8 The green-wood scenario

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8.1 Summary

In this section, an estimate is made of the maximum, long-term sustainable supply of firewood which might be obtained from the privately owned, native forests of the MDB under a “green-wood scenario”, that is, when firewood is obtained only by felling live trees and no woody debris is collected as firewood. It was estimated that there are 9.8 million (M) hectares (ha) (1.1 M ha mallee and 8.2 M ha non-mallee) of forest in the MDB suitable for harvesting under this scenario. Appropriate firewood harvest management regimes were developed for this scenario. For mallee forests, this involved clear-fell harvesting on a 50 year rotation, with regeneration by coppice. For non-mallee, it involved “flexible selection” management, with 2 or 3 thinnings over the life-time of a stand and with 50% of the standing tree basal area being removed at each thinning; such management should encourage maintenance of forest stands which contain a wide range of tree sizes and/or ages, consistent with contemporary community attitudes to native forest management. Over the next 100 years, it was estimated that the maximum, annual, sustainable supply of firewood from the MDB under the green-wood scenario would average 2.3 M oven-dry tonnes per year (t yr^{-1}), with a deviation in any year from this amount of no more than 0.2 M t yr^{-1}. About 22% of this supply would come from mallee forests and the remainder from non-mallee. This level of supply is about the same as the amount of firewood harvested presently from the MDB, which is believed to be within the range 2-2.5 M t yr^{-1}. Because the green-wood scenario does not involve removal of woody debris from the forest, it was considered that this approach to firewood harvest management in the MDB may have benefits for the biodiversity conservation and maintenance of landscape function of the region.

8.2 Introduction

Section 7 considered the sustainable firewood supply from the privately owned native forests of the MDB when firewood was collected only from coarse woody debris, a management strategy termed the “dead-wood” scenario.

This section concerns the supply that would be available under a second management strategy, the “green-wood” scenario. This would involve felling live trees to produce firewood and excludes collection of firewood from woody debris. A principle advantage of such a scenario is that the retention of woody debris in the forest ecosystems of the Basin may have important consequences for the maintenance of its overall biodiversity.

The general approach taken in this section to determine the sustainable firewood supply under the green-wood scenario was the same as that used for the dead-wood scenario (Section 7).

8.3 Forest area and stratification

The data for the scenario were derived using the GIS system described in Section 4. Full details of the information available to this project on the area of privately owned native forests in the MDB and their stratification by the relevant exploitation criteria (Section 3.1) are described in Sections 4.3.1 and 4.3.2. The exploitation criteria which apply to the dead-wood scenario also apply to the green-wood scenario, and are described in Section 3.2.

The additional exploitation criteria necessary to derive a final stratification of the forest suitable to apply for the green-wood scenario are described in Section 3.3 and their application to the data to derive the final stratification are described in Sections 4.3.5 and 4.3.6. These considerations are summarised below.

As will be discussed later in the section on management regimes, the green-wood scenario applies both to mallee and non-mallee forest of the MDB, for which different growth and yield models were developed in Section 6. Hence, the first step in forest stratification for the green-wood scenario was to separate mallee and non-mallee forests.

Secondly, the green-wood scenario excluded forests inside riparian zones (exploitation criterion 6) and land which sloped 15^o or more (exploitation criterion 7). In addition, regions where the landscape was assessed with a percent woody cover < 30% (exploitation criterion 8) and any remnant < 100 hectares in size (exploitation criterion 9) were excluded. Using the GIS system described in Section 4, there were found to be 9.8 M ha of forest suitable for the green-wood scenario; 1.1 M ha of mallee forest and 8.7 M ha of non-mallee (Table 8.1). (Sections 4.3.5 and 4.3.6, Table 4.11 and Table 8.1).

Thirdly, the 9.8 M ha of forest were stratified by site productive capacity, as defined by the net primary productivity (NPP) index of Barrett (2002) (expressed as tonnes of plant biomass ha^{-1} yr^{-1})[4]. This index has been described and discussed in detail in Section 6 and Appendix 5. The stratification method is described in Section 4.3.3 and the complete stratified dataset is presented in Appendix 6, Table 9. Figure 8.1 shows the distribution of both the mallee and non-mallee forests in relation to site productive capacity. For non-mallee forest, the distribution is similar in form to that shown in Figure 7.1 for the dead-wood scenario. Virtually all the mallee forest is located in areas of low productive capacity; 95% of its total area has an net primary productivity index below 2 t ha^{-1} yr^{-1}.

