DEPARTMENT OF CONSERVATION
AND LAND MANAGEMENT

SILVICULTURE SPECIFICATION 2/91

TREEMARKING AND SILVICULTURAL TREATMENT IN THE JARRAH FOREST

This Specification supersedes Silviculture Specifications 5/89 and 7/89.

CONTENTS

1. INTRODUCTION

The aim of silvicultural practice in the jarrah forest managed for multiple use purposes is to develop or maintain a forest structure that will achieve objectives for nature conservation, timber production, water quality and water production, heritage and aesthetics.

This specification details :

the broad goals for each value,
requirements for integrated planning,
the standards to be achieved for all values, and
guidelines for field application.

and outlines the variation to silvicultural practice that will be made to cater for various forest values, recognising their relative importance in different areas. It deals with the application of these strategies at the coupe level in areas from which timber is harvested.

The broader strategy that deals with zoning of the forest and the location, arrangement and harvesting is established at the regional planning level. This includes determining where harvesting can best located to achieve the strategic goals, the allocation of zones (e.g. water, wildlife) from which harvesting is to be excluded and the establishment of relative priorities between values.

This specificaton relates only to dieback-free jarrah forest designated as multiple use in the 1987 Regional Management Plans. Dieback infected forest is to be managed in accordance with Specifications 3 and 4/89.

The treemarking and silvicultural treatments outlined in Sections 4 - 7 of this specification do not apply to extensively managed areas of eastern and Sunklands jarrah forest (Sect. 3.2.3). A new specification is being prepared to cover these areas.

2. MANAGEMENT OBJECTIVES AND SILVICULTURAL STRATEGIES

2.1 WATER

Management Objectives

- To maintain the quality of water in all forested catchments.
- To enhance the quantity of water yielded from the forest within harnessed catchments.

Silvicultural Strategies

- Maintain an undisturbed stream zone in all forest areas. (dimensions and protective measures are specified in The Manual of Hardwood Logging Specifications).

- Ensure that harvesting in the salt sensitive areas of the intermediate and low rainfall zones does not lead to the excessive reduction of forest cover which may then result in a reduction in water quality.

This will be achieved through:

maintaining a stand basal area of at least 15m²/ha in the salt sensitive areas of the intermediate rainfall zone (900-1100mm) at the time of thinning.

regenerating no more than 70 per cent of a second order catchment in one felling cycle.

regenerating all gaps

separating felling cycles by at least 10 years.

Maintain regrowth stands in the high rainfall zones of harnessed catchments at a density which will enhance water yields by thinning to a density between 10m²/ha and 20m²/ha.

2.2 WILDLIFE

Management Objectives

- To maintain biodiversity at the genetic, species and ecosystem level in the forest throughout Western Australia.

- To maintain or replace populations of all taxa so that management activities do not lead to the loss of biodiversity at the local level.

- To protect and conserve threatened, rare and uncommon taxa and communities.

Silvicultural Strategies

- Maintain or enhance structural diversity of the forest.

- Retain those elements of habitat which could be lost through harvesting and tending and which take many years to replace.

This will be achieved by:

Maintaining, or developing several age classes within each coupe* After logging and regeneration treatment each coupe should contain a minimum of 3 age classes. Adjacent areas (e.g. riparian zones) within the same subcatchment should be considered as part of the coupe for this purpose.

By retaining mature trees at the rate of 3 per hectare and logs suitable for nesting and refuge throughout every harvested area.

By orienting temporarily retained strips of forest to link zones containing mature forest. These may act as wildlife corridors and allow greater use of regrowth areas.

Leaving distinctive, rare and uncommon plant species and groups undisturbed by harvest. This should include patches of secondary storey which will take many years to regrow.

Excising rock outcrops, distinctive floral assemblages or fauna habitat from harvested areas.

* In this specification "coupe" means a contiguous area of forest which is used to plan harvesting. A coupe will usually be harvested in 1 - 2 years, however not all the forest in the coupe will necessarily be harvested in one felling cycle.

2.3 TIMBER MANAGEMENT AND SUPPLY

Management Objectives

- To manage native forests so that an efficient timber industry is able to be sustained indefinitely, based on the following principles:

  all cutover areas will be regenerated to a full stocking and all previously regenerated forests will be managed to optimise the attainment of all forest values.

  harvesting will only occur where the potential productivity is sufficient to cover cost of regenerating, establishing and managing those forests.

  the harvest from the forest will be regulated to levels that can be sustained indefinitely.

  all forest management operations, including logging, will be controlled by the Department of CALM.

