# KARRI SILVICULTURE
## as it applies to
# PRODUCTION FORESTS

Notes prepared for the School of Agriculture and Forestry, University of Melbourne.



Forests Department
Western Australia
November 1983

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The management of the karri forest has become a well co-ordinated system of land use, yield control, logging, silviculture and fire protection.

These notes aim to provide a logical reference to readily available published material in this context. They describe the historical development of silviculture and present practices as they apply to those areas with a land use priority for wood production. The appendices include a variety of prescriptions currently in use. These are updated as the need arises. Current silvicultural practice is also based upon a considerable volume of unpublished information. Further information on specific subjects could be made available on request.

# CONTENTS

Plates



Maps

## 1. TAXONOMY AND DISTRIBUTION

Karri *(E. diversicolor* F.v.M.) is a tall, smooth barked eucalypt, endemic to the lower South West of Western Australia. It is taxonomically classified within the

Section Macrantherae
Subsection Cordiformes
Series Transversae
Subseries Inclusae.

A classification it shares only with *E. jacksoni*, Maiden. (1) Following the classification of Pryor and Johnson it falls within

Subgenus Symphyomyrtus
Section Transversaria
Series Diversicolores
Code SEB:A

Included in the same Section is *E. grandis*, *E. saligna*, *E. botryoides* and *E. resinifera*. (2)

Karri occurs generally within the 1,000mm isohyet, though outliers on particularly favourable sites occur where the rainfall is as low as 700mm (Map 1). Summer rainfall averages 25mm per month and there is a minimum 8 month growing season. (3)

The wet sclerophyll karri forest many occur as pure stands or in mixture with marri (CAFUA *E. calophylla)* and less commonly with both marri and jarrah (MADCA *E. marginata)*. (Plates 1, 2). In a confined area near the south coast at Walpole it also occurs in mixture with three tingle species (MAF:A *E. jacksoni*, SDA:A *E. guilfoylei*, MAE:A *E. brevistylis)*.

Pure karri generally occurs on deep well drained sandy loams derived from granite gneisses and the admixtures occur on podsols and gravelly podsols produced by the dissection of the lateritic duricrust. In outliers of the main karri belt it also occurs on soils derived from limestone. The strong association with soils and landforms (4) means that karri does not occur in large contiguous tracts. Within what may be described as the main karri belt, only 34% is karri type (including mixtures).

# KARRI DISTRIBUTION

MAP 1

LEGEND

MAIN KARRI BELT

KARRI OCCURRENCE

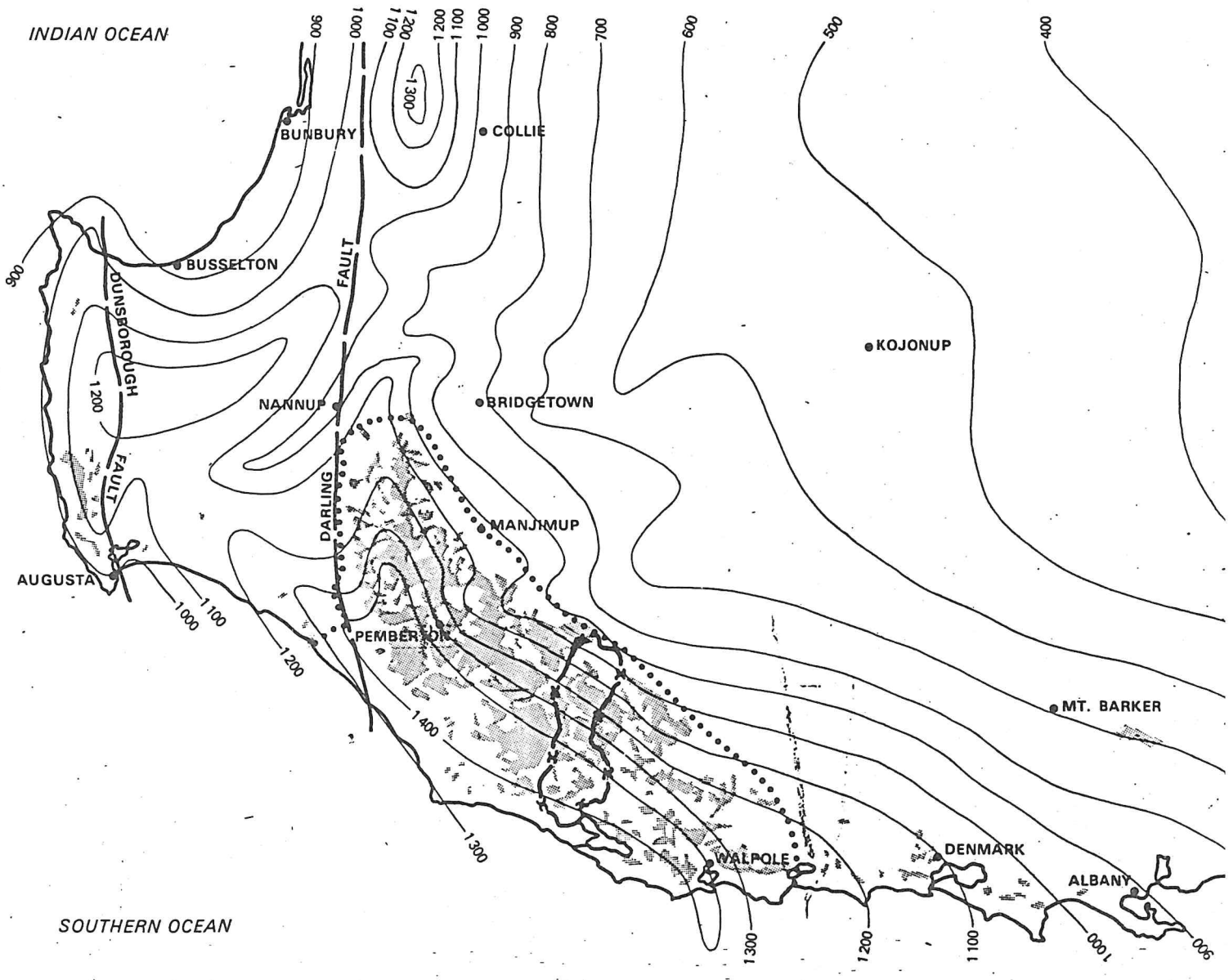
SHANNON WATERSHED

ISOHYET (mm)

N

SCALE 1:1 500 000

0 10 20 30 40 50 60 kms



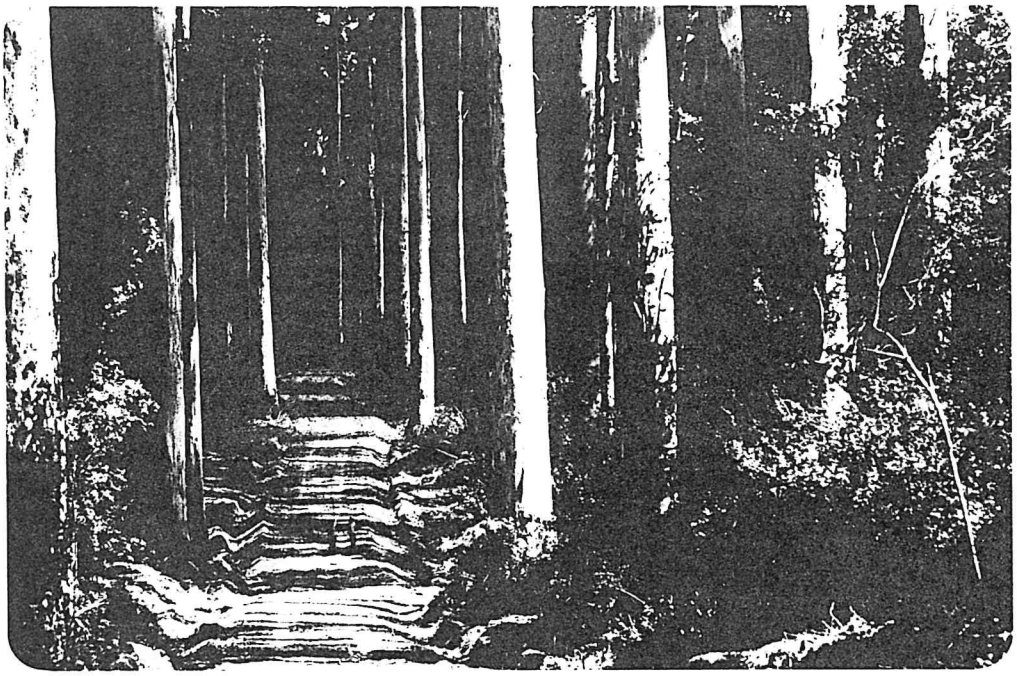


Plate 1. High quality pure virgin karri.

Plate 2. Virgin mixed karri-marri forest.

Within this belt, it is estimated that there was originally 208,500 ha of karri type. Of this

16% has been cleared for agriculture
5% is uncleared but privately owned
6% is National Park
2% is undedicated Crown Land
71% is State Forest.

55% of the State Forest (or 38% of the original total) has a management priority for wood production (at Nov. 1983).

## 2. HISTORICAL DEVELOPMENT OF SILVICULTURE

Utilisation of the karri forest began in the 1860's when a mill was established at Karridale on the west coast, north of Cape Leeuwin. The whole of this outlier of karri was clearfelled and following fires through the area, it regenerated prolifically with seed from the cull trees remaining. A fine second growth forest remains today. Similar activity followed at Denmark on the south coast but most of the original karri area was later cleared for agriculture.

Although the first settlers arrived in the main karri belt in the 1850's, no major activity occurred till about 1911 when a railway was extended to the area. In the following decade three large sawmills were built and a large area had been surveyed for agricultural development. (4) The purpose of the mills was to remove for utilisation, as much karri as possible from the forest destined for farmland and provide wood for the export and interstate market. Karri sleepers were cut at this time for the Transcontinental Railway. Forest which could not be logged was ringbarked (Plate 3) and all forest cutover till 1924 was alienated to agriculture.

Silviculture began in 1925 with the dedication of the first area of State Forest containing karri at Big Brook near Pemberton.

Clearfelling was the system employed. The mill having removed all millable trees, the tops were cut flat and sheoak and other understorey trees were felled or ringbarked (Plate 4). The area was burnt in a seed year and the area was regenerated successfully with seed from the cull trees left behind. Most of these culls were later ringbarked. Protection of the fire sensitive regrowth was provided by the regular burning of firebreaks around the regrowth compartments. The clearfelling system continued till about 1938.

The difficulty of keeping fire out of the areas prepared for regeneration till the following seed year (up to 5 years) led to the practice of annual regeneration burns regardless of whether it was a good seed year. This practice apparently continued till about the late 1940's. Hand seeding was practiced for some of the areas which had failed to regenerate naturally.

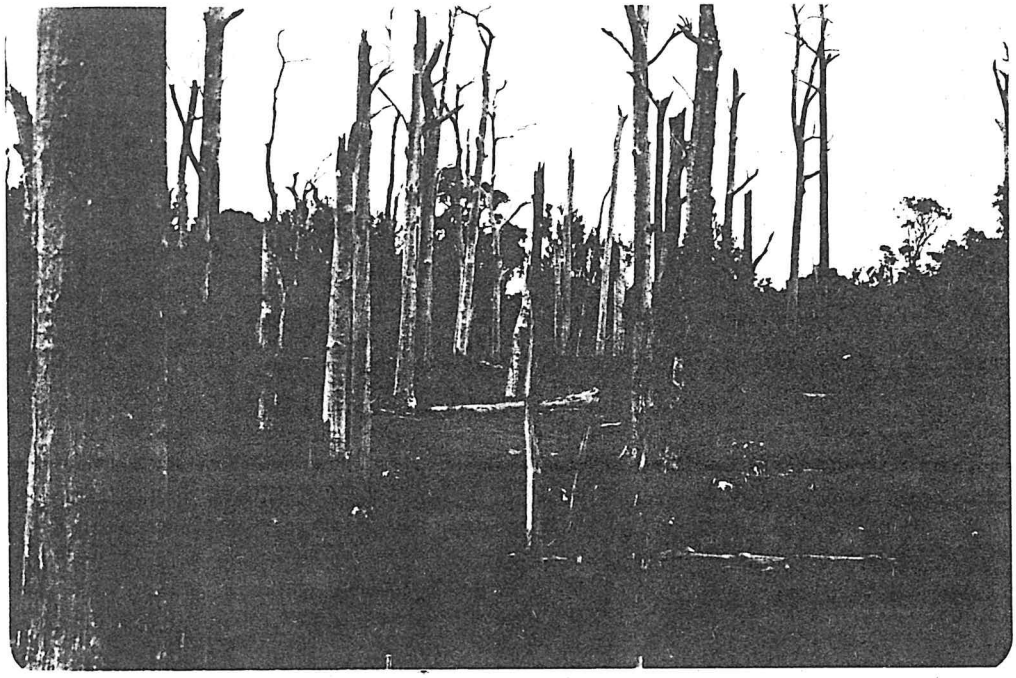


Plate 3. Karri stags still remain from ringbarking for agriculture in the 1920's.

Plate 4. Following clearfelling for sawlogs in the 1930's, marri and cull karri were ringbarked to allow regrowth to develop.

The system began to change towards the retention of smaller trees, firstly on a girth limit and later to what had recognisably become the Australian Group Selection System. There were several reasons for this:

Utilisation was directed towards large, fault free trees suitable for producing timber for a demanding export trade. Smaller trees and culls had to be felled to waste in the regeneration process.

A lighter cut meant that more area was cutover each year. This not only allowed a speedier salvage of the degrading old and fire damaged resource but the construction of tram lines also created access for the beginnings of a fire protection system.

Labour to carry out the intensive pre-regeneration treatment was not available during the war years.

Clearfelled areas, to the layman apparently devastated and no longer of forestry value, were a prime target for the still strong pressure for agricultural alienation. A selection system created an impression that the area was still growing useful trees and relieved the pressure on these areas for release to agriculture.

All these reasons contributed to the change from clearfelling to selection cutting which continued until 1967. By this time it had become evident that the application of the selection system to karri forest was fraught with problems. These included:

The difficulty of burning for regeneration in small gaps in the forest with a fire of sufficient intensity to create the necessary ashbed (5) but without damaging the retained trees. Few truly successful burns were achieved - they were either too hot or too cool.

The decline in health of the retained trees due either to fire damage or the sudden exposure of partial cutting (Plate 5).

The depressive effect of the retained trees on the new regrowth. (6)

The difficulty of carrying out the second cut; involving the removal of large, heavy trees among small regrowth followed by a regeneration

burn aimed at producing ashbed in the new gaps without damaging the adjacent regrowth. The damage was unacceptable. (It is important to draw the distinction between regeneration following selection cutting and the continued management of the forest on a selection basis.)

Karri regrowth requires complete protection from fire for at least 15 years. Selective cutting approximately doubles the area which would be cutover each year. The area requiring complete protection at any one time is therefore also doubled.

For these reasons the clearfelling system was re-introduced in 1967. (4,7)

The successful implementation of any silvicultural system depends upon the ability to use a full range of products.

Where only a sawlog market exists the problem common to all systems is what to do with the remaining trees which for one reason or another are not suitable for sawlogs. If left standing they have the effect of:

Occupying space which could be occupied by productive trees.

Suppressing surrounding regrowth.

Produce seed of inferior genetic quality and in the case of species mixtures, cause the gradual domination by the less useful species. (8)

These problems had been minimised by directing logging wherever possible to pure karri stands where a high proportion of the volume was suitable for sawlogs. Felling to waste of cull karri did not represent a major problem. However where mixed stands of karri and marri were involved the problem becomes enormous. (Only about 3% of all marri is suitable for sawmilling because of gum rings and water shakes.) Continued sawlogging in these stands without a market for these "cull" trees would result in:

A very high cost of cull and marri removal, with the inherent waste of a natural resource. (App 5.3)

The inevitable degrade of the forest brought about by high grading, ultimately leading to a forest of a quality or species unsuitable for milling.

For these reasons the Forests Department of Western Australia actively encouraged the establishment of a pulpwood market to utilise those trees unsuitable for sawmilling. This finally became a reality in 1975 with the establishment of a chipwood export industry.

# 3. PRESENT PRACTICE

Current silvicultural practice in the karri forest may be seen to have evolved as a result of research, observation and practical application of a variety of systems over a period of 60 years. A well developed and co-ordinated system of yield control, integrated sawlog/chipwood logging, regeneration, thinning and fire protection has now been established.

The following silvicultural practice is applied to karri and karri mixtures but varies according to the forest structure produced from past treatments. These may be considered as old growth forest, even aged second growth forest, and two tiered forests.

