DETERMINING APPROPRIATE STANDARDS

FOR KARRI REGENERATION FOR WOOD PRODUCTION

By

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INTRODUCTION

At the last RWG meeting members were encouraged to examine older regenerated stands to determine whether these stands had developed according to the prediction of the original regeneration survey. In WA, previous methods of regeneration survey are not adequate to provide sound, objective follow-up of this kind. We therefore decided to start from the other end and work back i.e. to try to determine more precisely the characteristics of the tree that we were trying to grow, the factors that influenced the form of that tree, the density of the forest needed to produce it and finally the density that would be required at the time of the regeneration survey.

BRANCHING HABIT

In Western Australia the primary objective of timber production management is the production of sawlogs (Anon. 1987). The biggest single reason for the down grading of sawn produce from regrowth eucalypts is the presence of knots (Waugh 1980 and McKimm 1986). Mill studies are currently being undertaken in an attempt to quantify the relationship between the branching characteristics of karri regrowth and wood quality. In the interim it has been assumed, (based on the work of Jacobs 1955), that where branches exceed a critical size and die the recovery of sawn timber will be significantly reduced due to the formation of dry knots. Recovery may be further reduced if rot and insect damage are found to be associated with the occlusion of branch stubs.

Jacobs (1955) discusses the branch shed mechanism in eucalypts. The salient features are:

1. Branches up to about 3 cm diameter are shed cleanly, either by complete ejection of the branch or by ejection of the brittle zone after the branch has broken off at the outer edge of the brittle zone.

2. The larger the branch the longer it takes to break off.

3. Branches greater than 3 cm diameter do not eject cleanly but the stubs remain to occlude as dead knots or may produce pockets of rot.

4. The knotty core resulting from cleanly shed branches is 5 to 6 times the diameter of the branch. i.e. for 3 cm diameter branches, the knotty core will be 150 to 180 mm diameter.

5. The size of the branches before they are shed increases with height.

6. Silvicultural treatment should aim to keep branch size to less than 3 cm till an acceptable log length is reached.

Marks et al (1986) showed that for *E. regnans*, branches which died before they have developed heartwood were shed and occluded cleanly. They also showed that branches greater than 1 cm diameter had only a 65% chance of rot free occlusion.

Observations of karri branches in the process of abcission suggest that under suitable conditions karri is capable of shedding branches up to 3-4 cm in diameter back to the solid wood of the trunk. On this basis silvicultural treatment should aim to maximise recovery by restricting branch size to less than 4 cm in diameter until an acceptable length of clean bole is achieved.

Tree Model

The above information suggests that the knot development in a tree may be depicted as in Fig. 1. This model supposes that in eucalypts which cleanly shed their small branches, the green knotty core and the dry knotty core will be almost the same up to where the dead branches exceed a critical limit (3 cm in Jacobs data). Above that point the (dry) knotty core will increase rapidly because the tree must occlude a dead stub. The length of this stub will increase with height because the diameter and hence time to break and rot off will increase.

The model also shows that the height of the clean bole in eucalypts can be very misleading by hiding an unknown length of occluded zone with an unknown diameter of dry knotty core.

Fig. 2 illustrates the likely magnitude of the knotty core in a tree at various stages of its development up to a maximum DBH of 100 cm when they are retained under maximum competition in their early stages.

Stage 1 illustrates a tree when the green knotty core just equals the stem diameter and there is a very small zone of dead branches. This tree would be about 24 m in total height. To maximise the clean bole, thinning should not commence till the trees have reached this size.

Stage 2 shows the condition which could be achieved when the height to the green crown is 30 m; this would be close to the maximum achievable for a tree of this total height (45 m). The appearance of a dry knotty core above 18 m is because branch size exceeds 3 cm at this point. It has been assumed that it would require about 10 cm of growth to occlude these stubs initially, gradually increasing up the stem as branch diameter increased.

