SILVICULTURE GUIDELINES 1/95

SILVICULTURAL PRACTICE IN THE JARRAH FOREST

These Guidelines supersede Silviculture Specifications 2/91.

CONTENTS

1. INTRODUCTION

The strategies for the sustainable management of the jarrah forest in areas designated as State forest and Timber Reserves under the CALM Act are contained in the *Forest Management Plan (1994-2003)* and the Ministerial Conditions.[1]

This document details the silvicultural guidelines for field application, in particular treemarking and silvicultural treatment to achieve the desired forest structure at the coupe level in areas from which timber is harvested.

These guidelines relate to dieback-free jarrah forest. Dieback infected forest is to be managed in accordance with Specifications 3/89 and 4/89.

Extensively Managed Areas

In areas such as the eastern jarrah forest (<800mm rainfall) and the Donnybrook Sunklands the proportion of sawlogs in the stand is low. In these areas the opportunity to thin and create regeneration gaps by commercial timber removal is limited. Nevertheless, the principles of these guidelines should still be applied. The resultant forest structure however, will be quite different because of the preponderance of unsaleable culls.

2. REGENERATION SURVEY

Detailed planning of the regeneration requirements will facilitate treemarking in areas of uncertain regeneration status.

Treemarking decisions will be significantly assisted by the early identification of shelterwood areas. Appendix 1 is a general guide to their locations. Where regeneration status is uncertain, broadscale ground surveys are necessary.

Ground surveys should be programmed following aerial burning or advance burning with the objective of eventually having all areas surveyed prior to harvesting. Specification 3/90 details this procedure. Appendix 1 provides a general guide as to location of potential shelterwood areas.

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1 Ministerial Conditions means the "Statement That A Proposal May Be Implemented (Pursuant to the Provisions of the Environmental Protection Act 1986). Amendments to the 1987 Forest Management Plans and Timber Strategy and Proposals to Meet Environmental Conditions on the Regional Plans and the WACAP ERMP." Department of Conservation and Land Management. Published by the Minister for the Environment' 24 December 1992 and associated Determination of Annual Sustainable Timber Resource Available for Allocation dated 16 August 1993, approved by the Minister for the Environment.

3. INTEGRATED HARVESTING AND REGENERATION PLANS

Prior to harvesting, detailed plans will be developed for each coupe, as detailed in "Timber Harvesting in WA".

From these plans appropriate silvicultural practices will be determined necessary to sustain appropriate values within the coupe (see Appendix 2).

Coupe planning is refined in the field as more accurate and detailed information becomes available through site inspection. It is important to field check those structural and species characteristics which will affect the prescription to be applied. Assistance from specialists may be required to assess some values.

4. TREEMARKING

4.1 General

Treemarking is the means by which stand objectives are marked out in the forest so that harvesting and treatment operations can proceed. By marking trees to be retained the forester provides a vision of the future development of the stand.

Before marking commences, the management zones appropriate to each part of the coupe must be clearly shown.

Marking guidelines will vary in accordance with these zones. (See Appendix 2).

One silvicultural objective will be determined for each group or patch. These are:

- Thinning - to promote growth on retained trees.
- Release regeneration (gap creation) - jarrah regeneration will be encouraged to develop unimpeded into saplings, poles and mature trees by the removal of competing overstorey.
- Establish regeneration (shelterwood) - seedlings will be encouraged to establish and develop into ground coppice by reducing the competition of the overstorey. A forest canopy is maintained to provide a continuity of forest values until the ground coppice is developed and capable of response to release.

The first task in marking a patch of trees is to determine its silvicultural objective (thinning, regeneration release, or shelterwood) and whether its boundaries are apparent. The process for making these decisions is outlined in "*Treemarking and Silviculture in the Jarrah Forest" (1987).*

Only after the objective has been identified for each patch can individual trees be marked.

Marking habitat trees and logs for retention is the first priority in each group or patch. (See Appendix 5)

4.2 Marking to promote growth (thinning)

Wherever possible stands should be thinned in preference to regeneration release or shelterwood. Thinning aims to increase the growth of selected crop trees.

Selection of Crop Trees

A crop tree is one with the capacity to grow vigorously into high value products. The key characteristics to look for are:

* an existing or potential for a well developed crown

* a bole capable of producing a high quality product of minimum specification.

Appendix 3 details the criteria for crop tree selection.