## 3.1 OLD GROWTH FOREST

### 3.1.1 Selection of Areas for Logging

Areas are selected for logging within a framework of a long term yield program (4) and are subject to a variety of land use, environmental, fire protection and resource considerations. Rolling 4 year logging plans and detailed annual plans are prepared which take into account land use, coupe size and dispersal, location with respect to the ability to safely carry out the regeneration burn and subsequent protection of the regrowth. Strategic fire protection, road access and haulage distances for the relevant sawmills, landscape considerations in sensitive areas and the balance of sawlog and chipwood resource required for an integrated operation are also major factors involved.

### 3.1.2 Selection of Prescription

Clearfelling is applied to all stands in this category which have been selected for logging. They may be either clearfelled with seed trees, clearfelled and planted, or clearfelled and artificially seeded. Since the prescription selected affects the resource balance of a particular years logging, the prescription is nominated at the time of planning. e.g. when cutting to seed trees the area cutover for sawlogs will be almost double that from clearfelling and therefore yield twice as much chipwood from the integrated operation. However when seed trees are being removed (up to two years later) almost no chipwood will be produced from this predominantly sawlog operation. The logging plan must accommodate such variations.

The first step in the process is seed sampling. Twig samples are obtained (using a high powered rifle) and the stage of capsule development is observed. An estimate is made of the quantity and viability of seed which is expected to be present at the time of the regeneration burn. (App. 5.1)

If sufficient seed is expected then the area will be nominated for clearfelling with seed trees (Plates 6,7). If not, then clearfelling with planting or hand seeding will be used.

The relative costs of the different methods are shown in Appendix 5.3. To avoid disruption to fruit development, areas selected for seed tree operations must not be burnt for at least 3 years prior to the intended date of the regeneration burn.

### 3.1.3 Demarcation and Marking

The cutting area is demarcated according to the predetermined plan. (App. 5.2) Maximum coupe size is 200 ha in karri types but is generally in the order of 100 ha. Reserves, steep slopes and fallers blocks are marked out. (App. 5.4, 5.5) If a seed tree operation is intended, the seed trees are individually marked. (App. 5.6)

### 3.1.4 Logging and Utilisation Control

Utilisation is controlled on a fallers block basis, each block being inspected and certified as completely utilised before the next one may proceed. (App. 5.7) The major contractor snigs all logs to the bush landing. Normal sawlogs are hauled to the mill which holds the licence for the area concerned. Karri sawlogs below this standard (salvage) are certified as such by the forest officer and delivered to another mill. Marri sawlogs (about 3% of the total) are similarly certified as sawlog and delivered to a sawmill. Chiplogs (both marri and karri) are delivered to the chipmill where they are further inspected by a forest officer. Any sawlogs found at this point are also diverted to a sawmill.

Wet weather logging can cause problems of soil puddling and compaction. (11) This problem is minimised by summer stockpiling and reduced activity in winter, careful selection of winter logging areas, snigging methods

Plate 5. Selection cut karri forest.

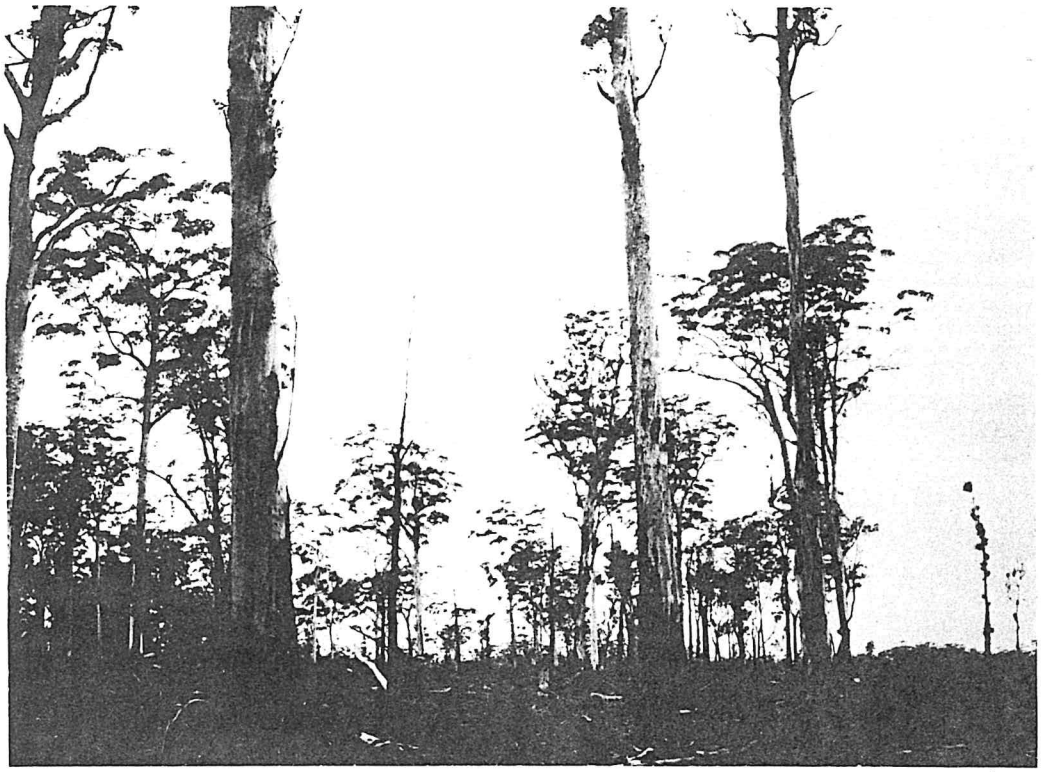


Plate 6. Karri seed trees.

and in some cases by the use of machines with lower ground pressure. Excessive compaction is prevented by regular survey of logging areas and the closure of the coupe for winter operations if limits are exceeded. (App. 5.8) Control of cutting by fallers blocks also facilitate progressive completion of environmental protection requirements.

### 3.1.5 Seed Collection

Seed collection (for use in the nursery and for broadcast sowing) is generally carried out at the time of logging in times of heavy seed crop. Until recently kiln equipment dictated the use of capsules without twigs. Capsules were removed using a modified wheat harvester or by hand "combing". A new kiln is capable of accepting either clean capsules or capsules and twigs. This kiln employs a single large drum, with forced air drying and capable of being programmed for a range of heating and rolling cycles.

The seed is cleaned with a commercial forced air and gravity table seed cleaner producing several grades of cleanliness and weight, suitable for vacuum seeding of jiffy pots, bed sowing or pelleting. Clean seed is then kept in a cool store till used.

Karri capsules normally contain only about 1 seed per capsule (though they are capable of containing more). (10) For this reason karri seed is expensive to collect. Cost and relatively low supply precludes the use for large scale broadcast seeding programmes. Seed orchard programmes are underway to improve the quality, quantity and cost of production of seed.

Although no significant provenance differences are evident, seed from different river valleys are kept in separate batches, for seeding or planting back into the same valley system.

### 3.1.6 Regeneration Burn

The objectives of the regeneration burn are to:

produce the maximum receptive seed bed for natural or artificial regeneration (5,15)

induce seed fall from seed trees

remove logging residues.

To meet these objectives the maximum fire intensity consistent with control and safety is required.

Following logging the area is "scrub rolled" with a bulldozer to increase the volume of flammable fuel and remove trees which have not been removed in logging but which if they remain alive will produce competition for the regrowth. (App. 5.9) Best burn results appear to be achieved in the first summer after logging. Burning is carried out between November and April. (Plate 8, App. 5.10)

### 3.1.7 Survival and Infilling

In the first winter after burning the area (if a seed tree or seeding operation) is surveyed using systematic milacre surveys. (App. 5.11) Understocked areas are planted in that winter. This technique has the disadvantage that late germination is undetected and some areas may be planted unnecessarily. However delayed appraisal means that remedial action cannot be taken till the following winter when newly planted stock must compete with established scrub. (9)

### 3.1.8 Removal of Seed Trees

Seed trees are removed from 6 weeks to 2 years after the regeneration burn. Six weeks allows time for the seed to fall. If left beyond two years then competition from the seed trees will kill all the seedlings beneath their own crown. Snigging of the felled seed trees is done with great care, along established snig tracks to avoid damage to seedlings.

### 3.1.9 Planting

Where planting is prescribed open rooted seedlings (12) are planted at the rate of 1,250/ha (4m x 2m). Planting is done by hand, planters departing from straight rows to plant on sites most suited for growth and development e.g. on the edge of ashbeds, away from logs etc. (App. 5.12)

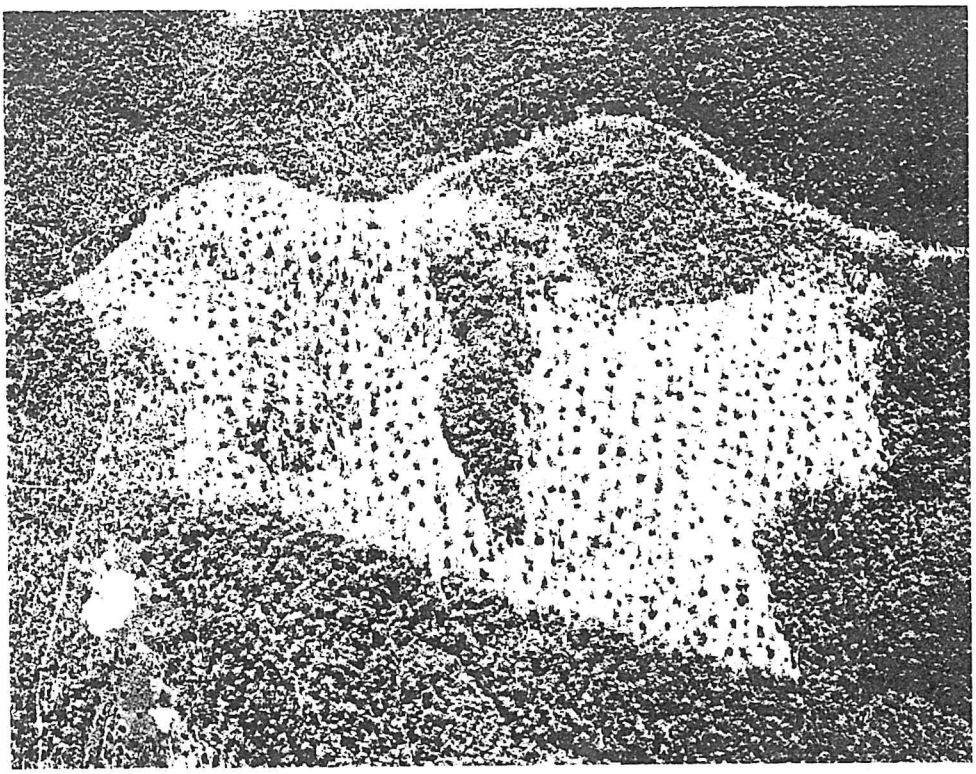


Plate 7. A clearfelled coupe with seed trees.

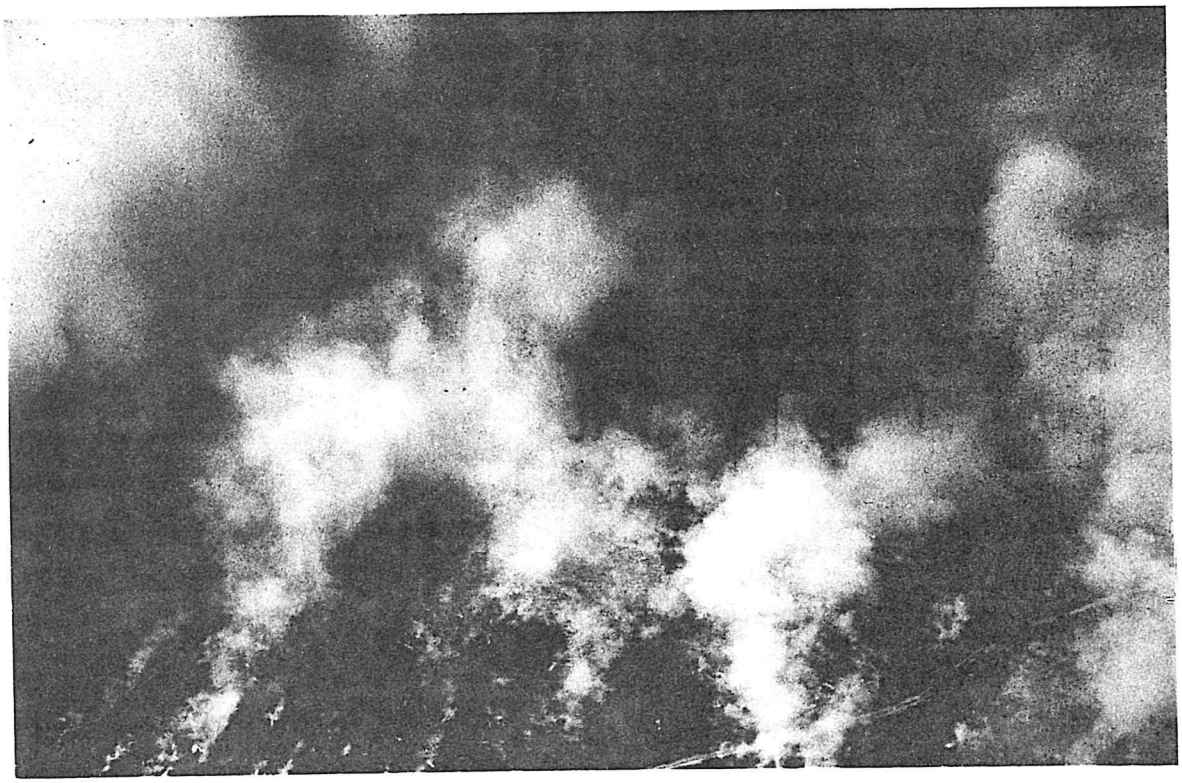


Plate 8. Regeneration burning.

Although only karri is planted, stands which were originally mixed stands will remain so because of the development of lignotuberous marri, though the proportions will tend to favour karri.

In stands which originally contained a low proportion of karri the planting rate may be reduced to 625/ha (4m x 4m). Survival rates generally exceed 80%. Jiffy pot stock (12) is used to plant rehabilitated landings, snig tracks and gravel pits because of their improved survival rate on these harsher sites. Each plant is fertilised at the time of planting (at present with 80g of Agras No. 1). (13)

### 3.1.10 Seeding

Because of the cost and availability of seed, broadcast sowing is a limited practice. Only about 200 ha/ann. are regenerated by this method.

Pelletted seed is sown at the rate of 35,000 seeds/ha using hand operated "Cyclone" seeders. (14) Aerial application has been used but is no more economical than hand methods for the small areas involved. Broadcast sowing requires 12 times the quantity of seed to regenerate an area of forest than does planting, because of the poorer survival rate in the field.

### 3.1.11 Rehabilitation of Landings and Snig Tracks

As logging is completed on each section the contractor is obliged to bar the snig tracks to reduce the possibility of erosion. The frequency of barring is determined by slope and soil erodability. (App. 5.13)

Following completion of logging, including seed tree removal if applicable, all areas which have been puddled or compacted are ripped by the industry. This involves all landings and major snig tracks. These areas are then planted with jiffy pot stock. The application of scrub seed to speed up the rehabilitation process is being tested for routine application.

### 3.1.12 Protection from Fire

Following regeneration young karri regrowth stands must receive complete protection from fire till such time as the bark is thick enough to protect

the cambium from even a wild fire. Though it varies with site this is considered to be of the order of 15 years. However, regular prescribed burning of these stands on a significant scale is unlikely to be carried out before age 20 years.

Protection from fire for these stands requires the implementation of a broadscale fuel reduction policy based on strategic burning buffers. (4)

## 3.2 EVEN AGED REGROWTH

For practical management purposes stands containing less than 15% crown cover of veteran trees above regrowth are considered even aged and managed as such. (6) These stands have resulted from wild fires which killed the original overstorey; clearing for agriculture followed by natural regeneration after they were abandoned; or as a direct result of logging. The most significant areas are those associated with periods when clearfelling has been practiced. (Plates 9,10,11, App. 5.14)

### 3.2.1 Thinning Prescription

Commercial thinning of 45-55 year old regrowth is currently being carried out on an operational basis at the rate of about 250 ha/ann.

The objectives of thinning are

to provide an intermediate yield of material which would otherwise die in the process of natural selection

to increase the diameter of retained stems (and therefore their value) for intermediate thinnings and final felling.

Thinning at this age is not expected to increase the volume of sawlog (at normal rotation age of 100 years) when compared to an unthinned stand since all final crop trees will have reached minimum size by this time even without thinning. However it will increase the size (and conversion value) of the retained crop trees while producing intermediate yields.

