Feb 2000

Comments on

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

Consultant's Report
by
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For The Victorian Regional Forest Agreement Steering Committee

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1. **(p.1)** ***Context*** The local community and conservationists spurred on by retired timber workers formed the Wombat Forest Society in early 1994. This followed several years during which current and retired timber workers and others passionately raised concerns about the Wombat State Forest being logged at an unsustainable rate and changes to forest management that created perceived inequities. The comment *'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.'* does not reflect the true nature, history or social construct of community concerns relating to logging in the Wombat Forest. The Society is often disappointed at how these matters are portrayed. The uniqueness of this transparent, sometimes highly technical and always inclusive approach to community participation in forest management processes is often understated.

2. **(p.3)** ***Methods used by NRE*** Although certainly an improvement on the HARIS database, the Statewide Forest Resource Inventory (SFRI) has some inherent problems and will not address all the data related issues evident with Victoria's forest management systems. The lack of an adequate tracking system to enable comparisons between actual and predicted log volumes and coupe areas is a glaring problem (see point. 15). Mapping standards have improved considerably during the RFA processes around the State. This work however, remains largely incomplete and often lacks adequate ground truthing to ensure accuracy of calculated volumes from satellite and Aerial Photograph Interpretation (API). Other issues with these more technically advanced planning tools exist, including the following
   - Limitations with FORPLAN and other computer assisted predictive models.
   - Accuracy of API predictions for specific log volumes from various forest types.

3. **(p.4)** ***Methods used by Wombat Forest Society*** This section requires an explanation of how the community often had trouble accessing data and had to knowingly rely on incomplete data sets on which to base assumptions. The Society recognises the weaknesses with this approach, however we envisage that given proper access to the required data these weaknesses could be easily overcome.

4. **(p. 4)** ***Issue 1: Protection of catchment values in calculation of the sustainable yield.*** The Wombat Forest Society would like further explanation of *Average expected rotations* shown as an outcome from the application of the Integrated Forest Planning System. Faster growing forests are located in wetter areas, should these areas be targeted for intense management to improve timber yields there will be a negative trade off with water yield. The catchment protection constraints described in the Midlands FMA Forest Management Plan are currently not being met in some designated water supply areas due to the area and age of regrowth forest from previous logging, this is acknowledged by NRE forest planners. Water issues must be looked at in light of community and social values, these values differ widely between and within different communities. Wombat Forest Society believes that the water values in the Wombat Forest were not properly considered and factored into the FORPLAN model. The input of water protection factors is highly subjective and depends heavily on the personal values of one or two forest planners, in the Wombat case the responsible forest planners have displayed a dismissive approach to water concerns in the past.

5. **(p.5)** ***Issue 2: 75% of the Wombat has had at least the first shelterwood harvest applied since 1974.*** Wombat Forest Society is concerned at the lack of up to date data used in this assessment. The Society looks forward to checking figures against NREs figures so we can come up with mutually agreeable area statements and resolve other differences and interpretations. The Society does not support a cut out of the most productive areas of the Wombat Forest and the maintenance of these areas in a highly productive (i.e. young, fast growing and short rotation) state. Longer rotations in low production areas do not compensate for shorter rotations in higher production areas. Clearly the fragmented nature of the forests in the Midlands FMA requires special consideration so as each island of forest is managed to provide a spread of all forest age classes. The IFPS Spectrum

model appears to be set to maximise the present net worth of timber not forests, further explanation is required as to how the present net worth of non timber values is factored into this model.

6. (p.5) *Issue 3: Basal area retention for the first shelterwood harvest was changed from 9-11m²/ha to 5-7 m2/ha and the consequence of this will be a reduction in sawlog yield from the second shelterwood harvest.* The statement refuting the change from low to high intensity shelterwood one harvests appears to be based on very scanty information that is considerably different from NRE published technical documents. The REVIEW OF SUSTAINABLE SAWLOG YIELD MIDLANDS FMA Dept C&NR Dec. 1995 and the REVIEW OF THE SHELTERWOOD SILVICULTURAL SYSTEM AS PRACTISED IN THE WOMBAT STATE FOREST. CFTT Sept 1994 both state that the current prescriptions provide for a retention of 7 to 9 m2/ha basal area following a shelterwood one harvest. The figure of 8-11 m2/ha quoted by the authors indicate that NRE are poorly informed on strategic planning matters and are not following the current prescriptions for shelterwood harvests as described in the above documents. The Society looks forward to NREs further examination of these matters, including field checking and requests that NRE give a commitment to undertake this work as soon as possible and provide the community with an expected completion date.

