report.

The DCNR report ends with recommendations concerning sustainable yield levels under various alternative silvicultural scenarios for the Wombat State Forest. The one which gave the highest level of sustainable yield (58 200 cubic metres/yr) provided for shelterwood harvesting of the medium/high site productivity areas of the Wombat State Forest followed by a regime of early (non-commercial) thinning. Warnings are given of the dire consequences of not carrying out the early regrowth treatment. Following this Departmental review, the sustainable yield was set at 58 000 cubic metres of D+ sawlogs per year, to be achieved over a five-year phase-down period.

Methods used by Wombat Forest Society

The methods used by Anderson (1999) are heavily dependent on the data presented by NRE in the 1995 DCNR report and the Midlands Forest Management Plan (DCNR, 1996) (the Proposed Plan was published concurrently for public comment with the review report). He has taken tables and graphs in those publications (principally from Appendix N of the Management Plan) and extended and extrapolated them under various assumptions alternate to those adopted by NRE, and has reached rather different conclusions, in particular that the Wombat State Forest cannot sustain the present rate of harvest. Some of his assumptions, he acknowledges, are based on estimates of local forest workers, including foresters, some are the result of misunderstandings about the interpretation of the data, which we hope are now clarified after the joint meeting of the consultants with Mr Anderson and NRE staff, and some require further checking by NRE staff against the Wombat Forest Society's data.

Specific issues raised by Anderson (1999) and responses

We now review the issues raised by Anderson (1999) in the order in which they occur in his critique, and where possible resolve them on the basis of our discussions with NRE staff and Mr Anderson, separately and jointly. We recognise that Mr Anderson has raised issues in his report that are not directly related to the calculation of sustainable yield, in particular the protection of the mineral water recharge areas, and offer no comment on those that are outside our brief (and expertise). We note the new state government's more open management policy which should allay Mr Anderson's concern about "the often dismissive and secretive nature that DNRE is with information requested by the WFS and the general public" (p.6).

Issue 1: Protection of catchment values in calculation of the sustainable yield (Pages 7-9)**.**

Mr Anderson believes that low-grade forests will be entirely cut out over a 50-year rotation and that the rotation length for medium/high quality Wombat will be 60 years (p. 7-8). No reference is given for these assertions. NRE staff have produced for us the input specifications which have produced the outcome of 58 000 cubic metres/ year. They show that the minimum allowable rotation is 65 years for the medium/high Wombat and 85 years for the low quality Wombat for the current forest and 75 and 95 years respectively for the regrowth forest. Average expected rotations for the Midlands as shown by the Integrated Forest Planning System results are 118-140 years for the next 40 years and about 80 thereafter. In addition there is a catchment protection constraint that within water-supply catchments, no more than 20% of the catchment area can have age classes of 20 years or less (DCNR, 1996). We are not in a position to judge whether this is adequate protection but it is not mentioned by Mr Anderson.

Issue 2: 75% of the Wombat has had at least the first shelterwood harvest applied since 1974. (Page 12)

This assertion is based on areas taken from a map which Mr Anderson has drawn up from Wood Utilisation Plans checked against actual logging records. This figure is somewhat at odds with data supplied by NRE but both NRE and Mr Anderson will check against one another and come up with a mutually agreed figure. NRE's figures (supplied at our briefing) indicate that the net productive area of high/medium Wombat State Forest was 26 140 ha. There are another 1 729 ha of low productivity forests that have had a first shelterwood harvest cut. The total area either available for shelterwood harvesting or that had already had a first shelterwood harvest cut was therefore 27 869 ha in 1995. Of this, the area already harvested under a shelterwood cut was 10 262 ha or 37% of the total available area. That leaves 10 974 ha of Mature and Selection forest, plus 6 633 ha of Regrowth, available for shelterwood operations as of 1995. We have not been provided figures on the area shelterwood harvested since 1995.

However, whatever the rate is, this cannot be taken as an indicator of overcutting of the Midland Forest Management Area. It may well be desirable to harvest the most productive areas of the Wombat State Forest first to maintain them in a highly productive state, provided there is other forest to maintain the level of harvest after this occurs (in this case Mt Cole may play that role), and other values (such as catchment values) are preserved. Given that the objective of the Integrated Forest Planning System's Spectrum model has been set to maximise present net worth of the forest for timber production, it is likely that the most productive areas of the forest would be selected first.

Issue 3: Basal Area retention for the first shelterwood harvest was changed from 9-11 m^2/ha to 5-7 m^2/ha and the consequence of this will be a reduction in sawlog yield from the second shelterwood harvest. (Page 14)

This alleged change from low intensity to high intensity harvesting in the first shelterwood harvest operation is not in accord with current silvicultural prescriptions. There was a reduction in residual basal area in the mid-1980s to 8-11 m^2/ha, but we are advised there has not been any change in prescription since then. NRE will reconfirm this following field checking and further discussions with Mr Anderson on his sources.