Silvicultural Strategies

- Current timber supply will be achieved from trees which are not required for other purposes, including those retained for sustaining long term growth.

- Timber sustainability will be achieved by developing a grouped forest structure where the areas of regeneration are of a minimum sustainable size (ideally 4 tree heights). One silvicultural objective will be determined for each group. These are in order of preference:

  Thinning - to promote growth on retained trees.

  Regeneration Release (Established regeneration released in patches):
  Jarrah regeneration will be encouraged to develop unimpeded into saplings, poles and mature trees by the removal of competing overstorey.

  Shelterwood (Establishment of regeneration).
  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.

- Wherever possible implement silvicultural objectives through commercial removal and sale. Only when this process has been completed will non-commercial removal of trees be undertaken, and only then if they inhibit the silvicultural objective.

2.4 VISUAL RESOURCE

Management Objective

- To implement harvesting in a manner compatible with the visual resource management (VRM) objectives specific to the site.

- To maintain , enhance and improve scenic quality.

Silvicultural Strategies

- The visual resources of each area will be inventoried and assessed to delineate and map Visual Resource Management Zones with the following Visual Quality Objectives:

  Visual Resource Management Zone A

  VRM Priority - High
  VRM Objective - Maximum Retention

  Avoid landscape alterations which would lead to a discernible deterioration in scenic quality in the short term. Focus on the maximum protection and retention of all existing visual attributes of the characteristic landscape.
  The recommended alteration is low, least accommodating to visual change.

  Visual Resource Management Zone B

  VRM Priority - Moderate
  VRM Objective - Retention

  Landscape alterations may range from visually apparent to visually dominant. Focus on the protection and retention of the dominant existing visualattributes of the characteristic landscape.
  The recommended alteration level would be moderately accommodating to visual change.

  Visual Resource management Zone C

  VRM Priority - Moderate
  VRM Objective - Partial Retention/Enhancement

  Landscape alterations may be visually dominant but should reflect the existing lines, forms, colours and textures of the characteristic landscape. Where possible, seek to optimise and enhance visual quality over the medium to longer term.
  The recommended alteration level would be highly accommodating to visual change.

  Special Visual Resource Management Area - Preservation

  VRM Priority - High
  VRM Objective - Preservation

  These preservation areas include those landscapes where visual resource values are of very high aesthetic importance and have priority over other natural resource values.

  The recommended alteration level for these areas allows for little more than natural change or very low impact changes which are carefully planned to accommodate and/or enhance the special visual qualities of the Preservation Area.

  Special Visual Resource Management Area-Rehabilitation

  VRM Priority - High/Moderate
  VRM Objective - Rehabilitation

Visual resource alterations which have resulted from past management practices or natural events and do not satisfy the Visual quality objective will require rehabilitation. This priority should be retained until the desired standard of visual quality is attained.

- Harvesting and treatment practices are to be varied in accordance with the site's visual resource management objectives. Gap size, thinning intensity, felling cycle, rotation length, treatment method and uncut strip width may all be adjusted. Coupes will be designed to attain the VRM objective with minimum impact on other values.

3. PLANNING FOR HARVESTING

Coupes for logging are nominated within a strategic framework at the regional planning level. This section deals with the planning of silvicultural practices to be adopted within a coupe. Details of operational planning (e.g. roading, disease management) are contained within the Manual of Hardwood Logging Specifications.

The aims of coupe planning are to:

(1) Identify the values present in the proposed cutting coupe, and
(2) Determine how the appropriate silvicultural practices will be implemented to the benefit of all values within the coupe.

Coupe planning is refined in the field as more accurate and detailed information becomes available through site inspection.

3.1 INVENTORY

The following are essential planning tools,

(1) Contour Maps showing watercourses
(2) Visual Resource Management Zones
(3) Rainfall Zones
(4) API Type maps, and maps showing cutting histories and silvicultural treatments
(5) Streams and other permanent zones
(6) Wildlife Values

It is also valuable to have current 230mm aerial photography as this assists in the interpretation of forest structure. Site/vegetation type maps for the area are useful indices for several values.