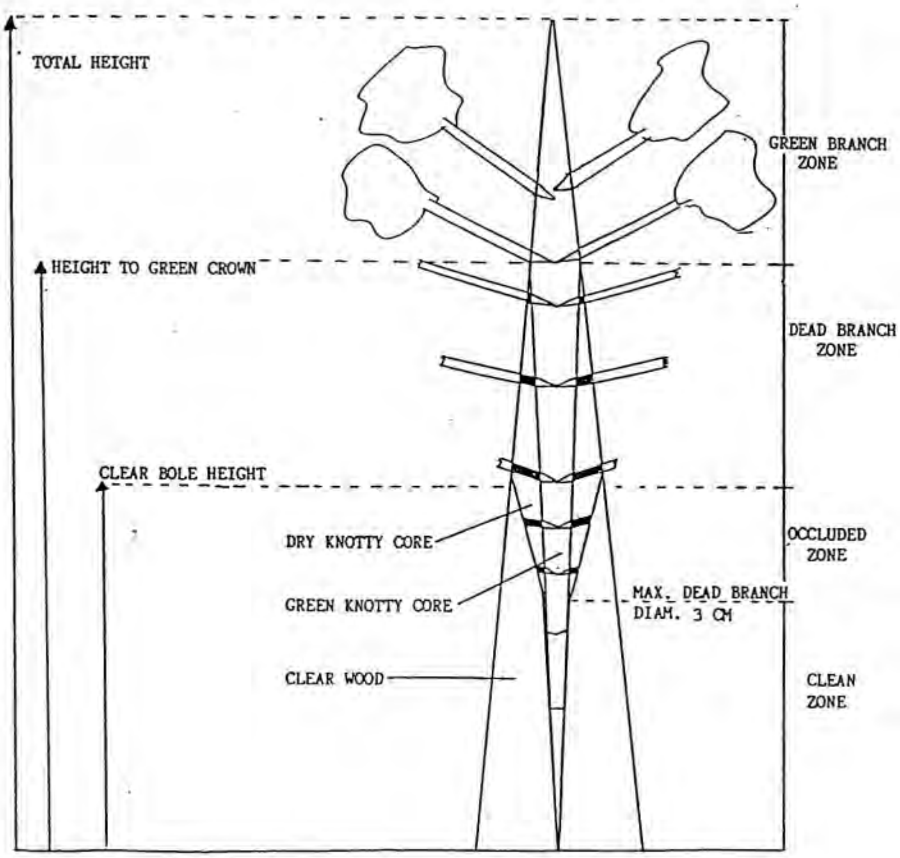

FIGURE 1: Diagrammatic representation of branch and knot development in a eucalypt.

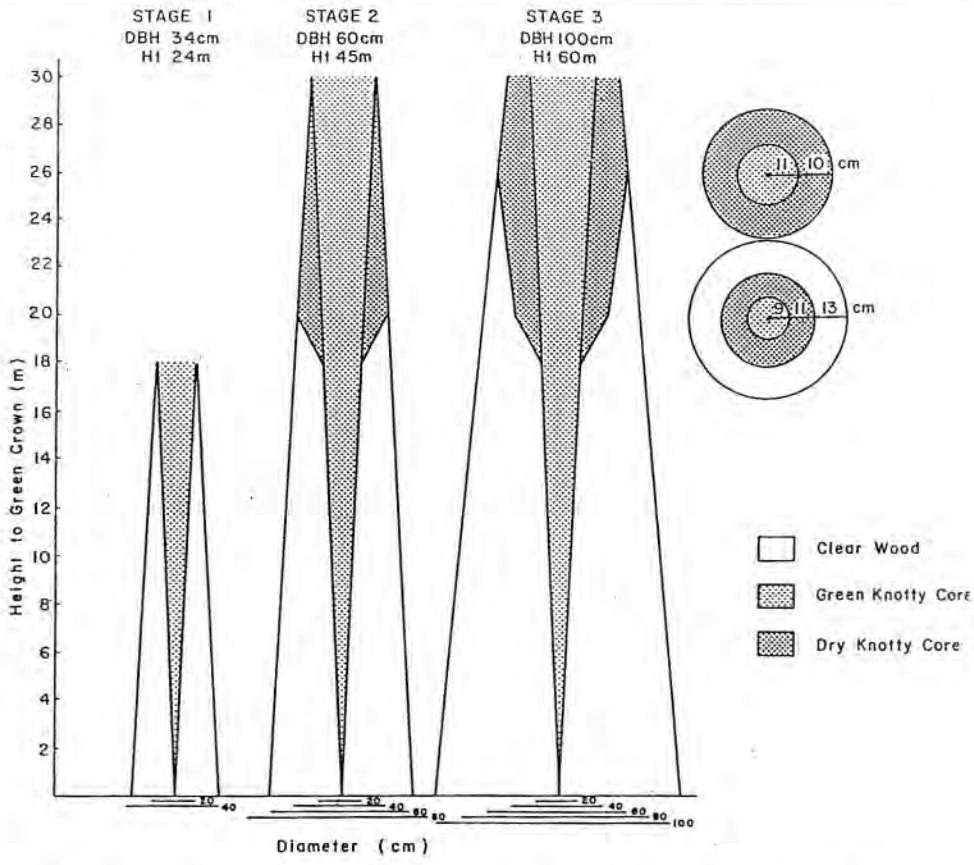

Fig 2. Representation of the internal knotty core zones of a Karri tree at different ages, managed to maximise the yield of clear wood.

