

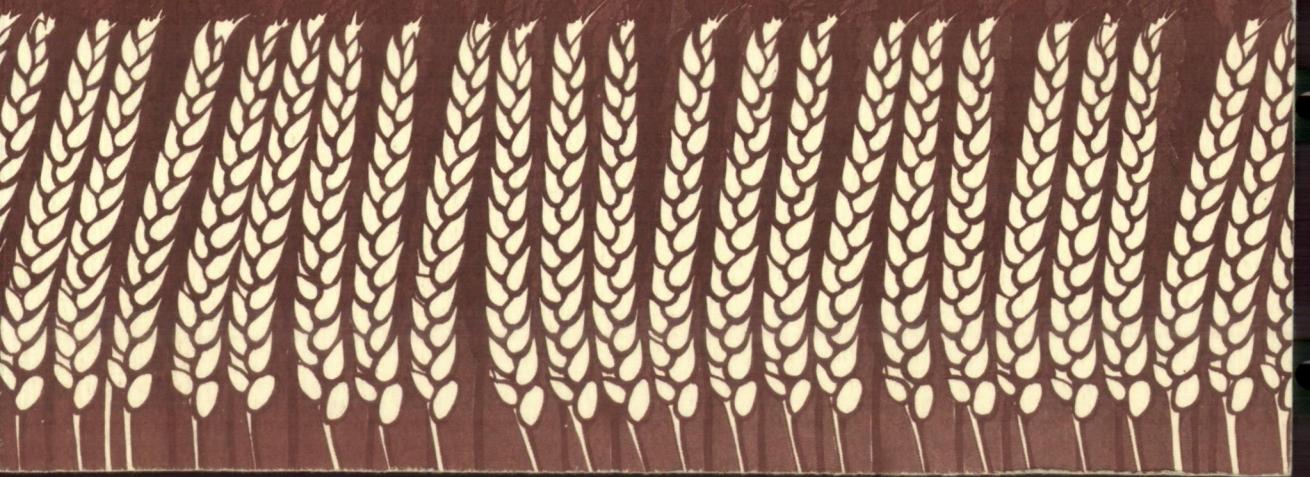


Biological Survey of the Western Australian Wheatbelt

Part 2: Vegetation and Habitat
of Bendering Reserve

by B.G. Muir

Records of the Western Australian Museum
Supplement No 3, 1977



BIOLOGICAL SURVEY
OF THE
WESTERN AUSTRALIAN WHEATBELT

PART 2: VEGETATION AND HABITAT
OF BENDERING RESERVE

by

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ABSTRACT

A detailed study of vegetation at Bending Reserve was undertaken to improve on the vegetation classifications currently available, and to then apply the classification to vertebrate habitats. The final classification was derived from that of Beard and Webb (1974) by subdividing some of their life-form groups, modifying other aspects of their system, and classifying all strata. Litter and soils were examined in some detail.

Although *ca* 80% of the vegetation on Bending Reserve is mallee dominated, all major wheatbelt formations except salt complex are represented there.

The number of plant species recorded is 288: 263 perennials and 25 annuals, in 37 families. Plant species diversity per square kilometre is comparable to Tarin Rock/North Tarin Rock Reserves (Muir 1976). The most diverse formation is woodland with 0.65 species/hectare. *Eucalyptus burracoppinensis* dominated mallee formations have about five times as many plant species as formations dominated by other species of mallee. Therefore they are regarded as a different faunal habitat to these other mallees. The greatest number of plant species restricted to a single formation type is 0.11 sp/ha in woodland, which constitutes only 3% of the area of the Reserve.

The Reserve has four plant species listed by Specht *et al.* (1974) as rare, endangered, or of particular interest. It is the type locality for a *Baeckea*, a *Chamelaucium* and a *Hakea*. An undescribed genus of Cyperaceae is also found on the Reserve.

Evidence from the Reserve suggests that some heaths may reach climax in 6-10 years, shrublands in 15-20 years, and other formations after much longer periods. Evidence is presented supporting the view that fire may not be essential for some vegetation types.

Some observations on successional changes in vegetation are presented, and the effects of fertilizers, grazing and rubbish dumping are discussed.

An air-photography project carried out concurrently with this vegetation survey is discussed briefly.

GENERAL INTRODUCTION

In 1971 the Western Australian Museum began a series of surveys of the relict vertebrate fauna and vegetation confined to reserves in the Western Australian wheatbelt. Kitchener (1976) lists the reserves selected for these surveys and outlines the approach adopted to them. The basic task of the surveys was to document the fauna and vegetation still present in each area. Studying the relationships between the vertebrate fauna and vegetation structure and floristics on these reserves was an important additional objective.

It was soon realised that none of the available techniques for classifying vegetation were satisfactory for describing the very complex wheatbelt

vegetation, mainly because they lacked sufficient detail. The Museum group conducting the faunal surveys in the wheatbelt decided that the vegetation of all reserves referred to in Kitchener (*op cit*) needed to be surveyed in greater detail using a classification based upon life-form and canopy cover and which considered all strata.

Bendering Reserve, one of the larger reserves selected in the Museum's wheatbelt project, was chosen as the major study area in which to develop and document such a vegetation classification. The Reserve was suited for this task because it was large, contained areas of most major wheatbelt formations and was relatively undisturbed. Many other reserves and virgin tracts of land in and adjacent to the wheatbelt were also examined during the development of this classification system.

This report documents a system of vegetation classification which will be used in surveys on other wheatbelt reserves. This report also records, as base-line data, all vegetation descriptions on Bendering Reserve. Thus changes in vegetation can be recorded in the future. Such base-line vegetation data have not been recorded before in Western Australia.

Although some ecological statements are made concerning vegetation, fire and edaphic conditions of Bendering Reserve, most will be made when similar vegetation studies on all the selected reserves are completed.

METHODS

Approach to classification of vegetation

Two possible approaches to describing vegetation are most likely to distinguish habitat preferences of the vertebrate fauna. The first approach is that of Webb (1959, 1968) and Kikkawa and Webb (in Webb *et al.* 1973): They selected a group of animals and recorded in detail the characteristics of the environment in which they were found. They then analysed the resultant data, obtaining a set of parameters to produce a vegetation classification. This approach requires a computerised data processing system and results in a habitat classification relevant only to a particular animal group. It is too slow for a rapid approach to faunal survey, or for rapid mapping and classification of vegetation. The alternative approach was to develop a simple vegetation classification, useful to botanists, but detailed enough to describe habitats of fauna, particularly vertebrates. Systems based on floristics were not considered for this study because there was not time to develop such a classification, and they are generally more difficult to use. Structurally based classifications are easy to use. Several structural classifica-

tion systems are widely used in Australia for botanical and faunal survey work.

Six structural vegetation classification systems were examined in an attempt to find one suitable for describing seral stages and habitat in the wheatbelt. Although these systems were designed specifically for describing the dominant stratum they had to be examined in detail to ascertain whether they were equally applicable to all strata. The vegetation classification systems examined are discussed below with the reasons for their being unacceptable.

Fosberg's system (Peterken 1967) used by the International Biological Programme for world vegetation mapping has extremely broad groupings. It tends to combine such structurally distinct formations as woodlands and mallees. The descriptive terminology is cumbersome: e.g. mallee dominated formations are called 'Mesophyllous, evergreen, sclerophyll steppe forest'. Goldsmith (1974) states that difficulties arise with Fosberg's system because of the variability of vegetation within given formations, and these difficulties are emphasised by the uniqueness of the Australian flora.

Williams' (1960) system presents difficulties which arise from the method of estimating density. Thus 'very dense' means spacing less than the diameter of canopy and can only indicate one class—rain forest. However, *Casuarina* stands in the wheatbelt may reach this density. Individual strata are not defined, and sedges and cryptogams are not included.

Specht (1970) does not classify lower strata. Information is lost even if the system is used to classify each stratum. For example, in loc. 3.1 (this report) strata 2 and 3 are lost, as both fall within 0-2m category. Specht also places mallees in shrub groups, and thus Bending loc. 3.6 (*Casuarina acutivalvis* 4m tall), comes into the same group as loc. 2.105 (*Eucalyptus* (2sp.) mallees 4-6m tall).

Walker and Tunstall (unpubl.) and Webb (in prep.) have produced complex classifications which are too time-consuming for large area surveys. The Zurich-Montpellier system (in Bridgewater 1971) presents similar problems.