Issue 4: Midlands Forest Management Area Strategic Harvest Schedule for Existing Forest Stands shows an obvious shortfall in the supply of logs. The current model shows the next shelterwood rotation to be between 50 and 60 years. (Page 14)

It is not clear to us how this conclusion regarding a shortfall was reached. The Chart referred to by Mr Anderson (p. 14 footnote) was not known to current NRE staff but according to Mr Anderson "is an NRE poster style spreadsheet that shows 'age of origin' by forest and gives area for these" (Anderson, pers comm), of about 1996 vintage. It is assumed that the Harvest Schedule referred to above is the current Wood Utilisation Plan. The Integrated Forest Planning System model does not permit harvesting of shelterwood

regrowth prior to age 75, and does not indicate any shortfall of supply under the 58 000 cubic metres/ year harvest schedule.

Issue 5: With predicted rotations of less than sixty years, delays of even five to ten years in achieving adequate regeneration, must severely compromise the possibility of meeting the model's necessary growth rates. (Page 15)

Recent regeneration surveys show that approximately 85% of first shelterwood harvest areas have been successfully regenerated without additional treatment. Most of the remainder have undergone or are undergoing remedial action, with remedial work being done usually within five years of initial treatment. NRE believes that 85% is an acceptable outcome and does not believe that there is a significant problem (except for the cost of re-treatment). In terms of the impact on sustainable yield, we concur with NRE, because delays of less than five years on such a low proportion will not materially affect yields in a model that uses 10-year steps. We assume that monitoring of regrowth areas will be continued to enable remedial work to be carried out in future and, silviculturally, we would hope that the aim would be to improve the success rate progressively.

Issue 6: Yield expectations are unrealistically high for the two shelterwood cuts. (Pages 17-19)

This conclusion is based on an analysis of information in Appendix N of the Midlands Forest Management Plan and additional information derived by Mr Anderson, who maintains that current harvesting in the Midlands is achieving around 42m^3/ha from first shelterwood harvest cuts and 35m^3/ha from second shelterwood cuts in medium/high grade forests, figures which he has gleaned from loggers.

NRE had no recent figures that would refute this, although they believe that current harvesting is yielding somewhat higher yields. We have done some analysis of coupes scheduled for harvesting over the period July 1999-June 2002, which shows that the average expected yield for the first shelterwood harvest cuts is 63m^3/ha and for the second shelterwood harvest is 31m^3/ha. D CNR (1995) indicates that the expected second shelterwood harvest yield is 47 m^3/ha. NRE staff pointed out that considerable care was taken in calibrating the continuous forest inventory data against felled tree volumes for the 1995 review. An adjustment of –27% was applied to correct the continuous forest inventory volume to D+ net harvestable sawlog volume, based on the application of grading rules to felled-plot trees by an experienced local assessor.

Anderson (1999) shows figures derived from Appendix N of the Forest Management Plan which indicate that the average expected yields for combined first and second shelterwood harvest operations for the 1995-2004 period are 49 m^3/ha, increasing to 95 m^3/ha in the 2015-2024 period. NRE staff have recomputed these figures in response to our request and have come up with revised figures of 39 and 81 m^3/ha respectively. This increase over the three decades is probably due to several factors, none of which are

explained in the previous documentation. The predicted growth after 1995-2004 is expected to be substantial according to NRE data, although the increase is too large to be solely due to growth. The principal cause is probably an expected movement of harvesting in the period 2005-2024 into the highly productive mature forests which had not had a selection or shelterwood cut earlier.

Issue 7: Yield expectations for clearfall are also unrealistically high. (Page 21)

The area of the Midlands Forest Management Area amenable to shelterwood silviculture is about half the total net productive area, the remainder (low quality Wombat State Forest, Mt Cole State Forest and remaining areas) are scheduled for clearfall silviculture. Mr Anderson believes that these forests are currently producing no more than 20 m^3/ha in clearfall operations based on loggers' estimates ("virtually nil" in current harvests in the 'remaining areas').

The model however assumes that average harvests will be 38 m^3/ha in the 1995-2004 period, increasing to 59 in the 2025-2034 period, and higher beyond that. If this is all due to growth (rather than changes in site) this represents an average increment of only 0.7 m^3/ha/yr, which seems quite reasonable[1]. The model itself uses mean annual increments of 1.22 and 0.87 m^3/ha/yr respectively for Mature and Selection forest of Medium to High productivity, so this value is quite consistent with those values, allowing for the inclusion of some forests of lower site productivity (mean annual increments 0.49 and 0.38 respectively for Mature and Selection). It would appear that Anderson (1999) has not allowed for any growth in these forests in his analysis (cf his statement that an average yield of 49 m^3/ha from clearfelling over the next 50 years "is absolutely ridiculous" (p.23))[2].

