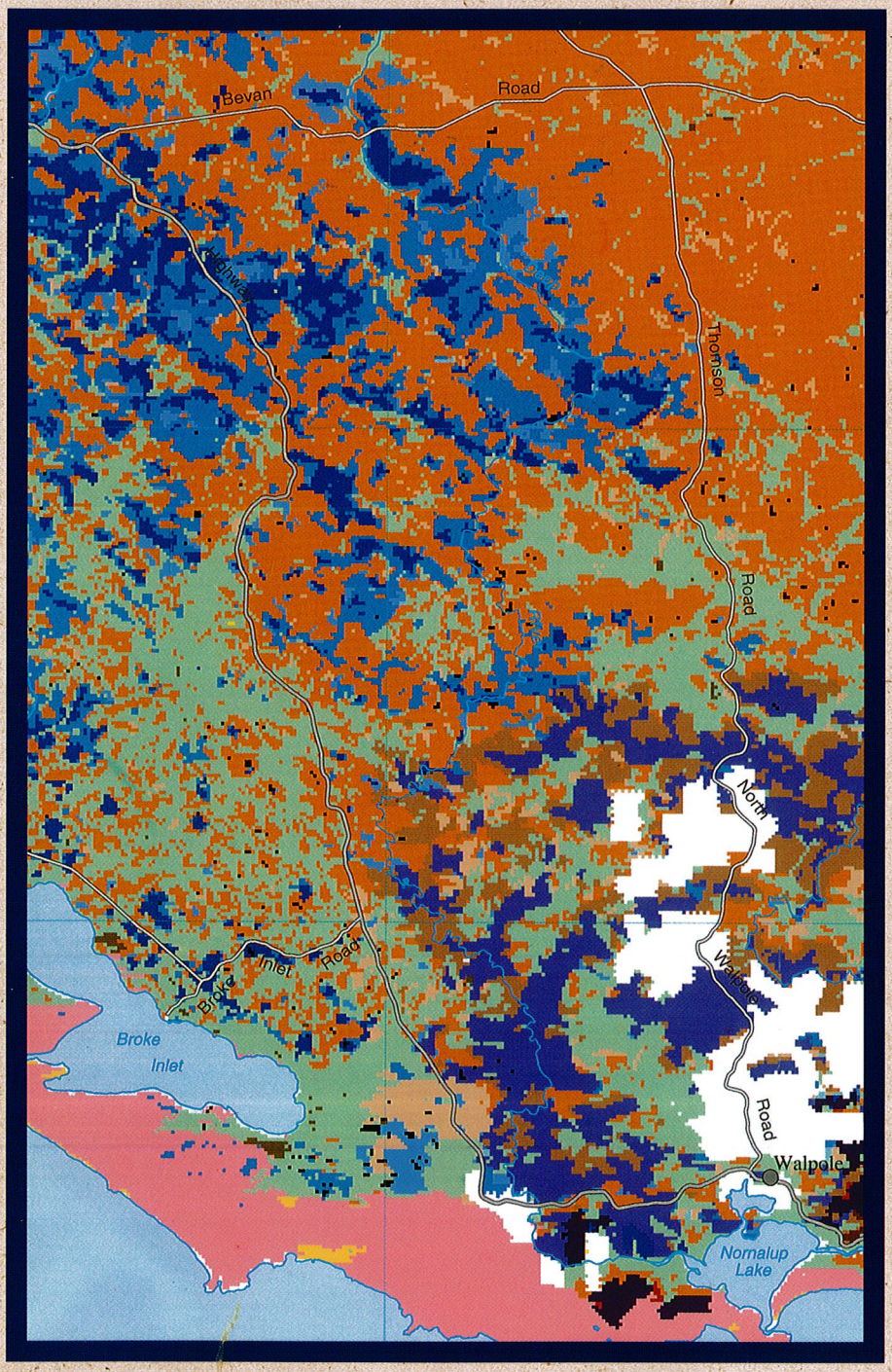
Forest Mapping in the South West of Western Australia

F. J. Bradshaw, P. M. Collins and P.J. McNamara



This booklet has been prepared to accompany the following maps:

1. ***Forest Associations in the South West of Western Australia***

Three parts—North , Central, South.

Scale1:250,000

2. ***Height of the Tallest Native Vegetation in the South West of Western Australia***

One map. Scale 1:650,000

3. ***Karri Distribution Before European Settlement***

One map. Scale 1:350,000

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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Preface

This booklet has been prepared to accompany a series of forest maps of the South West of Western Australia: Forest Associations, Height of the Tallest Native Vegetation, and Karri Distribution Before European Settlement. This series of maps has been produced in response to a growing interest in forest management by the public and by both State and Commonwealth agencies. The primary source of information is the aerial photo interpretation (API) mapping of the South West forests, which has been available in an unpublished form for many years. This information has been supplemented by more recent mapping and is presented in summary form at its original resolution.

The maps are the result of work carried out by many people over many years.

George Nunn, Pat McNamara and Frank Campbell were responsible for developing the aerial photographic interpretation (API) system. Bert Burrell was responsible for the cartographic aspects of the API mapping.

Interpreters on the API program were: F. Batini, F. Beitlich, J. Bradshaw, T. Brittain, C. Broadbent, D. Cox, H. Cransberg, T. Dinneen, D. Donnelly, J. Edwards, I. Ferguson, P. Gregan, F. Halden, L. Hammond, K. Hargraves, J. Hargraves, H. Liddelow, A. McDonnell, E. Miguel, D. Muir, G. Rees, G. Reid, A. Rice, M. Rutherford, T. Smith, J. Williamson, D. Wilson, T. Wood. The names of the following whose initials appear on early interpretation maps have not been able to be identified—WDF, HAW, FEL, AW, DM, FE, EM, LWG, LWS, LG.