The Beard and Webb (1974) system is the best available for classifying wheatbelt vegetation for studying the habitat of vertebrate fauna. It separates some life-form groups and strata and proposes a coding system easily transferrable to data retrieval systems (*cf* the complex codifications of Dansereau, 1951). It still loses some information; for example, shrub strata below 1m are not separated; sedges and cryptogams do not fit easily into any category; and mallees still fall into shrub formations. Beard and Webb replace the density term 'closed' with 'dense', a word more comprehensible to untrained people.

This survey uses the Beard and Webb (1974) classification with modifications based on the needs of workers specialising in mammals, birds, reptiles and frogs. Consistent results have been obtained, even from workers with

little botanical background, when the definitions and requirements of the classification were followed. The classification is set out in **Table 1**.

Life-form and height class

Many botanical studies only describe (and map) climax formations; sub-climax stages being interpreted on their probable nature when climax is reached. In contrast, habitat classification must describe vegetation seral stage in its existing form, regardless of its climax. Such an approach requires the resolution of questions such as when does a tree cease to be a bush (sapling) and become a tree. Definitions of life-form that are habitat-oriented hold the key to selection of terms in this situation. The problem then arises in habitat-oriented life-form classification that terms may vary between species of plants, the fauna sometimes utilising each plant species in a particular way.

This *vegetation* classification attempts to define life-forms in a manner which will produce consistent vegetation descriptions. The adaptation of these vegetation descriptions to describe *habitat* may depend upon the plant species involved, purpose of the worker, and the group of animals being studied.

The ambiguous term 'ground cover' is not used in this classification. Species which produce low vegetative cover for small fauna are apparent if the life-form and height class of each stratum is stated. The height class of any stratum is determined by the height of the top of that stratum. Thus, shrubs 0-2m tall, 0.5-2m tall, 1-2m tall and 1.5-2m tall will all appear as 'shrubs 1.5-2m tall' because the top of the stratum falls in the 1.5-2m tall range. The thickness of the stratum is stated in the location description. Definitions of life-form used in this study are presented in bold type.

Trees

Woody, usually perennial plants, generally erect, of variable outline but commonly with a spherical or ovoid canopy raised well above the ground. The major part of the canopy from bottom to top less than or equal to two thirds of the total height of the tree. Single stemmed, or if multi-stemmed, with fewer than 5 individual trunks that result from branching of a single trunk (which may be quite short) and which do not arise from a mallee-like lignotuber.

Height is variable but usually exceeds 2m when the plant is mature. When dead, hollow tree limbs are of sufficient size to provide habitats for vertebrates.

Coniferous trees, and some *Casuarina* species, may have foliage for more than the upper two thirds of the height, but they nearly always conform to other tree characteristics. Trunk size for any tree or mallee is expressed as circumference or diameter at breast height (1.37m or 4.5ft.) above ground level.

TABLE 1: VEGETATION CLASSIFICATION TO BE USED IN WHEATBELT SURVEY

LIFE FORM/HEIGHT CLASS		CANOPY COVER			
		DENSE 70-100% d	MID-DENSE 30-70% c	SPARSE 10-30% i	VERY SPARSE 2-10% r
T Trees >30m M Trees 15-30m LA Trees 5-15m LB Trees <5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low Woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B	
KT Mallee tree form KS Mallee shrub form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee	
S Shrubs >2m SA Shrubs 1.5-2.0m SB Shrubs 1 0-1.5m SC Shrubs 0.5-1.0m SD Shrubs 0.0-0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D	
P Mat plants H Hummock Grass GT Bunch grass >0.5m GL Bunch grass <0.5m J Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-Dense Hummock Grass Tall Grass Low Grass Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs	
VT Sedges >0.5m VL Sedges <0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges	
X Ferns Mosses, liverwort	Dense Ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses	

Trees >30m: Consensus amongst the Museum fauna survey team was that from 30m upwards there was probably little change in the habitat for vertebrates afforded by the trees; further, it was highly unlikely that two distinct strata of trees would co-exist where both strata were more than 30m tall.

Trees 15-30m and 5-15m: Several two-strata associations were found which were between 5 and 30m tall, but which fell within one of Specht's and Beard-Webb's categories because of the 10m cutoff point used by them. The cutoff point at 10m was therefore raised to 15m, in order to separate the strata. No associations have yet been found where the 10m cutoff was advantageous. If such an association is found, it may be better to use 5m increments.

Trees <5m: Many trees in the wheatbelt are less than 5m tall. However, because of their life-form, they are used differently from shrubs of similar height. Thus the White-browed Babbler (*Pomatostomus superciliosus*) commonly nests in *Casuarina acutivalvis* shrubs 2-5m tall but not in *Casuarina huegeliana* trees 2-5m tall because the latter will not support the nest effectively (J. Dell, pers. comm.).

Mallees

Woody, usually perennial plants of the genus *Eucalyptus*, generally erect, of variable outline but commonly with a spherical or vertically flattened canopy raised well above the ground. Leaves are commonly born only near the ends of the branches. The major part of the canopy from bottom to top may extend from the ground to the maximum height of the plant, or may occupy only the upper portion of the total height. Multi-stemmed, the individual trunks arising from a lignotuber or swelling at the base of the stem, at or below soil-level, and bearing dormant buds.

Mallees have been subdivided into two categories in this study.

Shrub mallee: Commonly less than 6-7m tall, usually with 5 or more trunks, of which at least three do not exceed 10cm in diameter at breast height. When the mallee is dead the hollow limbs and trunks are rarely of sufficient size to provide habitats for vertebrates.

Tree mallee: Usually 8m or more tall, with fewer than 5 trunks, of which at least three exceed 10cm in diameter at breast height. When dead, hollow limbs and trunks provide habitats for large vertebrates.

Trunk-feeding birds (e.g. Black-capped Sittella, *Neositta pileata*) can use many trunks on a single mallee plant. Not only is the surface area of trunk large per plant, but cover provided by the canopy is large. Most mallee eucalypts have regularly shedding bark which, unlike the bark of trees, often comes away in long streamers, forming dense clusters on the ground or hanging from the branches. This bark provides shelter in abundance for geckos and other lizards. Mallee eucalypts are also significant in that they

appear to produce some substance, perhaps wax or sugary exudate, on the young shoots, and which attracts large numbers of insects, particularly ants (A. M. Douglas, pers. comm.). The flowers of many species (e.g. *E. foecunda*) are often prolific and rich in nectar and pollen. They are thus very important for many species of vertebrates, both directly and indirectly, and should therefore be separated from shrub-like plants, which differ in form and provide often quite different advantages to the fauna.

Shrubs

Woody, usually perennial plants, generally erect but may be procumbent or of weeping habit. Commonly broadly conical in form with the foliage occupying all or only part of the total height of the plant. Multiple stems and branches arise from a rootstock or very short common trunk. Lignotubers of the mallee type absent.

Shrubs may be of any height but are generally less than 5m tall. Dead hollow branches rarely reach sufficient size to provide habitats for vertebrates. Enlarged rootstocks may be present in some *Hakea* and *Melaleuca* species. Unlike mallee eucalypts, shrub-form eucalypts do not have a lignotuber. Height classes were selected in order to separate all strata in shrub dominated formations. This was thought to be particularly important with reference to bird utilisation of these formations.

Mat Plants

Herbaceous or woody plants, usually perennial, prostrate and cushion-like. With densely compacted foliage which may occupy the whole volume of the aerial portion of the plant, or may only occupy the outside surface of the cushion. Usually numerous, very short stems.

Plants may vary from a few centimetres to several metres in diameter but rarely exceed 10cm in height. They provide no hollow limbs. Mat plants are separated from shrubs and herbs because they provide a different habitat for vertebrates. They provide perches on their outside surface, but generally are not penetrated into by vertebrates but may be burrowed under. Mat plants may be shrub-like woody species (e.g. *Astroloma compactum*) or herb-like species such as *Wilsonia humilis*. This growth form is not widespread in the wheatbelt.

Hummock Grasses

Herbaceous, perennial grasses of the genera *Triodia* or *Plectrachne*. Have a typical mound-like form due to trapping of debris and soil within the stem bases, building up into a hummock. Commonly with dead grass in the middle and living grass on the outer edge.

