VEGETATION SURVEY OF WESTERN AUSTRALIA

VEGETATION MAP

PEMBERTON S1 50 - 10

IRWIN INLET S1 50 - 10

1972

WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE

VEGETATION MAP OF PEMBERTON and IRWIN INLET

Latitude 34°00′ to 35°05′S

Longitude 115°30′ to 117°00′E

Scale 1 : 250,000

by

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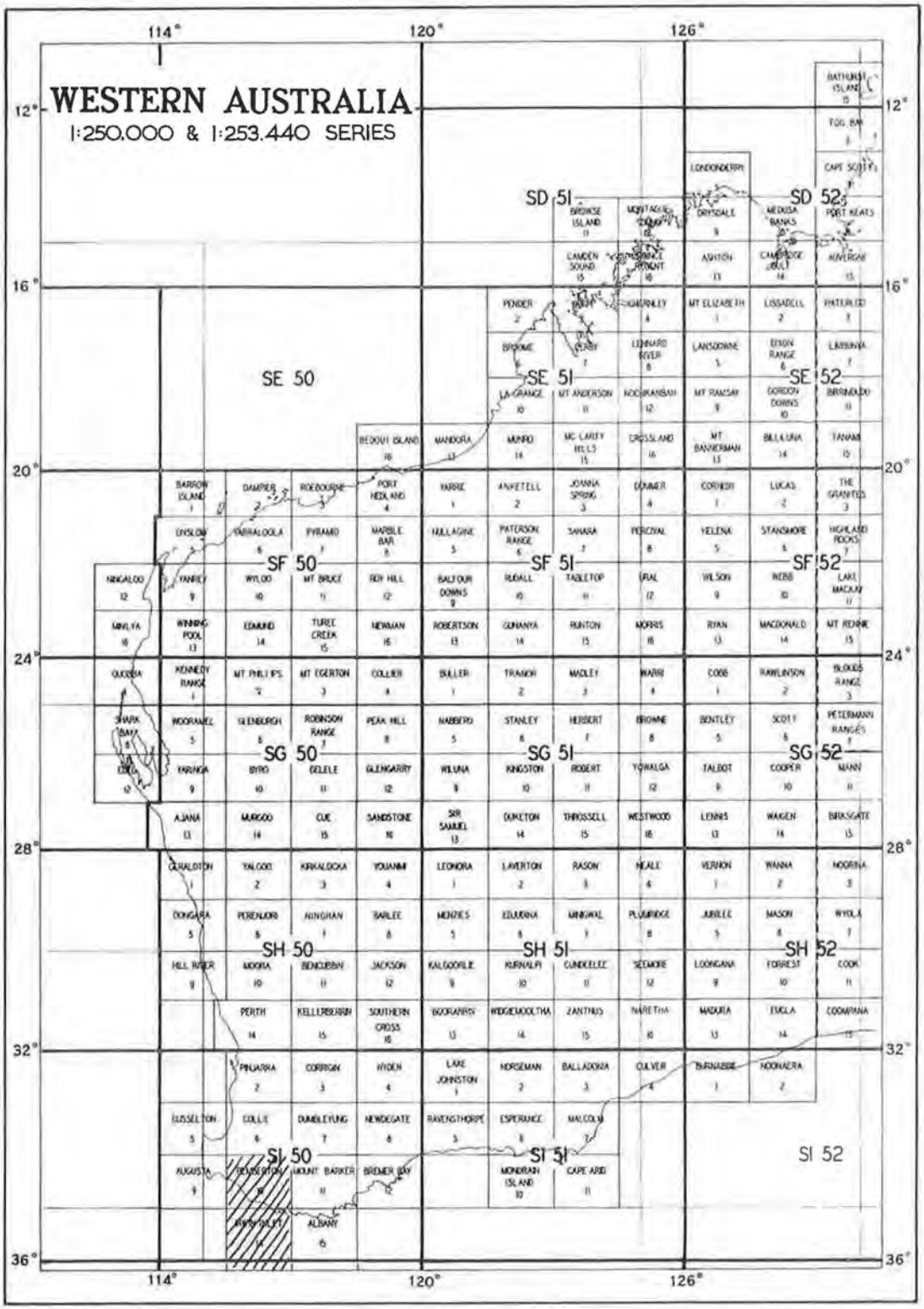
1972

WESTERN AUSTRALIAN DEPARTMENT OF AGRICULTURE



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CONTENTS

COMPILATION AND CLASSIFICATION

The Vegetation Map of the Pemberton area has been compiled and drawn by the author in accordance with the requirements of the Western Australia Vegetation Survey Committee. Sources of information were 1965 aerial photography mosaics at a scale of approximately 1 : 63,360 covering the whole area, individaul aerial photographs taken in 1970 of swamps and sand dunes of the southern areas and Forests Department's A.P.I. Plans which provided valuable information on vegetation structure and principal trees occurring in forested areas. Traverses by motor vehicle and on foot were made during the period December 1970 to January 1972 covering the routes illustrated. Plant material was identified in the field by the author; unfamiliar material was named at the Western Australian Herbarium. Photographs illustrating this text were taken and processed by the author.

Vegetation has been mapped on the basis of structural criteria of the tallest stratum. Structural formations are indicated by colours. The subdivisions of these formations are on the basis of plant associations, which are indicated by means of symbols.

Criteria used in the structural classification are life-form, height and density. There are three height classes for trees—over 30 m, 10

Life-form and height of tallest stratum	Projective foliage cover of tallest stratum, as per cent.	Description	Reference code
Trees over 30 m	70–100	High closed forest	A1
	30–70	High open forest	A2
	10–30	High woodland	A3
	under 10	High open woodland	A4
Trees 10–30 m	70–100	Closed forest	B1
	30–70	Open forest	B2
	10–30	Woodland	B3
	Under 10	Open woodland	B4
Trees under 10 m	70–100	Low closed forest	C1
	30–70	Low open forest	C2
	10–30	Low woodland	C3
	under 10	Low open woodland	C4
Shrubs over 2 m	70–100	Closed scrub	D1
	30–70	Open scrub	D2
	10–30	High shrubland	D3
	under 10	High open shrubland	D4
Shrubs Up to 2 m	70–100	Closed heath	E1
	30–70	Open heath	E2
	10–30	Low shrubland	E3
	under 10	Low open shrubland	E4
Herbs	70–100	Closed herbland, grassland, sedgeland, etc.	F1
	30–70	Herbland, grassland, sedgeland etc.	F2
	10–30	Open herbland, grassland, sedgeland etc.	F3

to 30 m, and under 10 m. There are two height classes for shrubs—more than 2 m, and up to 2 m. Herbs, which include grasses, sedges and hummock grasses, form the other life-form class.