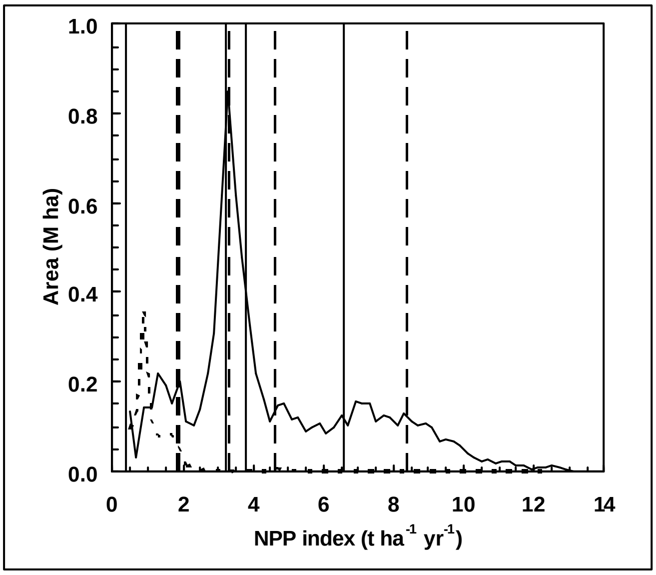

Figure 8.1. Distribution of the 9.8 M ha of forest eligible for use in the green-wood scenario in relation to site productive capacity (NPP index). The area has been divided into mallee (- - - -) and non-mallee (——) forest. The vertical solid lines delimit the ranges of the four productivity classes (see later) identified for use in applying the green-wood scenario to non-mallee forest and the vertical dashed lines show the weighted average productivities of those classes (Table 8.1).

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[4] Note that all weights of firewood, coarse woody debris and plant biomass referred to in this section are oven-dry weights.

As for the dead-wood scenario (Section 7.4), the 8.7 M ha of non-mallee forests were split into four classes of site productive capacity of roughly equal forest area and their weighted average productive capacities determined. The results are shown in Table 8.1 and on Figure 8.1.

Table 8.1. For forest eligible for the green-wood scenario, the site productive capacity classes (based on net primary productivity index) defined here for non-mallee forest are shown, together with their areas and their weighted average productive capacities. Results are shown also for mallee forest.

Productivity Class	NPP index class ($t\ ha^{-1}\ yr^{-1}$)	Area (M ha)	Weighted average NPP index ($t\ ha^{-1}\ yr^{-1}$)
Mallee forest			
-	0.4-11.2	1.07	1.2
Non-mallee forest			
1	0.2 - 3.2	2.95	1.9
2	3.2 - 4.0	3.12	3.4
3	4.0 - 6.6	3.09	4.9
4	6.6 - 14.0	3.12	8.3

The last step in the stratification for the green-wood scenario was to consider its age-class distribution (age being determined as the time elapsed since the forest regenerated from bare ground). This was done in exactly the same way as described for the dead-wood scenario (Section 7.4), i.e. it was assumed that, in 2004, 40% of forests would be aged 50-60 yr, 50% would be 100-120 years and 10% would be 150-178 years. To what extent this age-class distribution applies to mallee forests is difficult to say. Past harvesting of those forests for firewood will undoubtedly have altered the distribution. However, no other information was available to this project to allow better age stratification of mallee forests.

This stratification process led to subdivision of the 9.8 M ha of forest deemed appropriate for harvest under the green-wood scenario into a total of 305 strata. Appendix 11 lists the areas of each of those strata. Map 27 (Appendix 4) shows the distribution of the forests of the MDB deemed suitable for firewood harvest under the green-wood scenario. The non-mallee forest has been stratified by site productive capacity class as defined in Table 8.1.

8.4 Management regimes

8.4.1 Mallee forest

Mallee eucalypt forests have been exploited for firewood production for many years, particularly in South Australia. Sometimes “mallee roots” (the lignotuberous mass at the base of the trees from which coppice arises) have been harvested and sometimes live stems have been harvested.

Neagle (1994) reviewed the silvicultural management practices which have been found to be most appropriate for mallee harvesting in South Australia. He concluded that long term maintenance of the mallee forest ecosystem was best served by a clear-felling harvest of live trees at 50 year intervals, followed by coppice regeneration, which occurs reliably and is generally prolific in these forests, generally leading to production of even-aged regrowth stands.