7. (p.5) *Issue 4: Midlands Forest Management Area Strategic Harvest Schedule for Existing Forest Stands shows an obvious shortfall of the supply of logs. The current model shows the next shelterwood rotation to be between 50 and 60 years.* The Wombat Forest Society is happy to provide the authors with a copy of the charts in question. This material was presented to the Society during a presentation in Daylesford by NRE forest planners involved with the calculation of the Midland FMA sustainable yield during the earlier review. It is unfortunate that confusion surrounds this information, given it is fundamental to Wombat Forest Society analysis and was presented to us as the best ever sustainable yield work done by the department. The fact that this data is not known by current NRE staff is a manifestation of the downsizing of the department by the previous government resulting in an obvious skills decline and lack of continuity with forest management.

8. (p.6) *Issue 5: With predicted rotations of less than 60 years, delays of even five to ten years in achieving adequate regeneration, must severely compromise the possibility of meeting the model's necessary growth rate.* Wombat Forest Society is not convinced that the NRE method for assessing regeneration is adequate, our concerns are supported by ex Wombat forester Norman Endacott in his submission to the Midlands Forest Management Plan. The Society further submits that delays in thinning dense regrowth also have a negative impact on sustainable yield. The REVIEW OF SUSTAINABLE SAWLOG YIELD MIDLANDS FMA Dept C&NR Dec. 1995 states that there is 6230 ha of fire regrowth in the net productive area that is slow growing due to overstocking. The sustainable Yield forecast incorporated the assumption that *'all fire regrowth has lost 10 years growth but can be put back on a normal growth trend by thinning and fertilising individual trees over the next ten years.* The forecast also states *'It should be understood that if sustainable yield is set on a basis of a young regrowth management program which is not fully implemented overcutting will occur and the sustainable yield will ultimately fall significantly'.* The Turner/Ferguson review makes no mention of the regrowth (thinning) targets and whether or not they are being met.

9. (p.6) *Issue 6: Yield expectations are unrealistically high for the two shelterwood cuts.* Wombat Forest Society recognises that the accuracy of log volume predictions is dependent on accurate data collection, storage, retrieval and application. It is most disappointing that NRE are unable to provide accurate up to date figures to adequately account for logging operations in public forests. The Society believes that the authors analysis of coupes to estimate average predicted volumes is highly flawed as the format of the coupe data renders it impossible to properly compare actual and predicted volumes, as such assumptions made by the authors should be considered invalid. (see point 15). NRE notoriously has trouble producing an actual net area harvested for each coupe

following logging, if this information was made available it is a relatively simple task to calculate an average m3/ha for each coupe. NRE recomputed predicted forest figures at the request of the authors, this resulted in a reduction of predicted average log volumes. The reasons behind how and why the recomputation was undertaken by NRE is not described, did the authors request new data be considered or extra weight be placed on certain values.

10. (p.7) ***Issue 7: Yield expectations for clearfall are also unrealistically high.*** To resolve the confusion surrounding actual and predicted timber volumes in low grade forests NRE should maintain an accounting system that allows all data generated for each coupe to be presented in a chronological format, this would allow comparisons of volume and area changes over time.

11. (p.7) ***Issue 8: Regeneration and fuel reduction burns are reducing the quality of the timber obtainable from the forest.*** In relation to the impact of fuel reduction burns Wombat Forest Society submit as reference J. D. Kellas & R. O. Squires THE EFFECT OF DEGREE OF CROWN SCORCH ON BASAL AREA INCREMENT OF EUCALYPTUS OBLIQUA IN WEST CENTRAL VICTORIA Forest Commission Victoria, Research Branch Report No. 165 December 1980. This report relates the impact of fire on tree growth in the Wombat Forest to the degree of crown scorch suffered by individual trees during fuel reduction burns. The Society makes the point that post logging slash burns in the Wombat Forest are particularly hot burns that obviously cause considerable damage to retained trees, this is evidenced by the vast areas of overwood with excessive epicormic growth. The authors suggest that fire damage from post harvest burns are not factored into growth data even though this is a common occurrence in the Wombat State Forest. Again we look forward to further data from NRE to clarify this point