There are four density classes based on projective foliage cover. Crown area cover is not used because it does not allow for the difference in the amount of light passing through the canopy of forests of similar crown cover but vastly different foliage cover. Because the amount of light passing through the main or top canopy has a big influence on the structure of the understorey, the use of projective foliage cover should give a better basis of comparison of plant formations.

The life-form—height classes are indicated by different colours: tall trees—purple; medium trees—brown; small trees—red; tall shrubs—orange; small shrubs—yellow; and herbs—green. Density or cover is indicated by different shades of colour; the darkest for the most dense and the lightest for the most open.

Standard descriptions are used for each structural class as shown on table at page 7.

TOPOGRAPHY

Much of the Pemberton region consists of a hilly and steeply hilly dissected laterite plateau between 240 and 340 m high, the western limit of which is the Darling escarpment running south from Nannup. The rivers of this area, Barlee Brook near the western edge of the plateau, Donnelly, Warren and Shannon and their tributaries, flow through deep valleys in a generally south-south-westerly direction before reaching broad flats of the coastal plain.

West of the escarpment is a lower undulating dissected laterite plateau 60 to 140 m high, across which the Blackwood River meanders in a westerly direction after emerging from the escarpment at Nannup.

The plateau towards the north-east, while still maintaining its height, becomes more gently undulating and mature; it is drained by the Perup, Tone and Upper Frankland rivers. Laterite is still prominent, but in the extreme north-east it becomes confined to small hilltops and to gravel on the slopes.

Further south, adjoining Lake Muir, are extensive plains with shallow swamps and lakes, still at a high altitude but with no apparent surface drainage outlet, although Lake Muir, which is salt and dries occasionally, could overflow into Deep River in times of flood. The soils on this plain are leached sands and lateritic gravels.

In the south the plateau descends to plains of leached sand which are seasonally swampy. From these plains emerge numerous isolated knolls and hillocks, some with massive granite tors such as Mount Frankland, Mount Roe, Granite Peak, and Mount Chudalup.

Near the coast, and particularly where exposed to westerly winds, there are extensive areas of sand dunes, some of which rise to an altitude of 200 m or more. While most of the dunes have been stabilised by vegetation, there are some large areas of bare sand dunes between Point d'Entrecasteaux and the mouth of the Donnelly River.

Along the extreme south coast, from Cliffy Head eastwards, granite massifs form headlands and offshore islands. In the west, Black Point (Cape Beaufort) is composed of basalt while Point d'Entrecasteaux consists of limestone.

Mean annual rainfall varies from about 640 mm in the north-eastern corner of the area, where the Wandoo Woodland occurs, to between 1,020 mm and 1,530 mm in the Karri forest zone.

VEGETATION SYSTEMS

In the region covered by the Pemberton sheet six separate series of plant associations can be recognised, corresponding in their distribution to the soil combinations. The plant associations within a series or system form a sequence or pattern linked to topographic or edaphic factors. The vegetation systems are given the names which have been applied to the corresponding soil combinations.

Nornalup system

The Karri forest zone forms the Nornalup system. It extends from north-west of Manjimup in the valleys of the Donnelly river system towards the south and to the south-west almost to the coast. Karri high open forest (A2) occurs on the light granitic soils on the slopes and in the valleys while Jarrah open forest (B2) occurs on the lateritic gravels of the hills, interwoven with the Karri forest in an intricate mosaic. In the valleys and on the richer sandy soils Marri becomes a prominent component of the Karri forest. In the southern part near the coast, in the Walpole-Nornalup area, both Red Tingle and Yellow Tingle are important components. In the valleys the vegetation tends to be closed

scrub or low closed forest (D1 or C1), but in the broader valleys to the south, low open woodland (C4) of stunted Jarrah and Paperbarks with heath understorey, and sedgelands (F1) occur.

Darling System

The main mass of the Jarrah forest east of the Darling escarpment forms the Darling system. Jarrah open forest (B2) covers the dissected lateritic plateau with Marri on the deeper sandy soils. Forest Blackbutt occurs in some of the valleys and Flooded Gum occurs along river banks. In impeded drainage areas low woodland (C3) or open woodland (C4) of Paperbark and Banksias occurs with understoreys of closed heath and sedgeland.

Chapman system

This system occurs on the low lateritic plateau west of the Darling-Nannup-Fly Brook escarpement. The vegetation is mainly Jarrah open forest (B2) of a more open structure than that on the higher plateau east of the Darling escarpment. The river valleys contain a much better growth of Jarrah-Marri open forest (B2) which in parts is dense enough to be classed as closed forest (B1).

Jingalup system

In the north-west corner of the sheet, Wandoo woodland (B3) appears in the valleys and on the lower slopes, but much of it has been cut out to make room for agriculture. In some of the damper areas, Swamp Yate woodland occurs. Along water courses, Flooded Gum low woodland is usual. Jarrah open forest (B2) is confined to lateritic hill tops and merges with Wandoo woodland on the upper slopes.

Scott River system

On the extensive areas of seasonally swampy flats between the forests of the Chapman and Nornalup systems and the coastal sand dunes (Boranup system) there occurs low open woodland (C4) having scattered Paperbark, Banksia and stunted Jarrah with an understorey of small shrubs and sedges. In the damper areas sedgeland (F1) occurs, and where water is trapped by the dunes there are small rush and sedge filled swamps and lakes. Isolated hummocks of lateritic material support Jarrah in the form of open forest (B2) down to low woodland (C3). Characteristic of the system are low narrow sand ridges covered with Banksia low woodland (C3) or low open woodland (C4) and some stunted Jarrah. In some swamps, Paperbark or Agonis low open forest (C2) occurs.

Boranup system

South of the Scott River and Nornalup systems, the Boranup system occurs on the coastal sand dunes. On their landward side stabilised sand dunes support stands of Karri high open forest (A2), Jarrah open forest (B2), occasional Marri open forest and Yate and Bullich woodlands (B3). Much sand dune country is covered with Peppermint open scrub (D2) and woodland (B3) and in the more sheltered folds Peppermint closed scrub (D1) and low forest (C1 and C2). In the extreme south the dunes are covered with open heath (E2). Bordering the coast the more recent dunes support low shrubland (E3). The foredunes may be covered with open grassland (F3).