Tom Brittain carried out the pure karri and the cleared karri interpretation in the main karri belt and Denmark areas. Greg Heberle did much of the reconnaissance survey on the South Coast. Hank Cransberg revised the wandoo distribution. Alf Lorkiewicz revised the karri distribution and interpreted cleared karri on the west coast. Jeff Hall and John Webb interpreted and field checked much of the south coast existing and cleared karri. Matt Jones interpreted the tuart and associated areas on the west coast. John Meharry and Merv Smith interpreted areas of crown land in the Swan region that were not previously covered by API mapping.

Pat Collins and Danny Blechynden processed and edited the GIS data. Mark Laming prepared the final maps for publication.

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Introduction

A number of forest type and vegetation maps, dating back more than one hundred years, have been produced for the South West of Western Australia. They include those of Fraser (1882), Ednie-Brown (1896), Lane-Poole (1921), Kessell (1928a, 1928b), Gardner (1952), Harris (1967), Churchill (1968), Smith (1972–1974), Heddle et al (1980), and Beard (1981). These maps differ in their definitions, varying from the area where the species is present, to the area dominated by a particular species in forest formation. They also vary according to the level of knowledge at the time. The earliest maps were, of course, based entirely on broad-scale ground reconnaissance at a time when there was very limited access to the forests. The last three mentioned above show vegetation structure rather than tree species. The common feature of all these published works is that they are generalised, coarse resolution maps which primarily indicate the external boundary of the forest or species.

The first attempt at detailed mapping of forest types was that undertaken by the State Government's land classification teams from 1916 to 1923. This mapping was based on ground transects (800 m apart) of the forest area from Mundaring to Denmark. The primary purpose was to classify land suitable for dedication to agriculture, State Forest or other reserves (Woods and Forests Dept 1916, Forests Dept 1923). The surveys were conducted by surveyors and foresters, and they recorded forest type and timber volumes on these transects. The maps were the first to depict the fragmented nature of the different forest types and provided the first estimates of the net area of forest. Refinements to this mapping (on 400-metre transects) on parts of the forest were continued through the 1930s. These maps were designed primarily as a basis for silvicultural treatment of harvested forest. None of these maps were published.

The most detailed and comprehensive maps of forest type and structure prepared so far are those based on aerial photographic interpretation (API) by the Forests Department during the 1950s and 1960s. These maps were designed to provide the base information needed for forest management, inventory and planning. In addition to providing forest type information they also provided the first comprehensive topographical mapping of features such as roads, streams, swamps, rock outcrops etc. They, too, were not published.

The distribution of karri (*Eucalyptus diversicolor*) and wandoo (*E. wandoo and E. accedens*), based on this data, has been shown on standard Forests Department and CALM maps at 1:63,360, and later at 1:50,000, since the early 1970s.

The first reasonably detailed published maps of the vegetation of the South West were those of Smith (1972–1974). Although he used the API maps of the Forests Department as a basis, the primary purpose was to show broad vegetation structure. Species were shown simply as notations (without boundaries) on generalised (1:250,000) maps. These maps were the basis of the more generalised 1:1,000,000 series of Beard (1981).

In 1980, vegetation complexes, based on landform, were published as part of the 'System 6' study, covering the northern jarrah (*E. marginata*) forest, at a scale of 1:250,000 (Heddle et al 1980). These also drew on information from the API maps.

The API maps have been a fundamental forest management tool for more than thirty years, but for a variety of reasons they have not been generally available outside the managing agencies, although as indicated above they have been used as source data for generalised small-scale vegetation maps published elsewhere. Growing interest in forest management, by the public and both State and Commonwealth governments and their agencies, has highlighted the need for this information to be in a readily available published form. While some of the original structural information is now dated, these maps nevertheless remain the most detailed source of information on the distribution of forest tree species. With improved technology it is now feasible to present much of this information in its original detail.

The purpose of this booklet is to describe the information contained in the API maps and related supplementary mapping. The accompanying maps present summarised information from these data.

Aerial Photographic Interpretation (API) Mapping

Phase 1 (Crown Cover Classification)

Although aerial photographic interpretation trials began in 1945 and 1946, photo scale and quality were such that little more than forest and non-forest could be distinguished. Improved quality 1:15,840 black and white photography available in 1951, however, made it possible for the Forests Department to proceed with broad-scale forest type interpretation.

One of the primary purposes of the mapping at the time was as a stratification base for a forest inventory. In this period of the post-war building boom, the areas of particular interest were those with potential for new sawmilling development. The program began in the