The clumps are of uniform height and the seed heads rise above the clumps. The height of the clump, not the seed heads, is stated.

Bunch Grass

Herbaceous or rarely woody plants of the family Poaceae (Graminae). Perennial or annual, generally erect or spreading. Usually with distinct individual shoots arising from a single root system, or if not, then not forming a hummock.

The density of annual bunch grass is sometimes overestimated slightly because dead stems and leaves are invariably present, and these may have flattened out. Division has been set at 0.5m, as it is thought that this separates most of the grassland types, both native and introduced.

The following table (N. Marchant, pers, comm.) is of assistance in differentiating between grasses and sedges which are not flowering.

Grasses	Sedges*
Leaf sheath always split	Leaf sheath never split*
Ligule present	Usually no ligule
Leaf always flat	Leaf not always flat
Stem cross section circular	Stem cross section circular, triangular or polygonal
Evenly spaced internodes	Extended internode below inflorescence

Herbs

Herbaceous or slightly woody, annual or sometimes perennial plants. Herbaceous, annual species are commonly erect and woody, perennial species commonly creepers or climbers. Some species are tufted, e.g. *Borya nitida*, *Haemodorum* spp. Foliage usually covers the majority of the branches in shrubby and creeping forms. May arise from stolons, tubers, bulbs, rhizomes or seeds, but usually not from lignotubers. Rarely exceed 0.5m in height, unless climbing species.

Sedges

Herbaceous, usually perennial, erect plants. Generally of tufted habit. Arise from stolons, tubers, bulbs, rhizomes or seeds. Term includes Cyperaceae, Juncaceae, Restionaceae, Typhaceae and Xyridaceae and other plants of sedge-like form.

The literature does not define the terms sedge, reed or rush adequately. Where the terms do appear, they tend to refer only to semi-aquatics. Restionaceae and *Lepidosperma* spp. (Cyperaceae) are common components of terrestrial wheatbelt habitats and are not shrubs, mat plants, bunch grasses or herbaceous in character. The term sedge has been adopted to include all these plants. It also includes such plants as *Lomandra effusa* which will not fit into any other life-form and are of sedge-like character.

*Restionaceae—included in the sedges for purposes of this classification has the leaf sheath split to the base, but no ligule present. The leaves are linear to cylindrical. Also note *Caustis* spp., a member of the true sedges (Cyperaceae), but which looks like Restionaceae.

The height division appears to separate fairly effectively the swamp inhabiting sedges (usually >0.5m) from the dry land species (usually <0.5m tall).

Ferns, Mosses, Liverworts and Lichens

Broadly interpreted to mean **all cryptogams**, these are grouped together as they are transient, opportunistic species which provide two very different types of habitat at different times of the year. In the wet season they provide cover and food but produce no seed for granivorous species (*cf.* grass). In the dry season they provide cover or may dry up completely.

Significant Variations from Beard-Webb Classification

Specht's fernland and mossland groups are combined, as they provide similar habitats for vertebrates, at least in the wheatbelt.

The term 'forbs' has caused confusion amongst some workers. It has even been interpreted to mean only members of the Euphorbiaceae. Thus such plants as annual Compositae and Rutaceae have no position in the classification. To avoid this confusion, 'herbaceous species' is inserted in this classification.

Chenopods are omitted as they adopt the form of shrubs if tall, or herbs if short, and can be expressed in the coding system (see below) by a family or species. There seems little point in separating them from such shrubs as *Gunniopsis intermedia* (Aizoaceae), which is a halophyte but not a chenopod.

Canopy Cover

Canopy cover is the total area encompassed within the circumference of individual foliage clumps, and expressed as a percentage of a given area, e.g. quadrat or formation area. The term is used in this study in preference to the commonly used term 'crown cover' because it records the actual area of foliage more accurately. This is particularly so with mallees which have widely spaced foliage clumps.

The percentage canopy cover groupings of <10%, 10-30%, 30-70% and 70-100% as used by Specht, Beard-Webb and others are well established convenient groupings and probably represent fairly well the commonly used divisions of very sparse, sparse, medium and dense vegetation. It is not known to what level animals differentiate between various canopy covers, but it is probably safe to assume that they utilise 0-30% (sparse), differently from 30-70%, and 70-100% (very dense) vegetation. A lower limit of 2% canopy cover has been set because experience in wheatbelt vegetation has indicated that plants with less than 2% canopy cover are very widely spaced. They do not appear as a stratum and are therefore dealt with under 'comments' in the descriptions.

Canopy cover was estimated subjectively into the four canopy cover groups. The accuracy of these estimates was occasionally checked using line transects.

View down onto top of mallee

Crown cover greatly exceeds canopy cover.

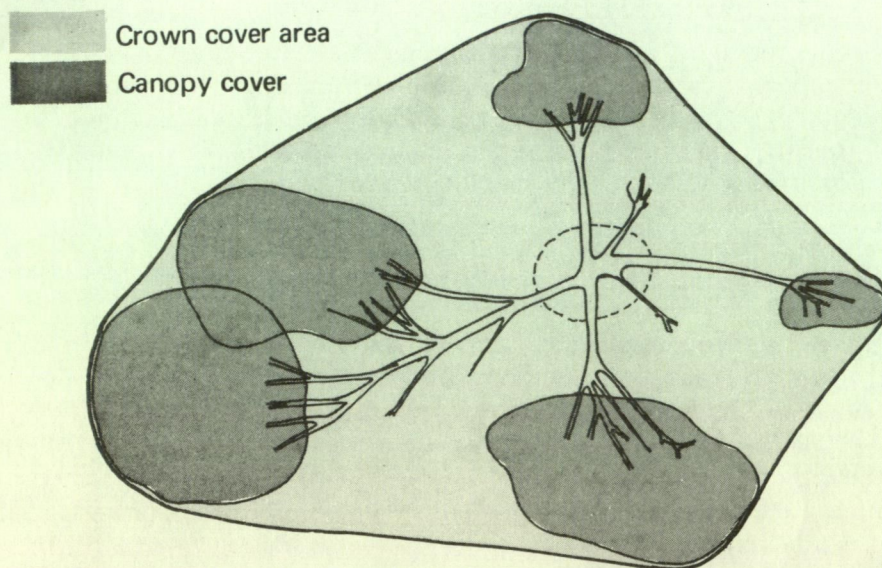


Fig. 1. Crown cover and canopy cover of mallee life-form.

Describing Vegetation in Terms of the Classification

Floristic information is not given in the key description. The life-form/height class/canopy cover term from the key is stated for each stratum, in order of descending height. The strata are separated in the description by the term *over*: thus, Low Woodland A *over* Low Heath C. As key terms have specific connotations, all words are capitalised. This also eliminates confusion between such terms as woodland—meaning formation of trees—and Woodland—meaning a group of trees 15-30m tall and 10-30% canopy cover.

Soil information is stated as textural name separated from the vegetation data by *on*. Thus Low Scrub B *on* sandy loam.

Codification of Data

The coding serves two main purposes: it allows a detailed shorthand description of the association; and it can be directly used in data retrieval systems. Although it does not codify *all* data for a formation it allows the basic common factors to be perused, intending to eliminate a portion of the field, thus simplifying more detailed comparisons. All codification of vegetation should be accompanied by a full location description.

The coding follows Beard and Webb (1974), with the omission of two canopy cover categories 'Barren (b)' and 'Grouped (p)' because they are

inappropriate in the wheatbelt. Thus, if density falls into 'barren' group, it ceases to be a stratum and becomes 'scattered' plants. Therefore, it has no place in a strata-based classification. The second term 'grouped' could mean one of three things. Firstly, if it means small clumps of plants in a close-knit distinct cluster (e.g. mallee) then the groups are usually repeated and a pattern of grouping results. These may be taken as a distinct stratum (e.g. patches of *Eucalyptus foecunda* mallee over a heath) or it may be incorporated as an aside to the description (e.g. a *Dryandra cirsioides* heath with occasional patches of *Eucalyptus foecunda* mallee). Secondly, the term can be taken to mean a mosaic. In such a case, the components should be described in full and the proportion of each stated. Thirdly, if the grouping represents an ecotone, then the end points of the ecotone, if discernible, should be described, together with notes on the variation and causes of the system. The term 'grouped' thus has quite different connotations depending on the purpose and background of the user. This can only lead to inconsistencies in classification.