A coupe plan is prepared showing:

WATER: Harnessed catchments
Rainfall Zones
Stream Zones=

VISUAL RESOURCE: VRM Zones (including seen area)
VRM Special Areas
Roadside Zones (Southern Forest Region)=

WILDLIFE: Significant values

TIMBER: Low Value/Non Productive Areas
Structural Types (where known)

= Note that these zones are currently subject to review

3.2 FIELD INSPECTION

A field inspection of each coupe must be made to verify the values that are present. Field examination should examine the following, although some may be not be finalised until the time of treemarking.

3.2.1 Permanent exclusion zones

Areas of very high value for visual resource, water or wildlife may be permanently excluded from harvesting. In most cases these areas will have been defined at the regional planning stage, others will be determined by appraisal on site. These include:

WATER
Stream and river zones
Steep slopes
(See Manual of Hardwood Logging Specifications)

WILDLIFE
Areas of high flora value (for example Declared Rare Flora) - including a buffer to ensure they remain undisturbed.
Areas of high sensitivity or fragility. These may include rock outcrops, areas of shallow soil, eagles' nests, caves and other fragile areas.

Areas of particular species richness, e.g. riparian zone, ecotones.

VISUAL RESOURCE
Roadside zones established by the Woodchipping E.I.S. (currently subject to review).

Areas visible from travel routes within VRM Zone A and B which, in consultation with Landscape Branch, are considered to be of significant scenic quality and sensitivity. These will usually be focal areas.

When VRM zones have been mapped, practices described for the zones in this specification will over ride existing practices for road zones outlined in the Manual of Hardwood Logging Specifications.

TIMBER
Areas of very low timber productivity when it will be expensive to attain adequate regeneration should not be harvested. Appendix 1 lists site types to which this constraint should apply.

Permanent exclusion zones, in addition to those shown on the logging plan, should be defined 2 years prior to harvesting to allow time for location of alternative timber resources.

3.2.2 Temporary Exclusion Areas (TEAS)

TEAS are buffers established to provide protection for a nominated value while the cutover area regenerates. Once a suitable time has elapsed and the TEAS is no longer required, then it also may be harvested. The appropriate interval varies and is listed under cutting cycle in Appendix 2.

Each TEAS should all be of a minimum dimension (see Appendix 2) to ensure that their subsequent felling will not damage regrowth and that they themselves can be adequately regenerated when cut.

TEAS are most commonly retained to protect wildlife, visual resource and water values. For the visual resource they are established to confine the area regenerated to a size which meets the VRM objectives relevant to that zone. Appendix 2 details how gap size should vary with VRM zones.

Water values are protected by ensuring that no more than 70 per cent of a second order catchment is regenerated at any one time. If necessary TEAS are maintained to achieve this goal.

For wildlife, TEAS act as corridors for movement and dispersal into adjacent regenerating forests and contain habitat elements absent from the regenerating area. They also allow for the development of patches of varying age within the coupe, through the staggering of regeneration over 10 to 20 years.

Design Considerations

Although the precise location of each TEAS will be finally determined in the coupe, they should be planned so that they protect the relevant values at the current and future harvests. Their design will therefore play a key role in achievement of all objectives. Important design considerations include:

VISUAL RESOURCE
Plan for each stage of cutting to ensure that visual resource values are adequately maintained or protected during both current and future operations.

Within sensitive viewsheds sequencing of harvesting should ensure that no more than 2 active coupes are evident at one time, and only one should be in the fore- or middleground.
Gap edges and boundaries should be free flowing to reflect the natural lines and forms of the surrounding forest visual resource. The location of TEAS between gaps should respect strategic focal points in the upper and lower reaches of the landform, skylines, ridges, valleys and watercourses.

Patches of uncut forest, thinnings or shelterwood constitute suitable buffers that may be required to limit gaps to a particular size.

Clusters or islands retained within a gap should be located in areas above and including other focal points such as rock outcroppings, corners, embankments, cuttings, etc.

Wherever possible gaps should be designed to be seen obliquely through their orientation and across rather than up and down slopes. A meandering boundary most assists screening.

DIEBACK HYGIENE
TEAS are to be accessible from current roading and whereever practicable remain within a single hygiene microcatchment.

TIMBER PRODUCTION
TEAS shall be accessible from current roading.

WILDLIFE
Permanent exlusion zones should be linked by TEAS allowing them to act as temporary wildlife corridors.