Thinning Intensity

The desirable retained density of crop trees varies with their size. When crop trees are small, the aim is to grow individual trees rapidly to sawlog sizes. Once crop trees are of sawlog size, the aim is to maximise the growth of sawlog volume per hectare. To achieve that, a relatively higher basal area is retained as the average tree size increases.

Thinning regimes for different crop tree sizes are detailed in Appendix 4. In areas of high visual resource value and salt sensitivity additional trees must be retained. (Appendix 2).

Diversity

To maintain diversity, up to 10% of the retained trees may be 'non crop tree' marri. Mark to protect native pear, river banksia and examples of snoddygobble, peppermint, large blackboys etc. Additional diversity of size and density of retained trees is required in the first 150 metres of VLM Zone A. (Appendix 2).

Technique

Mark to retain fauna habitat trees and logs (Appendix 5), the desired density of crop trees (Appendix 4), and elements for diversity. Where the number of acceptable crop trees exceeds the required thinning density, those of high commercial value (eg. power transmission poles) need not be marked for retention.

The retained basal area must be regularly checked with a 2-factor prism.

Isolated Large Trees

Isolated large merchantable trees frequently occur in thinnable patches. Regardless of their crop status, they should be retained as part of the thinning if their removal would cause excessive damage to crop trees or destroy the integrity of the thinned patch. They may also be suitable for habitat trees.

Partially-stocked Stands

Where the stocking of crop trees is less than specified in Appendix 4, but at least 50% of that density, all crop trees must be retained and sufficient non-crop trees to keep the stand at a minimum basal area of 10 m^2/ha (15 m^2/ha in the <1100mm rainfall zone).

4.3 Marking to release regeneration (gap creation)

Regeneration release by gap creation will be sought where there are insufficient crop trees to merit thinning (ie. less than 50% of required stocking), but where the stocking of ground coppice and saplings will adequately regenerate the gaps created by harvesting.

Technique

Where it is evident that insufficient crop trees exist to enable a thinning, the forester must check that the stocking of ground coppice/saplings is adequate, (Specification 3/90) then determine the boundaries of the gap. In general, only retain habitat trees within the gap when it is over 1 hectare in size, however, where good examples occur in small gaps they should be retained. Sub-merchantable crop trees with very good growth potential should only be marked for retention if they can be fully protected during logging and burning operations. Crop trees of commercial size will not be marked in the gaps.

Gap Size

Where the gap would exceed the maximum dimension (See Appendix 2) temporary exclusion areas (TEAS[1]) of uncut forest are required to confine the gap to that maximum. These must be at least 50-100 metres across depending on VLM zone (Appendix 2) and will not be available for timber harvesting until the next cutting cycle. Thinned or shelterwood patches also constitute acceptable separation types, provided special requirements apply for the <1100mm rainfall zone, (see Appendix 2 and Appendix 4).

Although the precise location of each TEAS will be finally determined in the field, they should be broadly planned beforehand so that they can be designed to fit within a broader framework.

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1 TEAS are patches of forest temporarily retained to provide protection for a nominated value while the harvested area regenerates, once a suitable time has elapsed and TEAS is no longer required, it may also be harvested.

TEAS are to be accessible from current roading and where practical remain within a single hygiene category.

Diversity

Mature secondary storey species (eg, sheoak) will also be marked and retained undisturbed, preferably in clumps, to enhance stand diversity.

4.4 Marking to establish regeneration (shelterwood)

A shelterwood is created where there is an inadequate stocking of crop trees for thinning and where there is insufficient ground coppice and saplings available for immediate release.

The shelterwood overstorey is retained to provide seed for regeneration and a continuity of forest values until ground coppice has developed to the stage where it is capable of rapid growth following release.

Technique

Virgin Stands - mark to retain 50% of the overstorey.

Cutover Stands - retain 10-15 m^2/ha. In areas of low site quality in the <800 mm rainfall zone it may be necessary to reduce basal area to as low as 6 m^2/ha.

Areas with <8m^2/ha of suitable shelterwood trees should be treated as shelterwood without harvesting.

Shelterwood trees should be relatively evenly spaced for seed dispersal and spacing should not exceed 1.5 x tree height.

Patch Size

Where adjacent to a gap, a shelterwood group should be at least 50 metres in diameter. This may be achieved by not releasing regeneration in a portion of the gap.