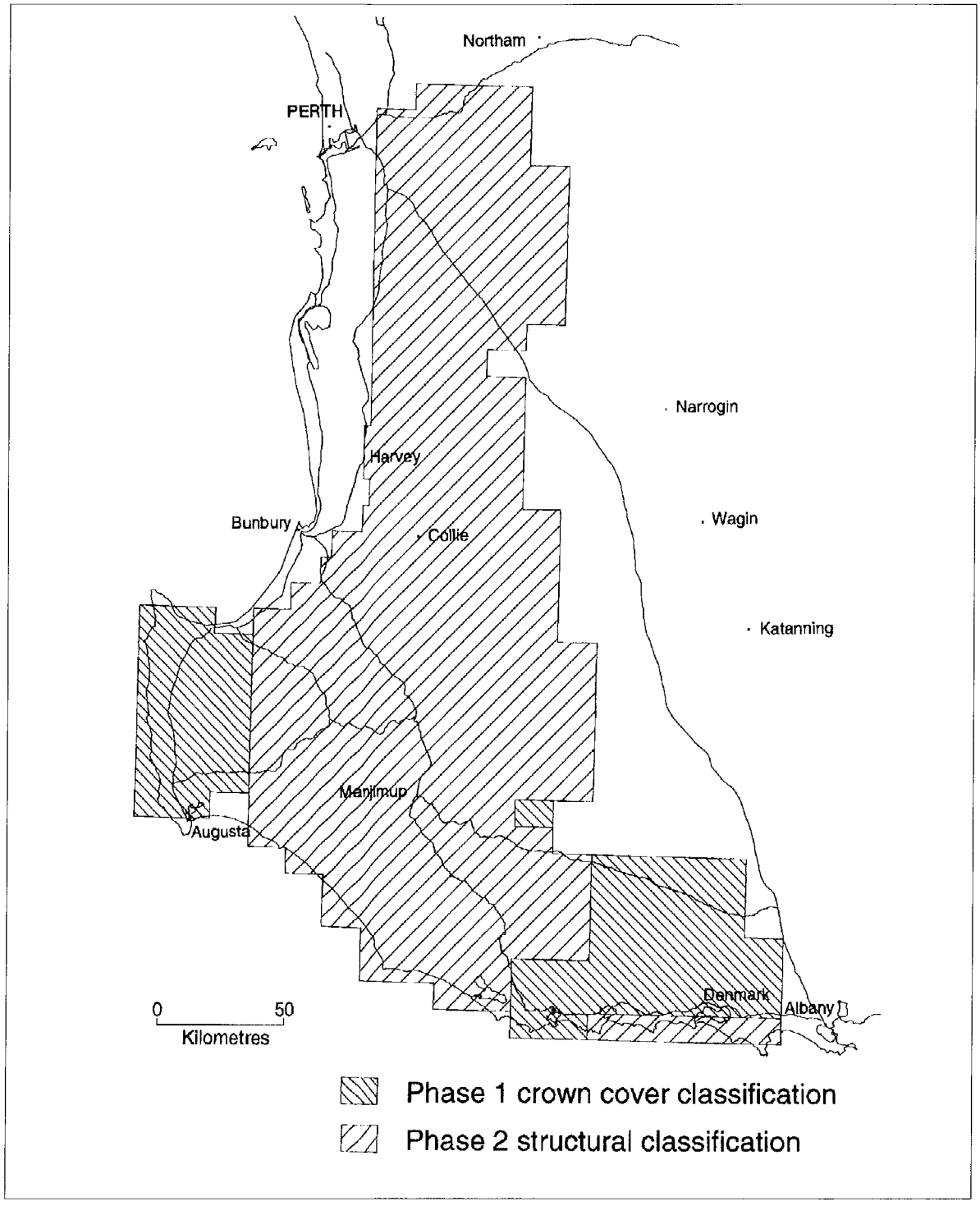

Figure 1 Coverage of aerial photographic interpretation (API) mapping.

Donnybrook Sunkland and the Mount Frankland region. This classification identified tree species (dominant and secondary species), co-dominant height, and crown cover (McNamara 1959). Height and crown cover classes were compatible with those developed for the National Forest Inventory at that time. Additional comments were made on fire damage, the status of clearing on farmlands and roading and topographic features (see Appendix 1 for detail).

The quality of the aerial photographs was not high, at least by current standards, and access for field checking was limited in some areas. For these reasons the reliability of interpretation at the detailed level was variable but nevertheless contributed valuable information for management purposes.

832,000 ha were interpreted in this fashion from 1951–1958 (Figs. 1 and 2).

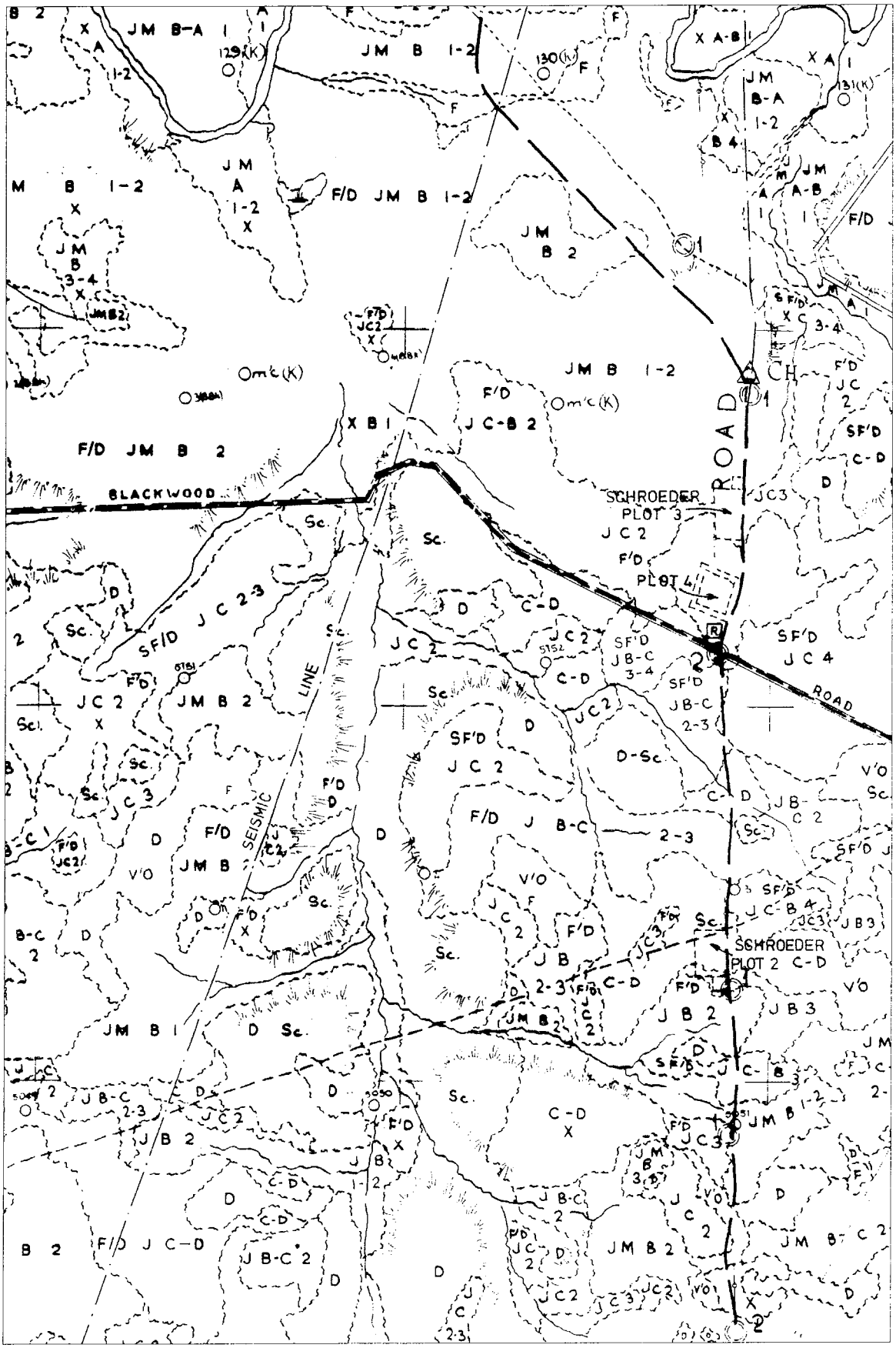

Figure 2 An example of the API maps based on the 'crown cover' classification. Scale 1:25,000. See Appendix 1 for coding details.