Life-form and height class coding follows Beard and Webb, except where new subdivisions have been made. In these cases, if the group is new (e.g. mallee) then a letter with no established connotation has been taken. With subdivision within a group, Beard-Webb's code letter is retained and followed by the letter A, B, C or D in descending order of height class. This simplified memorisation of the code and eliminated the need for additional new letters, some of which may already have connotations.

Each stratum in a formation is represented by a group of trinomials, the first being the basic floristics (codes listed below), the second the life-form/height class (shown in extreme lefthand column of classification), the third the canopy cover (top row in classification) as described by Beard and Webb (1974). All strata are coded, not just the dominant one. Each stratum is separated by a dot, thus—eKsr.xSAd.

FLORISTIC CODES USED

a = *Acacia* c = *Casuarina* e = *Eucalyptus*
g = *Callitris/Actinostrobus* m = *Melaleuca* t = *Triodia/Plectrachne*
x = mixed species n = other (usually specified with a suffix number).

The soil classification is added, being expressed as a textural group (as listed below) or as a Northcote (1971) code for the friable soil layer. NB: Light sandy clay loam is coded as LSCL, rather than SCL⁻ in order to facilitate incorporation into data retrieval systems.

SOIL CODES—TEXTURE:

S = sand LS = loamy sand CLS = clayey sand SL = sandy loam FSL = fine sandy loam
LSCL = light sandy clay loam L = loam Lfsy = loam, fine sandy
SiL = silt loam SCL = sandy clay loam CL = clay loam SiCL = silty clay loam
FSCL = fine sandy clay loam SC = sandy clay SiC = silty clay

LC = light clay LMC = light medium clay MC = medium clay HC = heavy clay K = gravel content >80%

An example of a more complex vegetation code, and an explanation of the data contained in it are set out below to clarify the system, and to illustrate the amount of data incorporated in the code.

e_{1+2} LAc.xSAr.n₁SDi/Uc1.41 $e_1 = Eucalyptus falcata$ $e_2 = E. gardneri$
 $n_1 = Phebalium filifolium$

Data contained in code: formation is a woodland type, comprising three strata. Stratum 1 comprises *Eucalyptus falcata* and *E. gardneri* trees, 5-15m tall, 30-70% canopy cover. Stratum 2 is of mixed species of shrubs, with no particular dominants, 1.5-2m tall, less than 10% canopy cover. Stratum 3 consists of shrubs dominated by *Phebalium filifolium*, 0.5m tall, 10-30% canopy cover.

The formation grows where the friable soil is of uniform profile, of sand or sandy loam texture, with little pedologic organisation and coherent and firm when moderately moist. The soil is non-calcareous and with a value/chroma of 2 or 3 (i.e. cream or pale brown coloration). Gravel in the soil either is absent, or constitutes less than 60% of the total friable soil volume.

Although complex at first sight the vegetation classification and code is much simpler than some already established.

An advantage is that no special equipment is needed once the basic density classes are recognised; and the vegetation key and coding can be applied, within certain limits, to oblique or vertical airphotographs, to colour or black and white slides or prints, and often, with some degree of accuracy, to vernacular descriptions.

It is noted that the vegetation classification system proposed here is not new but, as stated previously, is derived from Beard and Webb's (1974) classification and coding. It has been modified and added to in order to describe the vegetation of the wheatbelt in terms of habitat for vertebrates. The system can be directly related to either Beard and Webb or Specht's (1970) systems.

Foliage Density

Foliage density is determined with a Spherical Densiometer (type A) as described in Lemmon (1956). Foliage density is determined by 5 readings for each species in the association or, when there were too many species, readings are taken from the dominants. Figures are then adjusted to give a more accurate representation of the foliage density of the stratum as a whole. Some formations (e.g. heath) may have a similar foliage density for most of

the plant species present. Other species (e.g. *Dryandra cirsioides*) may have 100% foliage density. If such a species comprised several percent of the whole stratum, the foliage density figure was adjusted accordingly.

Plant Collection and Identification

The commonest species from each stratum were collected, always from within a 60m radius of the sample point. Species found outside this area were also collected or noted, but kept separate. In some areas a complete plant list has been attempted. Emphasis was placed on perennial species, but annuals were noted, particularly if abundant. Field identifications were made wherever possible, with the assistance of a field herbarium collection. Any doubtful or unidentifiable specimens were pressed and dried and returned to the laboratory where they were identified and/or referred to specimens lodged in the Western Australian Herbarium. Specialist assistance was obtained wherever there was uncertainty. Spelling of names generally follows Beard (1970).

Maturity

Maturity of strata was estimated rather than maturity of constituent plants, so that the maturity of a stratum reflects the majority of plants within it.

Divisions are:

1. **Immature**—plants are not thought to have reached maximum height, girth or canopy dimensions, but may be flowering, i.e. plants may be **sexually** mature but not **structurally** mature. Some species, e.g. *Eucalyptus torquata*, may flower as saplings when only one or two years old but the stratum containing such saplings could hardly be considered mature;
2. **Mature**—majority of plants in stratum appear (in the worker's opinion) to have reached maximum height, girth and canopy dimensions but dead or dying branches or portions of the plant are not conspicuous;
3. **Senescent**—dead wood is conspicuous amongst the canopy, and the plants in the stratum give the impression of regressing in vigour due to old age, disease or unnatural circumstances such as increase of salt content of the soil. The plants may still be flowering prolifically, but are obviously at maximum dimensions under the prevailing conditions.

Fire Evaluation

Locations were examined for fire scars, burnt stumps or twigs and charcoal. In some areas timber samples were taken and attempts were made to age the vegetation from them. The results of both these methods were compared with estimates of the age of the burnt areas determined from airphotographs taken at different times.

An attempt is made in this study to record whether the evidence of fire indicates the last burn to be very recent, recent, old, very old, or no evidence

at all. This is then compared with the age of the vegetation as determined from airphotographs and growth rings. From these data it is hoped to determine the accuracy of visual estimates of vegetation age.

Soils

Owing to limited time, soil profiles were examined to the depth of friable soil, or where friable soil was deep, to 1 metre. Even with this limitation, profiles could only be examined at some locations. In others I had to settle for texture, colour and perhaps pH and calcium content of the A horizon soil. Meaningful descriptions of soils for botanical studies are difficult to obtain. The main obstacles are the large areas to be examined, the high cost of chemical analysis, the needs of some soil classification systems for deep soil profiles (which are time consuming and often nearly impossible to procure in laterite country or heavy clay soils), and the general lack of training of botanists and zoologists in the field of soil classification.

Examination of root distribution through soil profiles indicated that the majority of smaller plants have their root systems within the friable soil zone. The soil classification of Northcote (1971) was adopted because it is easily applied to shallow friable soil layers and has a well-established code. Whenever possible Northcote's methodology was followed exactly. However, because of the nature of some samples and limitations of time, Northcote's methods had to be modified slightly on some occasions. These departures are discussed and set out below in alphabetical order.

Bleaching—expressed as even, blotched, or absent, with details given in some cases.

Boundaries—not expressed or described, but illustrated in profile descriptions by gaps in depth readings between consecutive horizons.

Calcareous—nature of each horizon was tested with 2-3 drops Normal Hydrochloric Acid. If no effervescence detected, recorded as non-calcareous. If detected, then expressed as per Northcote's carbonates.

Coarse fraction—expressed as a percentage of the total soil, its nature stated and average particle size expressed. Samples were not sieve graded.

Colour—defined as name and code following Munsell (1954). All samples were examined in the air-dry state as many soils were found to vary greatly in colour according to their moisture content. When value/chroma rating of a soil did not fall within those listed in the Principal Profile Forms (P.P.F.) the nearest VC rating in the listing was used. For example, in class Uc5.2 only VC ratings, 5, 4 and 2 are considered. If sample was VC3, then VC2 was accepted, as the sample in question was closer to pale brown than to the yellow VC4 or red VC5. The problem arose because of the shallow soil profiles examined.

Consistence—considered in view of the discussion by Butler (1965) and to its possible relation to burrowing vertebrates.

Fabric—expressed only as earthy or sandy because pedality is stated separately. Rough ped soils of sandy or earthy fabric have been found, and if only the rough ped nature is expressed, the sandy/earthy nature of the soil is lost. This information is considered of some significance to the ability of vertebrates to burrow in the soil.