For the present Section, this was the only silvicultural management system which was considered for the green-wood scenario for mallee forest. It was assumed that all mallee forests were of the same productive capacity. Firewood yields under this system may be predicted using model (6.23) as described in Section 6. The model predicts that a mallee forest yields 23 t ha^{-1} of firewood if clear-felled at 50 years of age.

In the age-stratification of mallee eucalypt forests, it was assumed that they are presently all aged 50 years or older. Given this, when firewood yields from mallee forests were estimated in later parts of this section, it was assumed that any one mallee stratum (Appendix 11) would be clear-felled for firewood at a year chosen at random over the next 50 years. This would be the end of the first "rotation" of that stratum. Thereafter, it was assumed that any stratum would be cleared felled in its second and subsequent rotations at intervals chosen randomly in the range 40-60 years. This is termed the "standard" management regime for mallee forests.

8.4.2 Non-mallee forests

Non-mallee forests within the MDB have been little used for commercial forestry in the past. Because of this, limited research has been done to identify the silvicultural practices appropriate to ensure either that regeneration after live tree harvesting is adequate or that harvest practices are appropriate to maintain the continued health and biodiversity of the forests. Whilst some work of this nature has been done with the species in the MDB which have been exploited commercially (*Callitris glaucophylla*, *Eucalyptus delegatensis* and *Eucalyptus camaldulensis*), few published reports of this work are available. In his substantial review of the silvicultural practices appropriate for the native eucalypt forests of Australia, Florence (1996) emphasises that most information presently available is based on experience with the more productive native forests of the coastal regions of Australia, not with the woodland forests of the MDB.

The paucity of information means that it is impossible to select specific silvicultural management regimes appropriate to apply to the non-mallee forests of the MDB in the green-wood scenario. Further, given the range of non-mallee forest types which occur in the MDB, it is not to be expected that any single management regime will be appropriate for all of them. Given this, it was felt impossible in the present project to do anything other than establish some basic principles for silvicultural management of the non-mallee forests of the MDB and assume those principles should apply to all of them. Accordingly, it was decided that the following principles should be adhered to in considering silvicultural management of these forests:

a) Silvicultural practice should encourage maintenance of forest stands which contain a wide range of tree sizes and/or ages: in consequence of contemporary community attitudes to forestry practice, clear-felling was considered an inappropriate silvicultural practice, whether or not it is the most appropriate technique to ensure adequate regeneration in any particular forest type. This means that harvest of wood for firewood in the green-wood scenario should involve some form of thinning practice;

b) Any thinning should aim to retain trees of good bole form and with canopy condition which would allow them to respond to the thinning with an acceleration in stem diameter growth rate. Although it is not within the ambit of this project to consider the use of forests of the MDB for wood products other than firewood, it was assumed that silvicultural practices which may lead eventually to production of higher value wood products might have long-term economic advantage;

c) Silvicultural practice should encourage the retention of larger trees (say >60 cm diameter at breast height over bark), since it is these which provide hollows important as faunal habitat, or may grow to a size such that they would do so in the medium term; and

d) Trees to be thinned for firewood should be 15 cm or more in diameter at breast height over bark. Trees smaller than this are unlikely to yield sufficient quantities of firewood to make their felling worthwhile (Wall 1997). This constraint will limit the timing and frequency of thinnings possible from any stand.

Given these principles, it seemed most appropriate that non-mallee forests of the MDB should be managed for the green-wood scenario using a "flexible selection" system of silvicultural management (see Florence 1996, p 229). This would maintain, or allow, the development of uneven-aged stands within the forests with a wide range of tree sizes and ages. It would be consistent with a management regime which has the multiple objectives of (a) supplying firewood, (b) encouraging development of trees which might ultimately yield logs of high quality suitable for solid wood products, (c) provision of a diverse habitat to encourage maintenance of biodiversity, and (d) maintaining a permanent forest cover, consistent with community attitudes to native forest management.

In a “flexible selection” regime, the trees selected for harvest at thinning would have diameters at breast height over bark in the range 15-60 cm. Trees with larger stems (>60 cm diameter), which have the potential in the medium term to provide suitable hollows as faunal habitats, would be retained (Gibbons and Lindenmayer 2002). Amongst trees with diameters of 15-60 cm, those with stems suitable for development to logs of high quality and with crowns in a condition appropriate to develop vigorously following thinning would be retained; the thinning would be done to provide those trees with sufficient space to encourage their crown development. The timing, intensity and frequency of these thinnings in any stand will be discussed further below. Regeneration in these stands would be expected to be either as coppice or as seedlings from natural seed shed, depending on the biology of any particular forest type.