12. (p.8) Issue 9: Volumes of B+ sawlogs cannot be sustained in the short term. Contrary to the authors comments Wombat Forest Society submit that the proportion of better quality logs has increased incrementally since 1993. Prior to this time reductions in actual log volumes reflect changes implemented under the Timber Industry Strategy together with a market downturn. Graph 1 (below) clearly shows that whilst the proportion of better quality logs has increased the proportion of lower quality logs has noticeably decreased. This trend is probably the result of predominately shelterwood two logging or intense shelterwood one operations on better quality sites.

13. **(p.8)** ***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.*** Wombat Forest Society believe that spatial representation (maps) of predicted future logging areas would provide a very valuable tool for assessing the sustainability of logging operations. NRE's ability to produce these maps will be a most welcome advancement to forest planning in Victoria.

14. **(p.9)** ***Table 1: Summary of estimated sawlog volume per hectare of D+ grade harvested from various operations***. Wombat Forest Society recognises the difficulty of accurately measuring mixed species forests, further reason to urgently implement a system to track predicted and actual log volumes.

15. **(p.10)** ***Table 2 Comparison of actual harvesting volumes from 20 coupes harvested in the last 6 months of 1999, with NRE Harvesting Schedule estimates (data supplied by J. Drohan and NRE)***. It can be clearly demonstrated that the data shown in Table 2: is not adequate to provide a basis for assumptions made by the authors. The Wombat Forest Society combined the data shown in Table 2: with historical WUP data in an excel spreadsheet (see attachment 1) to show the planning history of individual coupes. Coupes were then classified into one of four groups according to each coupes particular harvesting history. These groups are listed and described below.

- **3 x New coupes,** coupes that appear on the current WUP without being listed in previous years WUPs. Actual log volumes were well below predicted log volumes in all 3 new coupes

- **4 x Not shown on current WUP previous WUP listings noted** coupes that were not shown on the current WUP but listings from previous WUPs have been used to compare changes in predicted volume and area throughout the NRE planning process. Actual log volumes were well below the predicted log volumes for each of these coupes.

- **12 x Carry over coupes from '98**, coupes where logging operations were not completed during the previous year or two and were finished off in the current year. These coupes appear to have been partially reassessed to take account of the logging that had taken place in the previous years. The predicted sawlog volumes were reduced for the current WUP however no adjustment was made to area. Without knowing the full history of each of these coupes including the actual volumes logged in previous years it is impossible to properly calculate a predicted volume per hectare or conduct comparative analysis between predicted and actual log volumes. Actual log volumes were substantially above predicted log volumes in 10 of 12 coupes in this group.

- **1 x No WUP listing found** no current or historical data was found for this coupe, note actual log volumes were well below predicted log volumes in this coupe.

15. **Cont.....**Of the twenty coupes examined by Turner/Ferguson ten coupes were considered to have produced more logs than predicted, <u>all ten coupes were carry over coupes</u>. The carry over coupes would have been hurriedly reassessed in the middle of 1999 to take account of logging that had occurred in the previous financial year. It appears somewhat suspicious that only those coupes that were relatively recently reassessed produced more logs than predicted, coupes with older resource predictions all produced fewer logs than predicted.

    The carry over coupes would have been reassessed following the announcement by Mr. Tuckey that a review would be conducted to examine sustainable yield issues in the Midlands FMA. Could this added pressure, seen as Commonwealth interference by NRE (AGE 12th August 1999), have been the impetus for much more conservative assessments?

Wombat Forest Society is most disappointed to be told that the coupe data supplied to the consultants by John Drohan (VAFI) actually came from the local logging company. Were the coupes chosen to produce a contrived outcome that would allay concerns about the difference between predicted and actual volumes?

It is interesting to note that most of the carry over coupes were in fact contingency coupes brought forward in the previous year. Why are so many coupes being brought forward if standing log assessments have a reasonable degree of accuracy?

Wombat Forest Society has repeatedly raised concerns about the WUP process in the Midlands FMA. The Societies analysis of the 20 coupes assessed by the consultants clearly shows that few coupes go through a full three year planning process. In a number of instances harvesting took place in coupes not listed on the current WUP.