FORMATIONS AND PLANT ASSOCIATIONS

A2 HIGH OPEN FOREST

Karri Forest (K)

High open forest dominated by Karri, *Eucalyptus diversicolor* F. Muell., occurs mainly in hilly country where mean annual rainfall is between 1,000 and 1,500 mm and summer rainfall usually exceeds 300 mm. Karri grows on light soils derived from granite and gneiss, mostly on hillsides along the valleys of drainage systems and on hills and sides of rock outcrops rising above seasonally swampy flats to the south of the main block of forest.

The trees grow to 80 m high with 45 m of clean trunk and a wide, spreading and somewhat open crown. In prime stands areas of crowns in the top canopy cover 70 to 80 per cent. of the ground, but the relatively open structure of the individual crowns allows more light to filter through than in closed forests and permits the development of a substantial understorey of small trees and dense scrub.

Jarrah, *E. marginata* Sm. (J), occurs as a co-dominant on soils of more lateritic origin and Marri, *E. calophylla* R. Br. (M), becomes co-dominant on the deeper sandy soils. Both these species either separately or together form high open forest in favourable areas where their height exceeds 30 m.

In the more open parts of the forest understorey trees occur, particularly *Banksia grandis*

Willd., *Casuarina decussata* Benth., *Agonis flexuosa* (Spreng) Schau., *Agonis juniperina* Schau. and *Banksia littoralis* R. Br. The two *Agonis* species and *B. littoralis* occur mainly in bottoms of valleys in Karri forest and *A. juniperina* forms pure stands of closed scrub or low closed forest in waterlogged areas. A tree which looks like a small Karri at first sight and grows in damp sites is Bullich, *E. megacarpa* F. Muell. Bullich also grows close to the base of the massive granite tor of Mt. Frankland and with *Agonis juniperina* in rock clefts at its summit.

Shrubs form a closed scrub understorey up to 5 m high. Common species are *Trymalium spathulatum* (Labill.) Ostf., *Chorilaena quercifolia* Endl., *Hovea elliptica* (Sm.) DC., *Bossiaea laidlawiana* Tovey & Morris, *Acacia pentadenia* Lindl., and *Hibbertia tetrandra* (Lindl.) Gilg. Most of the scrub has now been greatly reduced by periodic controlled burning and bracken, *Pteridium esculentum* (Forst. f.) Nakai, thrives in its place.

In the lower reaches of the Deep, Frankland and Bow rivers Red Tingle, *E. jacksonii* Maiden (Tr), and Yellow Tingle, *E. guilfoylei* Maiden (Ty), are co-dominant with Karri. Pure stands of Yellow Tingle occur north of Walpole, and near Mt. Frankland, Yellow Tingle occurs in stands co-dominant with Marri.

Where Karri forest occurs on hillocks rising from the flats to the south of the zone, it tends to grow on higher ground near granite rock with Jarrah open forest surrounding it on the lower gravelly lateritic slopes.

B1 CLOSED FOREST

Marri Forest (M) and Jarrah-Marri Forest (JM)

Very limited areas of prime Marri, *Eucalyptus calophylla,* and of mixed Marri and Jarrah, *E. marginata,* closed forest occur in the Blackwood and Warren river regions. (See below.)

Pine Plantations (Pi)

Plantations of *Pinus* species established by the Forests Department have been mapped where the areas are large enough.

B2 OPEN FOREST

Jarrah Forest (J)

As the dominant and most abundant species, Jarrah, *Eucalyptus marginata,* forms extensive areas of open forest (B2). Jarrah forest reaches its best development in hilly areas on lateritic soil with a mean annual rainfall of 900 mm or more. In the Karri forest zone it occupies lateritic soils on hill tops and slopes. It is most dense in areas adjacent to the Karri forest and becomes more open in structure as it extends eastwards with decreasing rainfall, and westwards and southwards on the more sandy soils.

Jarrah forms pure stands on the lateritic gravels. While lateritic soil appears to be its prime requirement, it grows well on the sandy soil of the coastal plain and even on the older coastal sand dunes. It is absent from clay and from granitic soils.

Marri, *E. calophylla,* becomes co-dominant with Jarrah (JM) on the deeper and more sandy soils, and together they may form closed forest (B1) along permanent rivers, particularly along the lower Blackwood. In a few areas Marri forms pure stands of open forest (M). Blackbutt, *E. patens* Benth. (Bb), also occurs as a co-dominant in damp areas and on the banks of streams. In hilly country Bullich, *E. megacarpa* (Bu), also may occupy damp sites. On lower ground along watercourses and river banks subject to occasional flooding, Flooded Gum, *E. rudis* Endl., occurs.

In its densest blocks, the pure Jarrah forest is dark with an almost total absence of understorey trees. The darkness is accentuated by the dark brown fissured bark, frequently blackened by fire. The individual crowns have wide-spreading branches and on the whole Jarrah forms an open forest, rarely exceeding 30 m in height. On the more sandy soils, particularly adjoining flood plains, it forms woodland (B3) while on areas where drainage is impeded by clay or by quartzite, it forms an open woodland (B4).

Jarrah, on the most inhospitable sites, grows as a small tree or shrub, while on damp sandy flats overlying quartzite in the Northcliffe area, it forms extensive low open woodland (C4). On bare laterite hill tops in the north-east of the sheet, Jarrah forms low open forest (C2), while near the south coast where the tops of trees are wind blasted, it forms a very low closed forest (C1), as it does to the south-west of Walpole inlet.

The principal understorey trees in the Jarrah forest are *Banksia grandis* and *Casuarina fraserana* Miq. Other understorey trees are *Banksia littoralis, Persoonia longifolia* R. Br., *P. elliptica* R. Br., *Nuytsia floribunda* (Labill.) R. Br. ex Fenzl, and *Xylomelum occidentale* R. Br. Common in parts are Blackboys, *Xanthorrhoea preissii* Endl. and Zamia palm, *Macrozamia riedlei* (Gaud.) C. A. Gardn. In the more southern areas of Jarrah forest *Podocarpus drouynianus* F. Muell. is common. Near the head of the Perup River, heartleaf poison, *Gastrolobium bilobum* R. Br., forms a scrub understorey up to 3 m high. Near the coast, small trees and shrubs of *Agonis flexuosa* are abundant in the understorey.