The biology of some of the forests of the MDB may be such that seedling regeneration will occur adequately only in gaps within the forest. In these cases, it may be necessary to apply a “group selection” silvicultural management regime rather than a “flexible selection” regime. This would involve clear-felling of gaps (perhaps with radii of about 25 m) within the forest to create a matrix of open spaces within which seedlings could develop. Such a regime would not encourage the development of trees to produce high quality logs, although it could be accompanied by selective thinning between the gaps to do so. Insufficient is known at present of the silvicultural requirements of the individual forest types of the MDB to be able to say specifically which types should be managed with either “flexible selection” or with “group selection” under the green-wood scenario. For the remainder of the present Section, only “flexible selection” will be considered.

Insufficient is known of the growth dynamics of forests of the MDB to prescribe with any certainty what ages, intensities and frequencies of “flexible selection” thinning would be most appropriate in these forests. Experience of one forester familiar with them (A. Deane, State Forests NSW, pers. comm.) indicates that the management objectives and silvicultural principles considered here might be appropriate for stands aged in the range 30-120 years, on sites of higher productive capacity. However, no more than three thinnings within this age range would be appropriate. Stands of lower productive capacity might be in appropriate condition when aged 50-150 yr, but no more than one or two thinnings would be feasible. Further, to achieve a worthwhile response in stem diameter growth rate of retained trees, thinning should involve a very substantial opening of the stand with large gaps between the retained trees to allow their future crown expansion.

The next issue was the level of thinning intensity to be applied. Some published work supports the contention that a relatively intensive thinning practice can be appropriate in slow growing Australian native forests. Horne (1990) described experimental work in *Callitris glaucophylla* forests in the MDB. Twenty six years after thinning 7-year-old dense regeneration (>50,000 stems ha^{-1}) to stocking densities as low as 416 stems ha^{-1}, the stand basal areas of the unthinned and thinned stands were generally similar, whilst the average diameter at breast height over bark of the unthinned trees was 4.3 cm and of the thinned trees was 18.1 cm (Horne 1990, Table 2). The heaviest thinning caused some loss of production (less heavily thinned stands had higher basal areas than the most heavily thinned stand), presumably because full occupancy of the site was lost for some years following the thinning (i.e. too few trees remained on the site following the heaviest thinning to use fully the resources which limit tree growth, principally water in these forests). In 2003, when the trees were 46 years old, the authors of this report inspected the thinning experiment.

The most heavily thinned stands contained well developed and healthy trees, whilst the unthinned controls contained very small trees and substantial mortality was occurring amongst them.

Abbott and Loneragan (1983) examined the growth response to thinning (their experiment D) of 40-year old *Eucalyptus marginata*, a species which grows in medium-open forests in southwest Western Australia. By observing growth over the succeeding 15 years, they found that removal of 75% of the basal area of the stand at thinning was sufficient to cause some loss of production, presumably due to loss of full site occupancy following thinning. There was no loss of production in stands thinned by removal of 55% of the stand basal area. There was a progressively increased acceleration of stem diameter growth rates as thinning intensity was increased.

Florence (1996, p210-3) describes response to thinning in an east coast, mixed species eucalypt forest of rather higher productivity than forests of the MDB. Of unknown age, but certainly older than 50 years, the stand was very heavily thinned to retain only 25 stems ha^{-1}. Over the next 22 years, the residual stems showed rapid diameter growth and there was vigorous regeneration between the retained trees.

Ellis et al. (1987) studied the response to thinning in multi-aged *Eucalyptus delegatensis* forests of Tasmania, which had regenerated more than 250 years earlier. These forests are slower growing, more because of cooler temperatures at the higher altitudes at which the species grows than because of low rainfall as in the MDB. Ellis et al. concluded that as much as 87% of the stand basal area would have to be removed from these stands before there was loss of full site occupancy. Thinning was accompanied by a progressively increasing acceleration of stem diameter growth rate as the intensity of thinning increased.

These various results suggest that removal of 50% of the basal area over bark of 30-150 year old stands in the MDB should result in worthwhile acceleration of the stem diameter growth rates of the retained trees. At the same time, this intensity of thinning should not be so great that full occupancy of the site is lost, with a consequent loss of overall production on the site. In the absence of any other information, this thinning intensity was chosen in this section for “flexible selection” silvicultural management in the green-wood scenario.