3.2.3 Areas to be Harvested

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, however, broadscale ground surveys are necessary in areas with a high proportion of "shelterwood site-types". Ground survey should be programmed following aerial burning or advance burning. Specification 3/90 details this procedure.

SEED FORECASTING
As assessment of seed availability is required to determine whether and when natural seedfall can be used to regenerate a shelterwood stand. This is ideally done prior to marking so that a decision on the timing of harvesting can be made. Advice on assessing seedcrops should be sought from Silviculture Branch and seed collected and forwarded to the Seed Store to assess viability.

EXTENSIVELY MANAGED AREAS
In some areas of mature eastern jarrah forest and the Donnybrook Sunklands the proportion of sawlogs is low. In these areas the opportunity to create regeneration gaps by timber removal is limited i.e.gaps of 4 tree heights with a cull density of less than 12m²/ha will rarely be created. The requirement for TEAS and intensive treemarking discussed in this Specification are not appropriate for these areas. A more detailed specification for these areas is being prepared. Until this is available single tree selection will be practised, and subsequent regeneration work is not necessary.

4. TREEMARKING

4.1 GENERAL

Treemarking is the means by which stand objectives are marked out in the forest so that harvesting and tending 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 forester must know:

the water, visual resource and wildlife objectives within the coupe, and the type of trees likely to be removed commercially.

Marking specifications will vary in accordance with the above objectives. (See Appendix 2).

The first task in marking a patch of trees is to determine the 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 are the first priority.

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. In the high rainfall zone it will also increase the yield of water.

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 smaller 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 - therefore a relatively higher basal area is retained.

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

Diversity

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

Technique

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

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

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 10m²/ha (15m²/ha in the salt sensitive parts of the Intermediate 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 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 mark fauna habitat trees in gaps 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 shall also be marked for retention if they can be fully protected during logging and burning operations.

Gap Size

Where the gap would exceed the maximum dimension (See Appendix 2) temporary exclusion areas of uncut forest are required to confine the gap to that maximum. These must be at least 50-100 metres across depending on VRM zone (Appendix 2) and will not be available for timber harvesting until the next cutting cycle.

Diversity

Mature secondary storey species (e.g. sheoak) shall 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 inadequate stocking of crop trees for thinning and where there is insufficient ground coppice available for immediate release.

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

Technique

Mark to retain 50% of overstorey (up to 15m¬/ha) including habitat trees at a relatively even spacing. Preference for retention are jarrah trees which will grow vigorously for at least the next 20 years. In addition some elements of stand diversity, as outlined for gap creation, shall also be retained. The forester must endeavour to retain a stand which will sustain a harvesting operation in the future. Where the existing stand is of low density and a harvesting operation cannot be sustained, regeneration must be established before harvesting.

Group Size

Where adjacent to a gap, a shelterwood group should be at least 100 metres in diameter. This may be achieved by not regenerating in a portion of the gap.

4.5 MARKING IN STANDS WITH SMALL GROUPS

Frequently the existing stand structure consists of small groups of mature/overmature trees among small patches of thinnable forest, each below the minimum desirable size (i.e. 100m diameter). In these stands the forester should attempt to push the group/gap towards the desirable size. This may be achieved by:

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 times tree height) are acceptable.

5. CONTROL OF HARVESTING

This phase involves the removal of all unmarked merchantable trees. For restrictions on removal of products see Appendix 2. Details of harvesting control are contained in the Manual of Hardwood Logging Specifications.

Crop Tree Protection

Contractors are required to protect all marked trees during falling and skidding operations, and to remove debris larger than 7.5cm diameter to at least 1 metre away from marked trees. Where trees are wanted but not marked, contractors cannot be expected to protect them.

A zone of 5 metres is to be retained undisturbed around all habitat trees and groups.

Visual Resource

Retained vegetation in the roadside zones (Appendix 2) is to be free from visible damage and scarring. Damaged trees should be felled.

Utilisation should be maximised near roadsides and other visible areas. Log grades with a limited market shall be removed from the roadside zones in preference to their removal from remote and unseen areas.

Silvicultural Treatment

Some silvicultural treatments (e.g. disturbance for shelterwood regeneration, banksia scrub rolling, Section 6) are better carried out during harvesting than as a separate operation. Some logging contracts make provision for this.

6. TREATMENT FOLLOWING HARVESTING

The aim of these operations is to develop the stand to meet the treemarking objectives. Unless a stand is fully marked to indicate the silvicultural objective, interpretation for follow-up treatment will be difficult.