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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 of 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.

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7: Yield expectations for clearfall are also unrealistically high. Again we find no clear evidence of this. Yields from the low site 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."

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For some time (certainly prior to 1995) there have been problems from local conservationists that the sustainable yield rate has been set at a higher than sustainable level. In the Bendoo of this controversy 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 (DNRE) 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 DNRE 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).

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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 "robustness 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 projections 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 and 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.

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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 than 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 mediumhigh 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, 1995) (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 and against the Wombat Forest Society's data.

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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 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 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, 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, 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 of 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, because delays of less that 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 Area 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

	B	C	D	
539/6 95-96	30.51	126.16	71.31	
	5.05	8.82	1.89	143.37
	35.56	134.98	73.20	
505/8 94-95	110.02	440.79	138.09	206.33
	36.58	198.86	63.75	305.42
				202.51
	146.60	634.65	201.84	714.26
511/9 94-95	127.23	423.48	168.14	353.22
	45.43	149.79	49.71	96.53
				72.74
	172.66	573.27	217.85	522.49
516/10 94-95	107.75	519.85	216.99	
	74.26	123.23	55.65	318.95
				89.58
	182.01	643.08	272.64	176.46
				534.99
517/6 94-95	29.17	171.37	64.65	172.96
	106.58	254.45	82.4	207.74
	135.75	425.82	147.05	380.70
517/10 94-95	84.99	390.67	180.08	238.47
	27.59	132.54	82.2	186.42
				241.23
	112.58	523.21	262.28	636.12
526-06 94-95	50.21	219.66	88.31	155.07
	10.65	21.91	8.28	42.29
				84.92
	60.86	241.57	96.59	282.28
512.26 93-94	2.63	342.39	129.94	
	194.0	110.19	32.77	327.5
	8.78			
	36.91			
	242.32	452.58	162.71	
523/8 93 94	14-95	204.31	131.05	
	52-58	283.22	213.73	692.4
	67-53	487.53	344.78	
523/9 93-94	14.9	204.31	131.05	
	52.58	283.22	213.73	692.4
	67.48	487.53	344.78	

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 from regeneration fires or prescribed burning would reduce growth for a period. The

[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.

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)

	B	C	net vol. D	RL.
523/10	14·5	348·5	95·3.	
96-97	58 –	134·7	32·1.	1642.
	72·5	483·2	127·41	
	6·8	83.	15	
526/04	16·4	65·8.	9·03.	423.
96-97	25·2	148·8	24·03	
96-97	170.25	349·08.	81	
525/06	81·53	146·8	34·52	863·18.
	251·78	495·88	115·52	724·8
96-97	92·04	352·78	64·56.	
532/10	1·15.	·48		282·98.
	93·19	353·26	64·56	
95-96.	6·95.	859·29	430·86.	
503·1	448·29	20	37·75	1148·76
	472·18	879·29	468·61	
95-96	98·42.	533·87.	187·14.	
521-3	31·68.	83·01.	31·54.	1120.
	130·10	616·88	218·68	
95-96	45·35.	272·69.	184·68.	
526/04	~~·83~~	~~·36~~	1·38.	142·15.
		·53		
	45·35.	273·212	186·06	
531/5	~~12·88~~	~~748·29~~	~~335·81~~	
95-96	12·88.	728·37	335·81.	
	748·29			1051·08.
	1·62	5·31	1·74.	
	762·79	733·68	337·55	

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, 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
1	06-172-519-05	Black Range 1	710	1550	-840
2	06-172-519-08	Hardy's	173	400	-227
3	06-172-522-10	Eagle Dam	552	655	-103
4	08-185-523-13	Water Race 2	429	1600	-1171
5	06-192-505-05	North Babbington	1660	1100	560
6	06-193-528-05	North Paddy's	1068	500	568
7	06-193-529-03	Cockatoo West	1840	1000	840
8	08-193-551-05	Maxwell Track 1	1542	880	662
9	06-193-551-04	Maxwell Track 2	1585	680	905
10	06-194-560-05	Gentle Annie	1124	1850	-726
11	06-194-910-16	Binks Road	676	1000	-324
12	06-208-505-07	Wickham Track	1192	1920	-728
13	06-208-505-12	Kelly Swamp 1	588	550	38
14	06-208-505-13	Kelly Swamp 2	1461	950	511
15	06-208-605-09	SW Face	739	1000	-261
16	06-208-506-10	Hill Track South	849	1550	-701
17	06-209-511-13	Roatches	1401	420	981
18	06-205-523-01	Old Mill	337	150	187
19	06-209-524-01	North Finh	206	165	41
20	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:

	B	C	D	
523/9 93-94	76.67	219.49	93.44	
	52.77	90.6	36.54	637
	129.44	310.09	129.98	
537/10 93.94	51.32	267.4	162.05	
	151.59	321.89	167.78	837.76
	202.91	589.29	329.83	
539/8 93-94	81.19	517.52	347.46	
	37.23	220.92	109.23	795.45
	118.42	738.44	447.69	
185/503/9 92-93	303.8	879.77	386.9	
	15.9	44.99	33.12	
	319.7	924.76	420.02	
503/10 92-93	81.16	188.13	97.2	142.11
	12.05	69.84	62.54	17.72
				366.5
				159.86
517/11 92-93	5.17	16.59	5.39	
	90.83	207.2	111.86	
	96.00	212.79	117.25	
520/9 92-93				

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 (experience has shown 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 (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.

All graphic tiles are 16x16 pixels and can be combined to form the majority of the graphics in the game. Each tile is stored as a sequence of 16 bytes, each byte representing one row of pixels in the tile. The bytes are stored in the order they appear in the tile, from top to bottom.

Tiles are stored in a compressed format to save space. The compression algorithm used is a simple run-length encoding scheme. Each byte in the compressed data stream is either a literal byte or a repeat count. If the high bit of the byte is set, the remaining 7 bits indicate how many times the next byte should be repeated. Otherwise, the byte is a literal value.

The tile data is stored in a contiguous block of memory starting at address $8000. The tile index table, which maps tile numbers to their addresses, is stored immediately before the tile data at $7E00. Each entry in the table is a 16-bit little-endian address.

Tiles are organized into 32 banks of 256 tiles each, for a total of 8192 tiles. Only one bank is active at a time. The active bank is selected by writing to the bank register at $FF70. Bank 0 contains the most commonly used tiles, including the font and basic UI elements.

The font is stored in bank 0, tiles 32 through 127, corresponding to the standard ASCII printable characters. Each character is 8 pixels wide and 8 pixels tall, using only the left half of a tile. The right half is left blank for spacing.

Sprites are stored in bank 1 and are 16x16 pixels, using all four tiles in a 2x2 arrangement. Sprite data is not compressed, as the small size and frequent updates make compression impractical. Sprite attributes, including position, palette, and flip flags, are stored in a separate table at $FE00.

Animation frames for sprites are stored consecutively in memory. The sprite engine advances through frames at a rate determined by the animation speed parameter. When the last frame is reached, it wraps back to the first frame unless the animation is marked as one-shot.

Collision detection uses a simple bounding box test. Each sprite has a collision rectangle defined relative to its position. The engine checks for overlaps between the player sprite and all active enemy sprites each frame. Pixel-perfect collision is not supported due to performance constraints.

The tile editor tool allows designers to create and modify tiles directly in the game's native format. It supports copy, paste, flip, and rotate operations. Changes are immediately visible in the game when running in development mode.

Memory management for tiles is handled by a simple allocator that tracks free and used blocks. When a new tile is loaded, the allocator finds the first free block large enough to hold the compressed data. If no block is available, the least recently used tile is evicted.

Debugging tools include a tile viewer that displays all tiles in the current bank and a memory viewer that shows the raw contents of tile memory. These tools are accessible from the debug menu and are stripped from release builds.

Performance profiling has shown that tile decompression takes approximately 12 microseconds per tile on average hardware. With a budget of 16 milliseconds per frame, this allows for the decompression of up to 1300 tiles per frame, which is more than sufficient for normal gameplay.

Future improvements may include support for animated tiles, where the tile data itself changes over time, and a more sophisticated compression algorithm that can exploit inter-tile redundancy. These features are not currently planned for the initial release.

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.