Given these considerations, Table 8.2 shows thinning regimes which were selected for non-mallee stands for the different productive capacity classes. Hereafter, these are termed the “standard” management regimes for non-mallee forests of the MDB.

Table 8.2. The maximum number of thinnings and the thinning ages which might be appropriate for stands of the non-mallee native forests of the MDB for different site productive capacity classes (Table 8.1). All thinnings would involve removal of 50% of the basal area of the stand at the time of thinning. These are termed the “standard” management regimes for non-mallee forests of the MDB.

Productivity class	Maximum number of thinnings	Age range within which first thinning done (yr)	Delay to each subsequent Thinning (yr)
1	2	50-60	30-60
2	2	50-60	30-60
3	3	30-40	40-45
4	3	30-40	40-45

Table 8.3 shows predictions from the growth and yield model (Section 6) of the firewood yields that might be expected from typical examples of these standard management regimes.

Table 8.3. For each of the four productivity classes considered in the green-wood scenario for non-mallee forests of the MDB, predictions from the growth and yield model of the amounts of firewood which could be harvested (t ha^{-1}) at various ages (yr) from typical examples of the standard management regimes.

Productivity class							
1		2		3		4	
Age	**Firewood**	**Age**	**Firewood**	**Age**	**Firewood**	**Age**	**Firewood**
55	11	55	16	35	13	35	21
100	15	100	19	87	20	87	24
				129	19	129	22
Total	**26**		**35**		**52**		**67**

8.5 Sustainable firewood supply over the next 100 years

The prediction of the long-term sustainable supply of firewood available from the MDB under the green-wood scenario was done in a similar fashion to that described for the dead-wood scenario (Section 7). The prediction of firewood supply was confined only to the next 100 years, a period considered relevant to long-term industry planning.

8.5.1 Firewood supply with standard management regimes

Figure 8.2 shows estimates of the annual harvest of firewood over the period 2004-2103, from the 9.8 M ha of forests deemed appropriate for the harvesting under the green-wood scenario. The results were determined using the standard management regimes, described above, for mallee and non-mallee forests. No attempt was made to smooth the annual supply to a more or less constant amount from year to year.

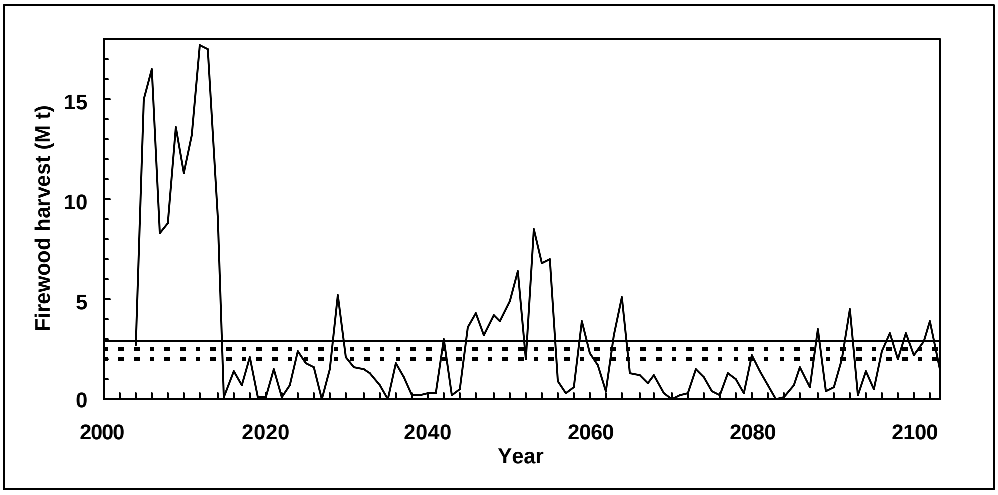

Figure 8.2 Estimates of the amounts of firewood which could be harvested in the green-wood scenario, annually over 2004-2103, of the 9.8 M ha of forest deemed appropriate for that scenario. The results assumed the entire area was harvested using the standard management regimes for mallee and non-mallee forests. The solid horizontal line is the average of all the annual estimates. The two horizontal dashed lines indicate the range of the estimated amount of firewood currently harvested from the MDB.

Figure 8.2 suggests that the annual supply of firewood available during 2004-2014 would be far greater than in later years. This reflects the fact that thinning of non-mallee forest for firewood has not been a common practice in the past. Therefore, when applying the standard management regimes for non-mallee, any thinnings due before 2004 were assumed not to have occurred. Thus, much larger yields were available at thinnings in the early years after 2004. The higher than average yields that appear during some of the years 2047-2064 occurred for the same reason. Beyond 2064, many stands would be entering their second "rotation", when all thinnings could be undertaken on time, so the thinning yields would tend to be lower.