6.1 TIMING

Manual silvicultural treatments required in regeneration patches and thinning groups should be carried out after burning (Section 7) 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. Where significant quantities of merchantable produce remain, do not treat until harvesting is completed.

6.2 PRIORITIES FOR TREATMENT

The resources required for silvicultural treatment following harvesting will not always be sufficient to complete the available work. In allocating resources the following priorities will be adopted:

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

(2) Only treat those areas which are either secure dieback free or low potential risk or of low dieback hazard.

(3) Areas of high quality forest where the potential for growth is greatest.

(4) Areas of shelterwood have highest priority as regeneration must be established now so they will be ready for release in the next felling cycle. Areas of regeneration release have second priority. Areas of thinning have third priority.

(5) Locate treatment in areas of highest utilization where the management objective has not been fully achieved by harvesting. This will ensure minimal conflict by the culling of potentially valuable trees.

(6) Areas of high landscape sensitivity where treatment is essential to meet the management objective.

6.3 TREATMENT OF THINNING GROUPS

Individually release crop trees by removing competing trees for a distance of 4 metres by removing all vigorously growing culls over 50cm DBH not required for habitat, and all mature Banksia grandis by notching with an approved herbicide (See Herbicide Manual, Technical Instructions). Where trees which appear to share a common root system with adjacent retained trees, fell without poisoning the stumps. Culling by felling and treating stumps with herbicide may otherwise 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.

6.4 TREATMENT OF GAPS

The object is to encourage regeneration by the removal of competing culls. 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.

Gap Size 0.25-2ha

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

Where the density of culls is high (>12m²/ha) treatment should be deferred until more produce has been removed.

This prescription should also be applied to larger gaps of higher visual resource value (see appendix 2).

Gap Size > 2ha

As for the above, but only remove the following unmarked culls:
DBH >40 cm - all cull trees.
DBH 20-40 cm 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.

Technique

Where stump coppice is needed, fell saplings (DBH <15cm) close to ground level. Otherwise remove all unwanted stems by pushing over with a machine or by notching with an approved herbicide. (See Appendix 2 and Herbicide Manual, Technical Instructions).

6.5 TREATMENT OF SHELTERWOODS

Competition removal and soil disturbance where regeneration is absent.

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. Also remove mature Banksia grandis and unmarked sheoak. Do not establish swathes within 3 metres of retained trees. This work must be done in dry soil conditions to ensure that a receptive seedbed results. Install erosion barriers at the appropriate

intervals (See Manual of Hardwood Logging Specifications).

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 18m²/ha.

Natural Seedfall

Examine the seed crop in late summer and where there is 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, it is necessary to broadcast seed. 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.

Establishment Survey

For both natural seedfall and artificial seeding undertake regeneration survey in the following February see Specification 3/90.

7. BURNING AND PROTECTION

Burning and protection requirements vary according to silvicultural objectives. The detailed requirements are listed in Specification 1/91.

8. RECORDS

Good silvicultural records are essential for future managers to assess 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.

Treemarkers should progressively record the objectives of their marking and enter these on the relevant H.O.C.S. prints and complete CLM 160 including requirements for completion of follow-up treatment.
Areas to be protected from fire should be recorded on district master burning plans.

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9. REFERENCES

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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 soils. 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
(FROM SPECIFICATION 2/91)