4.5 Marking in stands with small patches

Frequently the existing stand structure consists of small patches of mature/overmature trees among small patches of thinnable forest, each below the minimum desirable size (ie. 100m diameter). In these stands the forester should attempt to push the group/gap towards the desirable size.

- Where crop trees are of commercial size and numbers are low, small groups of crop trees may be felled to enhance gap size.

- Where gaps are small and cannot be extended without considerable loss of crop trees, retain trees and avoid creating a gap. These large trees will frequently be required as habitat trees.

Gaps as small as 50 metres in diameter (2 x tree height) are acceptable.

5. SILVICULTURAL TREATMENT

5.1 Timing

Manual culling required in gaps and thinning patches should be carried out after tops burning to improve operator access and safety. Machine treatments must be done before post-harvest burning. All treatments should commence within 2 years of the completion of harvesting.

- ***At the time of harvest***

Some silvicultural treatments (eg, disturbance for shelterwood regeneration, banksia scrub rolling), are better carried out during the commercial harvesting operation rather than as a separate operation and every effort should be made to encourage this where appropriate.

- ***Following harvest***

The aim of these operations is to complete the objectives of treemarking, which could not be achieved by commercial operations alone. Unless a stand is fully marked to indicate the silvicultural objective, interpretation for follow-up treatment will be difficult.

Where the silvicultural treatment cannot be fully achieved during the commercial harvesting operation separate treatments following harvesting are required.

5.2 Priorities for treatment

i. Only treat those areas which are secure from disturbance, (eg. outside the 25 year bauxite mining envelope), and will remain available for timber production.

ii. Only treat those areas which are either secure dieback free and uninterpretable.

iii. Areas of high quality forest where the potential for growth is greatest.

iv. Areas of shelterwood have highest priority. Regeneration must be established now so that it will be ready for release in the next felling cycle. Areas of thinning have second priority, areas of regeneration release have third priority.

v. Locate treatment in areas where minimal culling of potentially valuable trees would occur and to allow for a larger area to be completed with the available financial resources.

vi. Areas of high landscape sensitivity where treatment is essential to meet the VLM objective.

5.3 Techniques for culling

Culling may be done by:

Notching: preferred where there are predominantly large culls, for very small gaps; and for thinning.

Felling: *With herbicide treatment of stumps*. Preferred when there are adequate lignotubers available and for culling or thinning in visually sensitive areas (see Appendix 2).

Without herbicide treatment of stumps. Only where coppice is required for regeneration.

Machine Pushing: Preferred in gaps where there are a large number of small culls. Machine pushing should be restricted to culls with a dbh of <30cm to limit the quantity of debris left on the forest floor (the actual limit should be set for each operation). The operator should concentrate on patches where harvesting has achieved most of the gap creation.

Where a significant number of culls exist >30cm in diameter, it may be necessary to follow up the machine pushing with a notching operation to remove sufficient culls to release regeneration,

The technique for establishing regeneration will depend on the availability of seed.

5.4 Treatment of thinning groups

Remove all competing 'non-crop' trees (J, M, Allocasuarina) within 4m of a crop tree. Remove trees by:

* notching with an approved herbicide[5]
* felling and stump poisoning

[5] See Herbicide Manual, Technical Instructions

Where trees appear to share a common root system with adjacent retained trees, fell without poisoning the stumps. In all other instances, stumps must be poisoned. Culling by felling and treating stumps with herbicide may only be used where visual resource values are high (Appendix 2) and on burn boundaries.

Culls within 5 metres of fauna habitat trees should not be treated.

Do not individually release around retained trees which are not of crop tree standard.

5.5 Treatment of gaps

The object is to encourage regeneration by the removal of competing culls, and in some cases coppicing of malformed stems. This can be done either by:

- immediately removing all culls after harvesting, or
- initially removing sufficient culls to allow regeneration to develop into saplings and then in 20-25 years removing remaining culls and releasing saplings to grow into poles.

Where the density of culls is high (>12m^2/ha) treatment should be deferred until more produce has been removed. These patches are described as 'selectively' cut.

Techniques

Gap Size 0.25-2ha

Remove any unmarked non-crop trees <50cm in diameter and mature *Banksia grandis* by felling, pushing down or notching. Do not treat within 5 metres of habitat trees.

