JARRAH REGENERATION SURVEYS

This Guideline Supersedes Silvicultural Specification 3/90

CONTENTS:

1. INTRODUCTION

Silvicultural objectives in the jarrah forest vary in response to the structure and stage of development of the stand. The first priority when considering silvicultural objectives is to thin the forest, however where insufficient crop trees exist to permit thinning, then regeneration is required. One of two regeneration treatments may be applied:

- Complete removal of the overstorey will allow any existing dynamic ground coppice to develop unimpeded into saplings, poles and trees (gap creation).

- A partial removal of the overstorey will maintain a forest cover while regeneration develops to the ground coppice stage (shelterwood). Refer to Silviculture Specification 1/95.

Deciding on the appropriate regeneration treatment requires a knowledge of the status of the advance growth. This guideline provides a survey technique which can be used to assess the status of advanced growth and the standards to be applied when selecting the appropriate regeneration treatment.

It is also a useful tool for identifying areas unsuitable for harvesting and non forest prior to treemarking.

Objectives:

* To evaluate the status of advance growth as a guide to planning and treemarking the jarrah forest prior to harvesting.

* To provide information on forest structure as a guide to planning and treemarking the jarrah forest prior to harvesting.

* To identify areas not suitable for harvesting within the coupe before treemarking commences, eg. areas of diversity.

* To monitor the post harvesting development of regeneration in the jarrah forest.

2. PREHARVESTING SURVEYS

These surveys are to be undertaken prior to treemarking so that the most appropriate silvicultural treatment can be determined , i.e. whether there is sufficient regeneration to warrant release or if the area should be marked to establish regeneration.

Pre-harvesting regeneration surveys need to be carried out in any area which:

- Is a site type likely to have insufficient regeneration (Specification 1/95).

- Areas which have marked variation in regeneration status. Visual assessment is not adequate in these situations.

Advanced burning should be employed in stands which have a heavy understorey or where lignotubers are difficult to see.

Advance burning should ideally be completed well in advance of harvesting to enable enough time for planning and dieback indicator species to regenerate. This will avoid the advance burn interfering with future seed crops if the area requires treatment to establish regeneration.

If necessary, for reasons of access it may be completed prior to harvesting after permanent dieback boundaries have been marked but with sufficient time for lignotubers to re-shoot. This is not ideal silviculturally however.

2.1 SURVEY METHOD

2.1.1 Timing of Surveys

Regeneration is more easily assessed following prescribed burning and where possible surveys should be planned accordingly. Where burning is undertaken in autumn, ground coppice may take up to 12 months to develop before surveys can occur. Burning in spring will allow surveying to take place in approximately 6 months, less on some sites.

Regeneration surveys are best planned well in advance of harvesting to allow the information gathered to be used most effectively in the harvest planning process. Where possible the timing of surveys should be linked to the prescribed burning program to enable the development over time of a bank of regeneration status information. Surveys may be undertaken well in advance of harvesting following prescribed burning (5- 10 years) as regeneration status is unlikely to change significantly in this time.

Where this has not been possible and surveys are planned to be completed closer to the time of harvest, the timing of any advance burning will need to consider the lead time required to allow for full ground coppice expression to occur.

2.1.2 Purpose of Sampling

At any sample point the aim is to determine what level of stocking is present and at which stage of development.

This information determines future management options relevant to the sample point. For example:

- If a point is stocked with advance growth capable of responding to removal of the overstorey, then it can be potentially harvested to release regeneration.

- If the point is understocked with advance growth capable of responding to removal of the overstorey, retention of overstorey (shelterwood) and follow-up regeneration establishment may be required.

Note: - If the forest structure assessed at the point lends itself to retention of crop trees, ie. (thinning), then the stocking of advance growth becomes irrelevant.

2.1.3 Sampling Intensity

Extremes of regeneration stocking are readily visible where they occur and the treemarker will require only limited sampling in such areas to confirm this visual assessment and decide upon the appropriate silviculture to apply.

