DEPARTMENT OF CONSERVATION
AND LAND MANAGEMENT

SILVICULTURE SPECIFICATION 1/90

KARRI REGENERATION SURVEYS

CONTENTS

1.0 PREAMBLE

Regeneration of cutover forest is necessary to ensure the sustained yield of forest values and products.

The exact level of regeneration required will depend on the management objectives for the future forest.

Assessment of regeneration adequacy by casual observation can be misleading and for this reason surveys are required to evaluate regeneration success on a consistent and objective basis.

The intensive management of regrowth forests requires that detailed and exact information on the status of regeneration be available to forest managers.

This specification outlines the techniques to be used for regeneration surveys of karri types and the standards of acceptability to be adopted. It is applicable to planted, seeded and seed tree regeneration and replaces both the milacre and survival count techniques.

2.0 OBJECTIVES

To evaluate the success of regeneration operations in forests subject to timber harvesting and to establish the extent of infill planting required to achieve acceptable stocking.

3.0 STRATEGIES

The regeneration survey technique outlined in this specification will enable an assessor to:

(a) estimate the stocking of regeneration at a number of points within the regeneration area,

(b) estimate the overall stocking for the regeneration area based on the percentage of sample points which are acceptably stocked,

(c) locate areas which are understocked, and

(d) estimate the magnitude of infill planting that is required in the understocked areas.

In addition the technique will yield information useful for the prediction of future stand development and yield possibilities.

4.0 STANDARDS

4.1 Point Stocking

The stocking at any point may be classified using one of three possible categories:

(a) **Optimal stocking;** that at which crop trees will develop the maximum possible clean bole length. Optimal stocking at a point is achieved with a density of 3000 spha or more at age 1.*

(b) **Adequate stocking;** that at which crop trees will develop less than the maximum possible clean bole length but still provide a full stocking of acceptable crop trees at first thinning. Adequate stocking at a point is achieved with a density of 1666-3000 spha at age 1.*

(c) **Understocked;** that at which the bole length of crop trees at first thinning will be unacceptable. An understocked point is achieved with a density of less than 1666 spha at age 1.*

4.2 Overall Stocking Standard

The percentage of sample points at the different levels of stocking provides a basis for predicting future yield and for determining the extent of infill planting required.

All productive forest areas will be regenerated to a target stocking of at least 85% (Optimal + Adequate).

To achieve this target infill planting will be required where:

(a) the survey map indicates understocked areas of 1 ha or more, and

(b) 15% or more of the productive area# is understocked.

*Estimates of point density refer to those derived from the triangular method of Ward(1989),(refer to Appendices 3 and 4).

#Productive area refers to the area that has the potential to support an acceptable stocking of regeneration. Examples of non-productive areas may include rock outcrops, swamps and creeks which occur within the boundaries of the regeneration area.

5.0 SURVEY METHOD

5.1 Timing of Surveys

Initial regeneration establishment surveys of all planted, seeded and seed tree regenerated coupes are to be carried out from December to January.

This allows for some stabilisation of seedling numbers during the first summer, increased visibility of seedlings and for the finalisation of nursery stock to be raised in time for infill planting any understocked areas in year 2.

Results are to be forwarded to the Regional Regeneration Officer by the end of the first week in February.

5.2 Field Procedure

(a) Establish Survey Grid

(i) Divide the coupe to be assessed into a number of areas using roads or major snig tracks as boundaries. The size of these areas will be determined by the location of convenient boundaries.

(ii) A survey grid of 80 x 20 metres is to be established by compass and pacing with sample points at 20 metre intervals on parallel lines 80 metres apart (refer to Appendix 1 for compass and pacing surveys).

Survey lines in planted regeneration must not be located parallel to planting lines as this would introduce bias to the survey results.

(b) Assessment

The following procedure is to be undertaken at each sample point and all information recorded on a Regeneration Survey Sheet, (Appendix 7).

(i) Mark Sample Point

Make a mark on the ground at the sample point. This will help to relocate the survey grid after searching for regeneration.

(ii) Locate Acceptable Stems

Identify three acceptable stems which form the most compact triangle around the sample point. These stems must all be within a 5 metre radius of the sample point (refer to Appendix 2 for definition of acceptable stems and Appendix 3 for the selection of a triangle).

(iii) Measure and Record Triangle Sides

Estimate the length of each of the triangle sides by pacing and record these on the survey sheet, (refer to Appendix 3 for the measurement and recording of a triangle).

(iv) Record Species Mix

Tally each of the three stems of the triangle onto the survey sheet under their respective species ie. karri, marri or jarrah. When there is no triangle within 5 metres of the sample point simply tally the three closest stems according to species.

(v) Record Nature of Seedbed

(✓) If the seedbed around the sample point consists of uncompacted exposed mineral earth or ashbed place a tick in the seedbed column.