Gap Size > 2ha

As for the above, but only remove the following unmarked culls:

- DBH 20-50cm only if within 15 metres of other trees, including crop or habitat trees or other remaining culls.
- DBH 10-20 cm if within 7 metres of other trees.

Consider trees less than 3 metres apart as one tree. See Appendix 6 for interpretation.

5.6 Treatment of shelterwoods

The objective is to establish regeneration by competition removal, soil disturbance and seedling establishment.

Remove mature *Banksia grandis* and unmarked sheoak.

Where regeneration is adequate in number but too small for immediate release, no additional treatment is required.

Culls should also be removed where total basal area of the shelterwood exceeds 15 m^2 /ha (or 10 m^2/ha in the low site quality, low rainfall area - see section 4.4)

In areas where there is severe understorey rootstock competition, remove competing rootstock understorey in swathes at least 3 metres wide and not more than 10 metres apart. Preferably use a tracked machine with a rake blade. Do not establish swathes within 3 metres of retained trees. This work must only be done in dry soil conditions to ensure that a receptive seedbed results. Install erosion barriers at the appropriate intervals (See *"Timber Harvesting in W.A."*).

Soil disturbance must be done in dry soil conditions immediately prior to the tops burn. Pushing of banksia must not be done more than 12 months prior to the burn.

Natural Seedfall

Examine the seed crop in late summer and where there is a viable and plentiful crop, aim to burn in autumn (See Silviculture Specification 1/91).

Artificial Seeding

Where there is a poor seed crop or poor success by natural seedfall, broadcast seed is an alternative. Use a cultivator to lightly scarify the soil along the prepared swathes. Simultaneously seed and fertilise using a mixture of:

- 20,000 viable jarrah seed per ha, and
- 450kg/ha No. 1 superphosphate.

Apply seed and fertiliser to disturbed soil during autumn after burning.

Planting

If necessary plant at the rate of 1000 spha. Planted seedlings should receive the same follow-up treatment as seed regeneration, ie. subjected to regular burns until the lignotuber is sufficiently developed for release

Establishment Survey

For both natural seedfall and artificial seeding undertake regeneration survey in the following February, (Specification 1/91).

Even where regeneration is established by planting in shelterwood areas, continue to burn on a regular cycle in the same way as seeded establishment

6. BURNING AND PROTECTION

Burning and protection requirements vary according to silvicultural objectives. The detailed specifications are contained in Specification 1/91. The options available are discussed in *Silvicultural Guidelines for Virgin Southern Jarrah Forest. (1986).*

7. RECORDS

Good silvicultural records are essential for future managers to ascertain the condition and needs of the forest without having to undertake detailed assessment. The aim is to have an accurate description of the condition of the forest when the operation is completed. This will allow subsequent adjustments to be made to management if required.

The silvicultural objective of harvesting and completed operations are entered in the GIS database annually as a basis for performance recording and silviculture planning.

Syd Shea
EXECUTIVE DIRECTOR

REFERENCES

Bradshaw F.J. (1986) Silvicultural Guidelines for Virgin Southern Jarrah Forest. Tech. Rep. No. 4, Department of Conservation and Land Management, WA.

Bradshaw F.J. (1987) Treemarking and Silviculture in the Jarrah Forest. Training Brief. Department of Conservation and Land Management.

Havel J.J. (1975) Site Vegetation Mapping in the Northern Jarrah Forest (Darling Range). 1. Definition of Site Vegetation Types. Bull. 86 WA Forests Dept.

Strelein G.J. (1988) Site Classification in the Southern Jarrah Forest of Western Australia. Res. Bull. No. 2 Department of Conservation and Land Management, WA.

APPENDIX 1

A GUIDE TO SILVICULTURAL OBJECTIVES

ATTRIBUTE	PREDOMINANT	OBJECTIVE
History and API type Site vegetation types	More common in virgin forest of types below ***Northern Jarrah (Havel 1975)*** Types: B, F, J D, E, Z on sandy sils H, P with dense sheoak S occasionally with dense banksia ***Southern jarrah (Strelein 1988)*** Types: X, N, Y K with karri understorey S, Q, I, P with dense understorey and sandy soils	Shelterwood
History API Type Site preparation	Most virgin or light selection cut > 1940 Fire damaged stands Massed stands Pole stands with 30% crown density in upper strata Not applicable	Regeneration release
History API Type	Heavily cutover and treated prior to 1940 Pole stands with 20% or less in upper strata (but will contain groups of varying size)	Thinning
API Type Site type	Flats, rock outcrops, "C" class forest. S and P stands when upper and lower strata are the same ***Northern jarrah (Havel 1975)*** Types: A, G, J B (without regeneration) ***Southern jarrah (Strelein 1988)*** Types R, B, F, A ***Sunklands (McCutcheon)*** Type 6	Other than timber