Where regeneration status is visually variable or only apparent at very low levels a formal assessment is a necessity.

Where formal assessment is necessary, the sampling intensity to be used will be as follows :

- Sample on a grid of 50m x 20m within the proposed boundary of the coupe (approximately 10 sample points per ha).

2.1.4 Establishing Survey Grid

Prior to commencing sampling, a plan of the harvesting coupe showing the proposed sampling grid must be prepared. This will enable the most appropriate grid line direction to be determined. Survey lines should be placed to maximise coverage, i.e. narrow coupes should have many short lines, not a few long lines.

In the field the end of each survey line is to be numbered by tape (yellow and white). The tape must have a line number written on it for future reference.

Survey lines need to be mapped with an arrow indicating the direction the survey took place and the number of the line.

The first survey line should have an easily identified tie point, eg. (reference tree) to facilitate mapping and future reference.

2.2 Sampling Procedure

2.2.1 Avoiding Bias

Care must be taken to avoid bias when selecting sample points, eg. avoid looking specifically for advance growth until the sample point is located and marked. Sampling on a grid ensures that sample points are located with a minimum of bias and spread evenly across the proposed harvesting coupe.

2.2.2 Selecting Acceptable Advance Growth

Advance growth may exist in a number of different stages of development on the one site. These different stages of development, which relate largely to advance growth age, respond differently when the overstorey of mature trees are removed.

Older stages will be released by overstorey removal and commence dynamic growth. Younger stages will not respond to overstorey removal and will remain as advance growth following harvesting.

Appendix 1 describes the different stages of advance growth and how these are to be incorporated into the survey.

2.2.3 Acceptable Regeneration Standard

A sample point can be regarded as stocked if it is found to have the following densities:

- 1. 500 or more spha of jarrah or marri saplings, or
- 2. 1000 or more spha of jarrah ground coppice or marri advance growth, or
- 3. 1000 or more spha of a combination of jarrah or marri saplings and jarrah ground coppice or marri advance growth.

2.2.4 Sampling Method

On arriving at a sample point, the following procedure is to be adopted in the order given.

- Make a mark on the ground and determine the three saplings which form the most compact triangle (that closest to an equilateral triangle) around the mark. i.e. the sample point must fall somewhere within the bounds of the triangle formed by the three selected stems.

- Estimate the length of the triangle sides by pacing between the selected saplings and refer to the prepared table of density estimates (Appendix 2). The distances are to be estimated to the nearest metre. With practice, visual assessment may be used, but this must be checked regularly by pacing.

Note: The sum of any two sides of a triangle must be greater than the longest side. For each estimate of triangle sides make a quick check to ensure this is the case. This problem occurs due to the rounding off, of distances to the nearest metre. If this situation occurs, simply add 1 metre to the length of the shortest triangle side. The tables in Appendix 2 have blank boxes where impossible triangle configurations occur.

- At each sample point, (if the point is stocked with saplings) record the point density on the survey sheet (Appendix 3), record a tick (✓) in the stocking status column (saplings and ground coppice), and move on to the next point.

- If the point is not stocked with saplings repeat the above process using saplings and ground coppice or ground coppice only.
  If the point is not stocked with saplings or ground coppice record the point density on the survey sheet (Appendix 3), record a cross (x) in the stocking status column (saplings and ground coppice), and move on to the next point.

- When searching for saplings all three stems forming the triangle must be within an 8 metre radius of the sample point. When searching for saplings/ground coppice or ground coppice only use a 5 metre radius of the sample point.

- If three saplings, ground coppice or combination can not be found within these distance limits, record the point as not stocked (x) in the stocking status column (saplings and ground coppice) and move on to the next point.

2.2.5 Record Species Mix

At each sample point tally all the stems used to form the triangle (3), onto the survey sheet under their respective species, i.e. jarrah or marri.

2.2.6 Record Forest Structure

At each sample point record the forest structure on the record sheet. This may be either, (M) for mature forest or, (T) for forest suitable for retention of crop trees.