The ground is well covered with a rich mixture of small shrubs which vary in species from place to place. Important among these are *Agonis parviceps* Schau. and *Acacia Adenanthos, Astroloma, Bossiaea, Daviesia, Hakea, Hovea, Grevillea, Leptomeria* and *Leucopogon* species.

B3 WOODLAND

B4 OPEN WOODLAND

Wandoo Woodland (W)

Wandoo woodland (B3) occurs only in the north-east corner of the sheet in the upper reaches of the Tone and Frankland rivers, where mean annual rainfall is less than 700 mm.

Wandoo, *Eucalyptus redunca* Schau. var. *elata* Benth., grows in rich soils which may be gravelly on the surface, and on clay soils in valleys in the Jarrah zone. The woodland consists of widely spaced white-barked trees with a shrub understorey similar to that in the Jarrah forest, but without *Casuarina fraserana* or *Persoonia* species.

In low-lying areas Swamp Yate, *E. occidentalis* Endl., occurs and this may have an understorey of *Melaleuca* trees and shrubs. On the banks of watercourses, Flooded Gum, *E. rudis,* occurs frequently.

Yate Woodland (Y)

On the sandhills near the south coast, south-east from Broke Inlet, there are a few areas of woodland (B3) composed of Yate, *Eucalyptus cornuta* Labill., with an understorey of shrubs. The Yate is usually associated with an open scrub understorey of *Agonis flexuosa.* In these situations such as south-west from Lake Jasper, Bullich, *E. megacarpa* may also occur having the appearance of small Karri. It is, however, readily distinguishable by its large characteristic fruits.

Peppermint Woodland (Ag)

While Peppermint, *Agonis flexuosa,* is frequently prominent as an understorey tree in the Karri forest, in parts of the Jarrah forest towards the south coast, and in valleys and along banks of rivers, it comes into its own on sand dunes of the south coast. Here it forms extensive areas of woodland (B3) and in parts open forest (B2) up to 15 m high. In deep valleys and folds in the dunes it forms small stands of low closed forest (C1) with an undergrowth of the sedge, *Lepidosperma gladiatum* Labill.

Jarrah Woodland (J)

Jarrah woodland (B3) and open woodland (B4) are associated with areas of impeded drainage. Typically, the Jarrah, *E. marginata,* has an understorey of smaller trees, *Banksia ilicifolia* R. Br., *B. grandis, B. littoralis, Nuytsia floribunda,* and Paperbark, *Melaleuca preissiana* Schau. Often Blackboys, *Xanthorrhoea* species are common. The shrub layer is fairly open, except in the wetter parts where sedges become more numerous.

On some sites, where Jarrah forms open woodland (B4), the smaller trees may be rare or absent, and the understorey consists of a dense thicket of tall shrubs of which the most common are *Agonis parviceps, Leptospermum firmum* (Schau.) Benth., and *Pultenaea reticulata* Benth.

Another form of Jarrah woodland occurs on richer soils, usually riverine. In these situations Jarrah is accompanied by Marri, *E. calophylla,* Blackbutt, *E. patens,* and Flooded Gum, *E. rudis.* This woodland may be an interzone between Jarrah open forest (B2) and Paperbark low open woodland (C4).

C1 LOW CLOSED FOREST

Peppermint Low Closed Forest (Ag)

Peppermint, *Agonis flexuosa,* forms low closed forest (C1) with an understory of the sedge *Lepidosperma gladiatum* in deep valleys and folds in the south coast sand dunes, particularly near the coast. The areas are very small. Some examples lie between Callcup Sands and the sea.

Jarrah Low Closed Forest (J)

Jarrah, *Eucalyptus marginata,* forms a low closed forest (C1) in a small area south-west of Walpole Inlet where it is exposed to winds from the Southern Ocean. The short trunks are bare and the crowns interlaced into a dense mat. The ground is free of any understorey.

C2 LOW OPEN FOREST

Peppermint Low Open Forest (Ag)

Peppermint, *Agonis flexuosa,* forms low open forest (C2) and low woodland (C3) on the south coast sand dunes in favourable areas.

Jarrah Low Open Forest (J)

Jarrah, *E. marginata,* forms a low open forest on bare laterite hill tops in the north-east corner of the sheet towards Jingalup.

Paperbark Low Open Forest (P)

In swamps, a Paperbark, *Melaleuca rhaphiophylla* Schau., forms low open forest completely covering the swamp or forming a ring round the edge. There is an understorey of rushes. On slightly higher ground surrounding the swamp, another Paperbark, *Melaleuca preissiana,* may occur, alone or with *Banksia littoralis.* In limited areas *M. rhaphiophylla* is replaced by *M. cuticularis* Labill. Very few areas of Paperbark low open forest are big enough to be mapped.

C3 LOW WOODLAND

Banksia Low Woodland (B)

Low woodlands (C3) composed mainly of *Banksia* species are confined to limited areas on well-drained sand along the southern edges of the Jarrah forest, and generally form an intermediate zone between the Jarrah forest and the Paperbark low woodland or low open woodland of sandy flats subject to seasonal flooding.

Paperbark Low Woodland (P)

The Paperbark, *Melaleuca preissiana,* with thick trunk and deep broad crown forms a low woodland (C3) 5 to 7 m high in damp areas in and around the Jarrah forest. A common tree is *Banksia littoralis.* In some areas *Eucalyptus decipiens* Endl. occurs and *Banksia ilicifolia* is locally common. A prominent shrub in the Paperbark woodland is *Beaufortia sparsa* R. Br. Blackboys are frequent.

C4 LOW OPEN WOODLAND

Paperbark Low Open Woodland (P)

The Paperbark low open woodland, in which *Melaleuca preissiana* appears as a small tree, scattered or in small groups, covers large areas of open flats of leached sand subject to seasonal flooding. The Paperbarks vary from 3 to 7 m high and are heavily branched with spreading crowns. A frequent co-dominant is Swamp Banksia, *B. littoralis.* Stunted Jarrah may also be present, and Blackboys may be frequent. *Nuytsia floribunda* also occurs.

The understorey is a closed heath with closed sedgeland in the wetter parts. The shrubs *Astartea fascicularis* (Labill.) DC., *Agonis parviceps* and *Melaleuca preissiana* are particularly abundant, with *Leptospermum firmum, Agonis marginata* (Labill.) Schau., *A. juniperina, Kunzea recurva* Schau. and the conspicuous red-flowered *Beaufortia sparsa,* locally common. Common small sedges are *Lepidosperma longitudinale* Labell. and *Mesomelaena tetragona* (R. Br.) F. Muell. *Boronia* species also occur.