The thinning prescription is based on the principle of thinning all of the subdominants and a component of the codominants. The basal area retained therefore varies with age and site. The prescription uses

Plate 9. 8 year old regrowth at Big Brook. Note the large veteran to the left hand side of the photograph.

Plate 10. The same view 46 year's later. The veteran tree is still visible.

codominant height as an expression of this. (App. 5.15) The thinning removes about 55% of the total basal area or 25% of the basal area of the codominants and dominants.

It is likely that several subsequent thinnings will be carried out at perhaps 20 year intervals before a final clearfelling for regeneration.

Earlier thinnings (at perhaps 30-35 years) would have been preferred, however they could not be economically carried out until a market became available for small material in 1975 with the establishment of a chipmill.

### 3.2.2 Thinning Operation

Annual production from the operation is 40,000 $m^3$/ann. and is carried out by a subcontractor to the Forests Department. Logs from the operation are directed to various end uses. These have averaged 70% chipwood, 28% small sawlogs for tile battens and 2% peeler logs. The operation yields a nett return to the State of about $1,000 per ha (Plate 12). The operation is carried out by chainsaw felling, a three wheeled grapple for bunching and a forwarder.

Damage to crop trees by the operator incurs a monetary penalty. (Since the system has been introduced it has not had to be used.)

Coppice control is not carried out since although karri will coppice, evidence from earlier thinnings suggests that it does not develop beyond a whip because of suppression by the retained trees.

Following logging, tops and logs are removed from the base of crop trees and the area is burnt with a mild fire in spring. A relatively quiet burn in autumn when there is more available fuel will cause considerable damage, even death, to the crop trees.

Little empirical data is available on the response to thinning to different intensities or at different ages. This is being obtained now and the prescription described above will be reviewed when more data becomes available. The present prescription is considered to be conservative.

Plate 11. 7 year old pure karri regrowth at Pine Creek regenerated with seed trees.

Plate 12. 55 year old karri regrowth after thinning at Big Brook.

### 3.2.3 Further Development

A wide range of site quality exists in the karri forest. Estimates of future yield depends upon reliable predictions of these site differences. Work has almost been completed on the construction of site index curves. At this stage it appears that height can only be used as a reliable indicator beyond about 20 years of age. (Armstrong, pers. comm.). It is hoped site-vegetation techniques will provide a more reliable indication up to this age.

Some 200 permanent plots have been established so far in even aged regrowth (from 1-90 years) to provide basic growth and stand development data and later confirmation of site index predictions.

Combination of these two lines of research are expected to provide better predictions of future yield by computer modelling of stand and tree growth characteristics under different silvicultural and management regimes.

Research has also been undertaken into the effects of soil disturbance by logging machinery during thinning. This is a long term project and no conclusive results are available at present.

## 3.3 TWO TIERED FORESTS

Selection cutting and recurrent fires have produced stands with two or more distinct age classes. Where the upper storey exceeds 15% crown cover (usually 20-40%) the stand is classified as a two tiered forest. These forests have several problems affecting their management:

The regrowth develops at sub-optimum levels. (6)

Much of the upper storey consists of degrading or low value trees including culls. A considerable proportion of the growth is therefore going onto low value trees.

Their continued management as a selection forest (implying removal of larger trees and replacement with regrowth) has proved to be impractical. This is because of the excessive damage to the lower storey of regrowth caused by the felling and snigging of the larger trees or in the subsequent regeneration burning.

Two basic management options are considered for these forests depending on the stocking and the condition of the overstorey. Where there is 15-25% overstorey and it is healthy and vigorous the stand is thinned to promote growth on the trees of both ages. Where the overstorey is damaged or unhealthy the stand will be clearfelled and regenerated as an even aged forest. Where the overstorey exceeds 25% the stand is clearfelled as the regrowth component is not considered viable. Appendix 5.16 describes the full range of options considered.

The thinning or clearfelling is carried out in the same way as that described for even aged and old growth forest.

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# ESTIMATING KARRI SEED CROPS

PROCEDURE

Drive through the coupe looking at selected trees with binoculars, to get an idea of the uniformity of the capsule crop. Note any particular differences between hilltop and valley crop, or if any pronounced falling off in crop from one end of the coupe to the other. Plot any major differences on the Large Plan.

Pick small groups of trees throughout the coupe for measurement with the grid. Each group should be about 5 to 8 trees, fairly representative of the area. Each tree in the group must be far enough away to allow accurate grid assessment, but also within reasonable range of the telescope. The exact number of trees in the group, and number and location of groups assessed, will depend mainly on the distribution and number of seed trees present and the variability of the coupe conditions. However, the total mumber of trees assessed should be at least 5% of the total number of seed trees present. It is usually unnecessary to assess more than 10% of those present, unless it is a very small coupe or there is very large variation in individual trees. Formerly coupes have been around the 50 hectare range, and a 10% count of this size coupe means there will be 20 trees to count (assuming and average 4 trees per hectare). With much larger coupes, up to 200 ha, a 10% count will mean 80 trees have to be assessed, so it would be desirable to reduce the count to the minimum 5% i.e. 40 trees.

Each tree chosen should be measured by the grid. the grid is held up in front of the assessor, and moved backwards and forwards until the entire tree comes exactly within the area of the perspex window, i.e. the base of the bole ( ground level) should just cut the bottom scribed line, and the highest branch be level with the top scribed line. Holding the grid steady, the assessor then counts the number of squares occupied by the crown of the tree - the bole area below the crown being ignored. Some squares on the edge of the crown will be partially occupied, and these can be included at the assessors discretion two or more partially occupied squares can be counted as one complete one; or squares more than half occupied included, those less than half occupied ignored.

Each tree assessed with the grid must then be examined by telescope and the capsules per twig counted. The grid assessment and capsule per twig number is then noted on Form III, and each individual tree score worked out from Table X on Form III.

The actual assessment of capsule <u>per twig by telescope</u> is the most difficult step, and the one most subject to error. Heavy foliage, weather conditions, poor light, etc., often make counting difficul The line between immature capsules (late Region 3 to early Region 4), mature capsules, and over-mature capsules (Region 5) is sometimes hard to distinguish.

Even when only one of these regions is present, it is not always easy to tell whether this comes in the under mature, mature, or over mature category. One of the main sources of error in assesssing areas for seed is assuming that if many capsules are apparent, there must be some seed. Often capsules hang on till the 6th or 7th year, and all seed is already cast.

To overcome this problem, one or two branches should be shot down at the commencement of the actual assessment. These branches can be examined closely and the regions present worked out, with the actual components per twig counted (these actual figures can, of course, be used for that particular tree count included in the Table on Form III).

It is helpful if the assessor first makes an estimate of the particular tree from which the branch is shot down. He can then check his estimate from the shot branch. This, and perhaps a further visual examination of the tree after obtaining the figures from the shot branch, will give a good guide to the remaining trees in that group.

Even if it is impossible to count the exact number of capsules per twig for any of the trees examined, it is usually obvious whether the number of capsules present fall into the 'Heavy','Medium', or 'Light' range as laid out in Table X. In this case, a'heavy' crop can be given the average figure i.e. 9 capsules/twig, a 'medium' crop 6 capsules/twig and a 'light' crop 3 capsules/ twig. The size of the tree is then applied in each case to this average figure to abtain seed per tree.

As well as the actual groups of trees chosen for grid assessment, it is advisable to examine some of the intervening trees with telescope or binoculars - this gives a good overall impression of the Coupe and should confirm your actual grid and capsule assessment of the groups of trees.

SHOOTING

It would be ideal to shoot down a branch from each tree examined, but this would be too expensive and time-consuming. In practice, a minimum of 3 branches are shot down in each coupe examined, and more if the coupe is large, or the trees very variable or difficult to assess visually. A good guide would be, in an average, fairly assessable coupe, to shoot down one branch in every 8 trees examined. This would give the minimum 3 branches for a 50 hectare coupe ( with a 10% assessment rate ), and 5 branches in a 200 ha coupe ( with a 5% assessment rate).

The choosing of which branches to shoot down will become easier with experience, but the following points should be noted:

a) The number and siting of branches shot will depend on both the size of, and variation within, the coupe, but should be numerous and diverse enough to reflect any variation.

b) A reasonably 'average' branch should be chosen in each case, but the branch must offer a good target, contain enough' crown' to give a good sample, and have a free fall i.e. in practice, branches must be near the edge of the tree crown.

c) The target area of the branch stem should not be too thick from 4cm to 8cm is a reasonable size.

d) Branches often hang after breaking. In this case, it is futile firing of a dozen or so shots in an attempt to free it. It is better to try another branch. However it pays, particularly on a windy day, to check every area where branches are hanging before leaving the coupe. Often a branch will have freed itself by then, and is useful for a confirmatory check and another capsule sample.

e) Branches rising straight up, or at an acute angle, should be chosen for preference. This cuts down the number of 'hang-ups'.

f) Shooting range is up to the individual. However a distance of about 60 - 80 metres from the tree is about right. The most efficient way of obtaining the branch is to fire the first shot into the lower edge, second shot into the upper edge, then one or more shots into the centre. Precision comes with practice, and it is often possible to get a branch down with two shots - occasionally with one. But if a branch breaks with the first shot, more often than not it will hang. About 5 to 8 shots is the most frequent number to bring down a branch.

Once a branch is down, the components should be counted, each region separately. It is also helpful to count the bud stages also - though these will not be needed for that particular coupe, they will be useful record for the future seed years in that locality, and will supplement the normal annual seed forecast by Research Branch.

Region 4 capsules can be noted on Form III, and if Region 5, and/or immature 4 are also present they can be noted on separate forms and taken into account in the final assessment report.

The assessor must fill out Form III in the field.

A sample of at least 200 capsules from each stage should be collected from each branch. Thus there may be from 1 to 3 separate samples from each i.e. there could be 9 samples if 3 branches are shot down. Normally there is only one sample from each branch. Late Region 3 capsules, even if they appear green, should be sampled as they will sometimes open under heat, and will give a good guide as to when the next burn may be possible if the first one is delayed for any reason.

Each sample should have a label, inside the bag, giving the Coupe No., Region of capsules, Sample No. and date. (eg Iffley Block, Coupe 2 Region 4(early), Sample No.1 23/2/77). The rough area where each sample branch is shot should be marked on the coupe plan, or at least described on the report, e.g. "Sample No. 3 shot in north west corner of coupe, from junction of black and Smith Roads". Thus if there are any marked changes in seed per capsule from one area to another, this can be picked up, and if thought necessary can be checked on later by further sampling.

At this stage, the samples should be sent to Research Branch for seed extraction. This entails 2 or more days oven treatment so cannot be done in local offices yet. Research Branch will send the results back to Divisional H.Q.

Sometimes branches are shot down which contain less than 200 capsules needed for checking seed/capsule. In this case, collect all the capsules available, but note the actual number on the label. A total of 200 capsules give an accurate assessment, but as few as 50 will give a reasonable figure.

When all the information has been collected and seed/capsule figures obtained from Research Branch, Form III is easy to fill in. A copy of the form should be sent to Research Branch, as well as the Divisional requirements. A note of other regions present, from pin buds (Region 1) to flowering buds (Region 3) should also be sent.

## 4. GENERAL NOTES

Seed crop assessment is not a simple job, and if we can get our prediction to within 10 - 15% of the actual figure, we are pleased. The above procedure, 'mechanical' as it might appear, should give an estimate to within 20 - 25% of the true figure, which is quite acceptable considering the variability of any crop, and the several sources of error in the procedure. As the assessor does more seed prediction work, it becomes easier, and it may be possible to cut down on the use of the grid. However, it takes several seasons to get the 'Feel' of Karri seed prediction, and no short cuts should be attempted until some proficiency is reached. Particularly as wrong or insufficient forecasts can be very costly.

When shooting in any coupe; Divn Office, Bunnings, or nearby farmers should be informed if they are working in or near the coupe. Also ensure that the direction of shooting is away from any such working. All safety precautions with the rifle should, of course, be strictly adhered to. The wearing of ear-muffs is strongly recommended both for the shooter and any helpers.

# SEED FORECASTING - SAMPLING AND RELIABILITY

The following revised sampling technique provides a measure of reliability on a seed forecast as well as a time.

## 1. Standards

1.1 Sampling level is a compromise to achieve a reasonable level of reliability while not expending excessive effort in sampling. The proposed system allows the early rejection of coupes where variability of capsule crops between trees is high and excessive sampling effort would ne needed to reach the required level of reliability.

1.2 A reliability level has been chosen with the standard error within 12.5 percent of the mean. At this level the estimated mean of capsules per twig will be within ±25 percent (= 2 standard errors) of the true mean, with a probability of 5 percent.

1.3 Minimum capsule per twig numbers for a satisfactory seed crop are shown below in section 2.6. These capsule numbers were calculated from the numbers of seeds needed for satisfactory regeneration. These data are shown in 1.4 below. They represent some departure from past practic in that the ease of regeneration on different sites is taken into account, and a larger seed crop is assumed to be needed for the more difficult sites.

1.4 Minimum Seed Levels (at 4 seed trees/ha-some flexibility is possible in No. of Seed Trees/ha).

| Site Type | Seeds/Hectare | | Seeds/Tree | |
|---|---|---|---|---|
| | Spring * | Autumn | Spring | Autumn |
| Red Loams | 150 000 | 100 000 | 37 500 | 25 000 |
| Northern Podsols (Gen. mixed type) | 225 000 | 150 000 | 56 300 | 37 500 |
| Southern Podsols (Walpole Area) | 300 000 | 200 000 | 75 000 | 50 000 |

* Denotes anticipated season of regeneration burn.

## 2. Sampling Procedure

2.1 Sampling will be subjective in that only potential seed trees will be assessed.

2.2 Sampling will aim to cover roughly 5% of the potential seed trees. This amounts to assessing approximately 20 trees per 100 hectares of coupe area.

2.3 Sampling will cease temporarily after a rate of 10 trees per 100 hectares has been reached, and the calculations shown in Sections 3 and 4 will be followed.

2.4 Depending on the results of these calculations, the following alternatives will be performed.

2.4.1 If the standard ~~cover~~ error of the mean number of capsules per twig falls within 12.5% of the mean, sampling will cease. (the sample is adequa

2.4.2 If the standard error of the mean number of capsules per twig exceed 12.5% of the mean, then calculate the number of trees to be sampled to achieve the 12.5% level.

2.4.3 If the number of trees required is equivalent to 20# per 100 hectares or less, continue sampling to the requisite number.

2.4.4 If the number of trees required is greater than 20# per 100 hectares cease sampling and abandon the coupe as a seed tree proposition.

2.5 On return to the office, the mean capsule per twig figure will be compared with the minimum for an adequate seed supply shown in 2.6.

2.6 Minimum capsules per twig for an adequate seed supply (at 4 seed trees/ hectar (assumes an average of 1.1 seeds/capsule).

| Mean C.A.G. for Sample | Red Loams | | Northern Podsols | | Southern Podsols | |
|---|---|---|---|---|---|---|
| | Spring * | Autumn | Spring | Autumn | Spring | Autumn |
| 35+ | 2.4 | 1.7 | 3.8 | 2.4 | 5.0 | 3.4 |
| 25 - 34 | 3.8 | 2.5 | 5.6 | 3.8 | 7.8 | 5.0 |
| 15 - 24 | 7.5 | 5.0 | 11.1 | 7.5 | 15.0 | 10.0 |

* Denotes anticipated season of regeneration burn.

3. Calculation of Standard Error

3.1 Calculate standard deviation as follows :-

3.1.1 Subtract the lowest capsule per twig figure from the highest. This will give a range.

3.1.2 Refer to the range/standard deviation ratio table given below and read off the ratio applicable to the number of trees you have sampled.

3.1.3 Divide the range figure by the ratio figure read off the table. The result is a fairly accurate estimate of the standard deviation.

3.2 Divide the standard deviation by the square root of the number of trees in the sample. The result is the standard error.

Ratio of Range/Standard Deviation

| Number of trees in example. | Ratio Of range/SD |
|---|---|
| 10 | 3.08 |
| 15 | 3.47 |
| 20 | 3.73 |
| 25 | 3.92 |

| | | |
|---|---|---|
| 30 | _____ | 4.09 |
| 35 | _____ | 4.20 |
| 40 | _____ | 4.32 |
| 45 | _____ | 4.41 |
| 50 | _____ | 4.50 |

eg:

Assume 10 trees sampled and the 10 capsules per twig figures range from the lowest of 2 to the highest of 8.