The average annual yield of firewood over the 100 years is shown on Figure 8.2 as 2.9 M t yr^{-1}. However, if the exaggerated yields available over the earlier parts of the 100 years were omitted, it appeared that the long-term average annual supply of firewood would be about 1.8 M t yr^{-1}. Of this, about 28% would come from mallee forest and the remainder from non-mallee forests. For the non-mallee forests, about 15, 19, 29 and 37% of the supply would be obtained from productivity classes 1-4, respectively. A long term average supply of 1.8 M t yr^{-1} is just below the 2-2.5 M t yr^{-1} estimated to be the amount supplied annually from the MDB (Driscoll et al. 2000).

8.5.2 Sustainable firewood supply

As for the dead-wood scenario (Section 7.7), an attempt was made to determine how the firewood harvest management regimes should be applied to achieve a more or less constant annual supply of firewood from the MDB over the next 100 years. This was done using the linear programming system described in Section 7.7.1 for the dead-wood scenario, the only difference being that the values of the F_{ijk} in the system were the amounts of firewood harvested from live trees, at thinnings in non-mallee forest or at clear-felling of mallee forest, rather than amounts harvested from coarse woody debris as was the case in the dead-wood scenario.

A number (the r_i in the system) of management regimes were set as options for each stratum. For both mallee and non-mallee forest, the first option was that the stratum should not be harvested. Then either ten (in mallee forest and productivity classes 1 and 2 of non-mallee forest) or fifteen (in productivity classes 3 and 4 of non-mallee forest) different standard regimes were considered. The standard regime options were constructed simply by choosing harvest years at random, within the ranges allowed for the standard regimes. The ranges are defined for mallee forest in the last paragraph of Section 8.5.3 and for non-mallee forest in Table 8.2. Rotation ages for any one optional management regime for mallee were chosen randomly in the range 40-60 years and for non-mallee in the range 165-191 years. For non-mallee forest, any thinning due to occur before 2004 was ignored. In non-mallee forest only, up to ten (in productivity classes 1 and 2) and fifteen (in productivity classes 3 and 4) non-standard management regime options also were considered in each stratum. These simply involved no thinning in the first rotation, with a standard thinning regime in the second rotation; the objective of these non-standard regimes was to provide options to avoid large harvests during the earlier parts of the 100 year planning horizon (Figure 8.2).

After many runs of the linear programming system, it was found that with $\rho=0.1$ (that is the annual firewood supply from the entire MDB did not differ by more than ±10% in any year), a solution to the linear programming system could be obtained only when S (the annual average supply from the entire MDB) was no larger than 2.3 M t yr^{-1}. The annual supply of firewood from the MDB with this solution is shown in Figure 8.3. Those results may be compared directly with those of Figure 8.2, where no smoothing of the annual supply was attempted.