(D) If the seedbed around the sample point is soil damaged* record a "D" in the seedbed column. However a sample point may only be recorded as soil damaged if additional site preparation would be required to obtain acceptable stocking at the time of infill planting. As a guide, if 3 plants could be infilled around the sample point without additional site preparation, such that they would form a triangle with no side greater than 4 metres, then the point should not be recorded as soil damaged.

(N) If the seedbed around the sample point does not have the potential to support acceptable stocking because of rock outcrops, swamps or creeks then record the point as non-productive, "N", in the seedbed column.

(vi) Record Observations

Record any observations that may help interpret the final results eg. location of landings, snig tracks, seed tree tops, rock outcrops, changes in site type, etc.

(vii) Move to Next Sample Point

Finally relocate the sample point and pace to the next sample point on the grid.

*Soil damage is defined in the Manual of Hardwood Logging Specifications.

5.3 Office Procedure

Refer to Appendix 5 for a summary of calculations required and Appendix 6 for a worked example of the office procedure outlined below.

(a) Map Preparation

By transferring survey information to a map, calculations can be easily made without further reference to the survey sheets. The assessor can then use the map to calculate stocking, locate understocked areas and to plan which areas require infill planting.

(i) Complete Survey Sheet

For each sample point enter the point density of the triangle and the stocking status for that point onto the survey sheet by consulting the prepared table of density estimates in Appendix 4.

The following symbols are to be used to map the stocking status at each sample point:

● = Optimal stocking
O = Adequate stocking
X = Understocked
D = Soil Damaged
N = Non-productive

Sample points which were recorded as soil damaged but are not understocked are to be mapped according to their stocking rather than as damaged.

(ii) Prepare Map

Prepare a map of the assessment area showing the location of; boundaries, survey lines, sample points, landings, major snig tracks, creeks, different site types, etc. Number each survey line and draw an arrow to show the direction of travel along the line.

To ensure a standard approach to mapping all maps must be prepared using the format shown in Appendix 8. If the assessment area is too large to map onto the prepared sheet, copy the format onto a sheet of suitable size.

A scale of 1:5000 is recommended.

(iii) Record Point Stocking Status on Map

The stocking status of each sample point is to be marked onto the map. Mark all sample points clearly as this will help when counting these points for stocking calculations.

(iv) Locate Assessment Cells

Regeneration success will be assessed on a cell basis with a maximum cell size of 20 ha.

These assessment cells need not correspond to the same areas as those established at the time of the initial survey.

Survey data and other observations are to be used to establish boundaries of assessment cells reflecting any obvious changes in regeneration success due to factors such as site type, presence of swamps or creeks, etc.

In this way variation in regeneration success within cells can be minimised and if necessary different standards applied to particular cells.

The location of each assessment cell is to be marked onto the map.

(b) Stocking Calculations

Sample points are classed as stocked if they have the number and distribution of stems to provide enough crop trees of acceptable form by the time of first thinning.

The overall stocking for a coupe is the percentage of the productive area which is acceptably stocked. Sample points at either optimal or adequate stocking are regarded as acceptable.

For any calculation of area in hectares from an 80 x 20 metre grid, divide the number of sample points within the desired area or category by 6.25.

ie. Area (ha) = (N°· sample points) / 6.25

The number of sample points at different levels of stocking can be counted directly from the map.

The results of the following calculations are to be recorded on the Regeneration Survey Summary, (Appendix 9).

(i) Calculate Productive Area For Each Cell

For each cell subtract the number of sample points mapped as non-productive ("N") from the total number of sample points for the cell and use this number to calculate the productive area within the cell.

(ii) Calculate Percentage Stocking for Each Cell

Calculate the area of each cell at optimal stocking, adequate stocking and the area understocked along with the percentage of the productive cell area they represent.

(iii) Calculate Percentage Stocking for Coupe

Calculate the overall stocking for the coupe by summing the areas at optimal and adequate stocking within each cell and expressing this as a percentage of the total productive area within the coupe.

(iv) Calculate Area of Soil Damage

For each cell calculate the area mapped as soil damaged ("D") and express this as a percentage of the productive cell area. The total amount of soil damage for the coupe is given by the sum of soil damaged areas from each of the cells.

(c) Map Interpretation

Sampling on a grid basis produces a map showing the general location of larger understocked areas, but because the map is derived from a series of sampling points it will not necessarily indicate the exact location and size of all understocked areas.

Understocked points distributed evenly across a cell indicate patchy regeneration and sizeable individual understocked areas may not exist.

However if all of these small understocked areas sampled sum to an unacceptable proportion of the productive area then infill planting is required.

In the extreme this may necessitate walking over the entire area and restocking any gaps found at the required rate.

Example: The map below illustrates an area with no distinct large understocked areas but with a substantial understocked area overall.

```
—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—
—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—
—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—
—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—O—X—O—O—
```

Total N°. Points = 100 ie. 16 ha.
N°. of Points Understocked = 25 ie. 4 ha.