Range = 2 to 8 = 6 (3.1.1 above)

Range: Standard Deviation ratio = 3.08 (3.1.2 above)

Standard Deviation = $\frac{6}{3.08}$ = 1.95 (3.1.3 above)

Standard error = $\frac{1.95}{\sqrt{10}}$ = 0.62 (3.2 above)

4. Calculation of number of trees required in sample to give a standard error within 12.5% of the mean.

The formular for this calculation is

$$n = \left( \frac{\text{Standard Deviation}}{\text{Standard Error}} \right)^2$$

where n - is the number of trees which need to be sampled.

Standard Deviation - is the one you have calculated already for your sample.

Standard Error - is the one you wish to work to and calculated from the mean capsules per twig from your sample divided by 8 (=12.5%)

eg: Standard deviation = 1.95 (See example 1)

Standard error = 0·25 (Say mean caps/twig = 2, St.error required = $\frac{2}{8}$ =

Number of trees to be sampled to give a standard error of $\pm$ 12.5%

$$= \left( \frac{\text{standard deviation}}{\text{standard error}} \right)^2 = \frac{1.95^2}{0.25} = 61$$

i.e. 61 trees will give a reliable estimate in this example.

5. Calculate standard error for all samples and assign a reliability to the estimate as follows.

| RELIABILITY | STANDARD ERROR |
|---|---|
| GOOD | $\pm$ 12.5% of mean capsules/twig |
| FAIR | $\pm$ 25% " " " " |
| POOR | $\pm$ 25% " " " " |

eg: Mean capsules/twig = 4.3
Standard error of sample = 0.87
i.e. Standard error = $\frac{0.87}{4.3} \times \frac{100}{1}$ % = 20.23% of mean.
Reliability of the estimate is fair.

i.e. Estimated mean capsules/twig is within $\pm$40.46% of the true mean, with a probability of 5%.

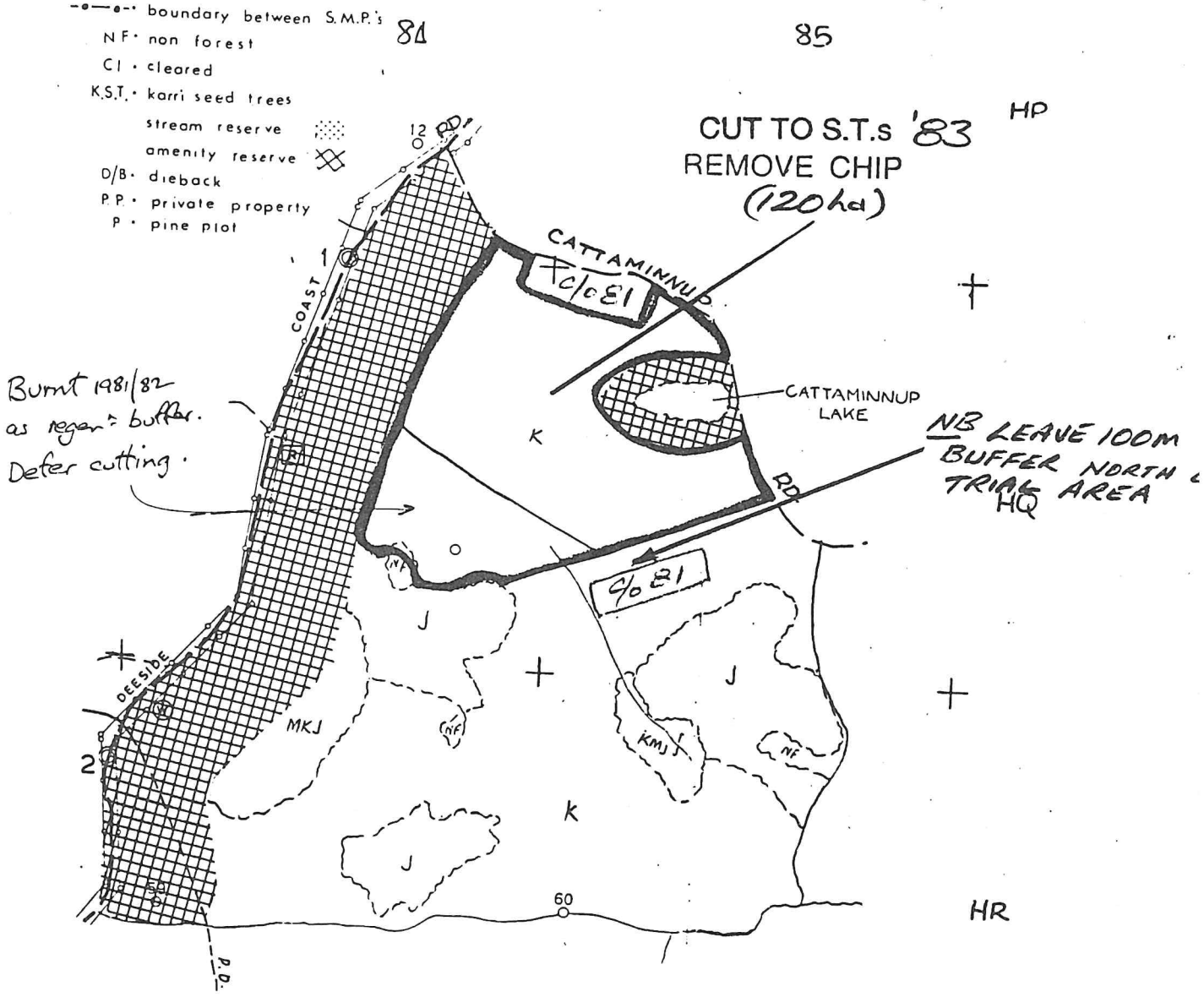
# MURTIN BLOCK compartment coupe 9

## CUTTING

SMP 1193

SYMBOLS USED:

- J · jarrah
- K · karri
- S · summer logging
- W · winter logging
- C/F · clear fallen
- STS · seed trees standing
- REGEN · regeneration
- G/S · group selection cut
- M · marri
- -X—X- boundary between S & W
- -•—•- boundary between S.M.P.'s
- N F · non forest
- Cl · cleared
- K.S.T. · karri seed trees
- stream reserve
- amenity reserve
- D/B · dieback
- P.P. · private property
- P · pine plot




COMPILED BY K.A.

CHECKED BY

ISSUED ON 24 DEC 1982

MANJIMUP SHIRE

GRID REF: HQ 85

1:25000 0 metres 500 1000 metres

~~PHOTO~~/INVENTORY DATE: FEB. 1975

# RELATIVE COSTS AND RETURNS OF SILVICULTURAL SYSTEMS

| 1981 ROYALTY V REGENERATION COSTS | | | |
|---|---|---|---|
| | | WITH WOODCHIPPING | WITHOUT WOODCHIPPING |
| INCOME | ROYALTY (For Average Yield) | PER HA | PER HA |
| | SAWLOG - $78m^3$/ha @ $9.60 | $ 749 | $ 749 |
| | CHIPWOOD - $150m^3$/ha @ $3.15 | $ 472 | - |
| | TOTAL | $1221 | $ 749 |
| COSTS | REGENERATION | | |
| | Option 1. Seed Trees | $ 85 | $ 173 |
| | Return/ha | $1136 | $ 576 |
| | Option 2. Hand Planting | $ 225 | $ 313 |
| | Return/ha | $ 996 | $ 436 |
| | Option 3. Hand Seeding | $ 173 | $ 225 |
| | Return/ha | $1048 | $ 524 |

# COUPE PLANNING PRESCRIPTION

## 1. CUTTING AREAS

The permit control officer will locate each coupe for cutting well in advance of any operation. Accurate identification of cutting coupes is vital. A known point (Theodolite Reference Tree, Road Junction, Private Property Boundary etc.) must be used to locate precise geographical location. Aerial photos will assist this work. Plotting of roads and other features cannot be assumed to be accurate on Departmental maps.

## 2. DEMARCATION OF COUPE BOUNDARIES

Coupe boundaries will be marked with white paint crosses. River reserves (200m from watercourse), Stream reserves (100m from watercourse) and Road Reserves (400m from road edge) will be marked with white crosses. Check measurements must be carried out.

Fire control and forest type considerations in boundary location should be discussed with the Regeneration Forester.

Boundaries will not be varied from H.O.C.S. plans without approval from R/L Planning.

Minor excisions from coupes have a considerable cumulative effect on the available resource.

It is recommended that coupe boundaries are demarcated with a bulldozed track in conjunction with the white painted crosses, in Karri scrub types. Dieback Hygiene should be planned for this machine activity.

## 3. INTERNAL MANAGEMENT BOUNDARIES

Dieback risk categories boundaries and steep slope "special care zones" will be demarcated after coupe boundaries are marked.

The boundary between dieback forest or suspect dieback forest and dieback-free forest will be marked with yellow painted blazes. Special Care Zones will be marked with orange flagging tape.

## 4. ROADING

In-coupe roads will be selected after dieback demarcation and alignments selected to maximise hygiene. Industry Control Specifications, Items 9 and 10, detail Industry Road Construction and Gravel Pit Working.

## 5. FALLERS BLOCKS

The permit control officer and Industry Foreman will jointly plan location of fallers blocks. Topography (summer and winter bush) must be considered at this stage. The location of fallers blocks will be marked on an enlarged H.O.C.S. plan. The Industry foreman will demarcate fallers blocks with white plastic flagging tape and associated tracks if required.

## 6. SCRUB ROLLING BEFORE FALLING

Scrub rolling before falling and treemarking will be checked by the permit control officer.

Excessive soil disturbance during scrub rolling is not permitted. Faller safety requires a distance of 3m to be cleared around each tree to be felled. Dieback Hygiene requirements must be observed during scrub rolling.

## 8. WORKING METHOD FOR LOG DUMPS

A suitable area will be cleared of debris. Topsoil may be stockpiled to assist rehabilitation. Areas of regrowth in jarrah types must be avoided. A heap of debris should be constructed at the rear or to one side of the dump. Off cuts and condemned logs will be added to the heap.

Debris must not be heaped against standing trees. One blade width is required between debris and standing trees. One large heap is preferred to a number of small heaps.

## 9. LOCATION OF MAJOR SNIG TRACKS

Major snig tracks should be marked prior to the commencement of falling. One arterial snig track for each fallers block, supplemented by a herring bone pattern of minor snig tracks will minimise Class 1 soil disturbance. Major snig tracks serving landings low in the profile should enter the landing from the side to prevent direct drainage of water onto the landing.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83
DATE FOR REVIEW: 31/12/83

# INDUSTRY CONTROL SPECIFICATION

## STEEP SLOPE LOGGING PRESCRIPTION

## 1. INTRODUCTION

It is recognised that careless management of steep slopes during logging could lead to problems, viz:

1.1 Soil erosion.

1.2 Mechanical disturbance of watercourses and siltation.

1.3 Wastage of resource - i.e. logs left in inaccessible defiles.

1.4 Visual disturbance - this is worse in steep areas as it can be easily seen.

To minimise undesirable effects, special action will be required at a number of levels involving Planning, Industry Control and Operations staff.

## 2. PRESCRIPTION

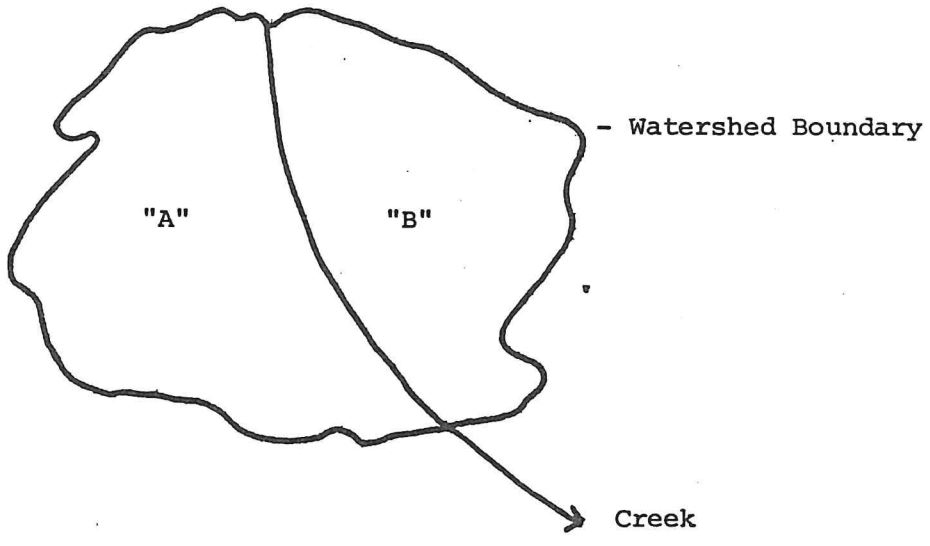
### 2.1 PLANNING

2.1.1 Identify problem areas on (i) an overall plan of the region, (ii) block plans, (iii) individual coupe sheets.

2.1.2 On enlarged coupe plans, demarcate major slopes and valleys (>5ha) which are steeper than 20°. Depending on circumstances, decide whether such areas are an erosion risk and will or will not be cut.

Within coupes, slopes and gullies steeper than 20° and 50 metres strips along water courses will be demarcated as "Special Care Zones", and shown as such on the coupe plans.

2.1.3 Wherever possible the facing slopes of major valleys should be cut and regenerated in different years eg.




Cut and regenerate "A" in years 1 and 2.
Cut and regenerate "B" in years 2 and 3.

2.1.4 Programme C/F not S/T cutting for all steep areas, irrespective of seed situation.

### 2.2 INDUSTRY CONTROL

2.2.1 Check the H.O.C.S. Sheet in the field and make recommendations for deletion of cutting areas and provision of "Special Care Zones".

All staff will be trained in the need for special attention during logging operations.

during every phase of operations in steep areas - from demarcation and initial roading through to intermediate and final erosion control and rehabilitation work.

2.2.3 Wherever possible, snigging should be uphill or across contours. Snigging patterns must be jointly pre-planned for each landing.

2.2.4 In designated "Special Care Zones" machine movements must be avoided or minimised and only made under the personal supervision of a forest officer.

2.2.5 Areas must be worked systematically from the back of the block and erosion control measures carried out on each snig track, or part of a snig track as the area behind it is logged out.

2.2.6 The Forest Officer may give consideration to whether utilization of small limb logs is to be required. This may result in considerable soil disturbance to recover a small volume of wood.

2.2.7 Cut steep slopes under dry soil conditions only.

2.3 OPERATIONS

2.3.1 Steep coupes will preferably be spring regeneration burnt - i.e. before Christmas in any Calendar year, to ensure scrub and bracken regeneration before the first winter rains.

2.3.2 Rehabilitation work will be carried out before the first winter after burning. All ripping must be across contours and special care exercised (i) to avoid damage to erosion barriers and (ii) to ensure adequate erosion control on temporary Forests Department burning tracks around the coupe perimeter.

2.3.3 Advance mop-up should not be used on steep slopes - use buffers if possible, or along the edge of watercourses.

2.3.4 Do not scrub roll the "Special Care Zones" on steep pinches or along watercourses.

2.3.5 All planting to be across contours and completed (including rehabilitation areas) in first winter after burning. Vehicles involved in planting operations must not damage erosion barriers; and erosion control must be done on tracks put in for planting access.

2.4 GENERAL

2.4.1 Training in the rationale and techniques outlined above must include all industry and Forests Department personnel involved.

2.4.2 A review of success or failure will be made at the completion of each coupe and remedial action prescribed when necessary.

2.4.3 Industry Control staff will keep abreast of world and Australian technology on steep slope management through the literature, invited experts and visits to other operations.

2.4.4 Industry and Industry Control staff, will initiate research into appropriate logging technology for steep forests.

2.4.5 Inventory and Planning will calculate resource "not available" on excised areas and advise Head Office for possible P/I review in next G.W.P.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83

SOUTHERN REGION

INDUSTRY CONTROL SPECIFICATION

# KARRI SILVICULTURE PRESCRIPTION

## 1. CLEARFELLING

Where an area is to be regenerated by hand planting or "artificial" seeding the cutting prescription is to remove all merchantable stems.

## 2. CLEARFELLING WITH SEED TREES

### 2.1 CUTTING TO SEED TREES

The aim of this operation is to retain and protect trees which will provide a seed source for regeneration.

#### 2.1.1 Seed Tree Stocking

Seed trees will be retained at a stocking of 4 trees per hectare. This corresponds to a spacing of about 50 - 60 metres between the boles.

Allowable Variation:

(i) up to 80m in high site quality pure Karri stands.

(ii) down to 40m in S.F.D. areas or MK stands.

#### 2.1.2 Seed Tree Specification

The seed tree will be a windfirm dominant or codominant with a healthy spreading crown, of a good form and free from hereditary defect.