NRE staff admit that growth data for these forests are somewhat scanty. Better estimates will be available when the Statewide Forest Resource Inventory data are collected and analysed. They pointed out that current operations are not indicative of average conditions in these forests. Due to the risk of *Armillaria*, clear felling is applied to higher productivity stands at Mt Cole, as well as to the lower productivity Wombat Low and Remaining Areas strata. This will contribute to a higher average yield than would be expected for the low productivity areas only.

Issue 8: Regeneration and fuel reduction burns are reducing the quality of the timber obtainable from the forest. (Page 24)

This claim is refuted by NRE staff. Neither NRE nor Mr Anderson has supplied any data to support or negate the claim. Intuitively, one would expect that severe crown scorch

[1] Note that there is an error in Figure 1 (p. 18) of Anderson (1999), carried through to Graph 6. The m3 per ha for the Clearfell Harvest Cycle for the period 2065-2074 (entitled 6065-2074 in the figure) should be 73.8 rather than 138. There are other minor errors of this nature in the report.

[2] The statement at the top of p.24 of Anderson (1999) is incorrect. The total Clearfall Volume (over the 120 year planning period) is divided by the sustainable yield of 58 000 m3/yr, but this includes volume from shelterwood as well as clearfall operations.

from regeneration fires or prescribed burning would reduce growth for a period. The average effects of scorch from prescribed burning are presumably already reflected in the continuous forest inventory plot data but the crown scorch resulting from regeneration burns would not be. This claim can only be resolved when more data become available, e.g., from NRE research staff or local staff.

Issue 9: Volumes of B+ sawlogs can not be sustained in the short run (Page 25)

NRE staff points out that NRE has no legal requirement to supply defined quantities or proportions of B+ logs, but that these are strictly run-of-the-bush. According to Anderson's (1999) figures on actual timber harvest yields (sourced from NRE), the volume of harvest from the Midlands was substantially reduced in 1990-92 over that before or since (presumably due to the market decline at that time). In that time the proportion that B+ logs were of the total also declined. If pre-1990 proportions are compared with post 1993 proportions there is still a decline from about 36% of D+ logs to about 25% (+/- 4% over the 1993-1998 period). However our analysis of 20 coupes harvested in the last 6 months shows that 31% of the D+ actual harvested volume was in B grade logs (mostly from second shelterwood harvest operations)[3]. Proportions by grade are not modelled so there can only be conjecture on what they will be in the near future, based on understanding of the sites and proportions of thinnings, first shelterwood harvest, second shelterwood harvest and clearfall operations scheduled.

Issue 10: NRE should make maps of scheduled coupes up to say the year 2060 available to the interested public by say 5 year time steps. (Page 29)

NRE indicate that they are able and willing to produce maps as byproducts of their Integrated Forest Planning System runs that will show in which broad areas harvesting is planned to occur by 10 year periods. Planning down to the coupe level does not occur until the production of Wood Utilisation Plans approximately three years before harvesting and hence actual coupe boundaries can only be shown for those coupes in the current Wood Utilisation Plan (i.e. for the next three years).

Differences in outcomes by the two methods

Anderson (1999) has raised a large number of issues about the modelling of the Wombat State Forest by NRE staff. Of the substantive ones (ie. those that are not based on incorrect calculations or misinterpretations of the data), the most telling are those related to the expected yields from harvesting operations (Issues 6 & 7). If current yields (the starting points for growth projections) are as low as those suggested by Anderson and growth rates on the existing forest are negligible (as he implies), then clearly the data used in the NRE models are incorrect and a reduction of the sustainable yield would be indicated. While some data on current yields can be obtained in the near future, improved data on growth rates are not likely to eventuate until after the Statewide Forest Resource Inventory has been completed in the Midlands Forest Management Area and

[3] Data supplied by J. Drohan (VAFI)

the total dataset for Victoria analysed. It is hoped that this can be done in time for the 2001 sustainable yield review.

Table 1 summarises the various estimates of current harvestable volumes. The differences are considerable in some cases but revised estimates by NRE of expected yields for the current decade are close to Anderson's for shelterwood operations. Estimating harvestable volumes in standing trees is notoriously difficult in these mixed forests. This is represented in Table 2, which shows a comparison between actual harvested volumes from 20 coupes and NRE estimates prior to logging. The overall differences in the total volumes for the 20 coupes, chosen because the two estimates were conveniently available, is negligible but the variation in differences is considerable. Most of these coupes are second shelterwood harvest operations. If the data for the 'Water Race 2' coupe which was a clearfall operation and had the biggest difference of all coupes, is extracted from Table 1, then the overall difference is about 6%, with actual harvested volume being higher than the estimated volume. This is only a small sample but it doesn't support the proposition that NRE estimates are much higher than actual harvestable volumes. NRE staff pointed out that the "NRE estimated volumes" in this table are estimates by field staff, and not data used in, or derived from, the modelling process. We do not know how these estimates are derived.