Although no large understocked gaps are present in this example 25% of the area is understocked and infill planting is therefore required. Because the understocked area of 4 ha is spread evenly across 16 ha it is necessary to walk the entire area to find the areas requiring infill.

Hence the survey map will not indicate the exact location of small understocked areas but it will indicate if infill is required, the general location of areas requiring infill and the distribution of understocked areas within this general location.

The procedure for determining if and where infill planting is required is outlined below.

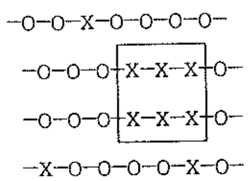
(d) Locating Areas for Infill Planting

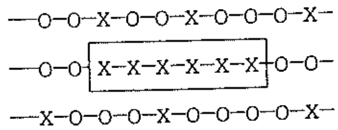
(i) Large Understocked Areas

Within each assessment cell outline any understocked areas of 1 ha or more. For an 80 x 20 metre grid this represents approximately 6 or more immediately adjacent sample points with at least 3 consecutive understocked points on any one survey line.

These areas will require infill planting.

Example: Any understocked area of the size outlined below or larger is to be identified for infill planting.





(ii) Smaller Understocked Areas

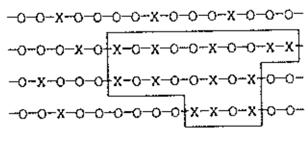
Calculate the percentage of understocked points in the productive area of each cell. For this calculation do not count as understocked any points outlined in (i) above because they have already been identified for infill.

If this percentage exceeds 15% for any one cell then infill planting is required. If not, only those areas outlined in (i) require infill.

The location of infill planting is determined by outlining areas on the map that contain enough understocked points, which if infilled, would reduce the remaining understocked area to less than 15% of the productive cell area. It is useful to firstly establish how many points 15% represents and then plan to outline at least that amount of understocked points.

Example: Although there are no large understocked areas present in the area below infill planting is required because greater than 15% of the points are understocked.

Total No. points = 60
N°. Understocked = 18
ie. 30% Understocked
Therefore infill is required



If the outlined area is infilled then only 6 understocked points will remain out of a total of 60 points, ie. 10%. Since this is less than the standard of 15%, infill planting of the outlined area is sufficient.

Several possible areas may be outlined for infill which will meet this condition. The assessor must choose which approach will be the most efficient and practicable in the field.

(iii) Calculate Total Area of Infill Planting

This is given by the number of understocked sample points within all of the areas outlined for infill divided by 6.25. Do not include stocked sample points which occur in the middle of infill areas because they represent patches of good stocking which planters will bypass at the time of infill planting these areas. Record this area on the summary sheet for each cell and the entire coupe.

(e) Rehabilitation of Soil Damaged Areas

The exact extent of rehabilitation work required for each coupe is best determined by a specific survey of landings and snig tracks. The area calculated in (ii) below will serve as a guide. If rehabilitation work has already been completed at the time of the regeneration survey the following steps will not be required unless significant areas of soil damage were left untreated.

(i) Outline all soil damaged points on the survey map which are associated with landings and major snig tracks adjacent to landings. These will require ripping and planting. Any additional large areas of soil damage, 1 ha or more, within the coupe are also to be outlined for treatment.

(ii) Calculate the soil damaged area outlined above.

(f) Check Final Expected Stocking

A check must be made to determine if the treatment of all the areas outlined on the survey map will be sufficient to obtain the target stocking for the whole coupe. Enter calculations on the summary sheet.

(i) Calculate the total area which will be acceptably stocked when all understocked and soil damaged areas outlined on the survey map are treated ie. Area at Optimal Stocking + Area at Adequate Stocking + Area of Infill + Area of Soil Damage Outlined for Treatment.

(ii) If the area calculated in (i) is less than 85% of the productive area then additional areas will need to be outlined for treatment such that the target stocking can be obtained.

Exactly which areas should then be selected will depend on the extent of soil damage and the location of the remaining understocked points within the coupe. Select areas which will achieve the target stocking in the most efficient and practicable manner.

(g) Calculating Infill Plant Requirements

Infill planting will aim to obtain a stocking at least that of full planting, ie. that given by at least 1666 spha.

All calculations are to be done on a cell by cell basis and recorded on the summary sheet.

(i) Calculate the Mean Density of Understocked Points Within Areas Outlined for Infill

Select the understocked points within areas outlined for infill and calculate the mean density of these points. It will be necessary to consult the original survey sheets for the point densities at these sample points.

If several large understocked areas have been identified for infill within the same cell calculate the mean density for each area of infill.

(ii) Calculate Total Number of Plants Required

If the mean density of understocked points within an area outlined for infill is less than 833 spha then full infill planting at 1666 spha (3m x 2m spacing) will be undertaken in that area.

If the mean density is 833 - 1666 spha then infill planting at 833 spha (3m x 4m spacing) will be undertaken in that area.