If no forest or very poor forest occurs at the sample point, record this also with a brief description, eg. (rock, flats). Record any other features such as roads which will aid in mapping. Finally move onto the next sample point.

2.3 Mapping and Calculations

2.3.1 Stocking

Following completion of the survey , harvest coupe maps indicating stocking status must be prepared. This is done by mapping the survey grid onto a coupe plan of suitable scale (1:12500) and marking points as either stocked (0) or unstocked (x). See Appendix 4 for an example of a stocking map.

In conjunction with the above map, stocking calculations must be completed as follows:

- Subdivide the coupe into cells at approximately 100 hectares based on roads/creeks or other definable boundaries. Within each cell, define the regeneration stocking as follows:

    - ***Large Understocked Areas***
      Outline any understocked areas of 0.5 ha or more. For a 50 x 20 m grid this represents approximately 5 or more immediately adjacent sample points. These areas will need to be treated with the objective of regeneration establishment (shelterwood).

    - ***Smaller Understocked Areas***
      For the remainder of the cell calculate the percentage of stocked points, ie. (exclude those points identified as being understocked above).

      If this percentage exceeds 65% then the cell is satisfactorily stocked for regeneration release, (gap).

      If the percentage stocking is less than 65%, the cell will need to be treated for regeneration establishment.

2.3.2 Species Mix

For each area defined in (2.3.1) above as being stocked, sum the number of jarrah and marri recorded on the survey sheet. Calculate the number of jarrah as a percentage of the total number of jarrah and marri recorded. Where the existing overstorey is predominantly jarrah but less than 20% of the regeneration is jarrah, the stand is to be marked as a shelterwood with preference for retention given to jarrah. Regular burning can then be used to encourage the development of jarrah regeneration in an attempt to restore the previous species mix.

Refer to Appendix 5 for a worked example of a pre-harvesting regeneration survey.

3. INITIAL ESTABLISHMENT SURVEYS

The aim of this survey is to measure the quantity of regeneration which has become established in areas cut to shelterwood and determine whether it meets the regeneration standards, and if not, to prescribe remedial measures.

3.1 Survey Method

3.1.1 Timing of Survey

Assessment of regeneration in shelterwood areas is to be carried out approximately 12 months after the establishment burn (November - December) so that:

- regeneration is readily visible, and
- infilling can be arranged before scrub competition is excessive.

3.1.2 Initial Establishment Standards

A sample point is recorded as stocked if it meets any of the following standards:

- 1. 500 or more spha of jarrah or marri saplings, or
- 2. 1000 or more spha of jarrah ground coppice or marri advance growth, or
- 3. 1000 or more spha of a combination of jarrah or marri saplings and jarrah ground coppice or marri advance growth.
- 4. 5000 or more spha of a combination of jarrah or marri saplings, jarrah ground coppice or marri advance growth and lignotuberous seedlings or seedling coppice.
- 5. 5000 or more spha of lignotuberous seedlings or seedling coppice.

3.1.3 Sampling Intensity

- Sample on a grid of 50m x 20m within the proposed boundary of the shelterwood (approximately 10 sample points per ha).

3.2 Sampling Procedure

The method for estimating point densities is given in Section 2.2.

Lignotuberous seedlings and seedling coppice are included in this assessment since young regeneration will not have developed to an advanced stage 12 months after the burn.

Estimates of density are to be made in the following order:

1. Saplings.
2. Saplings + ground coppice.
3. Ground coppice.
4. Saplings + ground coppice + lignotuberous seedlings / seedling coppice.
5. Lignotuberous seedlings / seedling coppice.

These estimates need only be made until a stocked point is obtained.

If estimates 1 or 2 give a stocked point, record the point density on the survey sheet, record a tick for the stocking status in the Sapling & G.C.Stocking column and proceed to the next sample point. If not, record a cross and proceed to estimate 3.