APPENDIX 2

JARRAH SILVICULTURE SPECTRUM

SILVICULTURE OBJECTIVE	MANAGEMENT ZONES								
	VLM A			VLM B		VLM C			
REGENERATION	VISIBLE 0-150M OR VISIBLE SLOPE >20 DEGREES *	VISIBLE >150m *	NOT VISIBLE *	VISIBLE *	NOT VISIBLE	VISIBLE	NOT VISIBLE	SALT SENSITIVE <1100MM	WITHIN 250M NATIONAL PARK or CONSERVATION PARK
- GAP SIZE	0.2 - 0.5ha (2-3 tree hts)	< = 1ha (2-4 tree hts)	< = 10ha	< 1ha (2-4 tree hts)	< = 10ha	< = 10ha Vary gap size along travel route including log road	< = 10ha	As for VLM Zone	As for VLM A
- MIN TEAS WIDTH BETWEEN GAPS	50 metres	50 metres	100 metres	100 metres	100 metres	100 metres	100 metres	As for VLM Zone	As for VLM A
- MIN CUTTING CYCLE	20 years 3 stages	20 years 3 stages	20 years 2 stages	20 years 2 stages	10 years 2 stages	10 years 2 stages	10 years 2 stages	As for VLM Zone but min 15 years	As for VLM A
- JSI	Fell or scrub roll	Fell or scrub roll	Notch, fell or scrub roll	Fell or scrub roll Fell on focal points	Notch or scrub roll	Notch or scrub roll	Notch or scrub roll	As for VLM Zone	As for VLM A
- HABITAT TREES	Only on edge of gap. Locate to visual advantage	Only on edge of gap	Normal	Normal. Locate to visual advantage	Normal	Normal	Normal	As for VLM Zone	As for VLM A
- OTHER	Travel route zone up to 20 metres *	Travel route zone up to 20 metres *		Travel route zone up to 20 metres *					
THINNING									
- INTENSITY (see Appendix 4)	Retain up to 5m2/ha extra for diversity with variation in size and density	Normal	Normal	Normal	Normal	Normal	Normal	Min 15 m2/ha **	As for VLM A
- TREATMENT	Fell and poison stumps	Fell and poison stumps	Notch	Fell and poison stumps first 50m	Notch	Notch	Notch	Notch	As for VLM A
- HABITAT	Normal, prefer close to road	Normal	Normal	Normal, prefer close to road	Normal	Normal	Normal	Normal	As for VLM A
SHELTERWOOD	Normal except travel route zone up to 20 metres *	Normal	Normal	Normal, except travel route zone up to 20 metres *	Normal	Normal	Normal	Normal	As for VLM A
TEAS								30% 2nd Order catchment > 15 m2/ha or not cut	
ACCESS	Rationalise access, close roads/tracks not required, limit access to management areas								
ROTATION	>200 years		> = 100 years						
PRIORITY FOR COMPLETION	High - aim for less than 2 years		Moderate			Low			
PRIORITY FOR RESIDUE REMOVAL	1	3	4	2	4	3	4		

NOTE: * Landscape Planner to assist with design
** See appendix 4 for detail

APPENDIX 3

CRITERIA FOR SELECTION OF CROP TREES

Select crop trees to retain using the following considerations:

* Crop tree selection is based on the following species priority:

  (a) Jarrah/Blackbutt (referred to as jarrah in the text)
  (b) Marri
  (c) Sheoak

* Eucalypt crop trees should be in the dominant level, with a healthy well structured crown. Trees with primary crowns are capable of expansion to take advantage of the space available. Secondary crowns show less capacity for expansion.

Trees with a deep, broad crown grow five times faster than trees with a narrow, shallow crown. Crown vigour is much more significant than bole length.

eg

Original diameter	30cm	30cm
Bole length	5m	10m
Crown condition	Deep, broad	Shallow, narrow
Diameter in 20 years	50cm	34cm
Volume on 20 years	.63cu.m	.5cu.m
Time taken to reach sawlog size (50cm)	20 yrs	100yrs

Crop trees should have a bole free of any defect that would preclude its use for either a sawlog or a pole (minimum defect free bole should be 3m for sawlogs).
In general, larger diameter trees will increase in diameter faster than smaller ones.
Sheoak crop tree selection should be based on the following criteria:

* healthy, well structured deep but narrow crown.