Hence the number of plants required is given by multiplying the selected infill rate by the area to which it will be applied.

(h) Planning Infill Planting

Outline each area to be infilled on the map and indicate the required infill rate. A copy of this map should be provided to the overseer at the time of infill planting.

Understocked areas outlined for ynfill will often contain patches of acceptable stocking. Although infill planting is carried out on a grid pattern, planters are to be instructed to bypass existing acceptable stems where they occur at the desired spacing.

Where the planting of landings and snig tracks is required this should be co-ordinated where possible with any infill planting required in that coupe.

It is important that infill planting succeed in the first instance otherwise increased scrub competition will severely limit further restocking possibilities. Where possible, infill planting is to be undertaken early in the planting season.

(i) Estimating Species Mix

(i) For each cell sum the number of karri, marri and jarrah recorded in the species mix column of the survey sheet.

(ii) Calculate the percentage of the total number recorded which are karri, marri and jarrah for each cell and for the entire coupe. Record these on the summary sheet.

6.0 RECORDS

It is important that an accurate record of all regeneration survey results be kept. These will be required for future reference with respect to:

(i) relocating understocked areas at the time of infill planting,

(ii) evaluating past regeneration performances in the light of refined standards, and

(iii) prediction of stand development and yield possibilities.

The following records should be kept in a separate Regeneration Survey File at the district:

(i) original regeneration survey sheets,
(ii) original survey maps, and
(iii) original survey summary sheets.

The following records should be forwarded to both the Regional Regeneration Officer and the Manager Inventory Section, for inclusion on the regional HOCS, by the end of the first week in February:

(i) copy of survey maps, and
(ii) copy of survey summary sheets.

7.0 FOLLOW-UP

All areas of infill planting must be assessed for survival between December and January in the year of infill planting.

Whilst small areas of infill planting may be assessed visually the success of large areas of infill planting (10 ha or more) is to be determined by a follow-up regeneration survey.

The aim of this survey is to determine finally if previously understocked areas have been successfully regenerated to an acceptable standard.

At the completion of this survey the % stocking for the whole coupe is to be updated by adding to the original stocked area the area which is now acceptably stocked due to infilling and the rehabilitation of landings and snig tracks.

These results are to be forwarded to the Regional Regeneration Officer by the end of the first week in February.

If large areas of infill planting fail additional site preparation and scrub control measures must be considered before any further infill planting occurs.

8.0 REFERENCES

Ward,D.(1989),Estimating the density of planar points.
In prep.

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APPENDIX 1 COMPASS AND PACING SURVEY

For the purpose of regeneration surveys a survey grid established by compass and pacing is sufficient. A hip chain may also be used to measure distances.

(a) Grid Spacing

Survey lines are to be 80m apart. Maintain parallel lines by following a set compass bearing.

Sample points are to be spaced at 20m intervals along the survey lines.

(b) Calibration of Pacing

If pacing distances an assessor must calibrate their pacing against a known distance. Allowance must also be made when pacing up or down slopes.

(c) Establishing Survey Lines

Select major roads or major snig tracks as boundaries from which the survey lines commence. The first line should start at a randomly chosen point between 0 and 80m from one end of the area to be surveyed.

At the end of a survey line the assessor should proceed to the next line, 80m at right angles to the line direction. If a boundary changes angle relative to the survey lines it may be necessary to move along the new line to get to the boundary again before the first sample point can be established.

For each survey line record the direction walked so that sample points can be mapped from the correct end of the survey line.

(d) Direction of Survey Lines

The direction of survey lines will be determined by the shape of the area being assessed. Where possible choose a direction with the clearest line of sight to the opposite boundary thereby making it easier to follow a bearing and achieve parallel survey lines. Establishing lines roughly perpendicular to boundaries can also help to space consecutive survey lines more accurately.

(e) Locating Sample Points

The starting sample point on each survey line is to be located at a randomly chosen point between 0 and 20m along the survey line. Thereafter sample points should be spaced at 20m intervals along the survey line.

It is not necessary to ensure that sample points are square between adjacent lines so long as the distance from the boundary to the first sample point is recorded for mapping purposes.

The location of the first starting point for the survey grid in each area is to be recorded on the survey sheet using a bearing and a distance given from a relocatable tie point eg. from a road junction or large stump. This will help to relocate any understocked areas found.

(f) Marking Survey Lines

A piece of flagging tape with the line number written on should be tied at the beginning and end of each survey line, adjacent to the boundary of the area, to act as a reference point should infill planting be required.

(g) Avoiding Bias

Care must be taken to ensure that sample points are selected with the minimum bias. The assessor should try to avoid looking where the last pace will fall to reduce any bias in sample point selection. Where possible the assessor should avoid deviating from the grid to place the sample point in a more convenient location.