Allowable Variation:

Retain any seed source (i.e. cull tree or group of piles) if no seed tree meeting the above specification is available at prescribed spacing.

#### 2.1.3 Seed Tree Species

Seed trees will be karri, but marri or tingle will be retained in the absence of a suitable karri seed tree at the prescribed spacing.

Marking for Seed Trees before Marri cutting is required.

#### 2.1.4 Seed Tree Protection

Retain any other tree which will uproot or damage the crown of a seed tree if the other tree is felled.

#### 2.1.5 Marking Procedure

Seed Trees will be marked with a white painted line at head height around the tree, or white painted "9" on three sides. Temporary marking using orange flagging tape is permitted.

Additional seed trees may be retained for the initial cut to provide for losses due to windthrow or falling damage.

2.2 REMOVAL OF SEED TREES

The objective of the operation is to remove seed trees with the minimum of damage to regrowth, and soil.

2.2.1 All trees will be toe-marked, for directional felling to enable crown bunching, to eliminate damage to growing stock, and to take advantage of gaps.

2.2.2 The primary cause of damage to regeneration and soil is uncontrolled movement by log hauling machines. The tree-marker is to decide with the bush boss the pattern of snig tracks and landings to be used. No new major snig tracks or log dumps to be initiated without authorization from the forest officer.

2.2.3 The bush crew will be instructed by the forest officer with regard to the following points:

(a) No unnecessary clearing of ground debris en route to logs. Logs blocking snig tracks to be cut and lifted, not pushed into regeneration.

(b) Machines will be reversed into butts and crowns at all times.

(c) A swamper is to prepare logs for snigging by digging underneath with a spade. No rolling or skidding of logs permitted to enable hook-up.

(d) Where a log has to be pushed it must be lifted and pivoted on the crown end.

(e) The selection of routes off main snig tracks should aim to minimize damage to regrowth.

2.2.4 Maximum supervision will be applied to Seed Tree removal operations.

Each coupe will be divided into appropriate fallers blocks.

2.2.5 Seed Tree removal will be carried out only under dry soil conditions. A nominal period from 15 November to 31 May each year is set. Extensions to this period may be negotiated. The operation will be suspended during wet weather during this time.

2.2.6 The forest officer will assess the likely impact of extracting small chip logs from seed tree crowns. He may decide to leave merchantable logs in order to minimize soil disturbance.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL

DATE: 1/3/83

DATE FOR REVIEW: 31/12/83

SOUTHERN REGION

INDUSTRY CONTROL SPECIFICATION

# COUPE CONTROL PRESCRIPTION

## ADVANCE PLANNING:

See Item 7 (Coupe Planning Prescription).

## FALLERS BLOCKS:

The forest officer will prepare a large scale plan of the coupe (enlarged HOCS Sheet usually at 1:12500 scale), and copies will be made available to the bush foreman. The Forest Officer and Bush Foreman will plan fallers blocks which should follow topographical features to facilitate seasonal extraction, and should be in a single dieback risk category.)

Demarcation of fallers blocks is required prior to the commencement of cutting. A maximum of two blocks per faller, each of 4 - 6ha (no more than 2 weeks cutting) to be demarcated by the bush foreman and checked by the Forest Officer.

A new block will not be commenced by the faller until one of the fallers blocks has been utilized to the satisfaction of the forest officer in charge.

Skidding and erosion control must also work progressively through fallers blocks cleaning up the coupe, block by block.

Fallers blocks will be demarcated using white plastic flagging tape. Supplementary tracks may be installed if considered necessary by the Industry.

## INTERMEDIATE INSPECTIONS:

Forest Officers will periodically check fallers blocks during cutting to monitor stump height, long butting and log dressing, branding stumps and logs, soil disturbance etc.

Forest Officers will use yellow chalk to sign and date stumps and logs during block inspection.

## FINAL INSPECTIONS:

Prior to a certification inspection of a fallers block the bush boss and the Forest Officer should walk the block and be satisfied that work is completed. The final inspection of a coupe will be performed by an authorized Divisional or Regional officer. The area OIC will authorise responsibility for certification by Divisional officers.

The certifying officer will indicate on the coupe plan that a coupe, or part thereof, has been completed. He may certify a block finished subject to the subsequent extraction of a stipulated number of logs taped in the field. The forest officer will follow up to ensure the extraction is completed and environmental controls satisfied.

The presence of a log to be cut,or extracted,or pushed out for inspection,or a tree to be felled,will be indicated by using yellow plastic flagging tape prominently displayed.

Landings will also be certified complete following removal of all logs and satisfactory heaping of debris. All rubbish (drums, filters etc. to be removed).

The Industry will not be expected to return to a coupe once it has been certified completed.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83

# LOGGING DISTURBANCE CONTROL PRESCRIPTION

## SCOPE:

This prescription outlines the method of control to limit the area of unacceptable soil disturbance in logging operations in the Southern Region.

## OBJECTIVE:

1. To restrict the total level of damaged soil to 20% of the coupe (including landings), at the completion of logging.

2. To restrict the level of damaged soil on landings to 5% of the coupe.

## DEFINITIONS:

### DAMAGED SOIL

Soil which has been subject to any of the following:

(a) The A soil horizon (topsoil) has been removed.

(b) The A soil horizon (topsoil) has been mixed with the B soil horizon (sub-soil usually containing clay).

(c) Severe compaction. (Normally meaning compaction which will affect germination or plant growth).

### UNDAMAGED SOIL

Soil which has retained its normal structure and where the bulk density as a result of compaction has not increased sufficiently to affect germination or plant growth.
(Bulk density is a measure of pore-space or aeration within a soil High Bulk density = low pore space).

### STOCKPILING

Accumulation of surplus logs during dry soil conditions to enable restriction of snigging activity during periods when soil is predisposed to damage and when risk of dieback spread is greatest.

### IN-COUPE (ROADSIDE) STOCKPILE

Approval must be sought for roadside stockpiling in nominated coupes. When approval is granted a deadline for stockpile removal will be set. (To enable regeneration to be programmed). The area of the coupe occupied by landings will generally be greater than 5% where roadside stockpiles are constructed. Where logging will continue outside the approved stockpiling period in such coupes the control level for snigging damage will be 10%. (See Control System Overleaf).

### APPROVED STOCKPILING PERIOD

15 November - 31 May

### APPROVED SEED TREE REMOVAL PERIOD

15 November - 31 May (Extensions negotiable)

## CONTROL SYSTEM:

WHEN: Survey will be conducted when:

1. Total soil damage is estimated to be reaching 15 percent (including landings)

2. Repeated frequently, particularly when soil conditions are likely to deteriorate rapidly over short periods of time.

WHAT: 1. Surveys will be carried out to determine:

1.1 The percentage area of each fallers block occupied by the landing(s).

1.2 The percentage area of each fallers block where damaged soil has been caused by snigging.

(Note: Areas of non-forest are not included in fallers block area).

2. If the area in 1.2 exceeds 15% or the area of 1.1 + 1.2 exceeds 20% then that fallers block and landing will be closed.

The logging supervisor will then be asked to select the best area in the coupe to continue logging.

If the damage levels are exceeded in the best area, then the whole coupe will be closed.

3. Where not all species or products are being logged (partial cut) a fallers block will be closed when the area of 1.2 exceeds 10% or the area of 1.1 + 1.2 exceeds 15%.

This is to allow for additional damage when the remaining trees are logged at a later date.

(Note: Intention of partial cutting to be given to the Permit Officer prior to commencement of a fallers block).

4. After a coupe is closed the decision to re-open it will be made by the Divisional O.I.C. Consideration will not be given to re-opening the coupe until the S.D.I. exceeds 25.

5. When a coupe has been closed once and re-opened, it will automatically close again when the S.D.I. falls below 25.

HOW: SOIL DISTURBANCE SURVEY TECHNIQUE

1. Establish a survey of the coupe boundary and existing roads. (vertical coupe photos will assist).

2. Survey the boundary of each fallers block to be assessed using compass and pace method, and plot on a blown up H.O.C.S. Sheet. Calculate the area of the fallers block.

3. Measure the size of the landing and calculate the area. Calculate the percentage of the fallers block occupied by the landing. (x)

Where $x < 5\%$ Maximum total snigging damage level = 15%

Where $x > 5\%$ Maximum total snigging damage level = 20 - x%

(For a partial cut the snigging damage levels will be reduced by 5%).

4. Determine, and if necessary, demarcate the extremities of snigging to establish the area to be sampled for snigging damage.

5. Establish four parallel sample lines at right angles to the main snigging direction. Line 1 to be 20m from the back of the landing. Lines 2 - 4 spaced evenly to separate the maximum snig distance into 4 approximately equal sections (see diagram below).

6. Using a notebook, to record, pace across each sample line classifying each pace as damaged or undamaged soil.

7. Complete the "Field Assessment of Soil Disturbance" form.

8. Survey results must be forwarded on the day of assessment, to the Divisional O.I.C.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83 DATE FOR REVIEW: 31/12/84

FIELD ASSESSMENT OF SOIL DISTURBANCE:

COUPE:

ASSESSOR: — EXAMPLE ONLY —

DATE:

TYPE OF CUTTING PRESCRIPTION:

LOCATION PLAN (See Over)

(Indicate survey details for fallers block boundary, landing and area assessed. Shown sample lines).

SURVEY SUMMARY

1. Total Area of Fallers Block ..15675.. $m^2$

2. Landing Damage ....900.... $m^2$ (5.7%)

3. Snigging Damage

| LINE | DAMAGED | UNDAMAGED | TOTAL |
|---|---|---|---|
| 1 | 14 | 80 | 94 |
| 2 | 17 | 85 | 102 |
| 3 | 19 | 86 | 105 |
| 4 | 10 | 77 | 87 |
| TOTAL | (a) 60 | (b) 328 | (c) 388 |

SNIGGING % DAMAGED SOIL = $\frac{(a)}{(c)}$ x 100 = ..15.5..%

4. Total Damage ..21.2..%

RECOMMENDATION (delete unwanted recommendation)

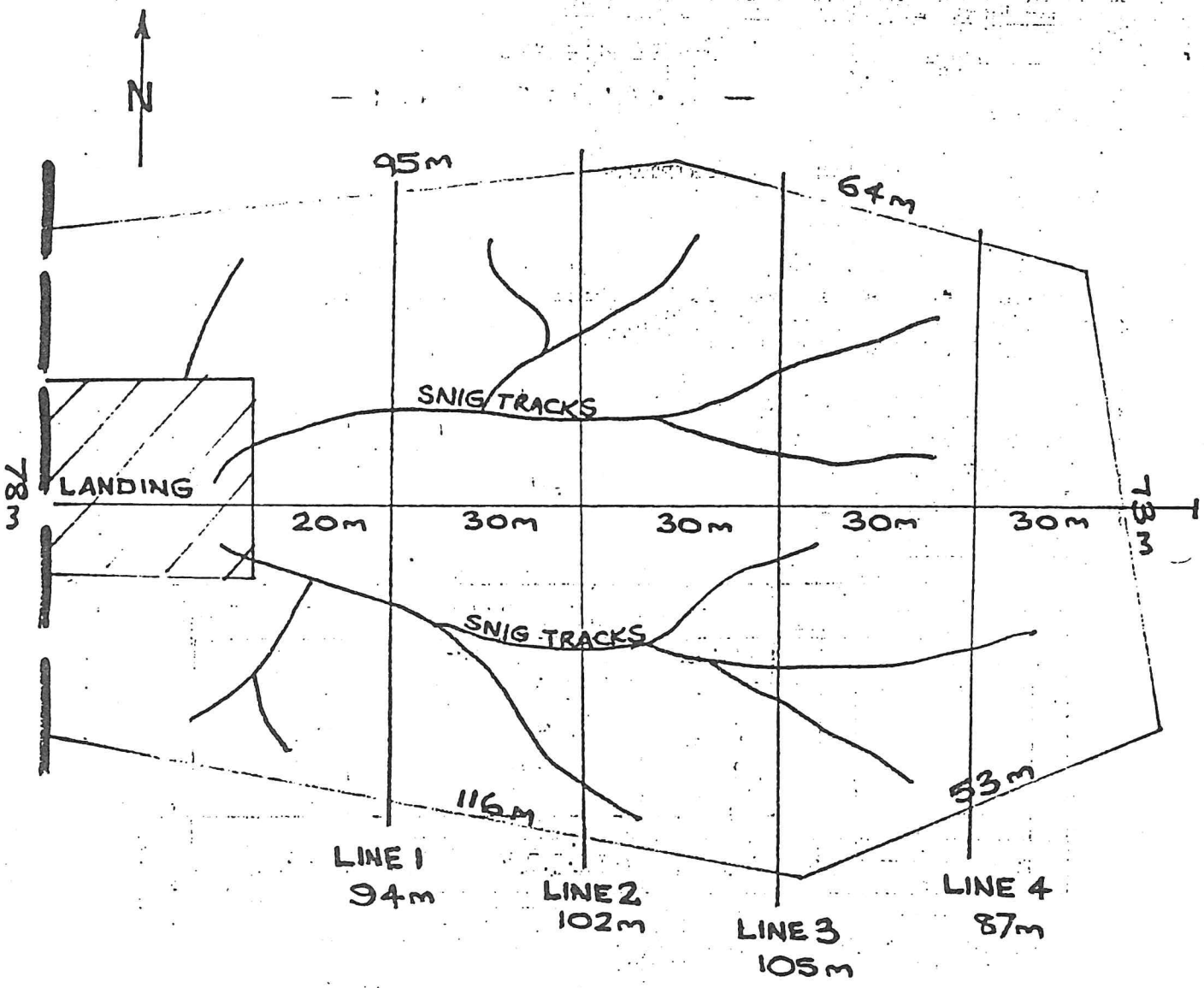
~~1. Operation continue but survey be repeated~~

..... ~~(nominate when - time period or after x rain)~~

(2.) Fallers block closed - best area to be selected.

~~3. Coupe closed~~

# LOCATION PLAN



Prepared by R.J. SNEEUWJAGT Revised: August, 1980

1. OBJECTIVE

To prepare cut-over Karri, Karri/Marri coupes to:

(i) provide adequate cover of dead fuel bed for high intensity slash burn with subsequent creation of ashbeds, and

(ii) to reduce scrub and tree competition to provide full stocking of subsequent regeneration. By means of bulldozer and chainsaw in the most efficient and economic methods, taking into consideration possible detrimental effects on soil and water values and operation safety.

2. PLANNING

Regeneration Officer and Principle treemarker to agree on an optimized cutting and burning boundary before cutting commences. Consider:

2.1 Symmetry of shape and cutting to type boundary.

2.2 Use of existing roads.

2.3 Location of stream and amenity reserves and research areas.

2.4 Avoidance of boundaries on excessively steep, rocky or wet areas.

3. PERIMETER TRACKS

3.1 Should be reasonably straight, avoid steep, rocky or wet areas.

3.2 Should be on cutting edge and tops must not occur outside perimeter tracks unless it is planned to burn area out as a buffer.

3.3 Should be 4 metres wide, formed and upgraded to permit all weather access. Pipes should be installed where road is likely to be a permanent access.

3.4 Turn arounds should be installed at 150 to 200m intervals.

3.5 Sections 2,3,4,5,6 and 7 of the Dieback Hygiene Manual must be adhered to in selection and construction of perimeter tracks.

4. BUFFER STRIPS

4.1 Ideally, slash burns should be surrounded by a buffer strip of minimum 100 metres in depth. The buffer may either be burnt in advance or on day of slash burn, or be left unburnt on days of suitable moisture differential and burnt out on first succeeding suitable day.

4.2 Optimally, buffers to be located in J, JM, MK, stands to a depth of 100 to 200 metres, and in flats and non-timbered areas to a depth of 400 metres. Buffers should take advantage of ridges where possible.

4.3 Consider scrub rolling buffer burn edges carrying karri scrub to ensure early edging and proper burn out in spring.

5. TREE PUSH AND SCRUB ROLLING

5.1 Scrub rolling is aimed at knocking down sufficient trees and scrub to reduce competition for subsequent regeneration, and to provide a suitable dead fuel bed for rapid fire development. Thus, it is <u>not</u> necessary to "walk over" every square metre of area. Small trees surrounded by heavy logging debris and likely to be killed in the burn need not be pushed.

culls and dead trees rejected by the industry must be pushed or prepared for subsequent stag falling.

5.3 Trees and scrub should be pushed to provide maximum distribution of fuels over bare areas such as snig tracks, but excluding landings.