Gravel—the nature, quantity, etc. are stated. Only ironstone gravels (laterite) have been detected in the wheatbelt, and the term where used in this report, can be taken to mean 'ironstone gravel' exclusively.

Horizons—O₁ horizon is described under the heading 'litter'. O₂ horizon is invariably soil plus organic dust. Details of constituents, decomposition, etc. have been omitted as they vary seasonally.

Soil reaction trend—when distinct horizons are not apparent and/or only a shallow soil layer is present, two samples are taken, one immediately below the O₂ horizon, the other as far down as possible within the depth limit discussed above. Soil pH is taken with a Pye Unicam (Model 293) pH meter. Samples are prepared by mixing 20 grams of sieved soil (less than 2mm particle size) with 100cc 0.01M calcium chloride solution and agitating periodically for five minutes. Soil reaction trend (SRT) as well as actual pH readings are stated, as SRT is required in the Northcote classification. SRT is not affected by seasonal changes and other factors which may make actual pH readings meaningless (Russell 1961).

Other Characters Noted

Leaf litter was described in some detail owing to its importance to reptiles. Litter layers are described by quantity, constituents, distribution, depth, and distance between clumps. Constituents are important; broad leaves, for example, provide much more cover than terete leaves of the same volume and depth.

The term large debris includes branches, logs and stumps. Distribution is expressed as evenly distributed or clumped, and, if clumped, as beneath vegetation or as water or wind piled. Litter depth is given as the average for clumps. Average distance between clumps is commonly equal to average distance between plants in some associations, but this does not necessarily apply. Clump spacing is important for lizards, as their exposure when moving between clumps may affect their vulnerability to predation. Unnatural litter, rubbish and carcasses are described in terms of quantity, state of decay, constituents, and estimated cover provided.

Root depth was examined in soil profiles, road cuttings and on plants uprooted during clearing of firebreaks.

Topography terminology follows Twidale (1968) and Jennings and Mabbutt (1971).

Vegetation Mapping

Vegetation mapping was basically carried out by the method of Kuchler

(1967), with slight variations to conform to the recommendations of Viktorov *et al.* (1969) and Howard (1970). Formation boundaries discernible on Lands and Survey Department 1:40,000 scale black and white airphotographs were examined by stereoscopic viewer, and approximate boundaries drawn directly onto the photograph. Areas thus delineated were examined on the ground, and the vegetation, litter and soils were described. A reliability diagram showing traverse positions is presented with the vegetation maps in this report.

Vegetation mapping has been divided into three levels of detail for this survey.

- Level 1: (a) each formation discernible on the airphotographs was examined on the ground, and numerous transects made throughout the reserve;
- (b) at least one location was described in detail within each association type, and a list of perennial species made for that location;
- (c) a soil profile was described in each association type, supplemented by one or more colour and texture descriptions from other places within the association.
- Level 2: (a) only the larger and more accessible formations were examined on the ground, and a limited number of transects performed;
- (b) at least one location was described within each association type and only prominent perennial species listed;
- (c) a soil profile was only described in unusual or large associations, all other soils were described by only colour and texture.
- Level 3: formations are mapped directly from airphotographs. Extrapolation from physiognomy and floristics of nearby areas used in interpretation.

Shifting of vegetation boundaries was avoided except where ground truthing provided it to be necessary. Boundaries between adjacent vegetation formations varied in clarity from abrupt to undetectable. Four methods of illustrating boundaries are adopted for the vegetation map. Abrupt boundaries (less than 60m in width) are mapped as solid lines; clearly defined, but not abrupt boundaries (60-120m wide) as dashed lines; where boundaries are fairly well defined but exceed 120m in width the line is dashed, with alternating letter 'C' (for continuum); and where no boundary is discernible on the airphotograph or on the ground, the transition from one formation to another is not delineated but is made apparent by differences described at adjacent location numbers.

Location numbers (e.g. loc. 4.27) refer to the vegetation, because in many instances variation within a mappable formation did not warrant subdivision,

yet a single area description was inadequate. Using the loc. method allows several detailed descriptions to fall within one area.

Terminology used in the description and discussion generally follows Beadle and Costin (1952). Because vegetation in the wheatbelt may change over relatively small distances, variation may be considerable and lead to atypical descriptions. Where possible, an area of several hundred square meters was examined at each loc., and an area considered to be fairly typical was selected. The loc. description is then a composite description of an area *ca* 60m in diameter, the centre of which corresponds to the decimal point of the location given on the map, or to the tip of the arrow indicating small areas. Only areas exceeding 80m in diameter, or in the narrowest dimension if long and narrow (excluding ecotone width), are mapped, with the exception of a few small areas of particular interest (e.g. loc. 5.5).

The loc. number comprises two parts: a prefix, which designates the basic formation type; and a suffix, which is an arbitrary number to differentiate between locations. The suffix numbers begin at 1 for each reserve.

Prefix numbers are:

1. Woodland formations
2. Mallee formations
3. Shrubland formations
4. Heath formations
5. Lithic complexes
6. Breakaway complexes
7. Salt complexes
8. Other

Formation Definitions

Woodlands are those formations in which the dominant life-form of the upper stratum is trees, the total canopy cover of which is greater than 2%.

Mallee formations are those in which the dominant life-form of the upper stratum is shrub-form or tree-form mallees (see definitions above), the total canopy cover of which is greater than 2%.

Shrublands are formations where the upper stratum is dominated by the shrub life-form and the top of that stratum exceeds 2m from the ground and has a total canopy cover exceeding 2%.

Heaths are formations where the upper stratum is dominated by shrub life-form and the top of that stratum does not exceed 2m from the ground but has a total canopy cover exceeding 2%.

Lithic complexes are mosaics of cryptogams, shrubs, sedges, trees, and other life-forms, the nature and distribution of which is directly affected by its proximity to granitic or other rock exposures. The term includes all the species growing in crevices or soil filled depressions and all the annual

species occupying rock pools. The term is used where the scale of work is not large enough to map the various component formations of the lithic complex. Beard (1968) uses the term 'rock pavement vegetation' to describe the complex of lichens, mosses and low shrubs associated with granite outcrops. Marchant, (in McKenzie *et al.* 1973) goes further, including tall shrubs and trees in the concept of the term 'lithic complex'.

Breakaway complexes are those plant species and physiognomic groups associated with the visor, pallid zone, and the scree or outwash zone of breakaways in the regions where the geomorphological characters are directly affecting the vegetation. A subjective decision must be made to where the outwash zone finishes, and the surrounding vegetation begins.

Salt complexes are those physiognomic groups and species associated with saline sources such as salt pans, lakes or streams or any other place where halophytes are prominent and associated with visible signs of vegetation changes or soil changes resulting from salt accumulation.

'Other' formations are those which are not obviously included in one of the other categories. Grasslands, herblands, sedgelands and fernlands are included in 'other', because they are uncommon in the wheatbelt.

With exception of lithic, breakaway and salt complexes, designation of vegetation into a formation type is complicated when seral stages are considered. Mapping of vegetation as if it had reached climax, is of little use in examining faunal utilisation of an area. Mallee formations 10m tall at climax are effectively heaths in their early stages of regrowth (e.g. after fire); they then grow to what is effectively a shrubland; and later to a mallee 'woodland'. It seems probable that the associated faunal suite, and the way in which it utilises the habitat, will change with seral succession, as has been proposed by MacArthur (1972).

In this survey vegetation is described in the seral stage in which it was found but climax physiognomy and floristics are suggested. The loc. prefix numbers state the formation climax—thus loc. 1.15 will be a tree formation in climax, but the description shows it to clearly be a heath formation at time of survey. This allows a current evaluation of faunal and vegetation assemblages, gives some indication of what original wheatbelt flora may have been like before extensive burning and clearing occurred, and allows some predictive value for reservation purposes.

INTRODUCTION TO BENDERING RESERVE

Location and History

Bendering Reserve (A20338), 23km north-north-east of Kondinin, and lying between lat. 118°27' 30"E and lat. 118°32' 15"E and between long. 32° 18' 45"S and long. 32° 25' 0"S is the second largest reserve considered in the biological survey of the wheatbelt and has an area of about 5119ha. It lies *ca* 210km E of Perth in the Great Southern Agricultural District. Named after Bendering Siding, *ca* 18km west of the Reserve, it occupies Lands Department Location No. 28324 in the Shire of Kondinin on Lands and Survey Lithographs No. 2533-11 and 2633-111.