APPENDIX 2 ACCEPTABLE STEMS

The following stems are considered equally acceptable when recording the stocking at a point:

(a) karri germinants
(b) marri germinants and advanced growth
(c) jarrah advanced growth
(d) karri, marri and jarrah coppice if the base of stem is at ground level. Coppice off the side of large stumps is not acceptable.

Only stems which appear likely to survive in the immediate future are considered acceptable.

Training in the identification of karri, marri and jarrah regeneration should be provided to the assessor as required.

APPENDIX 3 TRIANGLE SELECTION, MEASUREMENT AND RECORDING

(a) Triangle Selection

Search around each sample point for three acceptable stems which subscribe a triangle around the sample point. The stems chosen do not necessarily have to be the three closest but they must form the most compact triangle possible around the sample point i.e. that with the smallest perimeter.

If several such triangles appear possible choose the one closest to an equilateral triangle. All three stems selected must be within a 5 metre radius of the sample point. If no possible triangle exists within this area refer to c (iii).

(b) Triangle Measurement

Estimate the length of each triangle side.

For lengths up to 3.0 metres, estimates are to be made to the nearest 0.5 metre.

For lengths greater than 3.0 metres, estimates are to be made to the nearest 1.0 metre.

All lengths are to be estimated by pacing. With practice an assessor may use visual estimates but these must be checked regularly by pacing.

(c) Triangle Recording

(i) At each sample point the length of each triangle side is to be recorded on the survey sheet.

(ii) The sum of any two sides of a triangle must be greater than the third side. For each estimate of triangle sides make a quick check to ensure this is the case.

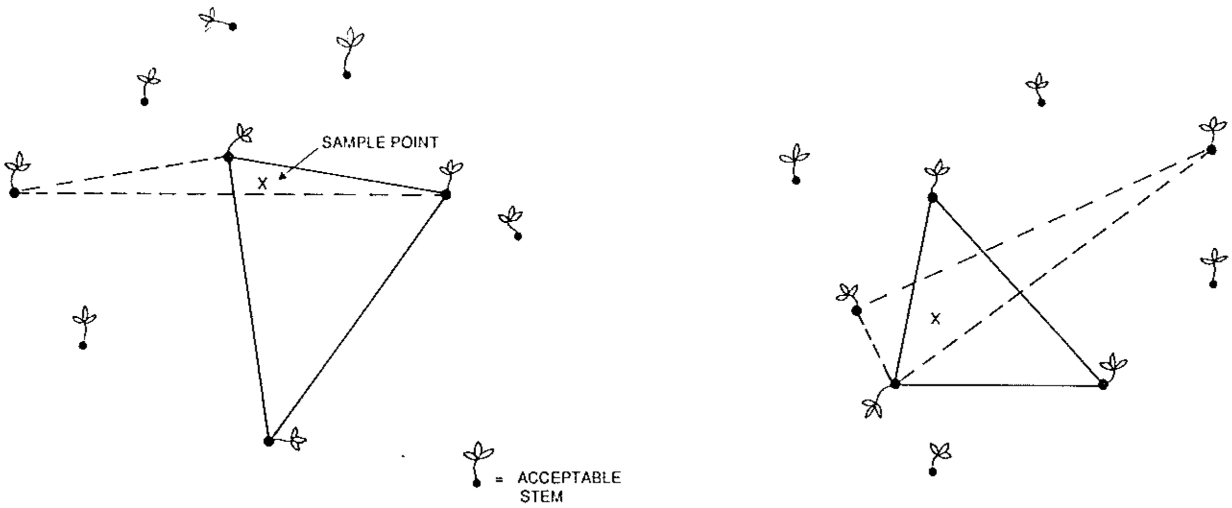
This rule may sometimes not be met due to the rounding off of distances to the closest 1.0 metre or 0.5 metre. If this occurs simply record the distances as estimated and these will be adjusted at the time of recording density estimates,(see Appendix 4).

(iii) If no acceptable stems occur within a 5 metre radius of the sample point record 0 for each triangle side.

If 1 or more acceptable stems occur within a 5 metre radius of the sample point but no possible triangle exists within this area then record a dash (-) for each triangle side.

Examples of Triangle Selection

Where a choice exists between several triangles of similar perimeter select the triangle closest in shape to an equilateral. In the examples below the prefered triangle is drawn with a solid line.



APPENDIX 4 PREPARED TABLE OF DENSITY ESTIMATES

This table gives the point density estimate for possible triangles at each sample point.

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 0.5 metre to the shortest side until the first possible triangle is obtained.