5.4 Care must be taken not to destroy erosion barriers on snig track, or else these should be repaired immediately.

5.5 Do not scrub roll when soil is wet and where soil damage or bogging can occur.

## 6. INTERNAL TRACKS

6.1 Internal tracks should be constructed to break up coupes into cells of 40 to 50ha to allow for maximum flexibility in lighting strategy and burn control. These roads allow for future use in planting and fertilizer operations and fire control access.

6.2 Tracks should be flat graded and drained to minimize soil erosion. Erosion barriers will be required on steep roads and all roads not likely to be required again after the burn.

## 7. ADVANCE MOP UP (OR PUSHING-IN)

7.1 The pushing-in of logs, trash, and other heavy debris away from the perimeter into the burn before burning commences, is done to save the need for massive mop-up after the burn. However, because of the apparent deleterious effect this activity has on regeneration growth, the costly operation must be confined only to those sections of the perimeter adjacent to highly hazardous and/or valuable areas that cannot be included in buffer burns. (eg. young regrowth stands, Private Property, Stream Reserves).

7.2 Pushing-in must be done with a rake blade to ensure that windrows do not contain soil. Wherever possible logs should be speared into the burn at right angles, and any balancing logs restacked, particularly on downslope edges.

7.3 Push-in distances vary according to slopes and the nature of perimeter being protected. General depth should be 20 metres from edge of perimeter track, although this should be increased to 40m in the case of perimeter adjoining cleared Private Property. On upslope edges the push-in depth need only be 10 metres, if required at all.

## 8. WATER POINTS

8.1 The provision of easily accessible, adequate water must be considered at time of preparation. Availability will vary with season, so that it may be necessary to provide more water points for autumn burns than for early summer burns. It is advisable to construct a minimum of 2 in spring and 3 in autumn. Allow enough room for at least 2 Heavy Duties in case of emergencies.

8.2 Where water is unavailable in close proximity, it may be necessary to set up temporary supply tanks (canvas or rubber) which are filled prior to the burns.

8.3 Provide distinct signposting to water points.

9. STAG AND CULL FALLING

9.1 Large dead and dying trees rejected by the Industry must be felled for the benefit of future fire control.

9.2 Dozers should clear around those trees too large to push over in the scrub rolling operation as preparation for hand falling.

9.3 Where trees are too dangerous to fall, logs and slash should be pushed against the base so that the tree may burn down later. Another method is to fall trees by use of explosives.

9.4 Dead trees adjacent to the burn perimeter should also be considered for stag falling. However, great care must be taken to avoid falling excessive number of culls into stream reserves. (No more than 1 every 50m of perimeter edge).

10. MISCELLANEOUS

10.1 Always prepare burns from the north of the coupe southwards. This enables a cut off to be made if the entire coupe cannot be burnt for one reason or another.

10.2 It is advisable to scrub roll in advance of perimeter road work to provide maximum time for scrub to dry out prior to the slash burn. This is particularly important in coupes with a heavy cover of regrowth scrub.

10.3 Use aerial obliques in the prescriptioning, preparation and burning of each coupe. Photos should show location of tracks, cell number, control point, water points and adjacent buffers and high risk areas.

10.4 Preparation prescription should be completed at least 1 week ahead of operation and extra copies should be distributed to O.I.C. Division, and dozer operator. These should be available for inspection by Regional Regeneration Officer.

10.5 Locate and signpost an official dieback washdown site near each burning coupe.

KARRI FOREST AREA

1. INTRODUCTION

Slash burning for karri regeneration or plantation establishment requires specialised firing and logistic techniques. These guidelines outline the current methodology, as applied in Southern Forests.

2. OBJECTIVES

The objectives of slash burning operations are:-

2.1 To produce maximum receptive seed bed for natural or artificial regeneration.

2.2 To induce seed-fall from seed trees.

2.3 To remove logging residues.

To meet these objectives, the maximum fire intensity, consistent with control and safety is required.

3. FACTORS AFFECTING SLASH BURN PERFORMANCE

A number of factors influence the intensity of a slash burn. These are:-

3.1 Fuel Quantity and Arrangement

The proportions, distribution and arrangement of the fine, flash fuels and the heavy, woody fuels will govern whether a fire will ignite, spread and be sustained. Generally, the amount of fine fuels determine the likelihood of igniting the heavier fuels and of spreading the fire from one fuel heap to another. The arrangement and distribution of the heavy fuels effect the amount of fuel consumed and hence the success of the burn. Material that is rough-heaped or windrowed, burns hotter and more completely than scattered, broadcast fuels. On the other hand, heaped fuels require a more intensive lighting pattern to ensure all heaps are lit.

3.2 Fuel Moisture Content

No other single factor affects burn success more strongly than the fuel moisture content (f.m.c.)

3.2.1 Fine Fuels Moisture Content

The fine fuels must be dry enough for fires to start and ignite the heavier fuels. The f.m.c. of flash fuels vary within a heap, and unless the f.m.c. of the lower sheltered fine fuels are dry enough the burn will normally fail. The fine fuels m.c. at which ignition will or will not occur, are:

| FINE FUEL M.C.% | IGNITION PROBABLY | REMARKS |
|---|---|---|
| 23 - 26 | Very Low | Will not sustain fire |
| 19 - 22 | Poor | Patchy result; requires heaping, strong winds, etc. |
| 10 - 19 | Good | Fires sustained |
| 7 - 9 | Very Good | Hot fires, difficult to suppress |
| Less than 6 | Excellent | Very high intensity fire; eratic fire behaviour. |

Providing the large fuels are dry enough, a satisfactory burn will be achieved if fine sheltered fuels do not exceed 18 percent moisture content.

3.2.2 Fine Fuel Moisture Differential

Due to the absence of canopy, drying on cut-over areas is more rapid than under adjacent forest. If a day can be selected within the drying cycle when the fine slash is dry, but the surrounding forest is still damp, then a satisfactory burn can be conducted with minimum of risk.

An adequate moisture differential occurs when the sheltered slash moisture content is below 18% and the surrounding forest is 22% or higher.

3.2.3 Heavy Fuels Moisture Content

Large woody fuels must be dry enough to ignite and burn away. Large variation in the m.c. and ignition of different species of logs exist. Ignition varies with the period since logging, and of the type of bark cover. Under the same conditions karri logs will generally ignite and burn before jarrah, marri and Tingle logs, in that order. Logs with m.c. below 30 per cent will ignite satisfactorily if dry, fine fuels are abundant.

3.2.4. Burn Rating and Fuel Moisture Content

| Byram Drought Index | Burn Success Rating | | | | Success Rating | Minimum Required For |
|---|---|---|---|---|---|---|
| 800 | G | VG | EX | EX | EX - Excellent ) | Seed Tree Regeneration or Direct Seeding |
| 400 | M | G | VG | EX | VG - Very Good ) | |
| 200 | P | M | G | G | G - Good | Areas for planting |
| 100 | VP | VP | P | M | M - Moderate ) | Windrowed or Heaped areas where reburning is planned |
| 0 | | | | | P - Poor ) | |
| | | | | | VP - Very Poor ) | |
| M.C. of fine Sheltered fuels | 20% | 15% | 10% | 5% | | |

3.3 Weather Conditions

Temperature, relative humidity and wind strength affect the drying rate and final minimum values of the fine f.m.c.

Wind is the most variable and least predictable weather factor affecting fire behaviour. Surface winds are strongly affected by the shape of the topography and by local heating and cooling of the ground surfaces. Wind is also influenced by local synoptic changes and by the stability of the upper atmosphere. There is no substitute for a sound understanding of local wind behaviour supported by local and continuous wind monitoring by towers or spotter aircraft.

3.4 Topographic Effects

The topography of a burn area strongly affects wind speed, turbulance and direction.

Topography also influences the rate of drying of fuels through the influence of aspect and slope or the degree of exposure of fuels to sun and wind.

## 4. BURNING TECHNIQUES

The behaviour of slash burns depends very much on the lighting pattern used. Lighting pattern may vary according to:

(a) Aim of burn

(b) Wind strength and direction

(c) Size and shape of coupe

(d) Terrain

(e) Fuel arrangement, distribution and flammability

(f) Presence and fuel condition of surrounding and intruding forest fuels, and other factors.

Lighting pattern can influence fire behaviour, for example through the deliberate creation of a convection column over the fire. With a strong convection column, fire on the perimeter can be drawn in on all sides.

Three basic patterns of lighting are used for slash burn operations. These are:

(a) Strip lighting

(b) Convection lighting (centre firing or moving column)

(c) Simultaneous area ignition

### 4.1 Strip Lighting

Firing in progressive strips has been the most commonly practiced method in W.A. because it is the most versatile for the range of weather and topographic conditions. Strip lighting is necessary on slopes greater than 15 degrees. The procedure involves the consolidation of the most vulnerable edge (eg. downwind edge or upper edge) followed by the progressive stripping out of the remaining area.

The main disadvantage is that light-up time is slow and therefore the burn is vulnerable to changes in weather conditions, particularly wind. The technique should only be adopted if the controller and fire boss have confidence in the forecast and a sound understanding of the influence of local conditions.

Because the down wind edge must be patrolled constantly, crews must work in smoke and heat. Likelihood of fire whirlwinds and hop-overs is high.

### 4.2 Convection Ignition

Convection ignition consists of lighting in such a way that a strong convection column is created at or near the middle of the burn area. When heavy, high-energy fuels such as logging slash are burned, the convection column tends to stabilize once it is formed and to act as a chimney toward which ascending warm air is drawn. In this way the flames, smoke, ash and burning embers are drawn back from the fire perimeter. Thus, the burn is easier to control, and working conditions are safer and more pleasant. Two general forms of convection ignition exist:

1. (Control firing)
2. (Moving-column ignition)

Centre firing is commonly employed on level areas but can tolerate slopes up to 10 degrees, with light winds. This system will work under negative slopes (gullies). A cluster of fires is started in the centre of the prepared area and allowed to develop until the rapid release of heat energy induces an active convection column. More fires are then lit 20 to 40 metres from the central fires as soon as the indraught winds are established. Sequential lighting is continued in concentric circles right up to the burn perimeter. A variant of this method is to light from the centre in a spiral pattern.

Once the convection column is established, follow-up lighting must proceed without delay. Delays will mean that the indraught influence of the central fire is lost.

To ensure a successful convection burn the following factors should prevail:

a) Central fires should be near to the geographical centre, preferably on a prominant hill and near heavy fuel accumulation.

b) Ground winds should not exceed 15 kph.

c) Slopes, other than those running up to the centre, should not exceed 10 degrees.

d) Follow-up lighting must be completed before central fires burn out.

4.2.2 Moving Convection Column

The moving convection column is a combination of the strip and central ignition methods. In this method, lighters walk through the burn in arrowhead formation. Lighting should be intense at the central head so that a convection column is formed.

Moving column ignition is employed on areas that are considered too large or narrow for the central firing technique. Like the central firing method, this technique should not normally be employed where open winds exceed 15 kph or slopes exceed 10 degrees.

4.3 Area Ignition

Area ignition involves the use of simultaneous multispot ignitions to produce an intense fire through the full use of junction zones and convection column.

However, area ignition has merit because it permits fuels to be burnt that are at a marginal moisture content level (eg. 18 - 22%). Electrical, or aerial ignition techniques can be used to achieve more-or-less simultaneous ignition of areas up to 100ha. Aerial ignition techniques for slash burns are still in the development phase, but electrical ignition is simple and effective.

## SUMMARY OF LIGHTING TECHNIQUES

| Lighting Technique | Most Suitable Conditions | Constraints | Disadvantages | Advantages |
|---|---|---|---|---|
| Strip | Winds constant, but can be up to 25 kph. Suitable for steep, irregular areas. Fuel M.C. can be reasonably high (up to 22%). | Normal control restraints. Must secure down wind flank first. Cannot be started until the afternoon when winds likely to be constant. | Slow light up time. Vulnerable to unexpected weather changes. Possibility of fire, smoke, etc. blowing over lines. Crew discomfort and safety at risk. | Versatile as it can be used in all conditions and for awkward, steep areas. |
| Convection | Calm winds only. Flat terrain up to $10^{o}$ Regular shaped cells. | Winds less than 10 kph. Total cell area less than 40ha. Fuels must be dry i.e. Well below 18%. Need for more careful preparation & greater expertise. | Greater chance of hopovers after burn out. Not suitable under marginally moist conditions. | Rapid light up time. Heat sparks and smoke drawn into burn and away from perimeter. Working conditions more comfortable and safer. Permits more crews available for ignition. |
| Area or Simultaneous | Suit areas of less than 20ha, particularly where surrounded by high risk/ value areas. Suitable for lighting central core in convection lighting. | Size Limitation. Intense convection column may carry fire brand and lead to long range spotting. Requires simultaneous multispot ignition. | Requires time consuming preparation and may be expensive. Size limitations means this is suitable in very special cases only. | Rapid, intense lighting ensures good result. Permits more crew for suppression. Safe and comfortable for crews. |

## —REGENERATION SURVEYS

*(The following instructions have been adapted from Technical Instruction No. 5 of the Tasmanian Forest Commission, August, 1968, Regeneration Surveys.)*

# MILACRE SURVEYS FOR REGENERATION THREE-QUARTERS TO THREE YEARS OLD

### A. INTRODUCTION

Regeneration surveys are used to map out areas that have too few seedlings so that they can be restocked.

Where very small seedlings are to be assessed, only small plots can be efficiently inspected. The standard plot is the circular milacre (one thousandth of an acre in area). In practice, the "milacre stick" should be used. This consists of a steel peg which is jabbed vertically into the plot point, to which is attached a 3 ft. 8⅔ in. long radius wire. The wire is free to move around the peg or up and down it.

In assessing regeneration, the wire is pulled taut and moved round in a circle about the central peg. The process is continued only until one seedling is found within the milacre. When several milacres have been assessed, it is possible to work out the percentage of milacres which are "stocked" (that carry one or more seedlings). This percentage of milacres stocked is the most commonly used measure of regeneration.

In practice, surveys should be made in January to February following the burn, enabling sowing if required to be carried out from March onwards.

### B. FIELD WORK

1. STRIPS. Parallel strips should be located at *4 ch. intervals* to cover the whole area to be assessed. It is often convenient to use the road as a baseline and to run the strips at right-angles to it. The first strip should start at a randomly chosen point between 0 and 4 chains from one end of the area. Numbered pegs should be placed where strips start or cross roads to aid later location of areas needing sowing.

If the results obtained from this 4 ch. grid are insufficient, intermediate strips may later be run to form a 2 ch. grid. Intensification of the survey in this way may be required where the area is less than 30 to 40 acres and the stocking is marginal, or in patches of larger areas where the stocking is marginal. Stocking for this purpose is deemed marginal where the mapping rules tend to map out understocked areas above 10 per cent. milacre stocking.

Strip direction should be maintained by compass. Plot spacing can in most cases be measured by pacing. Pacing greatly simplifies the field work but the assessor should check his pacing from time to time. The best test is to compare the length of a strip between two points obtained by pacing with that given by an existing survey. Tests of pacing against a tape over short distances or on the even surface of a road are not comparable to that obtained on the whole strip. In very rough or steep country, paces can be estimated over short distances, but the final pace to the plot point should always be controlled by the legs and not the eyes.

2. PLOTS. Plots should be spaced at 1 ch. intervals along the strips. It is convenient, for mapping purposes, to put the first plot in at one chain from the road. This means that, although the area within one chain of the road is sometimes undersampled, the plot number and its distance from the start of the strip correspond.

The plot point must be selected with the minimum bias. The assessor must therefore try to avoid looking where his last pace will fall. He should then implant his milacre stick either immediately in front of his toe or at some fixed distance in front of it.

At the end of the strip the assessor proceeds for 4 chains at right-angles to the strip direction to plot zero on the next strip. If this plot happens to be well inside the boundary of the area he should establish plots numbered —1, —2, —3, etc., until the boundary is reached. Then starting again at plot zero he should proceed back to the road with plots numbered 1, 2, 3, etc. Should plot zero fall outside the area he should still proceed back to the road with plots 1, 2, 3, etc., but he need not assess them until the boundary is passed. Some note should be made to explain why such plots were not assessed.