The area was Crown Land until 7 February 1930, when the land which now constitutes the Reserve was gazetted as 'C' class Timber Reserve (Mallet). It was then regazetted on 24 April 1964 to 'Conservation of Flora' and remained as such until 7 August 1970, when it was changed to 'Conservation of Flora and Fauna', and vested in the Western Australian Wildlife Authority.

Physiography and Basic Geology

The Reserve is situated on the granites and granitic gneisses of the Yilgarn Block, the oldest of the Precambrian complexes of Western Australia (Clarke *et al.* 1967, Geol. Survey 1975). The present topographic form of the Reserve is a result of extensive erosion of the granite, coupled with later pedogenic development of laterites. The Reserve and part of the surrounding land lies on a north-east/south-west trending ridge. The gentle long slopes of the low hills indicate erosion which has all but planed the original land surface to flatness. Laterite capped breakaway complexes are present; these appear to represent residuals of the old peneplain (Mulcahy *in* Jennings and Mabbutt 1971, Clarke *et al.* 1967) coupled with *in situ* lateritisation which is probably still continuing. Jennings and Mabbutt discuss the overall physiography and drainage of this part of the State; the physiography is discussed in some detail by Jutson (1934).

Some of the higher ground on the Reserve represents areas where granitic residuals are exposed. Steep slopes are of restricted distribution, and are always associated with breakaways or watercourses. The watercourses on the Reserve are all temporary and without exception are narrow and shallow. They represent the origins of floodways which pass off the Reserve onto adjacent farmlands. This is because the Reserve is the highest portion of land in the area (it carries a Laplace Station) and has hard surfaces which provide excellent runoff areas. The Reserve had not been cleared for agriculture during early settlement because granite and laterite near the surface makes tilling difficult or impossible. As a consequence of the Reserve being on high

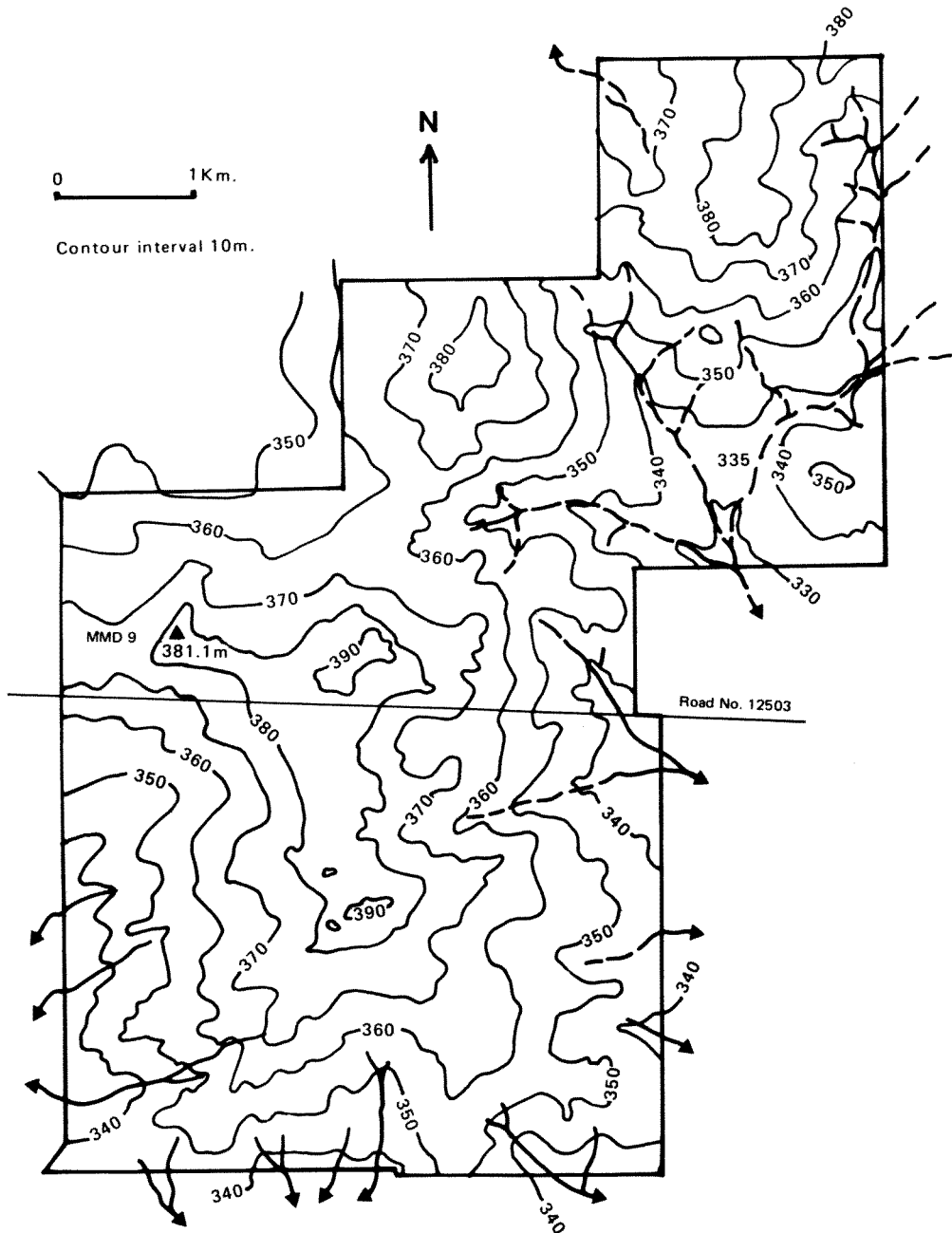


Fig. 2. Bending Reserve, showing contours and watercourses. Reproduced from Lands and Survey Lithographs No. 2533-11 and 2633-111.

ground, it shows no signs of salt accumulation which Wood (1924) states is a common occurrence following clearing on low lying ground.

Soil mapping of the region on a large scale has been done by Prescott (1931, 1933), and at a finer scale by Northcote *et al.* (1967). Teakle (1938) produced the earliest detailed descriptions of soil profiles and distributions, and Mulcahy and Hingston (1961) have dealt with soils in relation to landscape evolution. The significance of soil distribution to an interpretation of the wheatbelt as a natural region is dealt with by Gentili (1958).

Early descriptions placed Bending Reserve in the zone of red-brown earths (Prescott 1931, 1933) which were a zone between the highly leached (podsolised) soils of the western parts of the wheatbelt, and the pedocals of the grey and brown calcareous solonised soils of the eastern parts (Teakle 1938). Recently, Northcote *et al.* (1967) place the Reserve on duplex, alkaline, red or yellow soils which are quite variable in structure.

Laterites in the region have received particular attention and have been shown by Turton *et al.* (1962) to fall into three broad groups: sandy laterites, gravelly laterites, and truncated laterites. Both gravelly and truncated laterites are believed to occur on the Reserve. The chemical and physical structure of some soils similar to those found at Bending Reserve are discussed in Hingston and Mulcahy (1961).

A contour map of the Reserve, locating watercourses and breakaways is shown in **Figure 2**. The highest point on the Reserve is 392m and the lowest point 328m above sea level; the Reserve therefore, has an altitudinal range of 64m.

Fire History

No records of fire are available before 1962. Air photographs taken then showed that the Reserve had a number of fire scars of varying ages. Another series of air photographs taken in 1972 showed fire scars for the intervening period, and gave indications of the amount of regrowth in areas burnt prior to 1962. This allowed the extrapolation of the age of fire scars on to the 1962 photographs leading to estimates of burning more than 20 years before 1972. The estimated ages of vegetation on the Reserve as at the 1975 survey are illustrated in **Figure 3**. Apart from a few small areas of older vegetation, the whole of Bending Reserve has been burnt sometime between 1952 and 1975. Firebreaks around and across the Reserve were made by the Fisheries and Wildlife Department between 21-26 April 1975, and are ploughed each year to reduce regrowth.