Stage 3 illustrates the internal quality of the same tree after it has reached 100 cm dbh. It has been assumed that under the likely thinning regimes, the green crown will not increase above 30 m. This stage shows that at 20 m the annulus of clean wood will be in the order of 13 cm, decreasing to zero at 26 m. (Estimated radius required of occlusion is probably conservative at this height).

Therefore, for the tree sizes likely to be produced in the future, even under a conservative regime the occluded zone is unlikely to exceed 8 m and less than half of this will have an annulus of more than 10 cm of clear wood.

This would suggest that the pursuit of a clean bole height of more than about 20 m would not be worthwhile or feasible.

STAND DENSITY AND BRANCHING

Natural Regeneration

The influence of stand density on the form and branching characteristics of karri regrowth is marked. A preliminary survey was undertaken across a range of karri regrowth stands less than 20 years of age to establish if a relationship between stand density and branching characteristics might be quantified and form the basis for determining regeneration standards.

In fully stocked seed tree regenerated stands on good sites the maximum length of clean bole achieved on potential crop trees is approximately 18 - 20 m. This is consistent with the theoretical approach described above. These lengths occurred in those areas of the stand with spot densities of 3000 or more sph. Where spot density fell below this level the length of clean bole decreased, often to 10 metres or less. It was generally observed that a stocking of 3000 sph produced about 2000 active 'competitors' which contributed to branch suppression.

To set an establishment standard which will maximise the length of clean bole achieved it is necessary to relate the density of stems at age 15 - 20 years with that of age 1. No long term studies of stand development in karri regrowth have been made however indications are that mortality in the young regrowth stands after year 1 is not high. Rather many stems develop into whips which persist for many years without growing. The assumption is made that the total stocking (including whips) measured in these stands at ages up to 20 years approximates the stocking which existed after the first summer following germination.

In an earlier review of karri regeneration standards, White (unpublished) considered a stand with an initial density of 3000 or more sph to be fully stocked on the basis that this provided the maximum number of potential crop trees at 14 years. This agrees with the standard derived on the basis of maximising clean bole length. Intuitively it would be expected that a fully stocked stand supporting the maximum number of crop trees would also provide the maximum competition for light between trees resulting in maximum clean bole lengths.

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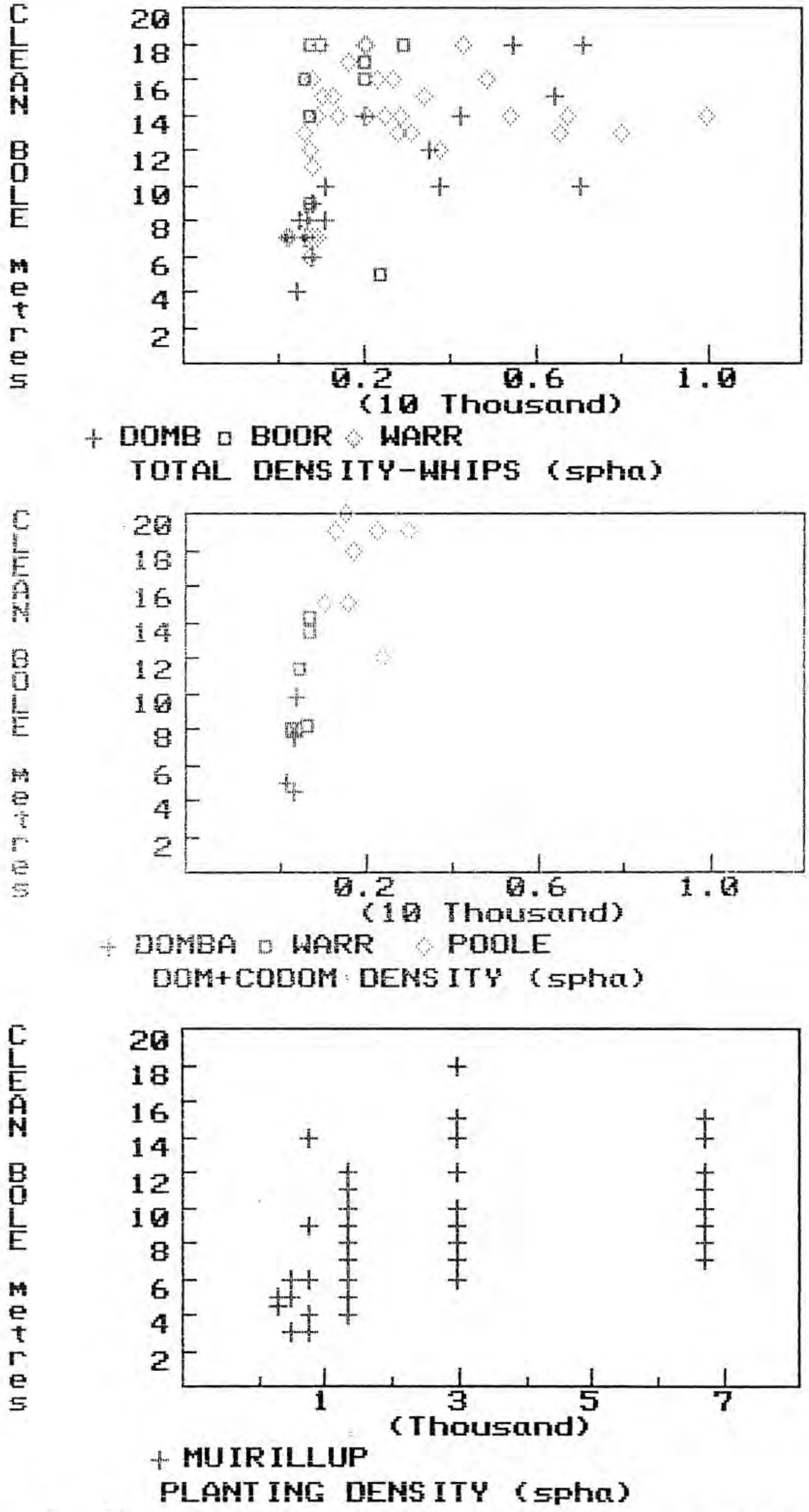