Included in the low open woodland (C4) are areas of closed scrub (D1), closed heath (E1) and sedgeland (F1) too small to be mapped.

Jarrah Low Open Woodland (J)

A Jarrah low open woodland in which the most common tree is Jarrah, *Eucalyptus marginata,* of very poor habit of growth, covers extensive areas of gently undulating ground on watersheds as well as in drainage lines. Drainage of the soil in these areas is impeded. In most places the soil is a peaty leached sand. Around Northcliffe and in the Fly Brook area the sand overlies deep deposits of quartzite. In addition to the scattered stunted Jarrah, there are Paperbarks, *Melaleuca* species; *Banksia* species; occasional Christmas trees, *Nuytsia floribunda; Agonis juniperina;* and *A. flexuosa* as small trees, and Blackboys, *Xanthorrhoea* species. *Casuarina humilis* Otto et Dietr. and *Kingia australis* R. Br. appear together on some sites and in others *Eucalyptus patens* is locally common.

The understorey may be closed scrub up to 4 m high composed of *Agonis, Leptospermum* or *Melaleuca* species, or it may be closed heath up to 2 m high containing a wider variety of species, the composition changing from place to place. In many areas height appears to be dependent upon the time since the last bush fire, though the taller closed scrub seems to be associated with areas in which wet conditions are more prolonged. In the wettest parts sedges predominate.

Banksia ilicifolia Low Open Woodland (B)

The *Banksia ilicifolia* low open woodland is of limited extent but is characteristic of low sand ridges which rise above and stretch across swampy flats. It occurs in the coastal plains and in the Lake Muir area. Scrubby Jarrah may also be present. The ground has an open cover of small shrubs and sedges.

D1 CLOSED SCRUB

Pultenaea Scrub (Pu)

On high ground either side of the Donnelly River and south of Nannup there are tablelands of leached sand on which grows a closed scrub up to 3 m high. *Pultenaea reticulata* forms almost pure stands in the Donnelly River area. Near Carlotta, south of Nannup, *P. reticulata* is accompanied by *Agonis parviceps.* Round the edges of the scrub occur scattered scrubby Jarrah, *Eucalyptus marginata; Xylomelun occidentale;* and *Podocarpus drouynianus.*

Myrtaceous Scrub (My)

Closed scrub up to 4 m high grows along drainage lines and the flat banks of streams and lakes in the higher rainfall areas where the soil is damp most of the time, and where water lies or gently flows during rainy periods.

The scrub is almost entirely Myrtaceous, consisting of *Melaleuca preissiana,* or *M. incana* R. Br., *Agonis juniperina, A. parviceps* and *Leptospermum firmum. Kunzea recurva* or *Pultenaea reticulata* may also be associated. Smaller associated shrubs are *Beaufortia* species and *Regelia ciliata* Schau. Wherever the canopy is broken, the sedges *Lepidosperma tetraquetrum* Nees, *L. longitudinale* and *Mesomelaena tetrogana* occur. In some places *Agonis juniperina* grows to 10 m high forming low closed forest. Along the banks of rivers in Karri forest areas a dense scrub may be formed of *Agonis flexuosa, Acacia pentadenia, Agonis linearifolia* Schau., *Agonis parviceps, Acacia horridula* Meisn. and *Oxylobium linearifolium* (Don.) Domin.

D2 OPEN SCRUB

Peppermint Scrub (Ag)

Extensive areas of coastal sand dunes are covered with open scrub dominated by *Agonis flexuosa* between 2 m and 4 m high with a shrub-like habit. *Jacksonia horrida* DC. up to 3 m high is common and there are occasional *Persoonia longifolia.* Blackboy, *Xanthorrhoea* species, is common in hollows with some *Macrozamia.* On steep slopes closed scrub of *A. flexuosa* occurs. In more open areas, the *Agonis* is accompanied by *Acacia cyclops* Cunn ex Don. and *Dryandra sessilis* (Knight) Domin. In limited, unmapped areas, *Dryandra sessilis* forms an open shrubland of its own, with an understorey of small shrubs.

E2 OPEN HEATH

Jacksonia horrida - Acacia decipiens Open Heath (Ja)

On the stable coastal sand hills of the extreme south, extending eastwards from Point D'Entrecasteaux, open heath occurs with the characteristic constituents *Jacksonia horrida* and *Acacia decipiens (Koen.)* R. Br. Other common plants are *Melaleuca* species, *Leucopogon parviflorus* (Andr.) Lindl., *Pimelea ferruginea* Labill., *Casuarina humilis* and *Loxocarya cinerea* R. Br. There may be occasional *Dryandra sessilis* and *Agonis flexuosa* in the form of low shrubs. *A. flexuosa* is more common in sheltered hollows which are also favoured by *Banksia* species and Blackboys, *Xanthorrhoea* species.

In very wet hollows in the dunes, *Agonis juniperina* may form closed scrub (D1) or low forest (C1-C2).

Where burning has been frequent, the heath appears to degenerate to a thin covering of *Loxocarya cinerea.*

E3 LOW SHRUBLAND

Coastal Shrubland (not mapped)

Close to the sea and on mobile sand dunes and blow-outs the open heath and scrub of stable dunes give way to a low shrubland characterised by the grey-leaved shrub *Olearia axillaris* (DC.) F. Muell. ex Benth., which grows to between 1 and 3 m high. Other constituents are *Spyridium globulosum* (Labill.) Benth., *Acacia cyclops, A. decipiens, Hibbertia cuneiformis* (Labill.) Gilg., *Exocarpos sparteus* R. Br., *Pimelea clavata* Labill., *Helichrysum cordatum* DC., *Calocephalus brownii* (Cass.) F. Muell. and *Scirpus nodosus* Rottle. *Scaevola nitida* R. Br. is very common in some areas, particularly in sheltered sites in the lee of mobile dunes.

F1 CLOSED HERBLAND

Sedgeland (S)

Towards the south coast on the black peaty sands of flats subject to prolonged flooding or waterlogging, there are extensive areas of sedgeland. In some areas the sedgeland is clearly defined. In other areas it merges with closed heath forming pockets of sedgeland in the wettest parts of the low open woodland (C4). In yet other areas the shrubby and herbaceous plants are so intermixed it is diffi-

cult to determine whether the formation should be called heath or sedgeland.