SILVICULTURE OBJECTIVE	MANAGEMENT ZONES									
	VRM A			VRM B		VRM C		SALT SENSITIVE		EXCLUSION
REGENERATION	VISIBLE 0 TO 150 M OR VISIBLE SLOPE > 20 ° *	VISIBLE >150M *	NOT VISIBLE *	VISIBLE *	NOT VISIBLE	VISIBLE	NOT VISIBLE	900-1100MM	>900MM **	DEFINED IN SECTION 3.2.1
GAP SIZE	0.25 - 0.5 HA (2-3 TREE HTS)	< = 1 HA (2-4 TREE HTS)	< = 10 HA (2-4 TREE HTS)	< 1 HA (2-4 TREE HTS)	< = 10 HA	< = 10 HA VARY GAP SIZE ALONG TRAVEL ROUTE INCLUDING LOG ROAD	< = 10 HA	NO MORE THAN 70% OF 2ND ORDER CATCHMENT	NO MORE THAN 70% OF 2ND ORDER CATCHMENT	NO HARVESTING
MIN TEAS WIDTH BETWEEN GAPS	50 METRES	50 METRES	100 METRES	100 METRES	100 METRES	100 METRES	100 METRES	AS FOR VRM ZONE	AS FOR VRM ZONE	
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 VRM ZONE	AS FOR VRM ZONE	
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 VRM ZONE	AS FOR VRM ZONE	
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 VRM ZONE	AS FOR VRM ZONE	
OTHER	ROADSIDE ZONE UP TO 20 METRES *	ROADSIDE ZONE UP TO 20 METRES *		ROADSIDE ZONE UP TO 20 METRES *						
THINNING										
- INTENSITY	RETAIN UP TO 5 M2/HA EXTRA FOR DIVERSITY WITH VARIATION IN SIZE AND DENSITY	N ORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	MIN OF 15 M2/HA	NORMAL	NO HARVESTING
- TREATMENT	FELL AND POISON STUMPS	FELL AND POISON STUMPS	NOTCH	FELL AND POISON STUMPS FIRST 50M	NOTCH	NOTCH	NOTCH	NOTCH	NOTCH	
- HABITAT	NORMAL, PREFER CLOSE TO ROAD	NORMAL	NORMAL	NORMAL, PREFER CLOSE TO ROAD	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	
SHELTERWOOD	NORMAL EXCEPT ROADSIDE ZONE UP TO 20 METRES *	NORMAL	NORMAL	NORMAL EXCEPT ROADISDE ZONE UP TO 20 METRES *	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	
TEAS	TEMPORARY EXCLUSION AREAS RETAINED TO VISUAL ADVANTAGE. WITHIN 150 METRES OF ALL MAJOR HAUL ROADS RETAIN 1 HA (MIN) MATURE PATCHES WITH MAXIMUM SEPARATION OF 200 METRES									
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 IN DESIGN

** MARRI FOR WOODCHIPS MAY NOT BE REMOVED FROM THIS ZONE IN THE SOUTHERN FOREST REGION

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.

e.g.

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 best150 stems/haat first thinning	Crop Tree Basal Area (m^2/ha)	Schedule
Less than 20cm	N/A	Release 200 jarrah stems/ha from overtopping and crown objective is to maintain healthy crown develop ment 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 under-stocked. 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 over stocked (50 years). More conservative thinning in the future will maximise s volume/ha.
40cm	18m^2/ha	Thin again when crop trees reach 50cm dbhob. Above comments apply.
50cm	20m^2/ha	

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

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

A further 1 sq.m/ha of potential pit props may also be retained where appropriate.
15m^2/ha (including habitat trees) in the Intermediate Rainfall Zone.

APPENDIX 5

CRITERIA FOR SELECTION OF HABITAT TREES

1. OBJECTIVE

To retain for hole nesting fauna the essential components of habitat which cannot be readily replaced through post-harvest forest manipulation.

2. STANDING TREES AS HABITAT

2.1 Characteristics of Habitat Trees

Mature and likely to live for many years. It is essential that these trees have the capacity to provide fauna habitat until regrowth trees can place them in the future.

Contain holes, or broken branch stubs below the live crown with the potential to develop into holes.
Average sized crowns. Excessively vigorous trees will affect regrowth over a wide area.
Marri in preference to jarrah.
Where there is a surplus of suitable habitat trees retain those of lower commercial value.

2.2 Rate of Retention

Habitat trees must be deliberately marked for retention. Trees, as defined above, are to be retained for fauna habitat at a rate of 3 trees per hectare. Where suitable trees are not present a rate of 15 trees per 5 hectares must be achieved. A clump of 3-4 trees is preferred to an even distribution. If insufficient trees with these characteristics are available retain mature trees as potential habitat.

Wherever feasible locate clumps on the boundary between patches of forest which are or will be of different ages, e.g. on the boundary of a gap and thinning or uncut strip.

In general do not retain habitat trees in regeneration gaps of one hectare or less, as they will provide excessive competition for regrowth. They may only be retained where required to attain the appropriate rate of retention or where they are of exceptional value.

3. GROUND HABITAT

3.1 Characteristics

Logs:

Diameter 30-100cm
Pipe 6-15cm diameter extending into log
Length - 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

Operators should be trained to recognise and retain suitable logs and stumps. If necessary they should be marked by the treemarker. Where available retain at least one per hectare. All marked logs must be retained undisturbed.