Table 1. Summary of estimated sawlog volume per hectare of D+ grade harvested from various current operations

Source	**First Shelterwood Harvest Operations**	**Second Shelterwood Harvest Operations**	**Clearfall Operations**
Anderson (1999)	42	35	20
DCNR (1995)	34	47	
App. N (DCNR, 1996)	[49] av. of first & second shelterwood harvests	[49] av. of first & second shelterwood harvests	38
1999-2002 scheduled coupes	63	31	97
NRE (1995-2004) model expected yields (calculated in Yr. 2000)	40	38	

Table 2. Comparison of actual harvested volumes from 20 coupes harvested in the last 6 months of 1999, with NRE Harvesting Schedule estimates (data supplied by J. Drohan and NRE). (Volumes in cubic metres)

Coupe	Coupe Name	Actual D+ Volume	NRE Est. of D+ Vol.	Diff
06-172-519-05	Black Range 1	710	1550	-840
06-172-519-08	Hardy's	173	400	-227
06-172-522-10	Eagle Dam	552	655	-103
08-185-523-13	Water Race 2	429	1600	-1171
06-192-505-05	North Babbington	1660	1100	560
06-193-528-05	North Paddy's	1068	500	568
06-193-529-03	Cockatoo West	1840	1000	840
08-193-551-05	Maxwell Track 1	1542	880	662
06-193-551-04	Maxwell Track 2	1585	680	905
06-194-560-05	Gentle Annie	1124	1850	-726
06-194-910-16	Binks Road	676	1000	-324
06-208-505-07	Wickham Track	1192	1920	-728
06-208-505-12	Kelly Swamp 1	588	550	38
06-208-505-13	Kelly Swamp 2	1461	950	511
06-208-605-09	SW Face	739	1000	-261
06-208-506-10	Hill Track South	849	1550	-701
06-209-511-13	Roatches	1401	420	981
06-205-523-01	Old Mill	337	150	187
06-209-524-01	North Finh	206	165	41
06-209-933-03	Tunnel Point Tk	692	970	-278
TOTAL		18824	18890	-66

SIGNIFICANT ISSUES FOR THE 2001 REVIEW OF SUSTAINABLE YIELD

Issues that are already recognised and are addressed in the Timber Resource Analysis

Some of these issues have in fact been addressed in the Timber Resource Analysis conducted by NRE staff as input to the West Victoria Regional Forest Agreement. In recognition of changes that have occurred in the region since 1995, they have made a number of changes to the Net Productive Areas for the Midlands Forest Management Area which have had the effect of reducing the total by about 16%. These changes are due to the following:

1. All spatial data are now incorporated in the GIS database (only Wombat State Forest was in for the 1995 review), making more accurate area calculation possible,

2. Wider stream buffers, as required under the revised 1996 Code of Forest Practices, are fully implemented (less completely in the 1995 review),

3. Productive areas of less than 10 ha within a matrix of non-productive areas are excluded (advice from NRE is that these areas are rarely logged),

4. Zoning as recommended in the 1996 Forest Management Plan is fully implemented (not available in final form for the 1995 review),

5. The harvesting of overwood from the burnt Trentham stands was excluded,

6. Owl habitat protection zones were delineated so that constraints could be placed on their future age class distribution,

7. The stand height was increased to 22 m for the Remaining Areas stratum, with the result that almost half of this category is now not included in the harvestable area base, and

8. A reduction factor of 10% has been applied to all categories of the net productive area to allow for differences between modelled and actual available areas, and factors that are not readily incorporated into existing models. Fire risk has been incorporated into this factor, rather than being a separate reduction factor.

In addition to these changes, constraints were placed on water catchment and owl habitat protection zones such that only 10 % of the area could be harvested in these zones over any decade. This is a tighter constraint than used in 1995 but more effectively reflects the constraints required by the Forest Management Plan. No changes were made to growth rates or harvest volume expectations as it was considered that no new information was yet available to justify change. The effect of all these changes is an indicated decrease in the sustainable yield from 58 000 to 45 000 cubic metres of D+ sawlogs per year, a decrease of 23%. Further analysis indicates that the expected reductions in state forest area due to the Regional Forest Agreement decisions should result in a further reduction of sustainable yield to 40 000 cubic metres, a total decrease of 31%. We emphasise however that these estimates are based on the current knowledge base and without the benefit of improvements possible to that resulting from the Statewide Forest Resource Inventory data.