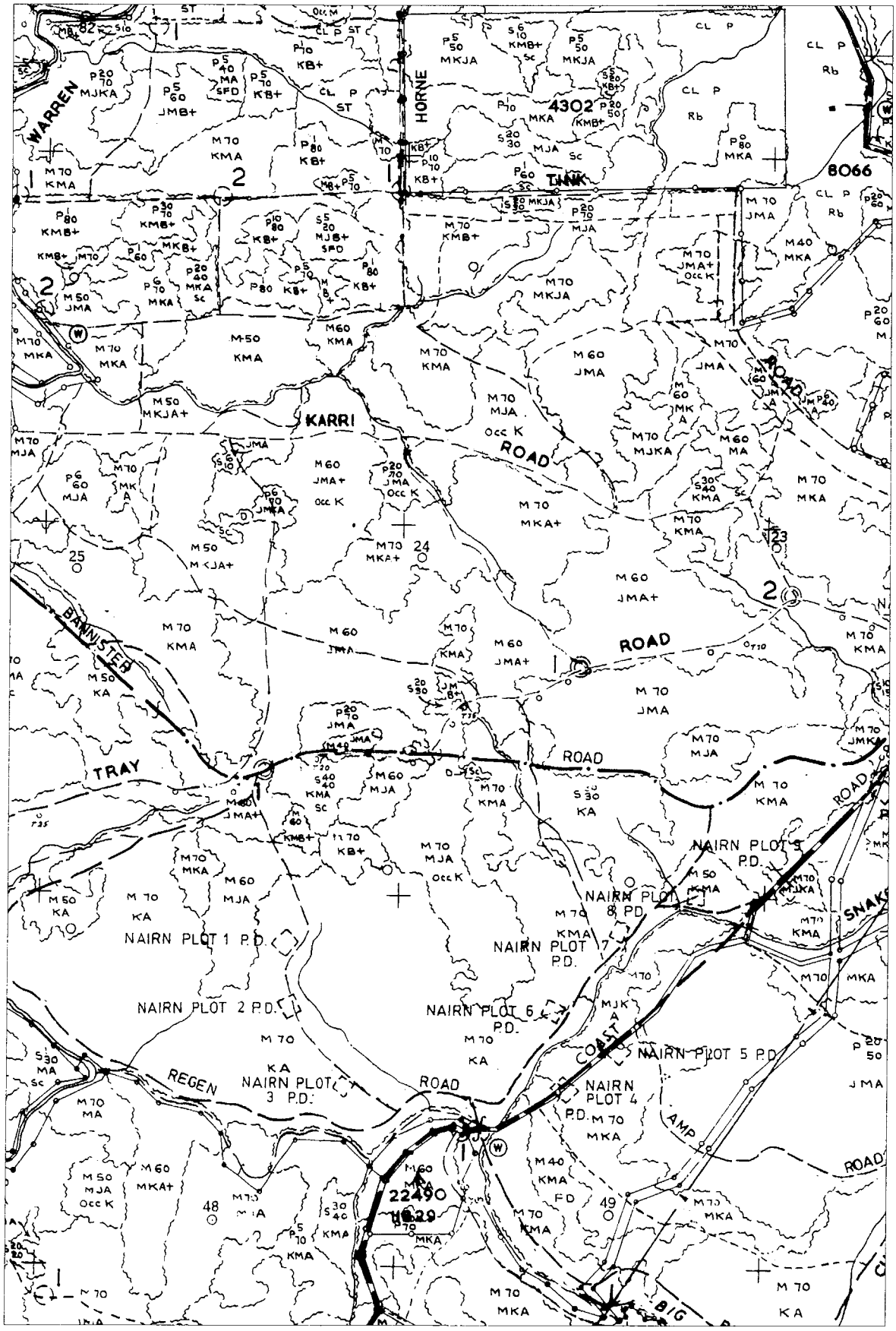

Figure 3 An example of the API maps based on the 'structural' classification. Scale 1:25,000. See Appendix 2 for coding details.

Plate 1 An example of a 1951 'summer' photo. The pale tone, especially near the 'shadow point' indicates marri. The darker tone in this photo is karri. Scale 1:15,840.

Phase 2 (Structural Classification)

While the crown cover classification was satisfactory for describing forest dominated by one structural stratum or storey, it proved inadequate for describing forest that had been previously harvested. These stands frequently consisted of two distinct strata. Total crown cover is made up of trees in the mature stratum, together with saplings or pole-size trees in a lower stratum. There was a need to separate the contribution of each to obtain a meaningful structural description. A new classification was therefore devised and, although primarily intended for use in cutover forest, was applied to all forest interpreted from 1959.

This classification used the same descriptions as before for species and height. In place of a single figure for crown cover, upper strata and total crown cover were recorded as well as a code to indicate whether the stand was primarily single storeyed, or a two-storey stand with poles or saplings in the lower storey (see Appendix 2 and fig 4 for detail).

While photo quality gradually improved with later projects there was, nevertheless, considerable variability.