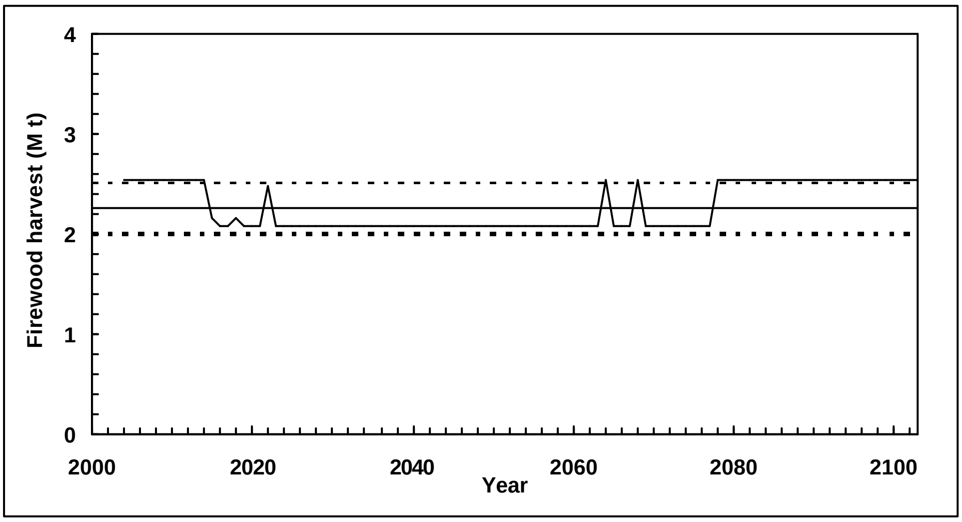

Figure 8.3. Estimates of the maximum amounts of firewood which could be harvested annually over 2004-2103, under the green-wood scenario. The results are for the 9.8 M ha of mallee and non-mallee forests of the MDB deemed appropriate for firewood harvesting under that scenario. The graph shows the results where the annual firewood supply from the MDB was kept more or less constant from year to year. The solid horizontal line is the average of all the annual estimates. The two horizontal dashed lines indicate the range of the estimated amount of firewood currently harvested from the MDB.

The average annual supply for the results shown in Figure 8.3 was 2.3 M t yr^{-1}. The smoothing constraints in the linear programming system ensured that the annual amount never varied outside the range 2.1-2.5 M t yr^{-1}. Of the total annual supply, on average 0.5 M t yr^{-1} (22%) came from mallee forest and 1.8 M t yr^{-1} (77%) from non-mallee forest. Of the non-mallee forest supply, 20, 31, 32 and 18% was obtained on average from forest of productivity classes 1-4, respectively.

As with the equivalent results from the dead-wood scenario (Section 7), there is little point in showing here the extremely lengthy details of this solution to the linear programming problem (i.e. the fine detail of exactly how much of the area of each of the 305 strata should be treated with exactly which harvest management regime). However, the results showed that the non-standard regimes would need to be applied in 2.1 M ha (24%) of the non-mallee forest, i.e. that there would be no thinning in the first rotation of that area of those forests to avoid the excessive yields which would otherwise be available because of the lack of thinning in the past (Figure 8.2).

8.5.3 Residual woody debris

Figure 8.4 shows the estimates of the unit area amounts of coarse woody debris remaining in the non-mallee forest, annually over 2004-2103, with the firewood harvesting done to obtain the solution to the linear programming system. These results are averaged over the entire 8.7 M ha of the non-mallee forest. Of course no woody debris is removed as firewood in the green-wood scenario. It was assumed that mallee forest has negligible amounts of coarse woody debris of importance for maintenance of biodiversity and landscape function. The cyclic trend apparent in the figure is a consequence of the assumed age-class distribution of forest; the results may be compared with those for unharvested forest in Figure 7.2 for the dead-wood scenario.

Also shown on Figure 8.4 are the amounts of residual coarse woody debris remaining in non-mallee forests harvested to produce a smooth annual supply under the dead-wood scenario, shown in

Figure 7.6. These results emphasise the extent to which the green-wood scenario ensures the maintenance of coarse woody debris in these forests.

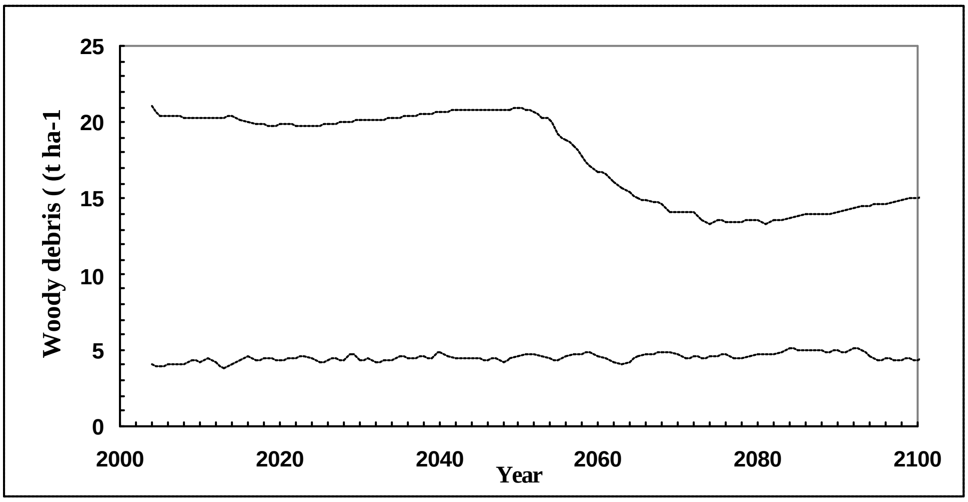

Figure 8.4. Estimates of the unit area amounts of woody debris remaining in the forest annually over 2004-2103, averaged over the 8.7 M ha of non-mallee forests of the MDB deemed appropriate for firewood harvesting under the green-wood scenario. The solid line shows the results for the green-wood scenario where the annual firewood supply from the MDB was kept more or less constant from year to year. The dashed line shows the (smoothed) results for the dead-wood scenario from Figure 7.6, for the corresponding time period, averaged over the 12.3 M ha of non-mallee forests.