Characteristic of the sedgelands are *Evandra aristata* R. Br., which grows to 1 m high, *Leptocarpus scariosus* R. Br., *Anarthria scabra* R. Br., *Lepidosperma persecans* S. T. Blake, *Lyginia barbata* R. Br. and *Anarthria prolifera* R. Br.

Shrubs most frequently associated with the sedgelands are *Leptospermum firmum, L. oligandrum* Turoz, *L. ellipticum* Endl., *Astartea fascicularis* and *Beaufortia* species. Numerous others occur and the mixture varies from place to place. The larger areas of sedgeland are intersected by low sand ridges supporting *Banksia ilicifolia* low open woodland (C4).

F3 OPEN HERBLAND

Marram Tussock Grassland (Am)

On the low foredunes either side of the mouths of the Meerup and Warren rivers, Marram Grass, *Ammophila arenaria* (L.) Link., has become established extensively.

SWAMP VEGETATION

The permanent swamps are filled with the rush, *Juncus pallidus* R. Br., which stands in the water. There may also be scattered Paperbarks, *Melaleuca* species, but most frequently there is a narrow belt of low open forest round the edge of swamps. Trees are most commonly Paperbark, *Melaleuca rhaphiophylla* and *M. preissiana,* occasionally accompanied by *Banksia littoralis.* In some areas Warren River Cedar, *Agonis juniperina,* forms dense low forest. The *Melaleuca, Agonis* and other Myrtaceous shrubs and small trees appear to become established where flooding is frequent but not permanent.

PRIMARY INDUSTRIES

The extensive areas of Karri and Jarrah forest feed a substantial timber industry based on mills throughout the area. Jarrah and Karri are the two timbers which are most used. The former is very suitable for high-grade work in furniture making and boat building; it is highly resistant to insect and fungal attack. Karri is a hard timber available in very large sizes and is suitable for structural work if protected from insect and fungal attack. Marri, although common and of large size, contains pockets of kino, a red resinous-like substance, which makes it unsuitable for most uses. It has been used successfully for bridge building and has a potential in the manufacture of certain types of paper.

Management of the Karri forest for natural regeneration has been highly successful. Extensive pine plantations have been established near Nannup, with others near Tone River sawmill and near the lower reaches of the Warren River. There are numerous trial plots of pines and various species of *Eucalyptus* on sites where Jarrah and Karri do not grow.

The Karri forest is remarkable as the most prolific source of honey in the world in the years when it flowers. From initial bud formation to flowering is a period of two years during which good rainfall is needed to prevent excessive loss of bud. Although the trees flower more or less throughout the year, the honeyflows occur mainly from December to April in hot humid conditions.

Another two years elapse before seedfall and the start of new bud growth. Adequate supplies of pollen are produced by the Karri. Marri is a more regular producer of honey, and the pollen is highly nutritious to bees. Jarrah flowers before the Karri and Marri and provides an opportunity for honey producers to build up their bee colonies to full strength so they can be at their most productive when the Karri and Marri are yielding nectar. Forest Blackbutt is also valuable for building up bee colonies. Yellow Tingle is another useful source of nectar and pollen; it flowers in mid-summer. Red Tingle is less valuable because of its more restricted area of distribution, but it also produces nectar and pollen, flowering a little after Yellow Tingle.

Of the areas cleared for agriculture, most, 53,000 hectares, are used for grazing cattle, mainly for beef production. Orchards, mainly of apples, have been established on 1,300 hectares. The principle arable crop is potatoes, 1,000 hectares, and there are small areas of other vegetables. Some barley and oats are grown in the driest areas in the north-east, in the vicinity of the upper Tone and Frankland rivers. Tobacco production has been attempted in the Northcliffe area but the high salt content of the rain blowing in from the Southern Ocean adversely affected the quality of the leaf.

Karri High Open Forest (A2 K) *Eucalyptus diversicolor* with understorey unburnt for 20 years; Warren National Park 397740

Jarrah-Marri High Open Forest (A2 JM) *Eucalyptus marginata* and *E. calophylla* after selective felling; Poorginup 473727

Yellow Tingle High Open Forest (A2 Ty) *E. guilfoylei;* Clarke Road, Walpole 473685

Karri-Marri High Open Forest (A2 KM) *E. diversicolor* and *E. calophylla;* near Shannon 436738

Red Tingle High Open Forest (A2 Tr) *E. jacksonii;* Walpole National Park 465680

Jarrah Open Forest (B2 J) *E. marginata;* Lower Donnelly 377750.

Jarrah Open Forest (B2 J) *E. marginata* with *Banksia grandis* understorey; Muir Highway 425760

Jarrah-Marri Open Forest (B2 JM) *E. marginata* and *E. calophylla;* near Frankland River, Muir Highway 490742

Jarrah Open Forest (B2 J) *E. marginata;* Lake Muir area 485743

Jarrah Open Forest (B2 J) *E. marginata* with dense understorey of *Gastrolobium bilobum;* near Heartlea 461792

Jarrah Open Forest (B2 J) *E. marginata* with understorey of *Acacia myrtifolia* and *Hovea elliptica;* Nyamup 431759

Blackbutt Open Forest (B2 Bb) *E. patens;* Yerraminnup River 439776

Marri Open Forest (B2 M) *E. calophylla* with bracken ground cover burnt frequently; near Black Point 353752

Wandoo Woodland (B3 W) *E. redunca* var. *elata;* Mullidup 480785

Jarrah-Banksia Woodland (B3 JB) *E. marginata* and *Banksia* spp.; Lake Muir 475746

Peppermint Woodland (B3 Ag) *Agonis flexuosa;* Wainbup area 427695

Bullich Open Forest (B2 Bu) *E. megacarpa;* Sputnik Road 378778

Yate Open Woodland (B4 Y) *E. cornuta* in area of Yate Woodland (B3 Y); south-east of Broke Inlet 455678

Swamp Yate Woodland (B3 Ys) *Eucalyptus occidentalis* with ***Melaleuca cuticularis;*** Mullidup 481785

Warren River Cedar Low Closed Forest (C1 My) *Agnois juniperina;* Treen Brook 400740

Peppermint Low Open Forest (C2 Ag) *Agonis flexuosa;* Callcup 387725

Paperbark Low Open Forest (C2 P) *Melaleuca raphiophylla* and rush *Gahnia trifida;* near Lake Muir 463737