A part of this variation was due to the normal effects of the season of photography (Plate 1 and 2)

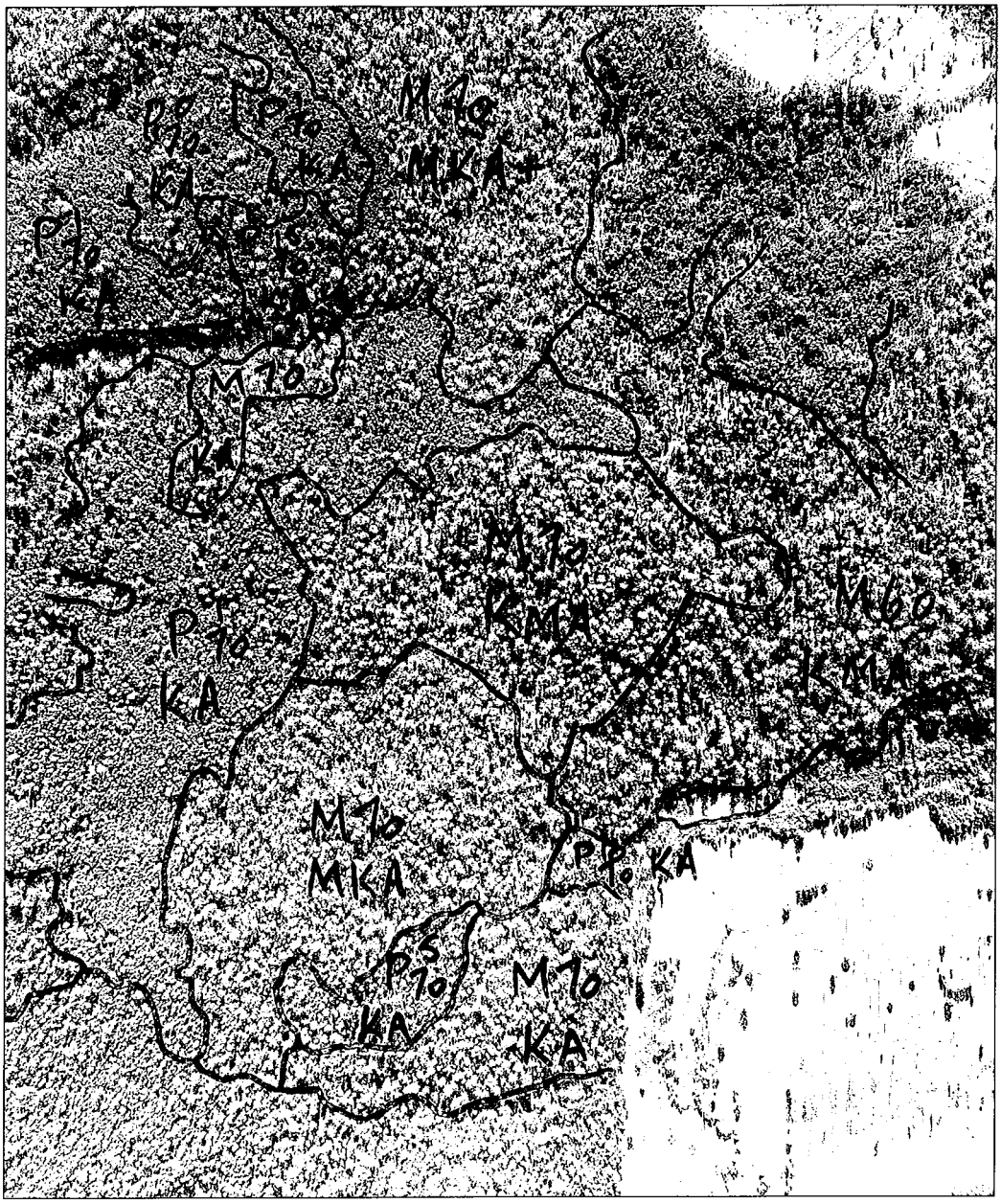

Plate 2. A 1962 'winter' photo interpreted under the 'structural' classification. The lower sun angle enhances structure but is less reliable for species interpretation. Remnant karri 'stags' are evident in the cleared farmland. Scale 1:15,840.

Improved access increased the opportunity for field checking and improved the reliability of the interpretation.

3,130,000 ha were interpreted under this system from 1959–1965 (Figs. 1 and 3).

Maps based on Phase 1 and 2 classifications were originally produced at 1:15,840. At the time of metrication they were converted to 1:25,000.

Supplementary Mapping

The interpretations described above cover the majority of the forest areas of the South West and no major re-interpretation has been done since that time. However, there have been a number of projects undertaken which either correct or supplement this work. These are described briefly below.

Pure karri

In the original classification, secondary species were only recorded if they constituted 20 per cent of the trees in the stand. Areas designated as 'K' on these maps may

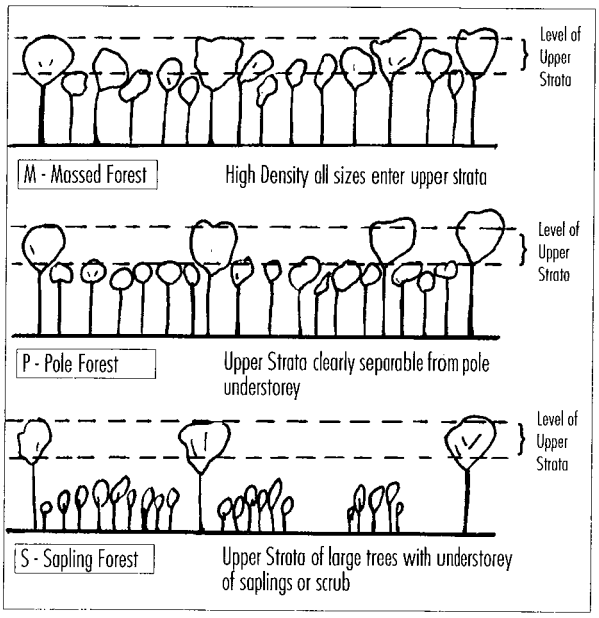

Figure 4 Structural composition of massed, pole and sapling stands.

therefore contain up to 20 per cent of other species, usually marri (*Corymbia calophylla*, formerly *Eucalyptus calophylla*). In 1980 a project was undertaken to re-map 'pure karri' within the main karri belt. This was done using 1:40,000 black and white photography, some of which was acquired to coincide with an anticipated heavy marri flowering. These photos not only had the advantages of summer photography, but the coincidence of a heavy marri flowering provided the opportunity for reliable mapping of pure karri stands by highlighting the white marri crowns.