4. FAUNA HABITAT PROTECTION

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

In this specification "coupe" means a contiguous area of forest used for the planning of harvesting. A coupe will usually be harvested in 1 - 2 years, however not all the forest in a coupe will necessarily be harvested in one felling cycle.

APPENDIX 6

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

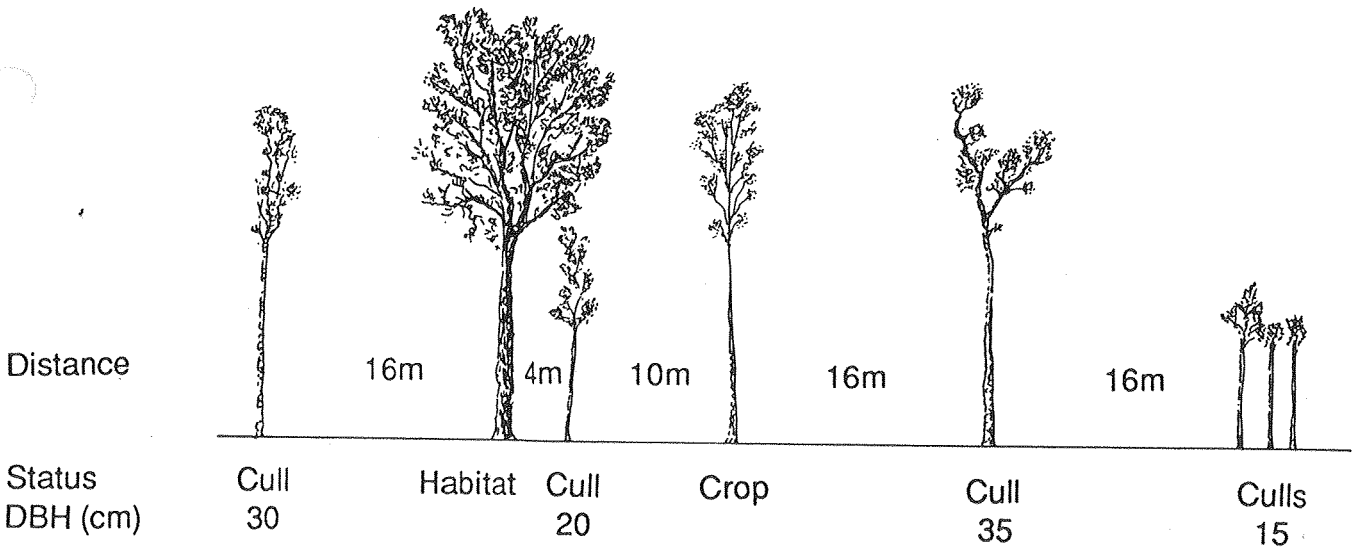

Figure 1A: Gap containing 2-3m²/ha culls which are widely spaced and do not require treatment.