If estimates 3, 4 or 5 give a stocked point, record the point density on the survey sheet and record a tick for the stocking status in the Total column, if not, record the point density on the survey sheet, record a cross and proceed to the next sample point.

3.3 Mapping and Calculations

Proceed as for Section 2.3 but make two stocking calculations. Firstly using only those points stocked in the Sapling & G.C. Stocking column and secondly using the total number of stocked points, i.e. Sapling & G.C. Stocking column + Total column.

3.4 Infill Requirements

All areas defined as large understocked areas will require total infill planting.

For the remainder where stocking is less than 65% stocked (Sapling & G.C. Stocking + Total column) infilling is required.

Infill planting must be undertaken in the planting season immediately following the year of establishment. It will be necessary to walk the entire area requiring infilling, bypassing well stocked areas and infilling where the average spacing of plants exceeds 3-4 metres.

Where infilling is required, infilling will aim at obtaining full stocking across the surveyed area.

Full stocking is defined as 1000 stems per hectare. To achieve this the planting rate will be 1300 seedlings per hectare.

The number of plants required is given by:

No. Plants = (100% - current stocked) x area of survey x 1300 spha.

For a 50 x 20 metre sample grid, the area surveyed can be estimated in hectares by dividing the number of sample points by 10.

4. MONITORING REGENERATION IN SHELTERWOOD AREAS

The aim of this survey is to monitor the development of regeneration in areas cut to shelterwood to determine when the site is available for gap creation.

The procedures and standards used are the same as for pre-harvesting surveys, (Section 2.0). The removal of the shelterwood overstorey may be undertaken once sufficient ground coppice or saplings are established.

The first monitoring survey should be carried out about 10 years after the shelterwood cut, and thereafter every 5 years if harvesting is contemplated.

5. RECORDS

Initial establishment and monitoring survey sheets must be filled out correctly and retained in the CIMCIS system as a reference for future treatment.

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Hardwood Silviculturist

APS:BB

August 12, 1997.

APPENDIX 1

STAGES OF JARRAH REGROWTH DEVELOPMENT

Successful and rapid development of jarrah regeneration following its release depends on the stage of development of the advanced growth.

The characteristics of the various regeneration states are outlined below:

1. SEEDLING

Less than 1 year old, usually with cotyledons still present, but with no lignotuberous swelling.

2. LIGNOTUBEROUS SEEDLING

Original single shoot still present, but with a small lignotuberous swelling.

3. SEEDLING COPPICE

Lignotuber is obvious and multiple shoots have developed after the removal of the original shoot by fire or other causes.

4. GROUND COPPICE

Shoot growth up to 1.5m, lignotuber 5-10 cm in diameter. Capable of rapid development into a sapling.

Incipient Ground Coppice - multiple shoots, no defined leader.
Dynamic Ground Coppice - multiple shoots with a defined leader.

5. SAPLING

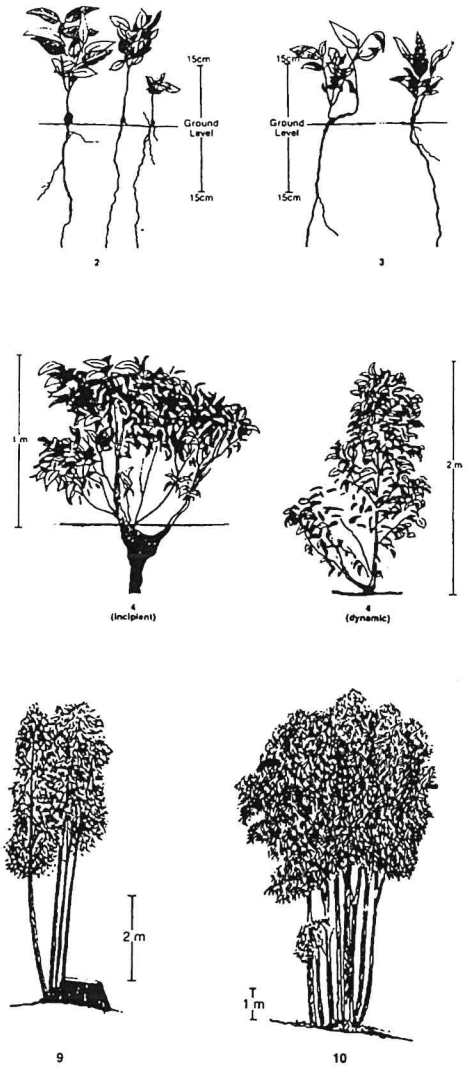
Stem >1.5 m tall, <15 cm, lignotuber large and ill-defined.
(Modified from Abbott and Loneragan).