South Coast karri

Karri occurs in a fragmented distribution for some 100 kilometres east of the area covered by the general API mapping. This fragmentation is partly natural and partly as a consequence of clearing for agriculture. With the exception of the Porongorups National Park which was mapped in the same style as Phase 1 API, most of the data on existing karri occurrence was acquired from the interpretation of small scale photography and reconnaissance surveys in the 1970s and completed in 1996.

West Coast karri

Originally interpreted in 1955, it was subsequently revised, and the mapping of its current and pre-European distribution was completed in 1996.

Cleared karri

In 1980 a project was undertaken to determine the pre-European extent of the karri forest within the main karri belt at the time of European settlement.

Early clearing on agricultural land had been done by ringbarking, generally of the cull trees remaining after an earlier sawmill harvesting operation, but in some cases by the ringbarking of virgin forest. Ringbarked trees were still a dominant feature of the agricultural landscape in the 1950s and 1960s when the majority of the area was photographed for mapping. Interpretation of the cleared karri was therefore done primarily from the direct evidence of ringbarked stags. Karri stags could be readily distinguished from jarrah by their relative size. Interpretation was supplemented by field inspection, interviews with landholders and to a minor degree by extrapolation on the basis of landform.

Further interpretation of more recent photos was used to identify areas that had been cleared since API mapping.

On the west coast, where clearing had occurred much earlier than in the main karri belt, there remained little physical evidence of stags. Cleared karri in this area was based on aerial photo interpretation, field reconnaissance and the relationship between existing karri remnants or regrowth and soil moisture as indicated by summer pasture condition. This mapping is considered to be a good reflection of the karri distribution but may somewhat overstate the area of karri 'type' as opposed to karri occurrence.

Interpretation for this purpose was not completed for the south and west coast until 1996.

Tingle

The original API attempted to identify the presence of red tingle (*E. jacksonii*) and yellow tingle (*E. guilfoylei*) in mixture with jarrah and karri. Rates tingle (*E. brevistylis*) was not a recognised species at that time. Photo differentiation of these species from each other and from the other main species is difficult. This, together with the fact that access for field checking at that time was very limited, meant that the original interpretation of these species was of a lower reliability than for other species.

During the period 1986–1991 extensive mapping of the distribution of these species was carried out by CALM staff using a combination of aerial photography, aerial surveillance and ground transects (Wardell-Johnson and Coates, 1996). This mapping attempted to map the distribution (i.e. presence) of the species rather than mixtures where it was a significant component (at least 20 per cent). It is therefore not directly comparable with the API mapping in intent and is also more generalised than the API mapping.

Despite these differences it was decided to use this distribution in the presentation of these maps, rather than

the API mapping, because it could be depicted more consistently in that fashion. It does, however, differ in detail from the maps of Wardell-Johnson and Coates in that discrete areas of pure karri and non-forest have been excluded from their generalised areas. The remaining areas are shown as mixtures with jarrah or karri according to the API type for these species. This map also differs in that it includes some additional tingle areas to that mapped by Wardell-Johnson and Coates.

Wandoo

The wandoo distribution was revised in the late 1960s using extensive road reconnaissance, aerial photos and landform relationships.

Additional Areas

Specific areas beyond those that were interpreted in the original program (including the Swan Coastal Plain and the Julimar) were completed between 1995 and 1997 using the Structural classification.

Jarrah Dieback Disease Mapping

The original API mapping attempted to map areas affected by jarrah dieback (*Phytophthora cinnamomi*) but with limited success. From 1965 to 1975 the forests of the South West were mapped specifically for dieback from black and white 1:40,000 aerial photography (Batini 1973). While this was successful for areas with advanced symptoms it was not successful for the early stages of the disease or where the under-storey impact was less severe. The development of large-scale shadowless colour photography techniques overcame these problems (Bradshaw 1974, Bradshaw and Chandler 1978). Routine photography and interpretation of dieback symptoms, initially using 70 mm format, but more recently with 230 mm format, is carried out annually on selected areas of forest (Brandis 1983). No details of this mapping are included in this series and species and crown cover reflect those at the time of API mapping.

Notes on the Accompanying Maps

Data from the original sources has been transferred to CALM's Forest Management Information System (FMIS) data base. FMIS is a raster-based Geographic Information System covering the forest areas of the South West. Forest type data is stored at a pixel resolution of two hectares, similar to the resolution of the original photo interpretation.

The accompanying maps are prepared using a selection of the above data and are based on the most current information available, i.e. where errors were known to exist in the original data they have been corrected for presentation here. Though the original interpretation covers both public and private land, these maps show information for public land only (as it was in 1996), with the exception of the map showing pre-European karri.

Species types and mixtures are simplified and presented as 'associations'. The maps have been produced for publication at 1:250,000 but they retain their original resolution and have not been generalised.

Map 1. Forest Associations in the South West

This map is presented in three parts at a scale of 1:250,000: North, Central and South. They cover the forest areas within the Swan, Central Forest, Southern Forest and parts of the South Coast Regions of the Department of Conservation and Land Management (CALM).

There is no universal definition of forest and woodlands. The terminology used in this map follows that of the National Forest Inventory:

> forest-tree crown-cover more than 20 %
> open woodland-tree crown cover 5–19 %

Only significant forest tree species with a relatively wide distribution are shown on this map (Appendix 3).

Karri is shown as 'pure' karri, and karri in any degree of mixture with marri/jarrah or tingle species. Small areas of 'open woodland' are included with forest.

Pure jarrah has not been shown separate from mixtures with marri. Blackbutt (*E. patens*) is included in jarrah forest.