The adjustment of the available area to exclude additional areas (and plots within them) specified not to be logged under the revised Code of Forest Practice is clearly appropriate. The effect of the removal of small isolated areas of productive forest which are surrounded by unavailable or unproductive forest is not so clear. We presume that

any plots within these areas will also be excluded so that the integrity of the sampling frame relative to the sample plots is retained.

Issues that can be addressed post Timber Resource Analysis and pre 2001 Review

Between the recently conducted Timber Resource Analysis and the need to review the sustainable yield rate in 2001, NRE should:

1. Ensure that as far as possible the differences between Anderson's (1999) figures and NRE staff's understandings are fully reconciled,

2. Ensure that the results of the Statewide Forest Resource Inventory and revisions of growth models resulting from it are fully implemented,

3. Review area reductions to get the net harvestable area Methods used in other Regional Forest Agreements, e.g., those used for the Northern NSW RFA, should be assessed for their possible applicability and use, in order to justify or amend the 10% factor used for the Timber Resource Analysis,

4. Initiate a system for constantly monitoring and feeding back data from harvested coupes to the assessment and planning systems, including the SFRI system (see also mention of this in the Turner review in 1995 – Appendix A),

5. Ensure that all areas of the Forest Management Area excluded from harvesting by the Regional Forest Agreement process are deleted from inclusion in the sustainable yield area,

6. Review the way in which water catchment areas and owl protection areas are handled in the model, and investigate the possibility of incorporating water yield into the model, and

7. Review the way in which fire risk is handled (or not) in the model, including the effect of regeneration and prescribed fires on future growth and D+ log grade.

Longer term issues

Reasonably accurate estimates of the harvestable volume on a coupe constitute a problem. Much of the problem relates to the sampling intensity or, more accurately, the number of samples in the coupe. Other less tractable problems relate to the issue of defect and the natural variation in the boundary between Grade D sawlogs and below. The sources of this variation are many, but fire damage is undoubtably prominent among them. It would seem to us that the variation exemplified in Table 2 (and incidentally found in native forest management in every other State) could be reduced through detailed research, encompassing a study of variations in site and tree characteristics, in operators and supervisors, in Codes and measurement methods, etc. It would be a very viable PhD research project.

COMMENTS ON THE RELATIONSHIP BETWEEN THE 1995 REVIEW AND THE 2000 TIMBER RESOURCE ANALYSIS

Why the difference?

Some of our recommendations concerning issues for the formal review of Sustainable Yield in 2001 require that we place the changes evident between the 1995 legislated Sustainable Yield (58 000 cu m/yr) and that of the recent Timber Review Analysis (40 000 m^3/yr) in context.

1. **Changes in technology.** The use of more comprehensive aerial photo interpretation, remote sensing and orthophotos, together with associated Geographic Information System technology, has greatly increased the capacity of NRE to delineate those areas to be excluded from harvesting as a result of the revised Code of Forest Practice provisions, and those which have so low a volume of sawlogs as to be uneconomic. Those relating to low sawlog volumes chiefly concern the forest of low productivity on the drier fringes of the Midlands Forest. The 7% reduction in the area of more productive forest (Wombat Medium/High plus Mt Cole) available for harvesting has a substantially more significant impact on sustainable yield than its value would indicate, probably of the order of 9% in yield. Taken together with the reduction in the area of low productivity sites, the overall reduction in yield would be around 10%.

2. **Changes in attitude to risk.** The 1995 review was predicated on the use of a more optimistic simulation than would be chosen today. In particular, it assumed that silvicultural treatment (thinning etc) would proceed according to

schedule, and that has seldom been the case. In the current Timber Resource Analysis estimates, an allowance of 10% has been made for contingencies such as losses due to fire, storms, diseases or pests, and to provide a buffer against as yet unrecognised impediments to harvesting and treatment. No such allowance was made in 1996.

3. **Changes due to draft CAR reserves.** Resulting from exclusions as proposed in the draft Regional Forest Agreement report, there is an additional 10% reduction of the original area of more productive forest. This probably equates to a 12% reduction in yield.

Thus these three major changes therefore account about equally for the total reduction in sustainable yield of approximately one third each..

How do the differences relate to the forthcoming formal review of sustainable yield in 2001?

We are unable to give any indication as to the outcome of the formal review due to be completed in 2001. The reductions in available areas are likely to hold but the implications for the standing volume on those areas are quite unclear. The new Statewide Forest Resource Inventory values may be above or below the estimated standing volumes used in these data, and likewise the new estimates of growth may or may not support those used in 1995 and in the Timber Resource Analysis. The reason for this uncertainty is that the Statewide Forest Resource Inventory is based on a very different design. There are no ways in which the two can be related pending the final outcomes of the Statewide Forest Resource Inventory.