Except on very favourable sites, advance growth smaller than ground coppice will not develop immediately into saplings.

For the purposes of the pre-harvesting survey only advanced growth at the ground coppice and sapling stages is to be considered when sampling.

Marri advanced growth with shoot growth >30 cm high is also to be included.

The stages of regeneration are represented diagrammatically on the following page.



Early stages in the developent of jarrah; (2), lignotuberous seedling; (3), seedling coppice; (4), ground coppice; (9), stump coppice; (10), stool coppice.

APPENDIX 2

PREPARED TABLE OF DENSITY ESTIMATES

This table gives the point density estimate for possible triangles at each sample point. (See attached.)

A. For each sample point select the table in which the corner box has the same value as the shortest recorded triangle side.

B. Within the table selected locate the longest triangle side on the horizontal axis and the remaining side on the vertical axis.

C. Read off the point density in stems per hectare (spha) given by the selected triangle sides and record it on the survey sheet.

D. If the three sides recorded on the survey sheet do not appear on any table, keep adding 1.0 metre to the shortest side until the first possible triangle is obtained.

APPENDIX 2

ESTIMATION OF POINT DENSITY USING TRIANGLES
JARRAH REGENERATION

Example: 3 metres x 4 metres x 6 metres = Density of 937 spha

Longest Triangle Side (metres)

Shortest Triangle Side (metres)

Remaining Triangle Side (metres)

Estimate of Point Density (spha)

3	3	4	5	6
3	1283	1118	1206	
4		899	833	937
5			699	668
6				574

1	1	2	3	4	5	6	7	8	9	10
1	11547									
2		5164								
3			3081							
4				2520						
5					2010					
6						1672				
7							1432			
8								1252		
9									1113	
10										1001

2	2	3	4	5	6	7	8	9	10
2	2887	2520							
3		1786	1721						
4			1291	1316					
5				1021	1068				
6					845	899			
7						722	777		
8							630	684	
9								559	611
10									503

3	3	4	5	6	7	8	9	10
3	1283	1118	1206					
4		899	833	938				
5			699	668	770			
6				574	559	654		
7					488	481	569	
8						424	423	504
9							376	377
10								337

4	4	5	6	7	8	9	10	11	12	13	14
4	722	641	630	738							
5		546	504	510	611						
6			442	417	430	523					
7				373	357	372	458				
8					323	313	329	406			
9						286	278	295	367		
10							256	250	267	334	
11								231	228	244	306
12									211	209	225
13										195	193
14											180

5	5	6	7	8	9	10	11	12	13	14
5	462	417	400	417	510					
6		367	340	334	354	439				
7			306	289	287	308	386			
8				263	251	252	273	344		
9					231	223	225	245	311	
10						207	200	204	223	284
11							187	182	186	204
12								170	167	171
13									157	154
14										145

6	6	7	8	9	10	11	12	13	14
6	321	293	280	280	302	379			
7		264	246	238	242	264	334		
8			225	213	208	214	234	300	
9				195	188	185	191	211	272
10					175	168	167	173	192
11						157	152	152	159
12							143	139	140
13								132	128
14									122

7	7	8	9	10	11	12	13	14
7	236	218	207	204	210	231	296	
8		199	186	180	179	186	206	266
9			172	163	159	160	167	186
10				152	146	143	144	152
11					137	132	130	132
12						124	120	119
13							114	111
14								105