Isolation

In 1962 Bending Reserve was almost surrounded by uncleared land. To the north, west and south of the Reserve lay *ca* 17,400ha of uncleared land. Eastwards, virgin bush extended to Hyden and beyond, indicating that at this time the eastern edge of the wheatbelt was virtually at Bending. By

1972, the only uncleared land contiguous to the Reserve was *ca* 2,300ha, about two-thirds of which lay on the north-east corner of the Reserve. The rest was in scattered blocks on the west and south boundaries. By 1975 a further 400ha had been cleared on the southern edge of the Reserve. Isolation of Bending Reserve has progressed rapidly in the last 13 years. Instead of being part of a huge continuous block of vegetation stretching eastwards to the arid interior, the Reserve is now almost totally isolated.

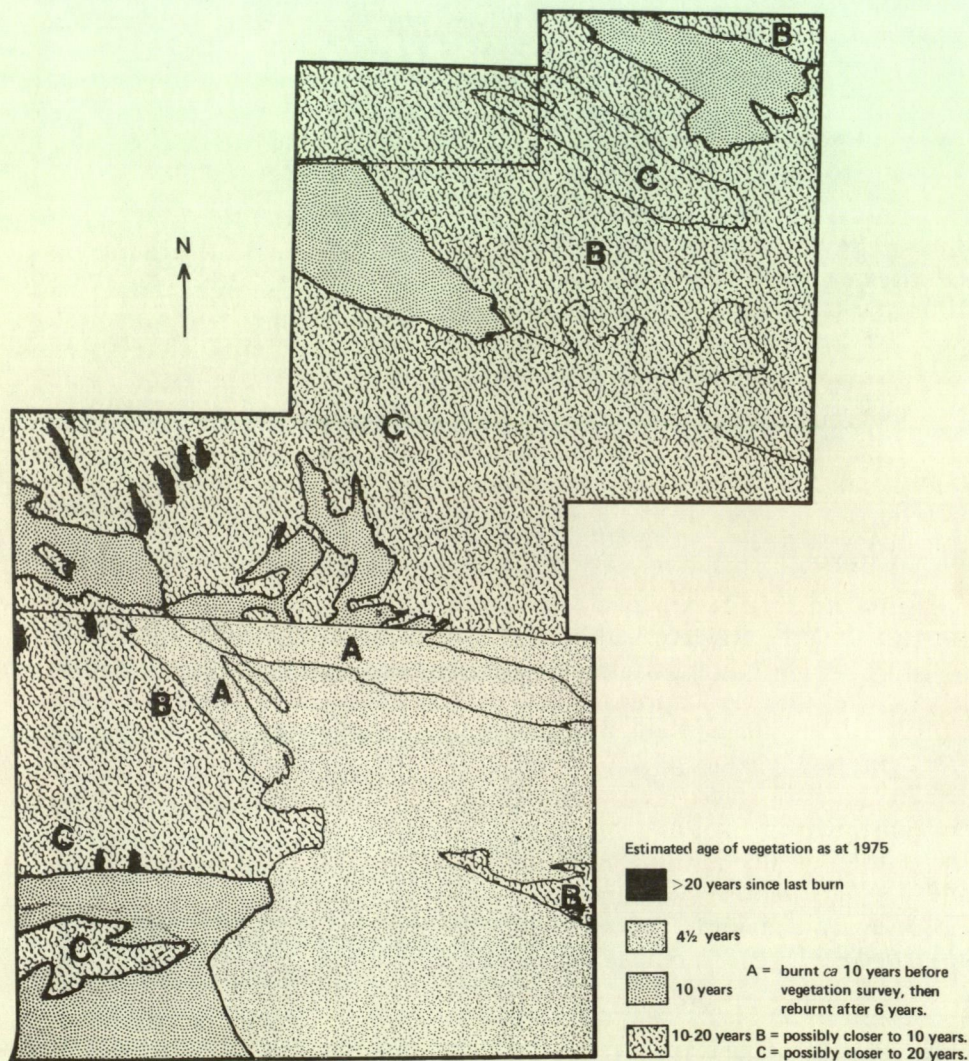


Fig. 3. Bending Reserve, showing fire patterns as determined from 1962 and 1972 airphotographs.

Flora

On 1 April 1970 K. Morrison and D. Mell of the Fisheries and Wildlife Department examined Bendering Reserve and submitted a report on the fauna and flora. This report was instrumental in reclassifying the Reserve to 'Conservation of Flora and Fauna'.

They recorded three plant species not found during this vegetation study. Two of them, *Psammomoya choretroides* and *Thryptomene stenocalyx*, possibly could exist on the Reserve.

The third species, *Eucalyptus formanii*, is thought to be restricted almost entirely to the Die Hardy Range, Pigeon Rocks and Mt. Jackson area, north of Southern Cross; it usually grows in association with Spinifex grass (*Triodia*) which is not found on Bendering Reserve or in the immediate area.

The only area near Bendering Reserve to have received a vegetation study is Dragon Rocks, about 67km south-south-east of Bendering Reserve (McKenzie *et al.* 1973). This study was not detailed. Beard (1972) has mapped the vegetation of the area to the east of Bendering Reserve at a scale of 1:250,000; on this scale, the whole Reserve is classified as 'Mallee'.

The Reserve lies in the Avon district of the South-West Botanical Province of Gardner and Bennetts (1956).

Climate

Climatic data for Bendering Reserve is presented in Anon (undated), Climatic Survey Region 11. Wherever possible, data is taken from Kondinin Weather Station (Bureau of Meteorology No. 010583 Kondinin Post Office, Lat. 32° 30S, Long. 118° 16E, altitude 271.6m above sea level.

Briefly, the region of the Reserve is characterised by an average yearly rainfall of 338mm, the rainfall being reliable and predominantly in winter. Average relative humidity for the year is 63% at 0900 hrs and 40% at 1500 hrs. Evaporation is thought to be about 1500mm per year at Kondinin, and about 45% of the rainfall is lost as evaporation.

Temperature data from Kondinin indicates:

Spring (September to November) daily average 16 °C.

Summer (December to February) daily average 23 °C.

Autumn (March to May) daily average 17.5 °C.

Winter (June to August) daily average 11.0 °C.

Yearly average 19.7 °C.

Hottest months are usually January and February, with an average maximum temperature of 32.5 °C.

Wind data shows that in May and June, when ploughing is taking place, the winds are predominantly north, northwest or west. Dust will thus enter the Reserve from this direction, and saltational movement of large particles is possible, considering that during this period, up to 6% of the winds exceed

30km/hr. In the hottest, driest months, February and March, the winds are predominantly easterly and south-easterly, and are of high speed, with up to 6% of the winds exceeding 30km/hr. Wild fires, which tend to be commonest in January to March, are highly likely to enter the Reserve from the south and east boundaries.

Gardner (1942) and Gentilli (1948) discuss the climate of the wheatbelt in relation to the rest of Australia.

SYNTHESIS

Physiognomy

Excepting salt complex, all wheatbelt formations are represented on Bending Reserve. The area and proportions of the Reserve having each formation type are set out below.

Formation	Bending Reserve	Adjacent Uncleared Land (1975)
	area in ha	area in ha
Woodland	154 (3%)	178 (9%)
Mallee	4146 (81%)	1354 (70%)
Shrubland	205 (4%)	176 (9%)
Heath	410 (8%)	128 (7%)
Lithic complex	102 (2%)	40 (2%)
Breakaway complex	102 (2%)	58 (3%)
	<u>TOTAL 5119</u>	<u>TOTAL 1934</u>

Mallee is the most extensive formation on the Reserve, and the other formations are poorly represented. The poorly represented formations are also scarce on uncleared land adjacent to the Reserve.

Stratification and Canopy Cover

The most common stratification and canopy cover characteristics of the major formations found on Bending Reserve are set out below.

Formation	Commoner Number of Strata	Canopy Cover %			
		Stratum 1,	2,	3,	4.
Woodland	2	<30	10-30	<10	<10
Mallee	2, 3	<70	10-100	10-30	<30
Shrubland	2	<100	10-70	<70	<10
Heath	1, 2, 3	30-70	<30	30-70	-

The table shows that number of strata is not directly related to the type or height of formation, although heaths and mallees are more variable in

stratum number. Further, canopy cover tends to decrease from the upper to the lower strata, probably as a result of shading. Approximately the same number of strata are present in the lowest formations (heaths), as are found in the highest formations (woodlands). Unstratified heaths often occur as post-fire regrowth on Bendering Reserve.