We understand that some questions have been raised about the plausibility of Statewide Forest Resource Inventory results for the North East Region of Victoria. In view of the importance of the Statewide Forest Resource Inventory in setting future levels of harvesting, it will be important for NRE to address these criticisms immediately and to ensure, wherever possible, that, if problems are identified, they are not repeated in western Victoria.

CONCLUDING REMARKS

Our analysis has shown that there are a number of issues raised by Anderson (1999) that are related to possible misinterpretations of NRE data and models, and these have been or will be resolved by improved communication between technical staff of NRE and Mr Anderson and the Wombat Forest Society. We applaud the efforts of Mr Anderson in attempting to provide an independent analysis of the data available. We believe that greater data transparency on the part of NRE, as evidenced by the progressive issue of

Statewide Forest Resource Inventory maps on CD-ROM and of other data, will ensure that the Wombat Forest Society and others are better informed and able to contribute to the resolution of these issues.

We have found no substantial differences between Anderson (1999) and the data used in NRE projections, in expected current sawlog outcomes from shelterwood operations. Mr Anderson's data are by his own assertion based on analyses of actual volumes obtained from recent harvesting operations whereas the NRE data are based on measurement of continuous forest inventory plots, with volumes calibrated against actual volumes through felled plots comparison in 1995. However, data supplied by NRE for scheduled operations over the next two years suggest that harvested volumes per hectare from first shelterwood harvest and clearfelling will be higher than both Anderson and NRE predict, but that second shelterwood harvest operations will return slightly lower than both would predict. On the other hand, data on a comparison between actual harvested volumes and volumes estimated by local staff pre-harvest, from 20 coupes felled in the second half of 1999 indicate on average the differences are not very great, with second shelterwood harvest operations yielding somewhat more than predicted. The differences on an individual coupe basis are, however, quite large, and the reasons for these are not discernable from our cursory examination. It is certainly a researchable question that warrants investigation.

Anderson (1999) also has some doubts about whether future expected sawlog volumes will be as high as predicted by NRE. We can only say, as stated by Turner in his 1995 review, that the growth models are reasonably-based, and derived from some of the best permanent-plot data available in Victoria in 1995. We assume that the growth information and models will be reviewed following the Statewide Forest Resource Inventory and prior to the next recalculation of sustainable yield in 2001.

Some adjustments to the area base since 1995 have resulted in a reduction in net harvestable area, even prior to the draft CAR reserves. In addition it has been considered prudent to reduce harvestable volumes by 10% to account for factors which affect yields but are difficult to quantify for each coupe. The sustainable yield rate has been recalculated with these adjustments and a few lesser ones included and have resulted in a suggested sustainable yield of 45 000 cubic metres per year (or 40 000 if the additional draft CAR reserves are factored in). No evidence has been presented as to why the reduction should be 10%. We strongly recommend that a more detailed analysis of the risks be conducted, perhaps after some sensitivity analysis to determine the impact of the various factors on the final sustainable yield rate. Of critical importance is that NRE establish a transparent and effective routine mechanism for feeding back the volumes removed in harvesting operations into the data used by the Integrated Forest Planning System for calculating sustainable yields.

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APPENDIX A.

Review of Sustainable Yield Forecasting Procedures for Midlands FMA

A consultant's report by Brian J Turner, D For.

Background and Brief

The Midlands Forest Management Area of Victoria is one of rich forest history. Because of its proximity to the Ballarat Goldfields it suffered heavy cutting in the second half of the 19th Century to the extent that most of the current forest is no older than about a century. It has also been an area of controversy for some time, as the forest has been thinned, burnt, has matured and is now being harvested and regenerated. Determining a "sustainable" yield under such changing circumstances is difficult and requires substantial data and the use of sophisticated tools which can handle the spatial and temporal complexity, for its calculation. The circumstances of the forest are quite different from those of most of the other forest areas of Victoria and thus it is pertinent to consider whether procedures used elsewhere have been appropriately adapted for determining a sustainable yield for this FMA.

The brief for this Consultancy was therefore to review the procedures being used by the Department of Conservation and Natural Resources (DCNR) in forecasting sustainable timber yields for the Midlands FMA (which includes principally the Wombat State Forest). No consideration has been given then to impacts or consequences of harvesting policies or actions resulting from the implementation of any particular level of removals.