8	8	9	10	11	12	13	14
8	180	168	160	156	157	165	184
9		155	146	141	139	141	149
10			136	130	126	125	128
11				122	117	114	114
12					110	106	104
13						101	98
14							93

9	9	10	11	12	13	14
9	143	134	128	124	124	126
10		124	118	114	111	111
11			111	106	102	101
12				100	96	93
13					91	88
14						84

10	10	11	12	13	14
10	115	109	104	101	100
11		102	97	94	92
12			92	88	85
13				83	80
14					76

APPENDIX 3
JARRAH REGENERATION SURVEY SHEET

Date: ________________ **District:** _________________ **Block/Coupe:** _________________

Assessor: ________________ **Line No:** _______ **Bearing:** ________ **Page No:** ________

SURVEY: PRE-HARVESTING / INITIAL ESTABLISHMENT / MONITORING

Point No.	DensityEstimate			Stocking Status		Species Mix		Forest Structure	
	Saplings	Sapling/G. Coppice or G. Coppice	Seedling Coppice/Seedling	Sap. & G. Coppice (✓ / X)	Sap. & G. Coppice & Seedlings (✓ / X)	J	M	(*M/T)	Other
A	TOTALS			B	C	D	E		

Stocking (Sap. + G. Copp.) = $\frac{B}{A} \times 100$ = ________% If ≥65% Gap may be created.

Stocking (Total) = $\frac{B + C}{A} \times 100$ = ________% If <65% Infill required.