Figure 3. Clean Bole length versus Density for naturally regenerated (a and b) and planted stands (c).

On this basis the standard for optimum stocking is 3000 or more sph at age 1. This will ensure that the maximum potential clean bole length is achieved in the regrowth stands.

Planted stands

Measurements suggest that stands planted with nursery stock develop shorter lengths of clean bole than do seed tree regenerated stands at equivalent densities. The standard planting density used in the past was 1250 spha. The length of clean bole achieved in these stands is approximately 6-8 metres, comparable to the minimum lengths achieved in seed tree regeneration with equivalent stand densities at age 1. Observations also suggest that not only do planted stands have larger branches than seed tree regeneration but that there are more of them. (Fig 3)

Higher planting densities were undertaken in an espacement trial established in 1971. Although maximum clean bole lengths for planted stands also occurred at a density of 3000 sph the majority of potential crop trees had clean bole lengths of less than 15 metres. It was also observed in planted stands, that even at stockings as low as 1250 sph about one third of the trees did not become active competitors.

STOCKING STANDARDS

In areas which are regenerated using seed trees optimum stocking can be obtained in a cost effective manner when conditions are suitable. Where planting is used to regenerate, the costs of obtaining optimum stocking increase significantly.

When determining a minimum acceptable level of stocking the costs of establishing regeneration to a given standard must be balanced against the costs of obtaining less than optimum clean bole lengths and subsequent yield reductions. Examination of the 1971 espacement trials shows that stands planted at 1250 sph have not achieved maximum volume production by the time they are ready for first thinning. An economic analysis of a range of planting densities established in the 1971 espacement trial suggest that the costs of establishing up to 2000 sph by planting can be fully compensated by the increased chipwood thinning yield which would result. This analysis takes no account of the benefits of improved small log utilisation and recovery that would be expected at the higher planting density. This could be significant both from a yield and an economic viewpoint given the importance of early sawlog production.

On this basis the target standard for adequate stocking is 2000 or more sph. This will ensure that an acceptable length of clean bole is achieved in both planted and seed tree regenerated stands.

The standards for optimum and adequate stocking presented here are based on the relationship between the density of stems at a point and their potential to yield particular products. A further standard is required which specifies the proportion of the cutover areas which must be regenerated to optimum and adequate stocking levels. This standard is a function of species productivity, and the economics of rectifying the shortfall in standards.

The minimum standard currently applied to areas of regenerated karri forest is a stocking of 85%. Although an ideal stocking of 100% would provide maximum yield the costs of obtaining at least adequate stocking on the remaining areas increases sharply. This is because the remaining 15% is frequently in the form of small isolated pockets of sub-standard regeneration. The cost of locating and treating these areas is very high.

CONCLUSION

After examining the impact of stocking on the form of the trees in the stand at the critical first thinning stage and the capacity of those stands to achieve the management objectives, the following standards have been adopted for stands to be used for future sawlog production:

> **a minimum of 85% of the area to be stocked at the rate of 2000 stems per hectare for adequate stocking, or 3000 stems per hectare for optimum stocking.**

Further research is required to determine the effect of branch size and condition on sawn recovery and the effect of stand density on branch size and condition; the relationship between initial stocking and first thinning yield; a solution to the undesirable branching habit of nursery stock; and the reasons for poor competitive performance of some trees.

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