The definition of sustainable yield used in this review is taken from the "Proposed Forest Management Plan for East Gippsland", published by the DCNR in February 1995, viz: "the estimated rate of sawlog harvesting that can be maintained for a given period without impairing the long-term productivity of the land, taking account of the structure and condition of the forest" (p37). This definition which presumably represents current DCNR policy is broad enough (e.g., what is the "given period"?) to allow the exploration of a range of options for satisfaction of other (social, biodiversity) goals.

Process of the Review

The review was accomplished by two lengthy meetings with DCNR personnel, one in December 1994 to review procedures to be followed and additional data to be collected, and one in August 1995 to review results of data collection and analysis and data used in the FORPLAN planning model. Relevant documents were supplied at various times at and between meetings. In addition, I visited the Wombat State Forest during the IFA Biennial Conference in May 1995 and received the benefit of some very useful briefings and discussion. It was not within the expectations of the consultancy that all data included in the forecasting models be verified and this has certainly not been done. My review has therefore been concerned with determining whether the data used is appropriate and carefully collected and analysed, and whether the analytical tools used are appropriate and the best available, and whether errors can be detected and corrected or at least indicated as contributing to the uncertainty of the forecasts.

Components Examined

Modern methods of timber yield forecasting require that the natural variability of the forest be explicitly recognised by the delineation of homogeneous units, and that the future development of each forest unit under likely management operations be predicted. An aggregation of all these forecasts can give a scenario of predicted timber yields over time. By intensive sorting and judicious choice, a subset of these scenarios which provides a continuity of timber yields and meets other management restrictions can usually be found. A choice can then be made between these according to various possible criteria, e.g., which scenario produces the most income or timber over time, which is most cost-effective, or which one preserves the most owl habitat. (The choice of the criterion is outside the ambit of this consultancy.) So the relevant components to be assessed here are:

- Whether the current variability of the forest is appropriately recognised and delineated,
- Whether there are means to predict the timber growth of the forest units under likely development and use options, and
- Whether the right tools are being used and whether they are being correctly used to find the sustainable options.

Overall Concepts and Tools Used

In earlier eras with scanty data and primitive computing tools it was necessary to make gross simplifying assumptions about the growth of forests in order to calculate sustainable yields. Today we are blessed with supercomputers and much improved, although still imperfect, databases, so the assumptions embedded in the calculations are such that they can be, and should be, explicitly stated. The usual procedure today is to simulate the development of the forest over very long periods of time under varying scenarios and then choose the "best". A very useful computing tool for doing this is the software package called FORTRAN, developed by the US Forest Service. This uses a process commonly used in many industries called linear programming to choose the "best" simulation. The DCNR has been using FORPLAN for several years now and is conversant with its value and foibles. It is therefore appropriate and suitable for calculating sustainable yields for the Midlands FMA.

Stratification of the forest

As indicated above, modern approaches to sustainable yield calculation require initially that the forest be spatially divided into relatively homogeneous patches of forest. Where data reside in a digital geographic database, this can be easily accomplished by a geographic information system (GIS). The data for Wombat State Forest have been manipulated by the DCNR's Arc/Info GIS, although the data for Mt Cole and other small areas have had to be included manually since they are not yet included in the digital database. The bases of stratification have been chosen to reflect the different logging history and site productivity of the areas, and also to account for potentially different silvicultural treatments in stream buffers, wildlife corridors, water supply catchments and powerful owl habitats. From the point of view of yield modelling the important issues are how well the different logging histories are known and how the site classes are differentiated. In the case of Wombat SF, the logging history is reasonably well known, and the 400 continuous inventory (CFI) plots which were installed in 1964 have been used to subdivide the forest into two productivity classes ('High' and 'Low'). Non-Wombat SF areas were subdivided only on the basis of logging history.

While the subdivision into only two productivity classes seems coarse and the differences in growth are substantial ('Low' estimated as growing at about 40% of 'High'), it is based on actual growth over 30 years and so the differences can be considered as real. No detailed soils or other site information is available for the region.

Current growing stock statistics by strata

Since timber yields in the near future are determined more by the status of the current crop of trees than their future growth, it is important that the current growing stock have been assessed accurately. The CFI plots, remeasured in 1990, and supplemented by 60 new plots (measured in 1995 mostly in areas not sampled by the CFI plots) have been relied on for current information. In order to relate measured volume to actual net volume (as used in quota statements), a number of plots were measured in 1995 and then felled and the products measured.

Average volumes have been calculated for the various strata from the plot data and used as starting points for the yield estimates and projections. The sampling precision can be calculated for the strata and should be stated explicitly in any reporting of the results.