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, if it is 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

COUNCIL MEMBERS

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COMMENTS ON THE DELTA/SOUTH BELMONT AND ROSEMEAD AND

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.

REFERENCES

Anderson, T. 1999. Midlands Forest Management Area Sustainable Sawlog Yield Model Analysis & Critique. Wombat Forest Society, Daylesford, Vic.

DCNR. 1995. Review of Sustainable Sawlog Yield: Midlands Forest Management Area. Dept of Natural Resources and Environment, Victoria, Forests Service Tech Report 95-5.

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Hamilton, F. and Brack, C. 1999. Stand volume estimates from modelling inventory data. Aust Forestry 62(4): 360-367.

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THE DEPARTMENT OF
THE PRIME MINISTER AND CABINET

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FORESTS TASKFORCE
FORESTS & OLYMPICS DIVISION

FACSIMILE COVER SHEET

DATE: 15/11/99

TO:	Mr Tim Anderson Wombat Forest Society		
PHONE:	035 348 1748	**FAX:**	035 348 1748
FROM:	Belinda Robinson, Assistant Secretary Forests Taskforce		
PHONE:	(06) 271 5548	**FAX:**	(06) 271 5511

RE: **TERMS OF REFERENCE FOR A REVIEW OF SUSTAINABLE YIELD ISSUES RAISED BY THE WOMBAT FOREST SOCIETY**

Number of pages including cover sheet: 2

MESSAGE

Please find attached, a draft Terms of Reference for an independent review of sustainable yield issues raised by the Wombat Forest Society. If you have any comments or queries, please contact Mr Tom Aldred on (02) 6272 5531 or Mr Ian Miles on (03) 9637 8424 by Friday 19 November 1999.

Yours sincerely

Ms Belinda Robinson and Mr Gerard O'Neil
Co-Chairs
Commonwealth/Victorian Regional Forest Agreement
Steering Committee.

...simile message may contain privileged and/or confidential information. If the reader of this ... the intended recipient, you are hereby notified that any use, dissemination, distribution ... document is prohibited. If you receive this message in error, please notify the ... of telephone.

ATTACHMENT 2:

	year	Block No	Compart-ment No	Cpe No	Coupe name	ha	silvi	yeild	B+	C	D	D+ Tot	D+ 3m per/ha	Residual	actual D+ vol	difference between actual and predicted
12	96-97	208	505	7	Wickham Track	38	SH1	H	520	1060	480	2060	54.2	4000		
	97-98*	208	505	7	Wickham Track	35	SH1	H	550	1140	550	2240	64.0	4200		
	98-00	208	505	7	Wickham Track	35	SH1	H	55	1300	650	2500	71.4	4200		
					turner report							1920			1192	-728
	********not shown on 1999-2000 (current) or 2000-2002 WUPs, D+ totals increased on previous WUPs															
13	99-01	208	505	12	Kelley Swamp 1	22	SH2	L				2000	90.9	1700		
	99-00	208	505	12	Kelley Swamp 1	22	SH2		63	287	200	550		600		
					turner report							550			588	38
	********carry over coupe from 98 on 1999-2000 (current) WUPs															
14	99-01	208	505	13	Kelley Swamp 2	38	SH2	L				2200	57.9	1700		
	99-00	208	505	13	Kelley Swamp 2	38	SH2		278	242	430	950		1000		
					turner report							950			1461	511
	********carry over coupe from 98 on 1999-2000 (current) WUPs															
15	99-00	208	506	9	SW Face	32	SH2		316	434	250	1000		800		
					turner report							1000			739	-261
	********new coupe on 1999-2000 (current) WUPs															
16	99-00	208	506	10	Hill Track South	52	SH2		481	499	570	1550		900		
					turner report							1550			849	-701
	********new coupe on 1999-2000 (current) WUPs															
17	99-01	209	511	13	Roaches Road	21	SH2	L				2000	95.2	1600		
	99-00	209	511	13	Roaches Road	18	SH2		127	173	120	420		500		
					turner report							420			1401	981
	********carry over coupe from 98 on 1999-2000 (current) WUPs															
18	99-00	209	523	1	Old Mill	10	SAL			50	100	150		300		
					turner report							150			337	187
	********carry over coupe from 98 on 1999-2000 (current) WUPs															
19	99-01	209	524	1	North Firth	13	ST	L				230	17.7	3900		
	99-00	209	524	1	North Firth	11	ST			65	100	165		200		
					turner report							165			206	41
	********carry over coupe from 98 on 1999-2000 (current) WUPs															
20	97-98	209	933	3	Tunnel Point RD	15	SH1	H	200	300	470	970	64.7	2300		
					turner report							970			692	-278
	********not shown on 1999-2000 (current) or 2000-2002 WUPs, D+ totals same as previous WUP															