Minimum bole length of 1.8m with at least 50% of the diameter defect free.

APPENDIX 4

JARRAH THINNING INTENSITY

MEAN DBHOB OF BEST 150 STEMS/HA AT FIRST THINNING	CROP TREE BASAL AREA (m^2/HA)	SCHEDULE
Less than 20cm	N/A	Release 200 jarrah stems/ha from overtopping and crown abrasion. The objective is to maintain healthy crown development on future jarrah crop trees without promoting a permanent low crown break.
20-25cm	#*10m^2/ha	This will usually be a non-commercial thinning. It will leave more than 150 stems/ha but ensures that the stand is not left understocked. A further thinning will be required before the crop trees reach 50cm dbhob
25-30cm	#*10m^2/ha	This is likely to be both a commercial and non-commercial thinning. The remaining trees are capable of reaching 50cm dbhob without the stand becoming overstocked (50 years). More conservative thinning in the future will maximise sawlog volume/ha
40cm	18m^2/ha	Thin again when crop trees reach 50cm dbhob. Above comments apply
50cm	20m^2/ha	

* An additional 5m^2/ha of the following may be retained:

Trees within 5cm of becoming an power transmission pole or sawlog
Sheoak crop trees
Second grade sawlogs in areas which will have follow-up non-commercial thinning.

\# In the Intermediate Rainfall Zone - 15m^2/ha
In the Low (<900mm) Rainfall Zone - 15m^2/ha - 30% TEAS
\- 10m^2/ha - 70%

APPENDIX 5

CRITERIA FOR MANAGEMENT OF FAUNA HABITAT

1. OBJECTIVE

To ensure the sustained availability of suitable refuge hollows for fauna through the retention of a sufficient number and age structure of trees and ground logs within timber harvestisng coupes.

2. STANDING TREES AS HABITAT

2.1 Characteristics of Habitat Trees

2.1.1 *Definitions*

Two types of habitat trees are recognised, viz *primary habitat trees,* being those which currently may offer refuge to fauna; and *potential habitat trees*, being those which may develop suitable refuges for fauna in the future.

Depending on the silvicultural objective of harvesting both types of habitat tree may need to be retained to ensure the sustained availability of refuges.

2.1.2 Primary habitat trees

- Priority must be given to trees that have obvious signs of use by fauna (eg, possum scratch-tracks) and/or contain visible holes and/or broken branch stubs with the potential to develop hollows.

- Trees should be mature to senescent, >70cm DBHOB, tall but windfirm with hollow butts <50% of diameter.

- Crowns should show some deterioration and be within crown structure categories 2-5 (see crown structure illustrations). Excessively vigorous trees with <10% crown decline need not be selected.

- No tree species preference need be shown.

2.1.3 Potential habitat trees

- Trees in this category should be immature to mature, 30-70cm DBHOB. Some small hollows and/or broken branch stubs with the potential to develop holes should be visible.

- Crowns should show some potential for deterioration, and be within structure categories 2-4.

2.2 Rate of Retention

- On all areas harvested an average of 4 primary habitat trees are to be retained per hectare.

- On areas where harvesting creates gaps separated by retained TEAS strips *6 to 8 potential habitat trees* if present may be retained per hectare in addition to the retention of primary habitat trees.

  Potential habitat trees to meet this requirement should be selected only from cull trees, including those that may otherwise be removed in cull removal operations (see section 5.5)

- Where suitable trees are not present on every hectare, a retention rate of 20 *primary habitat trees* per 5 hectares must be retained.

NOTE: If insufficient primary habitat trees exist which meet the above criteria, retain mature to senescent trees as potential habitat.

The required number of primary habitat trees ust be marked regardless of their commercial value.

During logging and subsequent silvicultural operations (including regeneration burns) care should be exercised to avoid disturbance to habitat trees.

2.3 Pattern of retention

- Habitat trees must be deliberately marked for retention with a large "H".

- Habitat trees should preferably be retained in groups.