ESTIMATION OF POINT DENSITY USING TRIANGLES
KARRI 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

If 0 stems within 5 metre radius then Density = 0 spha. (0,0,0)

If 1 or more stems within 5 metre radius but no triangle then Density = 200 spha. (——,——,——)

0.5	0.5	1	1.5	2	2.5	3	4
0.5	46188						
1		20656					
1.5			13522				
2				10079			
2.5					8040		
3						6699	
4							5010

1	1	1.5	2	2.5	3	4
1	11547	10079				
1.5		7071	6885			
2			5164	5264		
2.5				4082	4270	
3					3381	
4						2520

1.5	1.5	2	2.5	3	4	5
1.5	5132	4472	4824			
2		3596	3333	3750		
2.5			2795	2673		
3				2295	2616	
4					1697	2016

2	2	2.5	3	4	5	6	7	8	9	10
2	2887	2562	2520							
2.5		2182	2016	2445						
3			1768	1721						
4				1291	1316					
5					1020	1068				
6						845	899			
7							722	777		
8								630	684	
9									559	611
10										503

2.5	2.5	3	4	5	6	7	8	9	10
2.5	1848	1667	1667						
3		1467	1335	1755					
4			1053	1010	1377				
5				826	815	1136			
6					682	684	968		
7						581	590	844	
8							506	519	748
9								449	463
10									403

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
4	722	641	630	738			
5		546	504	510	611		
6			442	417	430	523	
7				373	357	372	458
8					323	313	329
9						265	278
10							255

5	5	6	7	8	9	10
5	462	417	400	417	510	
6		367	340	334	354	439
7			306	289	287	308
8				263	251	252
9					231	223
10						207

6	6	7	8	9	10
6	321	293	280	280	302
7		264	246	238	242
8			225	213	208
9				196	188
10					175

7	7	8	9	10
7	236	218	207	204
8		199	186	180
9			172	163
10				153

8	8	9	10
8	180	168	160
9		155	146
10			136

9	9	10
9	143	134
10		124

10	10
10	115

APPENDIX 5 SUMMARY OF CALCULATIONS

All calculations of area are expressed in hectares.

A. Stocking Calculations

1. Productive Area = $\frac{\text{Total No. Points - N°. Non-productive Points}}{6.25}$

2. Area of Optimal Stocking = $\frac{\text{N°. Points at Optimal Stocking}}{6.25}$

3. Area of Adequate Stocking = $\frac{\text{N°. Points at Adequate Stocking}}{6.25}$

4. % Stocking = $\frac{\text{(Area of Optimal + Area of Adequate Stocking)}}{\text{Productive Area}}$ x 100

5. Area Understocked = $\frac{\text{N°. Points Understocked}}{6.25}$

6. % Understocked = $\frac{\text{Area Understocked}}{\text{Productive Area}}$ x 100

7. Area of Soil Damage = $\frac{\text{N°. Points Soil Damaged}}{6.25}$

8. % Soil Damage = $\frac{\text{Area of Soil Damage}}{\text{Productive Area}}$ x 100

B. Infill Planting Calculations

1. Outline areas for infill where:
   i. individual understocked areas are 1ha or more, and
   ii. the % understocked is 15% more.
2. Area of Infill = $\frac{\text{N°. understocked Points in Infill Areas}}{6.25}$
3. Infill Rate

Where mean density of understocked points = 833 spha or more, then infill at 3m x 4m ie. 833 spha.
Where mean density of understocked points < 833 spha then infill at 3m x 2m ie. 1666 spha.
N.B. The mean density refers to that of the understocked points within the area to be infilled.

4. N°. Plants Required = Area of infill x Infill rate.

APPENDIX 6 COMPLETED REGENERATION SURVEY SHEET

Date: 6/1/90 District: Walpole Compt.: Deep 1 Assessor: S. Monden

Establishment Year: 1989 Tie Directions: Point 1 30m at 125° from White + Monden Rd. cnr.

Area No.: 1 Line Bearing: 270° (line 1) Page No.: 1

Line No.	Point No.	Triangle Sides (m) 1	2	3	Sp. Mix K	M	J	Seed-bed	Point Density	Stocking Status	Comments	
1	1	0	0	0	—	—	—	✓	0	X	Pushin at edge.	
	2	4	5	6	2	1		✓	504	X	Very patchy regen.	
	3	2	3	3	1	1	1	✓	1768	O	" "	
	4	—	—	—	1	2		✓	200	X	" "	
	5	4	4	4	3			✓	722	X	" "	
	6	1.5	2	2	3			✓	3596	●	" "	
	7	8	8	9	1		2	✓	168	X	" "	
	8	2	3	3	3			✓	1768	O	" "	
	9	5	5	7	2	1		✓	400	X	" "	
	10	1	1	1		1	2	✓	11547	●		
	11	0.5	2	2	3			✓	10079	●		
	12	0	0	0	—	—	—	D	0	D	Snig track	not
	13	0	0	0	—	—	—	D	0	D	Snig track	yet
	14	0	0	0	—	—	—	D	0	D	Landing	ripped.
	15	0	0	0	—	—	—	D	0	D	Landing	not
	16	0	0	0	—	—	—	D	0	D	Landing	yet
	17	0	0	0	—	—	—	D	0	D	Landing	ripped.
2	1	1	1	1	3			✓	11547	●	Line at 90°.	
	2	1.5	1.5	2	3			✓	4472	●		
	3	—	—	—	3			✓	200	X		
	4	0.5	1	1	3			✓	20656	●		
	5	1	3	3	3			✓	3381	●		
	6	0.5	2	2	2	1		✓	10079	●		
	7	2	2	3	1	2		✓	2520	O		
	8	5	6	8	1	1	1	✓	334	X		
	9	1	1	1	3			✓	11547	●		
	10	0	0	0	—	—	—	✓	0	X	Patchy regen.	
	11	2.5	4	4	2	1		✓	1053	X	" "	