8.6 Discussion

It is of interest that the results showed that the annual sustainable yield of firewood from the 8.7 M ha of non-mallee forest would average 0.20 t ha^{-1} yr^{-1}, whilst that from the 1.1 M ha of mallee forest would be much greater, 0.47 t ha^{-1} yr^{-1}. This difference occurs despite the fact that mallee forests grow on sites with far lower productive capacity than the non-mallee forests (weighted average productive capacity, as assessed by net primary productivity index, for the 1.1 M ha of mallee forest area was only 1.2 t ha^{-1} yr^{-1}, whilst that for the 8.7 M ha of non-mallee forest was 4.2 t ha^{-1} yr^{-1}). The higher yield per unit area from the mallee forests is a consequence of the different management systems used for the two forest types. It was assumed that all the production of mallee forests would be harvested by clear-felling on an average 50 year rotation; the growth and yield model predicted that this will provide a harvest of 23 t ha^{-1} of firewood every 50 years. By contrast, it was assumed that firewood yields from non-mallee forests were obtained only from thinnings of forests which grow on an average rotation of 178 years. The yields shown for thinning harvests (Table 8.3) will make it clear that the unit area amount of firewood available from mallee forests over any 178 year period is greater than that available from even the highest productivity class of non-mallee forest.

It is unlikely that the maximum annual supply of firewood available from the MDB under the green-wood scenario would ever be achieved in practice. The reasons are similar to those discussed for the dead-wood scenario (Section 7.9). Not all owners of forest will wish that it be used for firewood harvest, it would be impossible to insist that each and every forest property be managed with the particular harvest management regime that is necessary to achieve the maximum yield, supply would be determined on a regional basis rather than over the MDB as a whole and some species are preferred for firewood over others (Driscoll et al. 2000).

It is of interest that the maximum sustainable yield of firewood estimated under the dead-wood scenario (10 M t yr^{-1}) was far greater than for that under the green-wood scenario (2.3 M t yr^{-1}). Whilst the area available for harvest under the dead-wood scenario (12.3 M ha) was greater than that for the green-wood scenario (9.8 M ha), the greater total yield under the dead-wood scenario is due principally to the much greater unit area yields available from the non-mallee forest under the dead-wood (0.82 t ha^{-1} yr^{-1}) than the green-wood (0.20 t ha^{-1} yr^{-1}) scenario. In turn, this reflects largely the harvest management regimes used for the two scenarios. The harvest management regime for the dead-wood scenario involved removal of a very large proportion of the coarse woody debris produced over the lifetime of any stand. Harvests under the green-wood scenario involved only thinning of stands and no clear-felling and hence, removal of only part of the total live tree production over the life-time of a stand.

An advantage of the green- over the dead-wood scenario is the retention of coarse woody debris for maintenance of biodiversity and landscape function. Figure 8.4 provides a comparison of the results of the green-wood scenario and the dead-wood scenario (Figure 7.6). The comparison shows that, from time to time over the next 100 years, 4-8 times as much coarse woody debris would remain in the non-mallee forests of the MDB under the green-wood scenario than under the dead-wood scenario. The amount would vary from time to time under both scenarios in consequence of the existing age-class distribution of the forests of the MDB. The impact of substantially increasing the amount of coarse woody debris is discussed in more detail in the section on the ecological impacts of the green-wood scenario (Section 9).

Comparison of Figure 7.4 (dead-wood scenario) and Figure 8.2 (green-wood scenario) suggests that, in the short-term of perhaps the next 14 years, much greater yields of firewood might be available under the green-wood scenario than the dead-wood. This extra yield would be available because thinning of non-mallee forests has not been normally carried out in the past; in effect, there is a "back-log" of possible thinnings. It would be quite possible to devise a system to allow this additional supply to be made available for a short period and that the supply should then decline over subsequent years to a long-term, sustainable, more or less constant annual supply. This could be important if the firewood industry of the MDB is to be rationalised to reduce eventually the overall supply being obtained from native forests from the MDB; allowing the annual harvest to decline gradually is likely to lead to less social disruption than if it is reduced suddenly to much lower levels. Further management and policy implications of all scenarios are discussed in the concluding section of this report (Section 11).