- In areas harvested to gaps and TEAS strips:

  - groups should ideally comprise both *primary habitat trees* and *potential habitat trees*, and be distributed randomly throughout a coupe.

  - primary habitat trees at the boundary of the gaps are to be considered as part of the retained rate per hectare

- If trees which meet the required criteria are not positioned to facilitate marking as a group, mark individually at the required retention rate. The emphasis is on habitat quality rather than pattern of retetion.

- In forest which consists of small thinning patches and regeneration gaps of one hectare or less, aim to mark habitat trees to form groups near the boundaries of these patches.

- Isolated large merchantable trees frequently occur in thinning patches. These may be difficult to remove as part of a harvesting operation without damaging the integrity of the thinning patch. Where this situation occurs it is preferable to retain these large trees as habitat trees if they meet habitat requirements than to attempt to remove them.

3. GROUND HABITAT

Ground habitat in the form of hollow logs, stumps and leaning trees are also important refuge sites for forest fauna such as Chuditch, Brushtail Possum and Quenda.

3.1 Characteristics

Logs:

Diameter:	30-100cm
Pipe diameter:	6-15cm diameter extending into log
Length of log:	pipe at one end - 1.5 metres minimum
	pipe at both ends - 3 metres minimum

Stumps and Leaning Trees:

Stumps which have been lifted creating a protection underground cavity due to a leaning tree or some other agency.

3.2 Rate of Retention

Where available, retain at least one suitable ground habitat log or stump per hectare, even if it shows no obvious sign of use.

If necessary, they are to be marked by the treemarker with a large "H".

All marked logs or stumps should be retained undisturbed.

4. TRAINING

Operators should be trained to recognise and retain suitable logs and stumps.

5. REFUGE SITE PROTECTION

As for protection of crop trees, tops and other residues larger than 7.5cm diameter are to be removed for at least 1 metre from around habitat trees and groups and ground refuge sites to ensure subsequent protection from fire.

1

~ 10% Crown Decline

2

~ 25% Crown Decline

3

30-40% Crown Decline

4

50-60% Crown Decline

5

>70% Crown Decline

6

7

8

APPENDIX 6

Figure 1: Treatment of culls in gaps over 2ha.

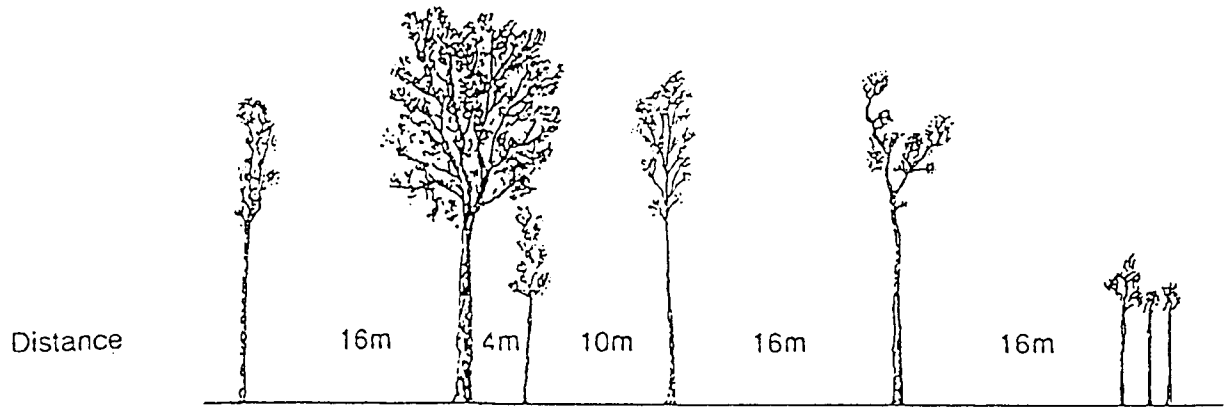

Figure 1A: Gap containing 2-3m²/ha culls which are widely spaced and do not require treatment.