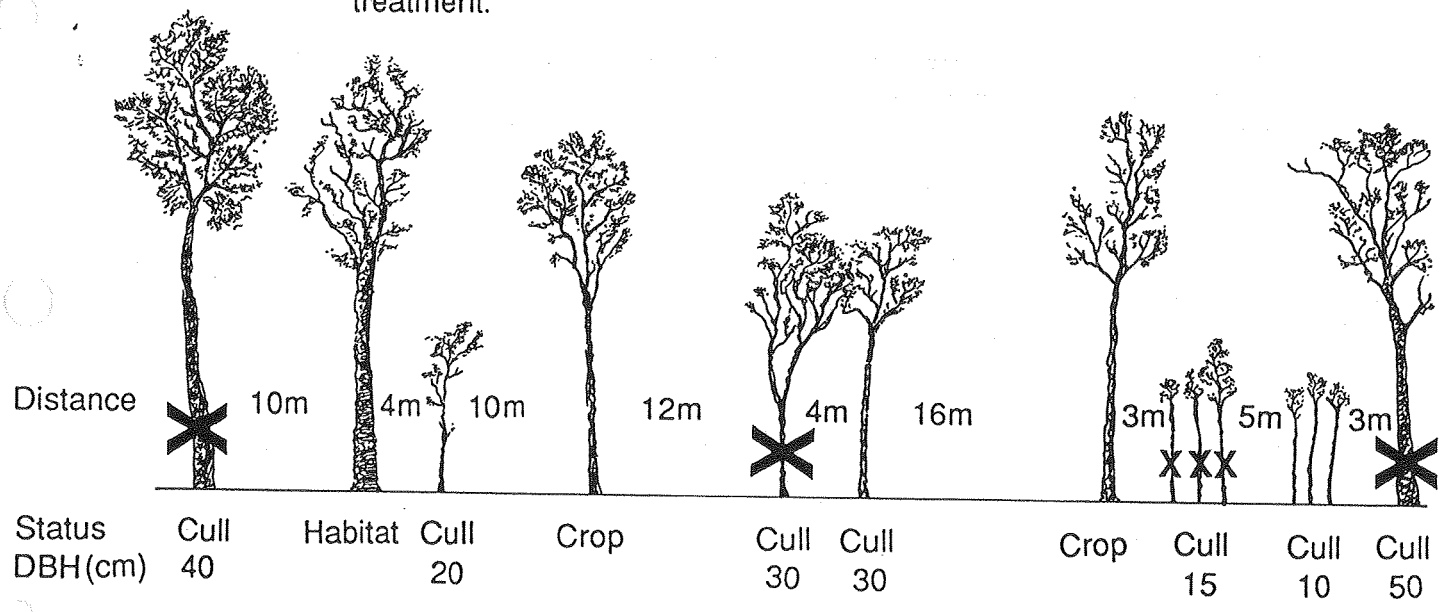

Figure 1B: Gap containing about 8m² /ha of culls, X indicating those to be removed.

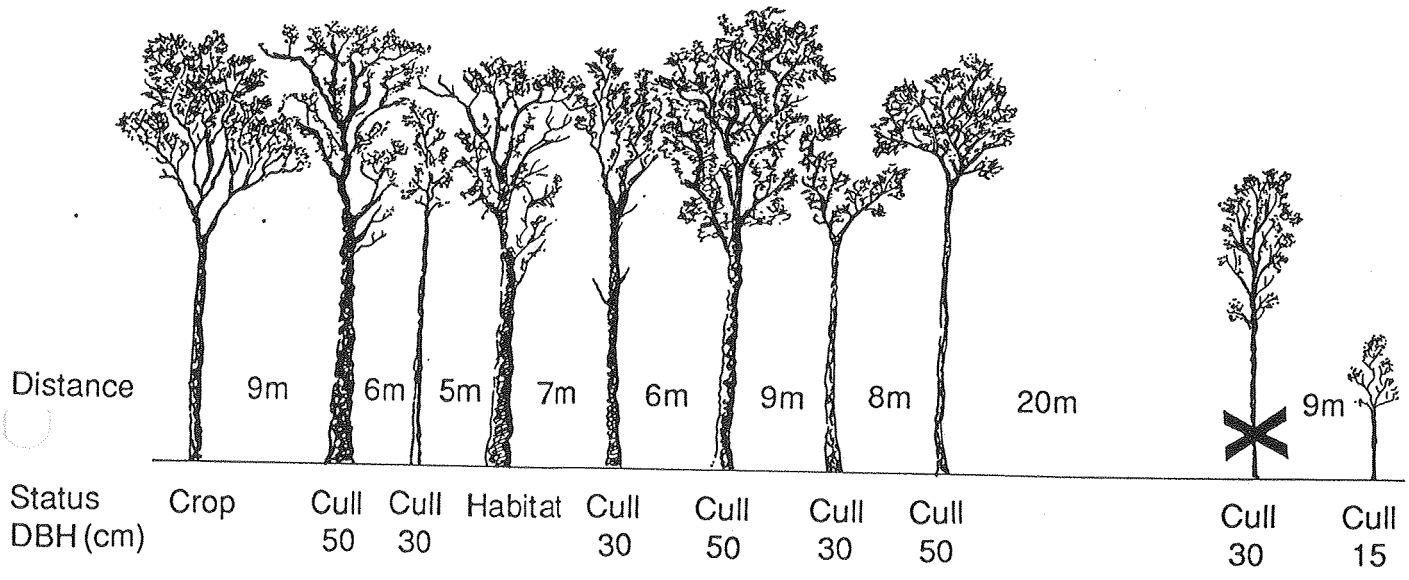

Figure 1C: Gap with a dense group of culls (> 12m²/ha) which should not be treated. Gap at right may be treated if 50 metres in diameter.