ATTACHMENT 2:

	Year	Block No	Compartment No	Species name	Sp Code	Tre	site	Yield	B	C	D	D+ Tot	D+ 3m perts	Residual	actual D+ vol	difference between actual and predicted
12	96-97	206	505	7	Wickham Track	38	SH1	H	820	1080	460	2060	84.2	4000		
	97-98*	206	505	7	Wickham Track	38	SH1	H	850	1140	550	2240	84.0	4200		
	98-00	206	505	7	Wickham Track	38	SH1	H	56	1500	860	2300	71.4	4200		
					turner report							1920			1192	-728
	********not shown on 1999-2000 (current) or 2000-2002 WUPs, D+ totals increased on previous WUPs															
13	96-01	206	505	12	Kelley Swamp 1	22	SH2	L				2000	90.9	1700		
	96-00	206	505	12	Kelley Swamp 1	22	SH2		85	287	200	550		800		
					turner report							550			588	38
	********carry over coupe from 96 on 1999-2000 (current) WUPs															
14	96-01	206	505	13	Kelley Swamp 2	36	SH2	L				2200	57.9	1700		
	96-00	206	505	13	Kelley Swamp 2	36	SH2		278	242	430	950		1000		
					turner report							950			1461	511
	********carry over coupe from 96 on 1999-2000 (current) WUPs															
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					turner report							420			1401	981
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	96-00	206	524	1	North Firth	11	ST			65	100	165		200		
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TERMS OF REFERENCE
FOR
A REVIEW OF THE SUSTAINABLE YIELD ISSUES IN THE WOMBAT STATE FOREST

The Wombat Forest Society (WFS) has prepared a critique of the Midlands Forest Management Area (FMA) Sustainable Yield, and the model used by the Department of Natural Resources and Environment (NRE) to derive the sustainable yield rate for the FMA. The WFS document is titled 'Midlands Forest Management Area Sustainable Sawlog Yield Model Analysis and Critique' published in May 1999.

The Victorian Regional Forest Agreement (RFA) Steering Committee is seeking a review of the issues raised by the WFS concerning the sustainable yield rate for the Midlands FMA. The findings of the Review will be considered in the development of the West Victorian RFA Directions Report.

The Steering Committee is seeking a report from the consultants on:

1. The methods used by NRE and the WFS to develop the respective sustainable yield estimates; and
2. The issues raised by WFS concerning the sustainable yield rate in the Wombat State forest.

The consultants should:

- Investigate and comment on the difference between the WFS resource estimates and the legislated sustainable yield rate; and
- Identify significant issues that should be considered in a review of the sustainable yield rate for the Midlands FMA due in 2001.

The Review is to be completed within ten working days of the work being commissioned.

The consultants should meet with Commonwealth and NRE staff, representatives of the WFS, the Victorian Association of Forest Industries and the CFMEU to seek input to the review.

A draft report is to be submitted to the Steering Committee for comment. The final report of the Review is to be submitted to the Victorian RFA Steering Committee.

TERMS OF REFERENCE FOR A REVIEW OF THE SUSTAINABLE YIELD ISSUES IN THE WOMBAT STATE FOREST

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1. The methods used by NRE and the WFS to develop the respective sustainable yield estimates, and
2. The issues raised by WFS concerning the sustainable yield rate in the Wombat State forest.

The consultant should

- Determine those matters in the critique that are relevant to the sustainable yield rate,
- comment on the difference between the WFS resource estimates and the legislated sustainable yield rate and
- identify significant issues that should be considered in a review of the sustainable yield rate for the Midlands FMA due in 2001.

The Review is to be completed within ten working days of the work being commissioned.

The consultant should meet with Commonwealth and NRE staff, representatives of the WFS, the Victorian Association of Forest Industries and the CFMEU to seek input to the review.

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