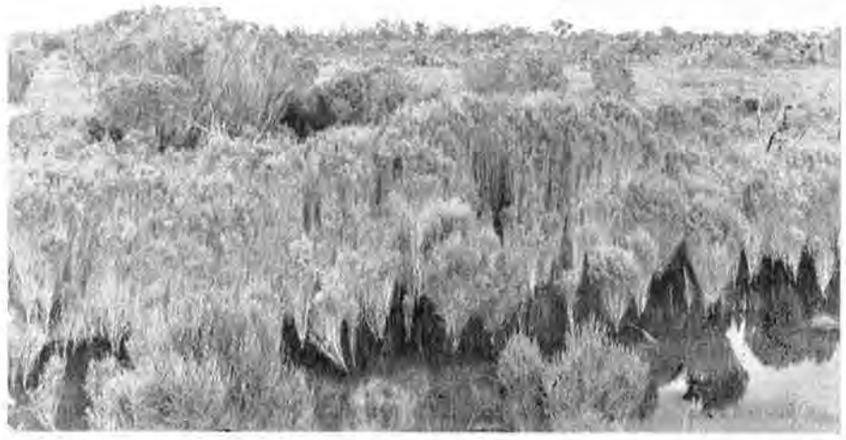
Banksia Low Woodland (C3 B) *Banksia ilicifolia;* near Lake Muir 470746

Paperbark Low Open Woodland (C4 P) *Melaleuca preissiana* in flower; near Lake Muir 463745

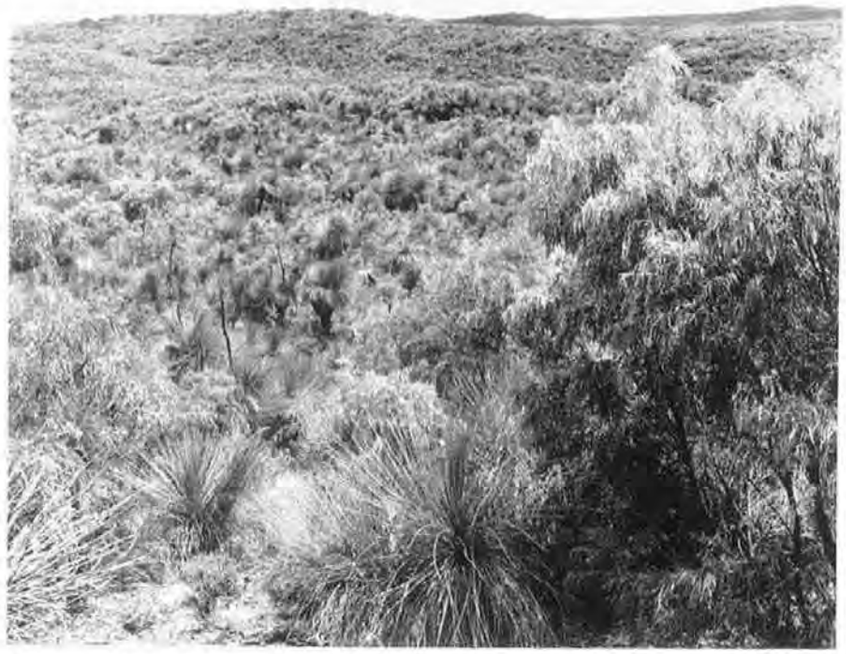
Paperbark Low Open Woodland (C4 P) *Melaleuca preissiana* with heath understorey; Lake Muir area 471746

Jarrah Low Open Woodland (C4 J) *Eucalyptus marginata* with *Banksia* spp. and *Agonis flexuosa;* quartzite hill near Fly Brook 387743

Myrtaceous Closed Scrub (D1 My) *Melaleuca polyaloides* and *M. hamulosa;* Yerraminnup River 439776



Myrtaceous Closed Heath with patches of Closed Scrub (E1 My); near Lake Muir 470746



Peppermint Open Scrub (D2 Ag) *Agonis flexuosa* with *Xanthorrhoea* spp. in hollow; near Black Point 353751

Jacksonia Open Heath (E2 Ja) *Jacksonia horrida* with small *Agonis flexuosa;* Point d'Entrecasteaux 401698

Coastal Scrubland (E3) on sand dunes in middle distance, Peppermint Low Open Forest (C2) in hollow in foreground, Marram Tussock Grassland (F3) on the low dunes in distance and Open Heath (E2) in immediate foreground and to the right with *Dryandra sessilis* prominent; Callcup 385724

Sedgeland (F1 S); Black Point Road 364763

Sedgeland (F1 S) from a sand ridge with *Banksia ilicifolia* Low Open Woodland (C4 B); hillocks covered with Jarrah Open Forest (B2 J) in the background; Chudalup area 406713