Yield prediction by strata

The trend which any standing volume follows over time has been determined by following trend curves produced by the STANDSIM growth model developed in Victoria for evenaged stands of mountain ash and subsequently adapted for other species such as silvertop ash. Its application to evenaged stands of messmate and other species of much slower initial development (as occur in the Midlands forests) is open to criticism. The STANDSIM model is very flexible and has proved to be reasonably reliable over a wide set of conditions when appropriate assumptions are made and calibrations performed. By examination of trends of growth on the CFI plots over 30 years it was possible to calibrate the model (by setting a very low site index) to mimic their development over that period. Data from these yield models, different for each stratum, were used in the FORPLAN model to simulate the growth of existing and regenerated stands over a period of 200 years from the present.

It has to be said that there is little evidence to suggest that messmate and other Midlands species follow a similar growth trend to mountain ash growing on very poor sites. In fact empirical evidence suggests that messmate inherently develops at a much slower rate than mountain ash. Nevertheless the calibrated STANDSIM model does seem to simulate the slow development growth pattern. While it is apparent that the models leave much to be desired in terms of credibility, it is hard to see how much improvement is possible given the fact that most stands are of similar ages, and there is almost no data available anywhere to suggest how these stands will develop if left to grow well beyond the current age. Since the current age is about the normal harvesting age, the CFI data are in fact indicative of growth up to normal rotation length.

Management options considered

Several different silvicultural options are being proposed, within the range currently practiced on the forest. In most cases harvesting options are constrained by the previous history of the stand. Minimal constraints are being imposed, but these represent the current management situation. As is commonly done with FORPLAN, an end condition is set such that the forest at the end of the planning period (200 years in this case) will have a fully balanced age structure and be in a "normal" condition. The yield from this future forest, termed the Long-Term Sustained Yield Capacity (LTSYC), is the steady state yield, but far from attainable at the present since the forest is far from an age-balanced condition. A "Non-Declining Yield" can then be calculated in FORPLAN, this being the yield stream such that it arrives at the LTSYC at the end of the planning period without experiencing a decline or reduction between any time periods (decades). Other constraints are likely, for example, that the harvest in the current decade is fixed at the current licensing rate. The overall objective being used is to maximise total production of sawlogs over the planning period. Only sawlogs are being considered in the sustainable yield calculations but production of other products (i.e., residual materials) is estimated concurrently.

The ways in which DCNR are using FORPLAN are consistent with the Department's definition of "sustainable yield" and with other management directives. It is also consistent with the way in which it is used in the USA. It would seem useful to consider other management options, if only to establish some benchmark scenarios. For example, one which would simulate a ban on clearfelling and final shelterwood cuts some time in the future, and one which maximises Present Net Worth rather than Sawlog Production, would seem worthwhile. The planning period of 200 years again seems long enough to consider longterm trends without complete loss of data creditability.

Sources of error and risk, and procedures taken to reduce them

Because of the way in which future yields are estimated, it is impossible to calculate statistical estimates of errors associated with predictions. Under such circumstances it is common to use sensitivity analysis to gain some indication of the impact on the output of changes in the input values. DCNR will be doing extensive sensitivity analysis with the FORPLAN model. In addition the planning schedules will be translated onto maps and remotely-sensed images to consider the spatial feasibility of the plans. An advantage of using FORPLAN is that it has many error checks built in so that inconsistencies in logic are trapped. However it doesn't pick up errors in values of volumes, costs, etc., so a means of audit tracing should be established if it is not in place.

Recommendations for future R&D

It would be logical for the analysis of growth data done for this project be continued using more refined techniques such as dynamical models and the inclusion of the effects of different degrees of overstorey on the growth of regeneration underneath. However this may be constrained by the lack of adequate data. Further investigation of differences due to site would also seem warranted, perhaps requiring soil mapping and land evaluation using the GIS. A clear mechanism for monitoring the yield predictions should also be established so that actual removals and growth are routinely compared with predictions.

Overall Evaluation

My review of the procedures being used to calculate sustainable yields for the Midlands Management Area indicates that an appropriate methodology consistent with best international practices is being used. The

FORPLAN model being used to establish the "best" simulation is a suitable vehicle for this purpose and relevant constraints to protect other forest values are included in the model. Growth models are supported by measurements of permanent plots over the last 30 years, a database superior to that supporting growth estimates of most similar forests in Australia. Correlation of plot measurements with felled plots has been established to ensure that volumes represent current practices. The land area statistics are contained within a GIS, providing flexibility and accuracy.

My primary concern is with the nature of the estimation of the future growth of the forest, although this is mainly an uncertainty about the projection of stands well beyond the current age structure. In actual fact most harvestable stands won't go much beyond the current age. I have some concern about the simplicity with which the development of the residual and regenerating stands are modelled in the so-called shelterwood cuts, and with the handling of site variation. However the processes being used are supported by the data trends, so gross errors (or major improvements) are unlikely. It is important that all these assumptions and simplifications are explicitly stated and that an audit trail be available for all significant data items.

2/9/95