% Jarrah = $\frac{D}{D + E} \times 100$ = ________%

*** M - Mature**
T - Thinnings

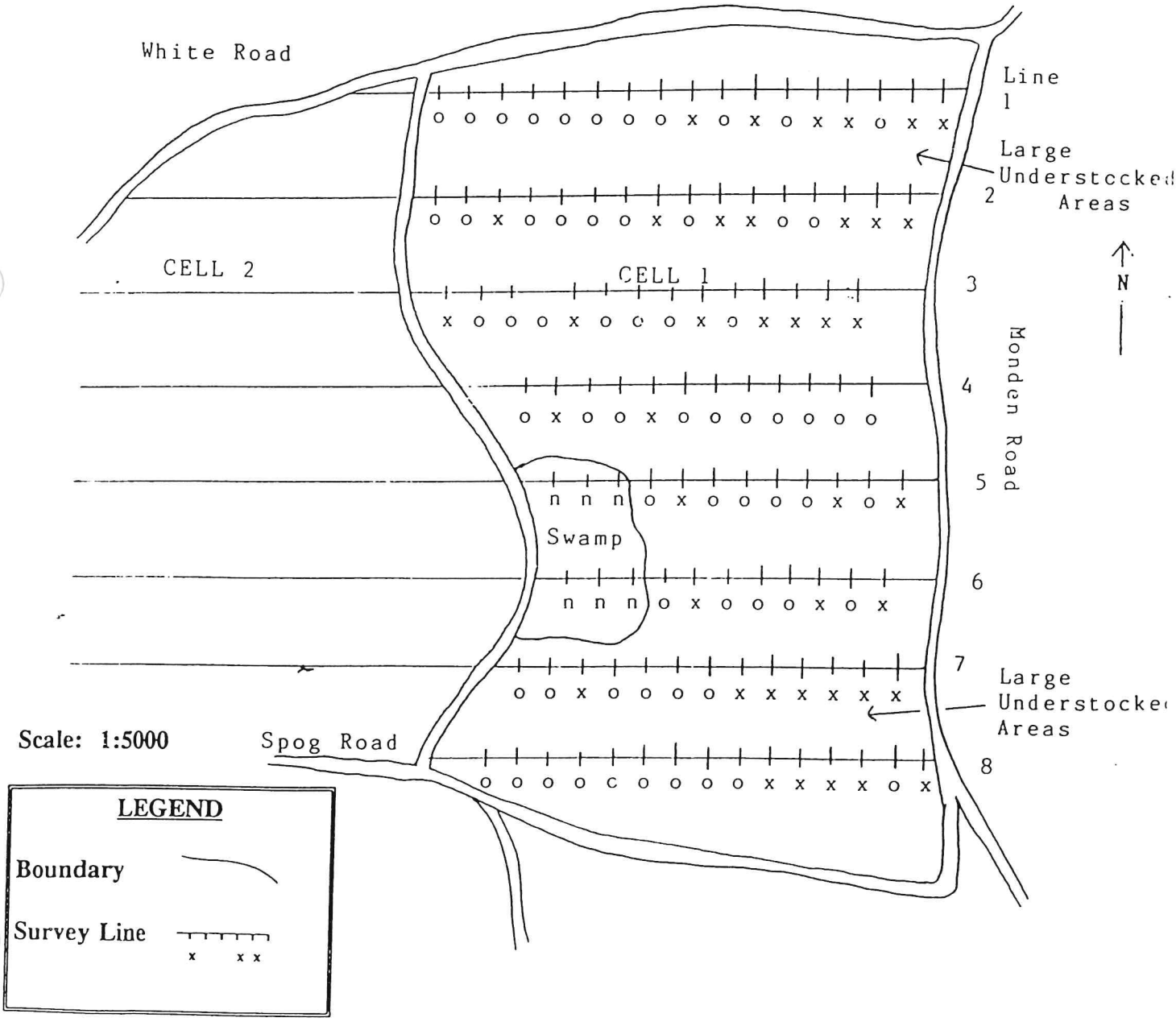
APPENDIX 4
COMPLETED
PREHARVESTING REGENERATION SURVEY MAP

Date: _____ District: _____ Compartment: _____

Year: _____ Assessor: _____

Tie Directions: _____

Area No: _____ Cell No: _____ Line Bearing: _____



jarrgen2.doc

APPENDIX 5
JARRAH REGENERATION SURVEY SHEET

Date: 13.1.97 **District:** KIRUP **Block/Coupe:** WOOP WOOP

Assessor: J. DANIELS **Line No:** 1 **Bearing:** _____ **Page No:** 1

SURVEY: PRE-HARVESTING / INITIAL ESTABLISHMENT / MONITORING

Point No.	DensityEstimate			Stocking Status		Species Mix		Forest Structure	
	Saplings	Sapling/G. Coppice or G. Coppice	Seedling Coppice/Seedling	Sap. & G. Coppice (✓ / X)	Sap. & G. Coppice & Seedlings (✓ / X)	J	M	(*M/T)	Other
1	630	–		✓		2	1	T	
2	–	1206		✓		3	0	T	
3	–	1021		✓		3	0	T	
4	–	1283		✓		3	0	T	
5	–	2520		✓		3	0	T	
6	510	–		✓		1	2	T	
7	–	504		✓		2	1	M	
8	1118	–		✓		3	0	T	
9	–	599		X		1	2	M	
10	–	435		X		1	2	M	
11	–	1021		✓		2	1	M	
12	–	–		X		–	–		NON FOREST
13	2520	–		X		3	0	T	
14	–	238		X		0	3	T	
15	3381	–		✓		2	1	T	
16	–	2010		✓		0	3	M	
17	–	1206		✓		3	0	M	
18	–	11547		✓		1	2	M	
19	–	574		X		1	2	M	
20	630	–		✓		3	0	M	
A	TOTALS			B 14	C	D 37	E 20		

Stocking (Sap. + G. Copp.) = $\frac{B}{A} \times 100$ = 70 % If ≥65% Gap may be created.

Stocking (Total) = $\frac{B + C}{A} \times 100$ = _____ % If <65% Infill required.

% Jarrah = $\frac{D}{D + E} \times 100$ = 65 %

*** M - Mature**
T - Thinnings