Append 1. Fig. 1 PAGE OF FIELD BOOK - REGENERATION SURVEY

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 17 | TB | ✓ | | | |
| 16 | TB | ✓ | | snig track | |
| 15 | A | ✓ | | | |
| 14 | TB | – | – | | |
| 13 | NS | – | – | rock outcrop | |
| 12 | TB | | ✓ | | |
| 11 | A | ✓ | | | |
| 10 | NS | – | – | unburnt scrub | |
| 9 | NS | – | – | creek | |
| 8 | NS | – | – | | puddled & compacted |
| 7 | NS | – | – | | landing |
| 6 | NS | – | – | | |
| 5 | D | ✓ | | | log road |
| 4 | TB | ✓ | | | |
| 3 | TB | | ✓ | | |
| 2 | A/TB✓ | ✓ | | snig track | |
| 1 | A | ✓ | | | |
| 0 | Road | | | Pine Creek Road | |
| Strip No 3 commencing 5½ chns. N. along Pine Ck Rd:– Bearing 85° (M). | | | of X roads 15/6/71 | Pine Ck Rd. A.P. Jones. | Telephone Rd |

3. BOOKING. A sample page of a field book is given in Figure 1, one horizontal line being taken up with all the observations made at one plot point.

(a) At the start of each new area, notes should be made covering the following:—

Location, Date, Compass Number, Pacing or Chain, Name(s) of Assessor(s).

(b) *At the start of each strip*—Take-off point, Bearing.

(c) *At each Plot Point:*—

*Column 1*—Plot number (equals the distance in chains from the strip T.O.P.).

*Column 2*—Nature of Seedbed, A.B. (Ash Bed), T.B. (Top Burnt), D (disturbed), U unburnt and undisturbed), etc.

If regeneration occurs on only one of the two or three seedbeds found on the plot, the successful seedbed should be marked with a tick. It is often of value to know this when restocking an area.

*Example:* D/T.B. = plot has disturbed and burn seedbeds present, but seedlings only occur on the burnt seedbed.

*Column 3*—Presence of one or more seedlings on the milacre is here shown by a tick. In addition, seedling heights should be estimated and recorded here every third stocked milacre.

*Column 4*—This column is one of the most important for mapping purposes especially where the stocking is marginal. *It should be used only when the milacre is NOT stocked.* It should show the stocking within twice the (milacre) radius of the peg (7 ft. $5\frac{1}{3}$ in.). The presence of one or more seedlings in this area is indicated by a tick in Column 4. The area within 7 ft. $5\frac{1}{3}$ in. of the peg is four milacres. When the milacre is stocked the four milacre must also be stocked so no search of the larger plot is required. Where several milacres in succession are unstocked little time should be spent inspecting the 4 milacres. However, as soon as some field observations (such as seeing a seedling between plots) suggest that the "stocked/understocked" boundary is being approached, greater care must be taken over the 4 milacre inspections. Similarly, the first few empty milacres after a series of stocked should have their corresponding 4 milacre plots thoroughly searched.

*Columns 5 and 6*—These columns should show all survey information and field observations that may help to improve the accuracy of the "stocked/understocked" boundary, *e.g.*,

Approximately location of: Seed trees; boundaries between good and poor burns; between burnt, unburnt, unlogged sites; wet gullies, change of aspect; rock outcrops, etc.

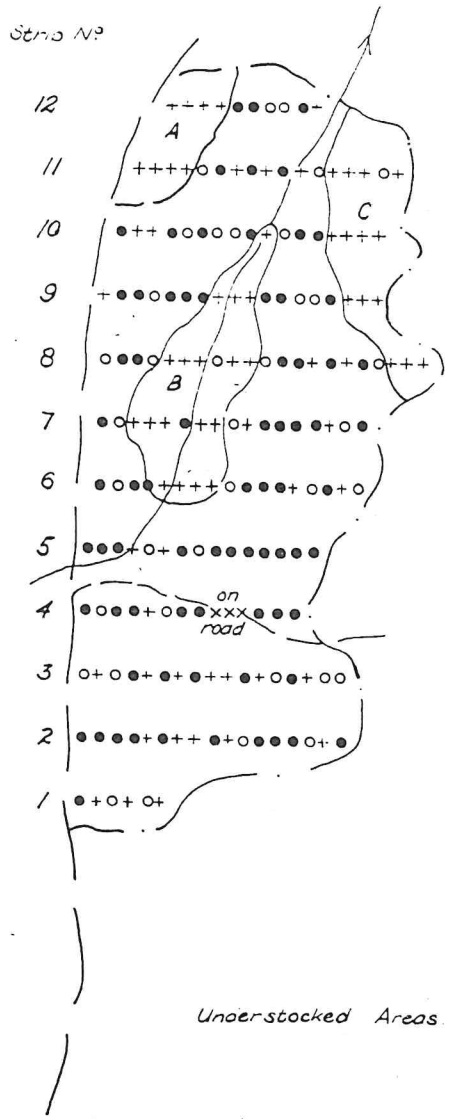
(d) *At the End of the Survey.*

Notes should be made at the end of the survey, *whilst still in the field,* of all general information likely to be of value in determining the treatment required to fully stock the area. Some attempt should be made to discover any possible correlation between the understocked patches and such natural features as aspect, rock outcrops, etc. Sketch maps of these features are likely to be of great value to those who have to re-stock the area. Notes should also be made of the most common seedling heights and the tallest and shortest seedlings.

## C. OFFICE WORK

If the area is not obviously entirely empty or fully stocked, a map should be prepared showing strips and all plot points. At each plot point a sign is made to indicate whether the milacre is stocked, or the four milacre only is stocked, or neither are stocked (*e.g.*, solid circle, hollow circle, and a cross, respectively). The stocking information will be used to map out stocked and understocked areas as described below (1). The final map (Fig. 2) showing these areas and recommended sowing area (see 4) should be given to those who are going to do the sowing along with any explanatory notes on seedbed types and recommendations as to the treatment most likely to succeed (see 3).

Append 1. Fig. 2 EXAMPLE OF SURVEY LAYOUT AND MAPPING




| | Mil acre score |
|---|---|
| 12 | 3 out of 10 |
| 11 | 3 " " 17 |
| 10 | 6 " " 17 |
| 9 | 8 " " 18 |
| 8 | 6 " " 21 |
| 7 | 7 " " 17 |
| 6 | 7 " " 17 |
| 5 | 11 " " 15 |
| 4 | 8 " " 11 |
| 3 | 5 " " 17 |
| 2 | 10 " " 17 |
| 1 | 1 " " 6 |
| Total: | 75 183 |

Understocked Areas A. 0/8 = 0% (poor burn)

B. 1/20 = 5% ( " " )

C. 0/15 = 0% (unburnt)

Total 1/43 = 2½% : Area = 43 × 0·4 = 17 acres.

Stocked area :- Total 74/140 = 53% : Area = 140 × 0·4 = 56 acres

Wholecoup 75/183 = 41% milacre stocking

Approx. 73 acres.

1. RULES FOR MAPPING NATURAL REGENERATION. The boundary between the "stocked" and the "understocked" area is drawn using the following rules:—

(a) If the milacre is *unstocked*, it can only be in the *stocked* area if if 4 milacre is stocked or if both its neighbours on the same strip are either milacre or 4 milacre stocked.

(b) If the milacre is *stocked*, it may be in the *understocked* area if neighbours on the same strip have neither milacre nor 4 milacre stocked.

(c) Where a *stocked* milacre occurs after two unstocked plots following the end of a stocked portion of the strip, and where field notes suggest no obvious change. In stocking, all three plots may be added to the stocked portion of the strip.

*Example:* If 1 = milacre stocked
4 = 4 milacre stocked
0 = neither stocked
1. 1.4.0.0.1; 1.1.1.0.0.1.; are stocked
but 1. 1.4.0.0.4; 1.1.1.0.0.4; 1.1.1.0.0.0.1 are only stocked for the first three plots.

(d) It is generally inadvisable to pull out stocked or understocked sections of a strip of two plots or less in size unless other survey information shows that they are representative of the area (*e.g.*, under the only tree with seed, small patch of unburnt seedbed, etc.) Where one or two unstocked plots are adjacent to a type known to produce NO regeneration (*e.g.*, unburnt or uncut forest), they can be mapped out as understocked. Similarly, one or two stocked plots near a roadside often indicate a real stocking near the road edge even though the rest of the area may have little or no regeneration.

(e) If a stocked section of strip falls below, say, 30 per cent. stocking by milacre but there is an unusually high ratio of 4 milacre to milacre stocking, it is likely that the seedlings are distributed in an unusually even way and the strip should be accepted as stocked. If the stocking falls below 30 per cent. for any other reason, the strip should be re-examined to remove further understocked sections.

(f) Once the boundaries of the stocked and understocked areas have been established on the strip they should be interpolated between adjacent strips, taking into account any features that might be responsible for the change in stocking. The boundary enclosing a stocked section of one strip should not be extended across to a single stocked milacre or 4 milacre on an otherwise unstocked strip, unless field observations show that this is justifiable. Even crossing four chains to two stocked plots (1 to 4 milacres) should be done with caution.

This method of mapping tends to produce understocked areas with less than 10 per cent. milacre stocking, usually much less. If in a marginal area the stocking for the understocked portion exceeds 10 per cent., despite all mapping care, further strips should be put in to increase the sample. With twice the information now available and the strip interval now only two chains, the boundary between strips can be more confidently drawn.

2. RESULTS. From the map, three stocking figures can be obtained—the percentage milacre stocking for the whole, for the "stocked", and for the "understocked" areas.

Of even more value is the *area* of each section, which is proportional to the number of plots in it, e.g., number of plots multiplied by 0.4 (4 ch. × 1 ch.) or 0.2 (2 ch. × 1 ch) gives the approximate area in acres of the type.

The map shows, therefore, how much area requires treatment and where it is.

3. DESIGN OF TREATMENTS. Other field notes combined with the map should also indicate the nature of the unstocked area and so help in the planning of restocking treatments. For instance, the presence of unburnt green scrub may indicate that scrub rolling and reburning before planting may be necessary.

Restocking treatments should be recommended at the time of the survey because the assessor has the most complete knowledge of the area.

4. RELOCATING THE AREA REQUIRING TREATMENT. If several small understocked patches are mapped out without being obviously related to some natural feature there will be difficulty in finding these areas again when restocking. This can only be overcome by planting rather more than the minimum area.

The understocked areas should be either easily re-identifiable by some obvious natural feature (*e.g.*, aspect, very poor burn, etc.) or should be surrounded by a regular figure on the map including as much of the understocked area and as little of the stocked area as possible. It is better to replant a regenerated patch than to fail to sow an unregenerated one. This surround line should be clearly shown on the map along with all information required to find its take-off point.

## D. ASSESSING THE EFFECTIVENESS OF THE TREATMENTS

The treated areas should be assessed later with further regeneration surveys to gauge their success and to enable further treatment to be prescribed if necessary.

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## 1. GENERAL

1.1 The transplanting of one year old open-rooted karri seedlings is an essential operation for the reforestation of many cut over forests in the karri area.

1.2 Planting is a costly yet vital job and extreme care must be taken to ensure the survival and satisfactory development of transplanted seedlings.

## 2. NURSERY STOCK

2.1 Nursery procedures aim to produce karri seedlings to the following specifications:

(i) 30 - 45 cm in height

(ii) woody stem

(iii) fibrous root system no longer than 15cm

(iv) at least 1/3 of the stem is leafy

2.2 Minor variations around these specifications are acceptable, but substandard seedlings will be rejected at time of lifting, (not in the field).

2.3 After lifting, plants will be bundled and tightly wrapped in wet bags.

Every effort must be made to prevent drying out of roots and leaves, through exposure to wind and sun. Bags must be kept thoroughly soaked and completely protected from wind during transport from nursery to planting site, and while waiting for planting.

2.4 The time between lifting and planting may not exceed 4 days. Where plants are kept overnight, bags must be opened, plants laid in a trench, watered and covered with soil to the nursery level. This must be done in a cool, shady spot to avoid moisture loss. Plants should not be left in a running stream or a pool of water.

2.5 Planting and lifting operations must be carefully planned to avoid waste of plants or delays to planting gangs.

2.6 No root pruning or topping of plants is permitted in the field.

## 3. PLANTING SEASON

3.1 The planting season in the karri area is usually limited to the months of June and July, although suitable planting weather can occur in May or August in the Walpole/Northcliffe areas.

3.2 Before planting commences, the soil must be thoroughly wet to a depth of 25cm. An experienced officer should walk over the planting site and examine soil profile moisture before the decision to start planting is taken.

3.3 Permission to commence planting, or to continue it after July 31st, must be obtained from the Operations Officer.

3.4 Planting must cease during periods of no rainfall of more than 4 consecutive days in duration, particularly early in June.

4.1 Planting will be in lines across the contours and lines should be kept reasonably straight.

4.2 However, the survival and future development of the tree is more important than the straightness of the lines, so deviations around large logs or stumps are acceptable. In addition, planters should try to make maximum use of ASHBEDS as survival and growth is significantly better on ashbeds than off them. No plants to be planted closer than 1 metre to stumps and logs.

4.3 Where planting areas adjoin major through roads, lines should parallel roads rather than be at right angles to them. This preserves the appearance of "natural" forest.

4.4 On landings and snig tracks where planting is carried out on ripped lines, these lines will parallel the contours to prevent erosion. Landings must be planted with container karri seedlings, except those designated by the Planting Officer to be suitable for open-rooted seedlings.

4.5 No planting is to be done within 4m of the edge of landings or on major snig tracks within 50m of these landings. These areas will be rehabilitated at a later date.

4.6 Planting lines should not commence within 2m of the edge of any road.

5. SPACING

5.1 Spacing between plants is aimed at producing a stocking rate of about 1250 plants per hectare.

5.2 To achieve this, plants will be planted in rows 4m apart and with 2m between plants within rows.

5.3 Spacing can be varied at any time within rows or plants to ensure selection of a satisfactory site (eg. ashbed) for the individual seedling. Planters should by-pass natural karri germinants on the planting line if these occur, but the occurrence of marri or jarrah can be ignored.

5.4 Supervising officers should check spacing at frequent intervals to ensure that correct distance between plants are maintained and also to see that maximum use is made of ashbed sites.

Appendix I indicates the method of checking stocking rates of the various planting crews.

6. PLANTING

6.1 Whilst economy and efficiency must always be considered, quality is the essential objective in the karri planting operation.

6.2 Before planting begins each season, all personnel must be trained in correct procedures. Demonstrations of correct methods and desired results must be made.

The following points must be covered in pre-planting training:

1. Inspection of previous years planting areas. Highlight good and bad results.
2. Examine and explain snig tracks and landings.
3. Demonstrate double spearing and planting.
4. Each man to check measure his pacing, 4m and 2m.
5. Digging-in plants for temporary storage.
6. Planting away from logs, stumps.
7. Observe and explain ashbeds.

[illegible] permanently responsible for day to day planning, supervision and quality control of the whole operation.

6.4 Seedlings will be planted after an absolute minimum of root exposure. Plants must be carried in bags for maximum protection, and should not be carried in the hand or under the armpit. The planted seedlings must be firmly in the ground, vertical and erect, with its roots straight, and 50mm deeper than the Nursery level. Double spearing and heavy tramping will be done to eliminate airpockets around the roots. After plant is installed a spear hole is to be left approximately 150mm - 200mm uphill from base of plant. This is for placement of fertiliser.

6.5 On compacted or disturbed areas (such as landings and snig tracks) planting should be done into prepared areas ripped to 50cm by a bulldozer. Container stock rather than open rooted seedlings will be used on such areas. Special attention to the elimination of airpockets is essential in ripped areas. In areas where rough heaping has been done, the compacted landings must be pegged to distinguish them, so planters can avoid them.

A separate prescription for planting of ripped landings and gravel pits have been drawn up.

6.6 The role of the Overseer is to supervise his planting crew. His duties include crew organisation, plant supply, checking plant depth and firmness of planting, check spacing, monitor production rates, daily planting records, overnight plant storage. He also is responsible for ensuring that root exposure is kept to a minimum.

## 7. FERTILIZER APPLICATION

7.1 Research work has indicated that the best response to fertiliser occurs when fertiliser is applied within 4 weeks of planting, at a rate of 80gms per plant, applied in a shallow depression (eg. spear hole or heel mark) approximately 150 to 200mm (6 to 8 inches) up-slope of the tree. Care must be taken to avoid direct contact or spillage of fertiliser onto the leaves of seedlings.

7.2 Fertilisation can be done at time of planting or as a separate operation after planting. However, fertilisation can be done as late as mid September with only minor loss of effectiveness.

7.3 The fertiliser to be used will comprise phosphorous, nitrogen, and potassium mix. Current research and cost structure favours the use of Agras No. 1 at 80gms per plant (or 100kg/ha.).

7.4 O.I.C.'s should order their fertiliser requirements in advance of the planting season to ensure adequate supply.

## 8. SURVIVAL COUNTS

8.1 The target rate for karri planting is 95% survival.

8.2 Transplanted karri seedlings often appear very unthrifty in the early months after planting. Inexperienced officers can become alarmed by their appearance during the first spring after planting. However, by early summer, survival success can be readily determined.