Swamp in lee of coastal sand hills; callcup Road 391727

11744/10/72—2M

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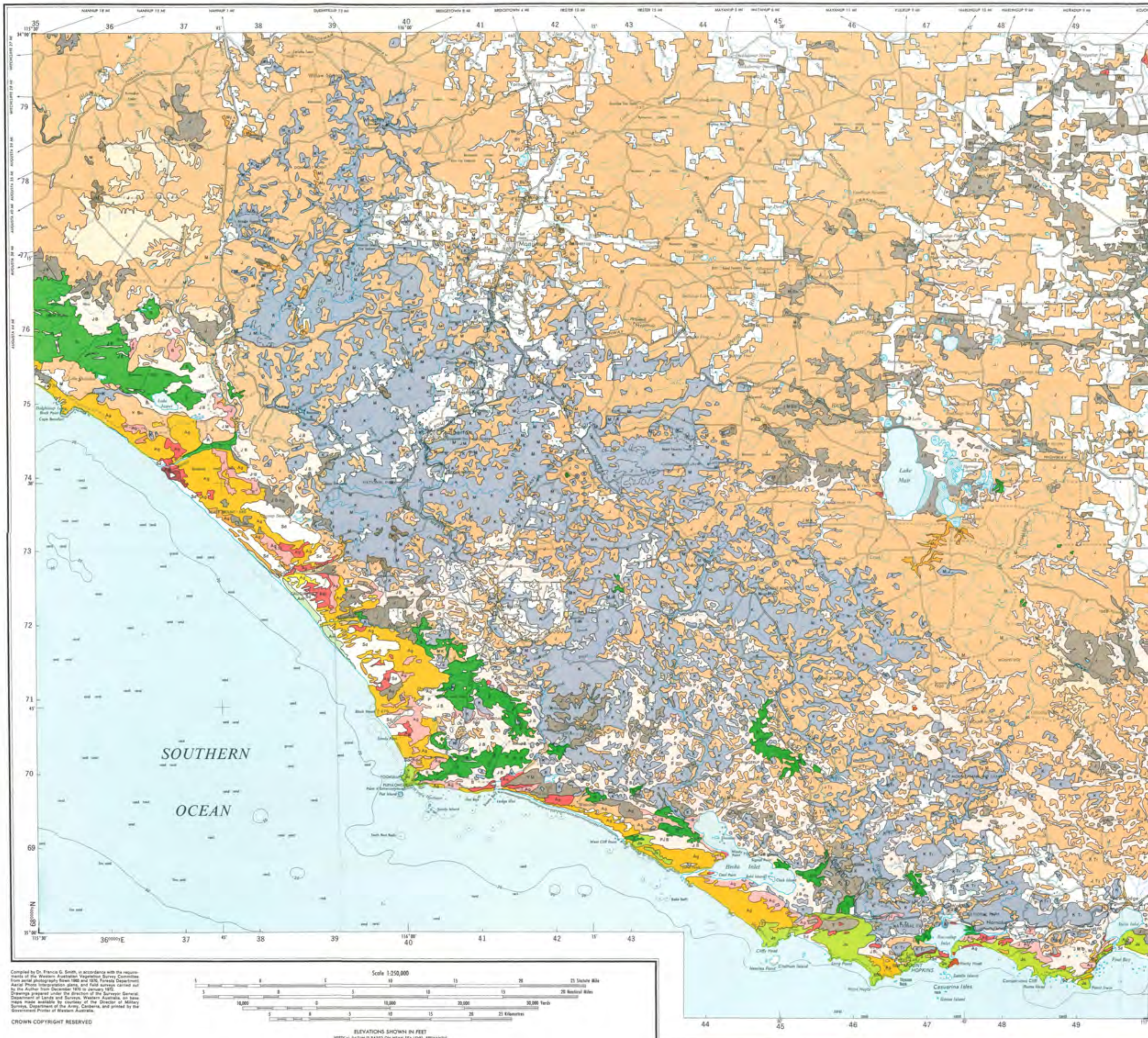
PEMBERTON AND IRWIN INLET

REFER TO THIS MAP AS: SI 50—10 AND SI 50—14 VEGETATION



VEGETATION SURVEY TRAVERSES

Aerial Photography 1970 A
Photographic Mosaics 1960 B

LEGEND

VEGETATION STRUCTURE

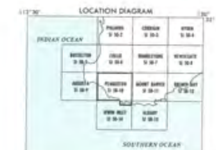
LIFE FORM AND HEIGHT OF TALLEST STRATUM	FORMATION	PROJECTIVE FOLIAGE COVER OF TALLEST STRATUM, PER CENT
TREES (Above 30 metres)	High closed forest	70-100
	High open forest	30-70
	High woodland	10-30
	High open woodland	BELOW 10
TREES (10 to 30 metres)	Closed forest	70-100
	Open forest	30-70
	Woodland	10-30
	Open woodland	BELOW 10
TREES (Below 10 metres)	Low closed forest	70-100
	Low open forest	30-70
	Low woodland	10-30
	Low open woodland	BELOW 10
SHRUBS (Above 2 metres)	Closed scrub	70-100
	Open scrub	30-70
	High Shrubland	10-30
	High open shrubland	BELOW 10
SHRUBS (Below 2 metres)	Closed heath	70-100
	Open heath	30-70
	Low shrubland	10-30
	Low open shrubland	BELOW 10
HERBS	Closed herbland	70-100
	Herbland	30-70
	Open herbland	10-30
BARREN	Sand Dunes	Sd
CLEARED LAND		

PLANT ASSOCIATIONS

Common name	Species	Symbol
Peppermint	*Agonis flexuosa*	Ag
Marram Grass	*Ammophila arenaria*	Am
	Banksia species	B
Blackbutt	*Eucalyptus patens*	Bb
Bullich	*E. megacarpa*	Bu
Jarrah	*E. marginata*	J
	Jacksonia horrida	Jo
Karri	*E. diversicolor*	K
Marri	*E. calophylla*	M
Myrtaceae		My
Pine Plantations		Pi
Paper Bark	*Melaleuca preissiana*	P
	Pultenaea reticulata	Pu
Sedges		S
Red Tingle	*E. jacksonii*	Tr
Yellow Tingle	*E. guilfoylei*	Ty
Wandoo	*E. redunca var. elata*	W
Yate	*E. cornuta*	Y
Swamp Yate	*E. occidentalis*	Ys

Waterhole; water tank; dam; dry lake
Lake; river or stream perennial
Lake; river or stream intermittent
Dam or weir; falls; rapids
Drain or ditch perennial, intermittent
Spring perennial, intermittent, ricefields
Marsh or swamp; mangroves

LOCATION DIAGRAM



Compiled by Dr. Francis G. Smith, in accordance with the requirements of the Western Australian Vegetation Survey Committee from aerial photography flown 1960 and 1970, Forests Department Aerial Photo Interpretation plans, and field surveys carried out by the Author from December 1970 to January 1972. Drawings prepared under the direction of the Surveyor General, Department of Lands and Surveys, Western Australia, on base maps made available by courtesy of the Director of Military Survey, Department of the Army, Canberra, and printed by the Government Printer of Western Australia.

Scale 1:250,000

5 0 5 10 15 20 25 Statute Miles
5 0 5 10 15 20 Nautical Miles
10,000 0 10,000 20,000 30,000 Yards
5 0 5 10 15 20 25 Kilometres

ELEVATIONS SHOWN IN FEET
VERTICAL DATUM IS BASED ON MEAN SEA LEVEL, FREMANTLE

TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM IS BASED ON PERTH OBSERVATORY

GRID NUMBERS INDICATE THE 10,000 YARD TRANSVERSE MERCATOR GRID, ZONE 1 (AUSTRALIA SERIES), CLARKE 1858 SPHEROID
THE LAST FOUR DIGITS OF THE GRID NUMBERS ARE OMITTED

1968 MAGNETIC DECLINATION FOR THIS SHEET VARIES FROM 4°30' WESTERLY FOR THE CENTRE OF THE WEST EDGE TO 3°45' WESTERLY FOR THE CENTRE OF THE EAST EDGE. MEAN ANNUAL CHANGE IS NEGLIGIBLE.

VEGETATION
PEMBERTON AND IRWIN INLET
WESTERN AUSTRALIA