Wandoo includes wandoo (*E. wandoo*), powder-bark wandoo (*E. accedens*) and scarp wandoo (*E. laeliae*) whether pure or in mixture with jarrah.

Tuart (*E. gomphocephala*) includes pure and mixed stands.

Small areas of pure marri are included in the surrounding type (ie as either jarrah or karri).

Tingle mixtures reflect occurrence of occasional trees as well as significant proportions. Where mixtures of red and yellow tingle occur, priority for presentation is given to red tingle.

The map depicts forest on public land only. Public land includes all Crown land, and land owned by various government departments.

Table 1. Areas of Forest Associations on Public Land in the South West of Western Australia (to the nearest 1000 hectares)

MAIN SPECIES	MIXTURES				TOTAL AREA (ha)
	Marri, Marri/Jarrah	Yellow Tingle	Red Tingle	Rates Tingle	
Jarrah forest [1]	1,571,000	8,000		1,000	1,580,000
Jarrah open woodland	71,000				71,000
Karri forest - pure					58,000
Karri forest - mixed	107,000	12,000	5,000	1,000	125,000
Wandoo forest					140,000
Wandoo open woodland					26,000
Tuart forest and woodland					11,000
Bullich and Yate woodland					2,000
Banksia woodland					84,000
Peppermint and coastal heathland					89,000
Shrub, herb and sedgelands					284,000
Swamps					11,000
Rocky outcrops					14,000
Sand dunes					15,000
Exotic species					106,000
Crown land not classified					12,000
TOTAL AREA (ha)	1,751,000	20,000	5,000	2,000	

These areas apply to the areas depicted on the accompanying Forest Associations maps (North, Central and South).

Not differentiated: [ ]

1 Includes 5,000 ha shown on the maps as "Jarrah/marri: density is not classified".

Map 2. Height of the Tallest Native Vegetation in the South West

API mapping assigned height classes to each stand on the basis of the co-dominant height of the stand at maturity. Height classes are different for wet and dry sclerophyll forest (see Appendix 1 and 2). In this map they have been amalgamated to produce a broad index of potential forest productivity. The tallest jarrah and the shortest karri class have been combined into one class (25–40 metres). These classes conform with the original productivity classes of the National Forest Inventory. This map relates to the eucalypt forest only, and the scale is 1:650,000.

Map 3. Karri Distribution Before European Settlement

This map depicts existing karri forest and that cleared since European settlement in 1826. It covers public and private land. It shows the situation at 1996. The map scale is 1:350,000

Table 2. Estimated Area of Karri Before European Settlement (to the nearest 500 hectares)

	Public land		Private land		Original Total
	Existing	Cleared	Existing	Cleared	
West Coast [1]	5,000		1,500	8,000	14,500
Main Karri Belt [2]	174,500	500	10,000	32,000	217,000
South Coast [3]	3,500		7,000	8,000	18,500
TOTAL	183,000	500	18,500	48,000	250,000

1 West of a line drawn north from the mouth of the Donnelly River.
2 Between the mouth of the Donnelly River and a line drawn north from Irwin Inlet.
3 East of Irwin Inlet.

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Appendix 1.

PHASE I. CROWN COVER CLASSIFICATION

This classification is based on: **species, mature height** and **total crown cover per cent.**

This classification was used until 1959 for the interpretation of virgin forest.

1. Species

Species are coded as follows:

Jarrah	J	Karri	K
Marri	M	Wandoo	W
Blackbutt	B'bt	Yellow tingle	TY
Red tingle	TR	Tuart	Tu
Paperbark	P'bk	Unknown eucalypt	E
Unknown species			X

(Minor species, e.g. yate (*E. cornuta*) are generally written in full.)

The most common species is written first. The presence of a secondary tree species is not recorded unless it constituted more than 20 per cent of the stems greater than 15 cm diameter.

If occasional trees of a species are present, they are sometimes mentioned, e.g. Occ.K.

2. Height

Different classes were used for wet and dry sclerophyll forest. Stands are classified by the co-dominant height class of the mature forest. Height applies to the dominant species.

Original height classes	*'Soft' metric conversion*	*NFI*[1]
Jarrah, marri, blackbutt, yellow tingle, wandoo		
A >90 feet	> 25 metres	III
B 50–90 feet	15–25 metres	IV
C < 50 feet	< 15 metres	V
Karri, red tingle		
A > 170 feet	> 50 metres	I
B 130–169 feet	40–49 metres	II
C < 130 feet	< 40 metres	III

[1] Original National Forest Inventory Class

3. Crown Cover

This is the percentage of the area covered by the projected crown cover of eucalypts (assuming the crowns are opaque and ignoring overlap). Four classes were recognised:

	NFI
1 dense Over 80% crown cover	D
2 moderate 50–70% crown cover	M
3 scattered 20–40% crown cover	S
4 open10% crown cover	O

4. Other descriptions used

F/D	fire damaged
Cl	cleared
Pt Cl	part cleared
Rb	ring barked
R'g	regrowth
Cul	cultivated
P	pasture
Br	bracken
S"T	shade trees
V'O	very open

Buildings, dams, some tracks

5. Expression of the Classification

(dominant species) (secondary species) (height class) (crown cover class) (extra classification)

e.g. JMA 1 F'D

KMB 2

6. Examples

A stand described as **JMB 2** will have the following characteristics:

Predominantly jarrah with 20–50% marri

Co-dominant height 15–25 metres

Total crown cover 50–70%.

Appendix 2.

PHASE 2. STRUCTURAL CLASSIFICATION

This classification is based on: **stand structure, percentage crown cover, species** and **height class.**

1. Stand Structure

Two types are recognised:

One-Layered Stands

Stands composed mainly of trees larger than pile size (30 cm–50 cm diameter) forming one layer (the 'upper stratum') with no easily separable understorey layer ('lower stratum'). All stands with an upper strata crown cover >40 per cent are included in this category.