8.3 Survival counts are necessary to check the success of the operation and to demarcate areas for refilling the following year.

A count of all planted areas must be done in February. A 10% sample is deemed minimal, though the surveying officer should walk over the whole coupe to form a general impression of the result.

8.4 Survival results and recommendations regarding any action necessary will be forwarded to the Operations Officer, by 1st March, each year.

9. REFILLING

9.1 Refilling of odd individual plants is not necessary, but definite areas of over 1ha where survival is less than 50% must be demarcated and programmed for refilling.

9.2 Refilling must be done in the first winter after planting to avoid excessive scrub competition. Refill early in the planting season.

9.3 Some rudimentary scrub control (eg. dozer rolling or ploughing) should be considered in refill areas.

10. ACCIDENT PREVENTION

10.1 Accident prevention is an integral part of every job, karri planting is no exception. A safety induction session will be conducted each year at the commencement of the planting season.

10.2 Common accidents include jarred wrists through planting spear striking a rock or root, slips and strains through the use of rubber boots and falls from climbing over or jumping from logs and stumps.

10.3 O.I.C.'s should encourage regular safety sessions during the planting season to provide short breaks from the monotony of the operations and free discussion of hazards and dangers.

R.J. SNEEUWJAGT
SENIOR DIVISIONAL FOREST OFFICER
OPERATIONS

RJS:SG

5 June, 1981

## PLANTING STOCKING RATES

Overseers and Planting Supervisors should regularly check that correct spacing be maintained by all planting crews each day.

Current prescription aims for a stocking of 1250 plants per hectare achieved from a spacing of 4 x 2 metres. Because lines are not required to be deadly straight, it is often difficult to determine if this stocking rate is achieved.

The most effective method of checking stocking rate is to pace out 100 metres along a row and count the number of plants within that distance. To cover the likely variation between planters, the row being counted should be switched every 30 metres or so. After recording the 'along row' count, a similar count should be made of the number of rows along a 100 metre line perpendicular to the rows.

The estimated stocking per hectare can be obtained from Table 1. Reading off the 'along row' count and 'across row' count and obtain the stocking rate from the body of Table 1. eg. 'Along Row' count of 46 and an 'Across Row' count of 26, gives a stocking of 1200 - considered acceptable.

PLANTING STOCKING FROM 100 METRE ROW COUNTS

| No. per 100m Along the Row | Across the Row (No. per 100m.) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20 | 22 | 24 | 25 | 26 | 28 | 30 |
| 40 | 800 | 880 | 960 | 1000 | 1040 | 1120 | 1200 |
| 42 | 840 | 920 | 1000 | 1050 | 1090 | 1180 | 1260 |
| 44 | 880 | 970 | 1050 | 1100 | 1140 | 1230 | 1320 |
| 46 | 920 | TOO LOW 1010 | 1100 | 1150 | ACCEPTABLE 1200 | 1290 | 1380 |
| 48 | 960 | 1050 | 1150 | 1200 | 1250 | 1340 | 1440 |
| 50 | 1000 | 1100 | 1200 | 1250 | 1300 | 1400 | 1500 |
| 52 | 1040 | 1140 | 1250 | 1300 | 1350 | 1460 | 1560 |
| 54 | 1080 | 1190 | 1300 | 1350 | 1400 | 1510 | 1620 |
| 56 | 1120 | 1230 | 1340 | 1400 | 1460 | TOO HIGH 1570 | 1680 |
| 58 | 1160 | 1280 | 1390 | 1450 | 1510 | 1620 | 1740 |
| 60 | 1200 | 1320 | 1440 | 1500 | 1560 | 1680 | 1800 |

Stocking between 1120 and 1380 plants/hectare are acceptable.

INDUSTRY CONTROL SPECIFICATION

## EROSION CONTROL PRESCRIPTION

1. At the completion of logging or during temporary cessation of logging in any coupe, erosion control must be completed. All snig tracks and roads will have cross drains installed as prescribed below. (Roads and tracks listed in the regeneration prescription will be exempt. Roads not required for fire control purposes must be cross-drained immediately following regeneration operations).

2. Cross drains will prevent the accumulation and concentration of water and reduce its velocity. The banks of the drain must be constructed at an angle (approx. $30^{o}$) to the water flow and have a tapered outlet so that water discharges onto surrounding undisturbed ground, preferably into tops or vegetation silt trap.

   The banks of the drain must be at least 40cm high and 40cm thick to withstand peak run-off.

3. Drains must not divert water into another drainage line.

4. The Forests Department will prescribe spacing of drains, according to slope and soil type as shown on the table below. The erosion control requirement will be shown on Industry H.O.C.S. sheets (Foreman's copy).

   The table below lists maximum spacing of cross drains. Karri loams and sands are highly erodable soils and require greater protection than lateritic soils.

| SLOPE | LATERITIC GRAVELS | ALL OTHER SOILS |
|---|---|---|
| $0 - 2^{o}$ | Nil | Nil |
| $2 - 5^{o}$ | 200m | 100m |
| $5 - 10^{o}$ | 100m | 50m |
| $10 - 15^{o}$ | 60m | 30m |
| $15^{o}+$ | 30m | 15m |

5. Fallers blocks will not be certified completed until erosion control has been carried out to prescribed standards.

6. Logging roads shall not enter stream reserves unless approved by the Divisional O.I.C. In such cases a bridge or culvert crossing must be designed to handle peak flows. Temporary crossings must be prescribed in detail, as to construction and subsequent removal.

7. Snig tracks and roads will not be constructed along creek beds or adjacent to water courses.

8. Snig tracks and roads crossing non-reserved streams are to be made with minimal disturbance to streamside soil and vegetation. If temporary culverts, log or earth fills are used, the forest officer will make recommendation for retention or removal depending on potential siltation.

9. Landings and log dumps will not be constructed in a non-reserved stream.

10. Stream Reserves will be a minimum of 100m each side of the stream and will be greater when considered necessary by the Forests Department. Trees felled into the stream reserve may be required to be pulled back into the coupe. Excessive tops in the Stream Reserve will make it difficult to exclude fire during Regeneration Burning. Snigging is only permitted in a stream reserve if authorised by the forest officer.

11. Tractor blades will not be used to remove soil from a snig track or road. Mud and slush shall not be bladed off the track.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83
DATE FOR REVIEW: 31/12/84

# KARRI STRUCTURAL STATUS IN TIMBER PRODUCTION - 1983

| DESCRIPTION | AREA (HECTARES) |
|---|---|
| EVEN AGED REGEN. 1866@1899 | 63. |
| EVEN AGED REGEN. 1900@1909 | 0. |
| EVEN AGED REGEN. 1910@1919 | 53. |
| EVEN AGED REGEN. 1920@1929 | 147. |
| EVEN AGED REGEN. 1930@1939 | 3801. |
| EVEN AGED REGEN. 1940@1949 | 527. |
| EVEN AGED REGEN. 1950@1959 | 204 |
| EVEN AGED REGEN. 1960@1969 | 2302. |
| EVEN AGED REGEN. 1970@1979 | 7181 |
| EVEN AGED REGEN. 1980@1982 | 7112 |
| VIRGIN OLD GROWTH FOREST | 31463 |
| TWO TIERED FOREST | 27413 |
| IN PROCESS OF REGENERATION | 592 |

# SOUTHERN REGION
# INDUSTRY CONTROL SPECIFICATION

## COMMERCIAL THINNING OF KARRI REGROWTH STANDS

The aim of the prescription is to leave the regrowth stand in the optimum condition for the growth of future sawlogs and veneer logs.

1. Stands will be marked for retention, the intensity varying with both site and age as reflected by co-dominant height. Control will be by basal area.

| CO-DOMINANT HEIGHT (M) | BAOB RETAINED $M^2/HA$ |
|---|---|
| Less than 29 | Don't thin* |
| 29 - 31 | 8 |
| 32 - 34 | 10 |
| 35 - 37 | 12 |
| 38 - 41 | 14 |
| 42 - 45 | 16 |
| 46 - 48 | 18 |

2. Trees retained, in order of priority, should be:

   2.1 in the dominant and co-dominant class.

   2.2 healthy crown.

   2.3 good form without excessive branching.

   2.4 selected with due regard to spacing.
   (closer spacing will be necessary at the edges of gaps.)

   2.5 marri regrowth may be retained as crop trees when no suitable karri exists.

   2.6 minor existing butt damage in vigorous, well growing trees, can be tolerated. (regrowth stems immediately adjacent to major snig tracks should be favoured for removal.)

3. Veteran trees will be removed after the thinning is completed if they can be removed without damage to growing stock and if there is a regrowth stem or stems to fill the gap created. This must be borne in mind when selecting crop trees. Smaller vigorous "veterans" which will continue to produce sawlog may be left as growing stock if it is the only stem effectively occupying the site.

4. A buffer of unthinned forest of 20m width will be retained around Private Property and other large openings, to reduce wind velocity. These buffers may be thinned 3 years after adjacent forest is thinned.

   Stands will be thinned in strips approximately 400m wide across the destructive wind direction (i.e. strips to run approximately north-south). Unthinned buffer strips should be <u>either</u> stands containing no regrowth <u>or</u> a viable future thinning unit.

5.1 Coupe Control will be by fallers blocks as per the coupe Industry Control Specification. (Item 8)

5.2 Extraction tracks will be selected and marked by the forest officer and bush boss prior to treemarking. These should be selected to minimise the possibility of butt damage and root damage by snigging. The major extraction track should be straight (to minimise damage) and located beneath veterans where possible.

A system of secondary tracks on a "herring bone" system should also be marked. Felling should then take place in a 5m strip along the selected extraction routes. Treemarking can then proceed.

5.3 Advance burning is required 3 - 5 years before thinning. (In manual felling operations).

5.4 Top disposal around retained stems is to be carried out by the operator. All fresh debris in excess of 50mm diameter should be removed to at least 1m from the stem.

5.5 Landing debris is to be heaped at least 3m from crop trees.

5.6 Systematic measurements of co-dominant height and basal area are to be carried out at the completion of each section for quality control checking and as an inventory base for the new crop.

## 6. ENVIRONMENTAL

6.1 All standard environmental constraints and dieback hygiene measures during logging will apply with the following exceptions:

6.1.1 There will be no constraint on coupe size.

6.1.2 Road Reserves will be 50m to prevent machine activity and landings adjacent to tourist roads. These reserves will be thinned as a unit at a later date.

6.2 SOIL DISTURBANCE

6.2.1 Maximum soil disturbance levels will be 10% Class 1 and 2, including loading areas.

6.2.2 Shallow raking of snig tracks and landings may be carried out to promote scrub germination. Deep ripping will not be carried out because of damage to established root systems.

6.2.3 Erosion control on slopes will be done according to Industry Control specification No. 16.

6.3 STEM DAMAGE TO CROP TREES

Damage assessments will be carried out as required.

A.W. WALKER
S.D.F.O.
R/L INDUSTRY CONTROL
DATE: 1/3/83
DATE FOR REVIEW: 31/12/83

# SILVICULTURAL OPTIONS FOR THE TWO TIERED KARRI FOREST.

## DEFINITIONS USED IN DECISION TABLE:

### 1. OVERSTOREY

< 15%

15 - 25% Assessed from Aerial Photography

> 25%

This refers to the area of the overstorey canopy as a percentage of the total land surface. N.B. < 15% overstorey and the stand can be considered a pure regrowth stand.

### 2. REGROWTH STOCKING

Adequate: for any given age and site the stocking of regrowth must fill 75% of the growing space available to it.

Inadequate: for any given age and site the stocking of regrowth is lower than that required to fill 75% of the growing space available to it.

We can produce a rough figure that represents 75% of full stocking for a pure regrowth, even-aged Karri stand, at any given age and site combination as a guide.

### 3. PHYSIOLOGICAL CONDITION OF THE OVERSTOREY-VETERAN TREES

The majority of the overstorey is composed of veteran trees. A veteran is an individual tree that is substantially taller than the surrounding regrowth and/or is substantially larger in diameter than the surrounding regrowth. It is either mature, overmature or senescent.

VIGOROUS GROWING STOCK

These trees are obviously older than the majority of regrowth stems. However, their crowns are not all that much taller than the surrounding regrowth and are healthy. These trees are approaching maturity and are still putting on net increment.

### 4. MARKETABILITY OF REGROWTH

This refers to the ability to sell the majority of regrowth stems and will depend on the marketability standards of the day. The marketability standard to be applied is the minimum requirement for sale. Today it is the minimum specifications for chip.

Commercial: Minimum chip requirement.

Potentially Commercial: Will reach minimum chip requirement within 15 years. (2.1m length with minimum 150mm S.E.D.)

For stands approaching 25% overstorey the regrowth has to be very close to being commercial size before you wait for it.

Non-Commercial: Will not reach minimum chip standards in 15 years, due to being too small or too damaged. In stands with < 15% overstorey, regrowth that is too small is only small because it is young. It has no competition that will retard development and should be left standing.

In stands approaching the 25% overstorey the regrowth has a substantial amount of competition from the overstorey that will retard its development. In these stands if the regrowth is non-commercial due to size it is going to take a long time to become commercial. These stands should be clearfelled to produce a productive forest once more.

We can produce a rough guide showing diameter growth for even aged Karri in any age/site combination.

MANAGEMENT CONSTRAINTS

Various management constraints will have to be applied depending on the size and location of an area to which a prescription is to be applied.

| PRESCRIPTION | MANAGEMENT CONSTRAINTS |
|---|---|
| Thin or<br>Wait and Thin. | When a stand worth thinning is located in surrounding bush that is to be clearfelled:<br>- Thin if it is larger than 2ha.<br>- Clearfell if smaller than 2ha. |
| Clearfell or<br>Wait and Clearfell | When a stand prescribed for clearfelling occurs in surrounding bush that is to be thinned:<br>- Clearfell if area is larger than 10ha.<br>- If area is less than 10ha in extent, selection log to retain vigorous growing stock. |

The attached tables and flow diagrams show the hierarchy of decisions that must be undertaken to obtain a prescription for the stand.

R. Armstrong

R. ARMSTRONG
A.D.F.O.
PROJECT OFFICER

RA:SAL

| OVERSTOREY < 15% | | | |
|---|---|---|---|
| REGROWTH STOCKING | PHYSIOLOGICAL CONDITION OF OVERSTOREY | REGROWTH MARKETABILITY | PRESCRIPTION |
| ADEQUATE | Vigorous Growing Stock | Commercial | Thin |
| | | Potentially Commercial | Wait and Thin |
| | | Non-Commercial - Size | Wait and Thin |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | Thin |
| | | Potentially Commercial | Wait and Thin |
| | | Non-Commercial - Size | Wait and Thin |
| | | - Damage | C/F |
| INADEQUATE | Vigorous Growing Stock | Commercial | Thin or C/F |
| | | Potentially Commercial | Wait (Thin or C/F) |
| | | Non-Commercial - Size | Wait (Thin or C/F) |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | C/F |
| | | Potentially Commercial | Wait and C/F |
| | | Non-Commercial - Size | Wait and C/F |
| | | - Damage | C/F |

| OVERSTOREY 15 - 25% | | | |
|---|---|---|---|
| REGROWTH STOCKING | PHYSIOLOGICAL CONDITION OF OVERSTOREY | REGROWTH MARKETABILITY | PRESCRIPTION |
| ADEQUATE | Vigorous Growing Stock | Commercial | Thin |
| | | Potentially Commercial | Wait and Thin |
| | | Non-Commercial - Size | C/F or Wait and T |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | C/F (2 stage) |
| | | Potentially Commercial | Wait and C/F (2 s |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |
| INADEQUATE | Vigorous Growing Stock | Commercial | Thin Is |
| | | Potentially Commercial | Wait and Thin sta<br>a wl<br>ful<br>sto |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | C/F |
| | | Potentially Commercial | Wait and C/F |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |

| OVERSTOREY > 25% | | | |
|---|---|---|---|
| REGROWTH STOCKING | PHYSIOLOGICAL CONDITION OF OVERSTOREY | REGROWTH MARKETABILITY | PRESCRIPTION |
| ADEQUATE | Vigorous Growing Stock | Commercial | C/F (Thin?) |
| | | Potentially Commercial | Wait and C/F (Thin |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | C/F |
| | | Potentially Commercial | Wait and C/F |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |
| INADEQUATE | Vigorous Growing Stock | Commercial | C/F |
| | | Potentially Commercial | Wait and C/F |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |
| | Veteran Trees | Commercial | C/F |
| | | Potentially Commercial | Wait and C/F |
| | | Non-Commercial - Size | C/F |
| | | - Damage | C/F |