Additional Comments: Landings and snig tracks require ripping
Eastern edge of area is very patchy.

APPENDIX 6 COMPLETED REGENERATION SURVEY SUMMARY

Survey Date: 6/1/90 District: Walpole Compartment: Deep 1 Assessor: S. Monden.

Establishment year: 1989. Initial Survey or ~~Infill Survey~~

	AREA (ha)
Seed Tree Planted Other	17

Standards Applied
Optimal stocking: ≥ 3000 spha Adequate stocking: 1666 - 3000 spha Understocked: < 1666 spha

A. STOCKING SUMMARY

Cell Nº.	Productive Area(ha)	Optimal Stocking Area(ha)	Optimal Stocking %	Adequate Stocking Area(ha)	Adequate Stocking %	Understocked Area(ha)	Understocked %	Soil Damage Area(ha)	Soil Damage %
1	16	3·2	20	4·5	28	5·8	36	2·6	16
—									
—									
—									
—									
TOTAL	16	3·2	20	4·5	28	5·8	36	2·6	16

Current Stocking = 48 % (Optimal + Adequate)

(ie. % of Coupe Stocked to Standard)

Target Stocking > 85%

B. INFILL PLANT REQUIREMENTS

Cell Nº.	Area of Infill(ha)	Existing Density (spha)	Infill Rate 3x4 or 3x2	Plants Required
* 1 a)	2·4	900	3×4	2000
b)	1·8	200	3×2	3000
TOTAL	4·2			5000

C. STOCKING CHECK

Area of Infill = 4·2 ha

Area Outlined for Rehab. = 2·6 ha

Area Currently Stocked = 7·7 ha

Total = 14·5 ha

Final Expected Stocking = Total / Productive Area x 100 = 90 %

* a) and b) refer to large understocked areas on map.

D. SPECIES MIX SUMMARY

Cell Nº.	Karri Nº.	Karri %	Marri Nº.	Marri %	Jarrah Nº.	Jarrah %	TOTAL Nº.
1	175	69	50	20	27	11	252
TOTAL	175		50		27		252
		69%		20%		11%	