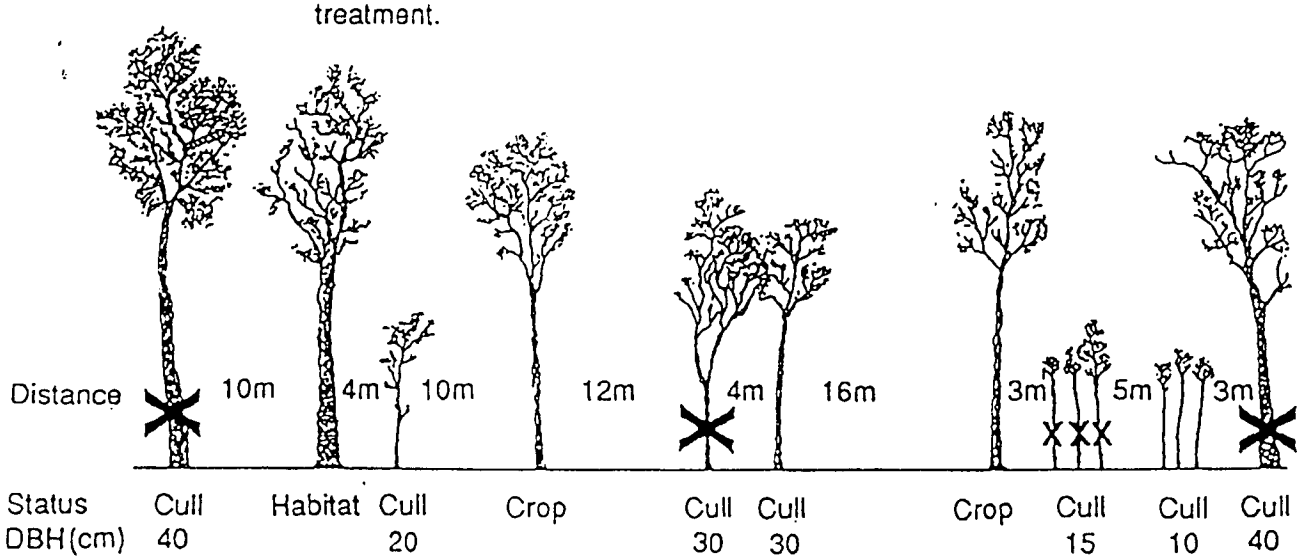

Figure 1B: Gap containing about 8m² /ha of culls, X indicating those to be removed.

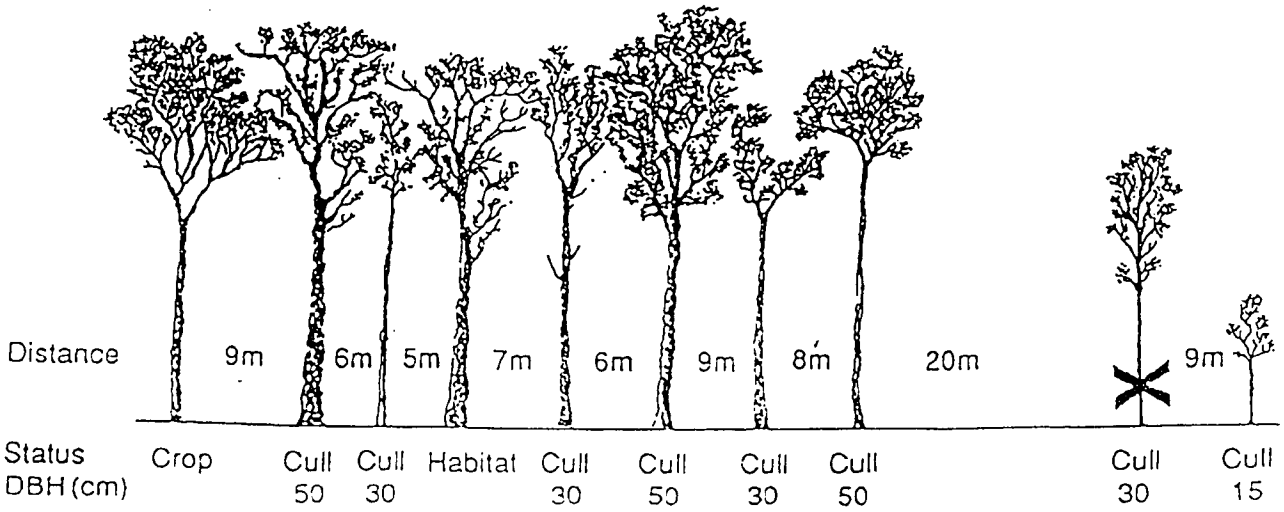

Figure 1C: Gap with a dense group of culls (> 12m²/ha) which should not be treated. Gap at right may be treated if 50 metres in diameter.