Such stands are classified as "M" = **massed stands.**

Two-Layered Stands

These are stands where the upper stratum crown cover is less than 40 per cent and where there is a definite lower stratum. These may be classified as:

"P" = **pole stands**—in which the lower stratum comprises mainly poles
(15 cm–30 cm diameter)
or

"S" = **sapling stands**—in which the lower stratum is mainly saplings
(less than 15 cm diameter).

See Figure 4 for a diagrammatic representation of stand structure.

2. Crown Cover

This is the percentage of the area covered by the projected crown cover of eucalypts (assuming the crowns are opaque and ignoring overlap).

Only total crown cover is recorded for M stands, while both upper strata and total densities are recorded for P and S stands.

Lower stratum crown cover is not recorded but can be arrived at by deduction of the upper strata crown cover from the total crown cover.

Upper Strata Crown Cover

The percentage of the area covered by the crowns of trees in the upper stratum (piles and trees of more than 30 cm diameter).

There are separate classes for wet and dry sclerophyll forest:

Jarrah, marri, blackbutt, yellow tingle, wandoo

0	0%
1	1–5%
6	6–19%
20	20–29%
30	30–39%

Karri, red tingle

0	0%
1	1–4%
5	5–9%
10	10–15%
15	15–19% etc. in 5% classes to 39%

Total Crown Cover

The percentage of the area covered by crowns from all strata.

The same classes for karri and jarrah.

1	1–5%(rarely used—really non-forest)
6	6–9%
10	10–19%
20	20–29%
	(and so on in 10%classes)

3. Species

Species are coded as follows:-

Jarrah	J	Karri	K	Marri	M
Wandoo	W	Blackbutt	B'bt	Yellow tingle	TY
Tuart	Tu	Powderbark	P'bk	Red tingle	TR

(Minor species e.g. yate are generally written in full.)

The most common species (with most stems more than 15 cm diameter) is written first. The presence of a secondary tree species is not recorded unless it constitutes more than 20 per cent of the stems of more than 15 cm diameter.

If occasional trees of a species are present, they are sometimes mentioned, e.g. Occ.K.

4. Height

Different classes were used for wet and dry sclerophyll forest. Stands are classified by the co-dominant height class of the mature forest.

Original height classes *'Soft' metric conversion*

Jarrah, marri, blackbutt, yellow tingle, wandoo

A+	> 110 feet	> 30 metres
A	90–110 feet	25–29 metres
B+	70–90 feet	20–24 metres
B	50–70 feet	15–19 metres
C	< 50 feet	< 15 metres

Karri, red tingle

A	>170 feet	> 50 metres
B	130–169 feet	40–49 metres
C	< 130 feet	< 40 metres

5. Other Descriptions Used

D'b	dieback
F'D	light fire damage
S'F'D	severe fire damage
D	non forest-virtually treeless areas (not flats)
F	flats (non forest in flats)
Sc	thick scrub present
DEC	decadent (over mature) crowns—seldom used
V	virgin forest.

6. Resolution

Two-hectare areas are the minimum recognised for major structural types and species differences. Eight hectares are generally the minimum for minor species variation.

7. Expression Of The Classification

One-Layered Stands

(stand structure) (total crown cover) (dominant species) (secondary species) (height class) (extra classification) e.g:

M 70 JMA Sc F'D V

M 60 KC DEC

Two-Layered Stands

(stand structure) (upper strata crown cover)/(total crown cover) (dominant species) (secondary species) (height class) (extra classification) e.g:

P^{30}_{60} JMA D'b

S^{10}_{70} KMB F'D

8. Examples

A stand described as **M60 JB+ F'D** will have the following characteristics:

A one-layered forest (massed stand) consisting mainly of trees of sawlog size (more than 30 cm diameter) but trees of other size classes would be present

Total crown cover ranges from 60–69%

Upper strata crown cover ranges from 40–69%

(By subtraction—lower strata crown cover ranges between 0–29%)

Jarrah is the dominant species but there may be 0–19% marri and/or other species (e.g. blackbutt, wandoo, karri etc depending on where this stand is located)

The co-dominant height of the stand is between 20 and 24 metres

The stand is fire damaged.

A stand described as **P^{30}_{60} JMA D'b.** will have the following characteristics:

A two-layered forest, the upper strata composed of mature trees and piles (i.e. trees more than 30 cm diameter) and a clearly separable lower strata composed mainly of poles (trees 15–30 cm diameter)

Upper strata crown cover ranges from 30–39%

Total crown cover ranges from 60–69%

By subtraction the lower strata crown cover ranges from 21–39%

Jarrah is the dominant species and there is more than 20% marri (there is less than 20% of any other individual species)

The co-dominant height of the mature stand is between 25 and 29 metres

The stand shows signs of jarrah dieback.

A stand described as S^{20}_{20} **JB** will have the following characteristics:

A stand that is theoretically two-layered but is probably only one-layered

Total crown cover is 20–29%

Upper strata crown cover is 20–29%

By subtraction lower strata crown cover is 0–9%

While the lower strata (if any) could be saplings (or scrub), it is more likely that there is no lower strata and the stand is a very open marginal forest with a total crown cover of 20–29% of mature trees

Jarrah is the dominant species, but there could be up to 19% marri

Co-dominant height is 15–19 metres.

Appendix 3

LIST OF TREE NAMES

Banksia	*Banksia spp.*
Blackbutt	*Eucalyptus patens*
Bullich	*Eucalyptus megacarpa*
Jarrah	*Eucalyptus marginata*
Karri	*Eucalyptus diversicolor*
Marri	*Corymbia calophylla* (formerly *Eucalyptus calophylla*)
Peppermint	*Agonis flexuosa*
Powder bark	*Eucalyptus accedens*
Rates tingle	*Eucalyptus brevistylis*
Red tingle	*Eucalyptus jacksonii*
Scarp wandoo (Darling Range ghost gum)	*Eucalyptus laeliae*
Tuart	*Eucalyptus gomphocephala*
Wandoo	*Eucalyptus wandoo*
Yate	*Eucalyptus cornuta*
Yellow tingle	*Eucalyptus guilfoylei*