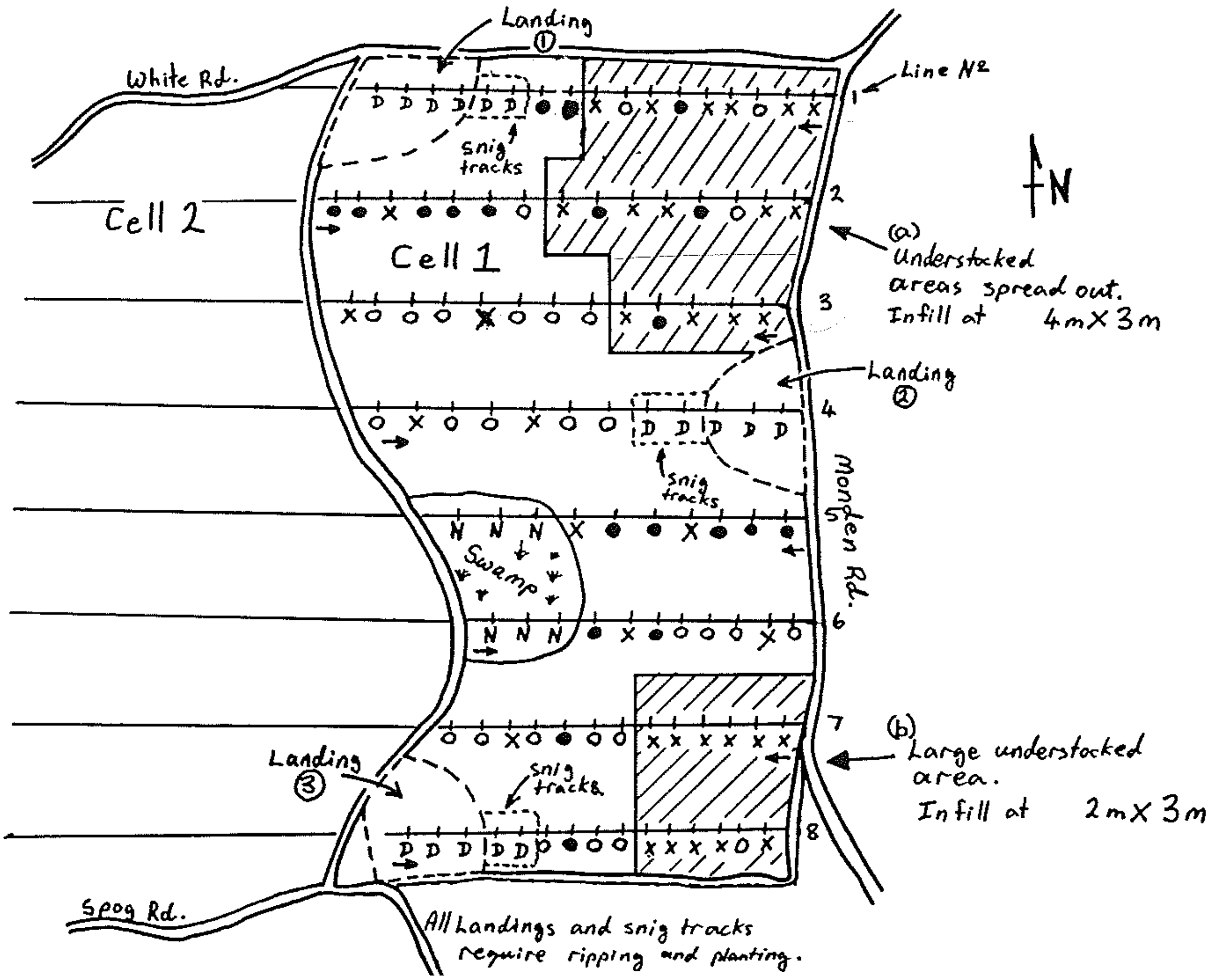
APPENDIX 6 COMPLETED REGENERATION SURVEY MAP

Date: 6/1/90 District: Walpole Compartment: Deep 1

Establishment Year: 1989 Assessor: S. Monden

Tie Directions: Point 1 30m at 125° from junction of White and Monden Rd's

Area N°.: 1 Cell N°. 1 Line Bearing: 270° (line 1)



SCALE: 1 : 5000

0 100m.

LEGEND

		Sample Points	Symbol	N°.
	Boundary	Optimal Stocking	●	20
	Survey Line	Adequate Stocking	O	28
	Landings & Snig Tracks	Understocked	X	36
	Area to be Infilled	Soil Damaged	D	16
		Non-productive	N	6
		Total		106

APPENDIX 7 KARRI REGENERATION SURVEY SHEET

Date:________ District:__________ Compt.:__________ Assessor:________________

Establishment Year:_______ Tie Directions:______________________________

Area Nº.:______ Line Bearing:________________ Page Nº.:_____

Line Nº.	Point Nº.	Triangle Sides(m)			Sp. Mix			Seed-bed	Point Density	Stocking Status	Comments
		1	2	3	K	M	J				

Additional Comments:______________________________________

APPENDIX 8 KARRI REGENERATION SURVEY MAP

Date:________ District:___________ Compartment:____________________

Establishment Year:_______ Assessor:_____________________________

Tie Directions:____

Area Nº·:______ Cell Nº·______ Line Bearing:____________________

SCALE:

LEGEND

	Sample Points	Symbol	Nº·
Boundary Survey Line Landings & Snig Tracks Area to be Infilled	Optimal Stocking Adequate Stocking Understocked Soil Damaged Non-productive	● O X D N	
	Total		

APPENDIX 9 KARRI REGENERATION SURVEY SUMMARY

Survey Date:_______ District:__________ Compartment:_____________ Assessor:____________

Establishment year:__________ Initial Survey or Infill Survey

	AREA (ha)
Seed Tree Planted Other	

Standards Applied
Optimal stocking: ≥________spha Adequate stocking: ________-________spha Understocked: <________spha

A. STOCKING SUMMARY

Cell Nº.	Productive Area(ha)	Optimal Stocking Area(ha)	%	Adequate Stocking Area(ha)	%	Understocked Area(ha)	%	Soil Damage Area(ha)	%
TOTAL									

Current Stocking = _______% (Optimal + Adequate)

(ie. % of Coupe Stocked to Standard)

Target Stocking > 85%

B. INFILL PLANT REQUIREMENTS

Cell Nº.	Area of Infill(ha)	Existing Density (spha)	Infill Rate 3x4 or 3x2	Plants Required
TOTAL				

C. STOCKING CHECK

Area of Infill = _______ ha

Area Outlined for Rehab. = _______ ha

Area Currently Stocked = _______ ha

Total = _______ ha

Final Expected Stocking = Total / Productive Area x 100 = _______%

D. SPECIES MIX SUMMARY

Cell Nº.	Karri Nº.	Karri %	Marri Nº.	Marri %	Jarrah Nº.	Jarrah %	TOTAL Nº.
TOTAL							