The upper stratum in woodlands commonly have about half the canopy cover of the upper stratum of other formations because although trees have large canopies, they are usually well spaced. This spacing may be due to competition between the large root systems of trees in woodlands, particularly as most woodlands on Bendering Reserve tend to occur on lateritic or clayey soils. These compact, dense soils force the roots to grow laterally.

Shrublands have the greatest density of canopy cover in stratum 1. Life-form of the component species does not seem to be the reason for this density, as heaths with the same life-form are not of similarly high canopy cover.

Mallees tend to have mid-dense stratum 1 canopy cover as individual clumps are spaced well apart. This may be due to lateral root competition in shallow soils as suggested for woodlands. Although canopy size of mallee clumps may vary, the spacing between lignotubers may be very regular. Some understory species may show a decrease in height or vigor as they approach the lignotuber. Such changes in understory, and lignotuber spacing may be due to shading or competition, or may be due to allelopathic factors (Muller 1969).

Heaths also have mid-dense canopy cover in stratum 1, probably because, on Bendering Reserve, most soils are shallow and low in available nutrients.

In the lower strata, woodlands and heaths have the lowest canopy cover in stratum 2 (about half that of other formations) and woodlands and mallee have the lowest canopy cover in stratum 3.

Root Depth

The distribution of plant roots of woodland and heath species in the solum are illustrated below (**Figure 4**).

Shrubs beneath trees appear to have shallower root systems (with narrower range of depth) than those in heathlands. This is possibly because of reduced soil temperature (Specht and Rayson 1957) and higher moisture content (Kittredge 1954) beneath the trees, coupled with avoidance of competition with the deeper tree root systems. Minor variations in root depth under trees and in heath are probably mainly controlled by canopy cover variations and physiographic aspect (Gilmour 1968) although root distribution at a gross scale is probably not directly related to canopy cover.

Zimmer and Grose (1958) and Grieve (1955) discuss the need for heaths to have larger, more widely ranging root systems due to hotter, drier soil conditions. Bendering Reserve evidence supports this.

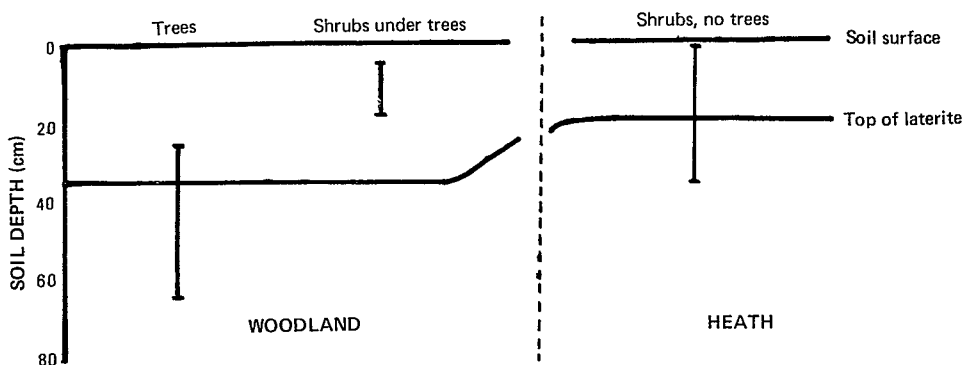


Fig. 4. Distribution of plant roots of woodland and heath species in the solum, and comparison of friable soil depth in the two formations.

Moisture retention and cooling of the soil by litter (Roberts 1964) effects minimum root depth. On Bending Reserve, leaf litter was abundant (>2cm deep) in 73% of the locations where rootlets were found in the O₂ horizon. In 63% of the locations where litter was sparse (<1.5cm deep) rootlets were absent from the O₂ horizon.

Floristics

Total number of plant species recorded on the Reserve was 288, of which 263 were perennial and 25 annual. Families and genera represented are listed in **Appendix 3**. Myrtaceae, Proteaceae and Mimosaceae were most abundant amongst the dicotyledons, and monocotyledons are dominated by Cyperaceae and Poaceae.

This survey revealed that some mallee associations differed greatly in species composition, physiognomy and soil characters compared with others. *Eucalyptus burracoppinensis* dominated these associations. Fifteen species of mallees (other than *E. burracoppinensis*) were found on Bending Reserve: ten did not occur in association with *E. burracoppinensis*; the remaining five (*E. eremophila*, *E. foecunda*, *E. pileata*, *E. redunca* and *E. transcontinentalis*) occurred only rarely in *E. burracoppinensis* associations, whereas they were common in other mallee associations. This suggests that *E. burracoppinensis* associations grow on soil types generally unsuitable for other species of mallee. *E. burracoppinensis* was found only in eight associations outside the thirty in which it is dominant: three in other mallee, two in shrubland, two in heath and one in woodland. Further, about five times as many plant species are found in *E. burracoppinensis* associations as are found with other mallee associations. *E. burracoppinensis* associations are treated separately in the location descriptions and in the following discussion because of these characteristics.

Major Associations present on Bending Reserve.

Associations as used here refers to those units of vegetation dominated by one or more species having the life-form characterising the formation to which the association belongs. Seral associations (associes) are included in the lists for convenience.

WOODLAND

E. falcata
Eucalyptus falcata – *E. gardneri*
E. falcata – *E. redunca*
E. gardneri
E. salmonophloia
E. salubris – *E. salmonophloia*
Callitris canescens
Acacia lasiocalyx

MALLEE

Eucalyptus redunca
E. redunca – *E. transcontinentalis*
E. redunca – *E. transcontinentalis* – *E. pileata*
E. redunca – *E. falcata* – *E. pileata*
E. redunca – *Casuarina acutivalvis*
E. transcontinentalis
E. transcontinentalis – *E. redunca* – *E. eremophila*
E. transcontinentalis – *E. sheathiana*
E. foecunda – *E. transcontinentalis*
E. foecunda – *E. calycogona* – *E. transcontinentalis*
E. foecunda – *E. eremophila* – *E. pileata*
E. eremophila – *E. transcontinentalis* – *E. pileata*
E. incrassata – *E. cylindriflora*
E. eremophila – *E. foecunda*
E. calycogona – *E. eremophila* – *E. sheathiana*
E. foecunda – *E. redunca*
Mallee spp. unspecified
E. burracoppinensis
E. burracoppinensis – *E. foecunda*
E. burracoppinensis – *Acacia desertorum*
E. burracoppinensis – *C. acutivalvis*
E. burracoppinensis – *E. pileata*
E. burracoppinensis – *E. redunca* – *E. transcontinentalis*
E. burracoppinensis – *E. foecunda* – *Melaleuca uncinata*

SHRUBLAND

Acacia acuminata
A. acuminata – *Casuarina acutivalvis* – *C. corniculata*
A. acuminata – *Hakea scoparia* – *C. acutivalvis*

C. acutivalvis
C. campestris — *Calothamnus quadrifidus*

HEATH

Casuarina acutivalvis — *Melaleuca uncinata* — *M. cordata*
M. uncinata — *C. acutivalvis* — *Hakea ambigua*
Petrophile ericifolia — *M. spathulata* — *Isopogon scabriusculus*
P. ericifolia — *Dryandra cirsioides*
Hakea falcata — *P. ericifolia* — *M. spathulata*
H. scoparia — *M. spicigera* — *Acacia dielsii*
M. spathulata — *M. cordata* — *M. uncinata*

TOTALS ARE:

Woodland	8 associations
<i>E. burracoppinensis</i> dominated mallee	7 associations
Other mallee	17 associations
Shrublands	5 associations
Heath	7 associations
TOTAL	44 associations

Comparison of floristic diversity with other areas.

Marchant (1973) uses species per square kilometre as an estimate of floristic diversity. Such estimates will depend on distribution of vegetation types within the Reserve boundaries and reserve size, both largely fortuitous. However, few alternative methods of expressing diversity are available.

Bendering Reserve has an average of 5.9 species/km², compared with Tarin Rock/North Tarin Rock Reserves with 8.7 spp/km² and Tutanning Reserve with 22 spp/km².

It is apparent from the figures quoted by Marchant and the figures for Bendering and Tarin Rock Reserves that there may be a regional consistency of species number per square kilometre. Gentilli (1958) and Gardner (1942) suspect that the wheatbelt is not a natural region but a transition zone between the forest region of the west and the inland desert region. Similarly Wood (1929) suggests that the mallee zone of South Australia is a transition zone. If this is so, one could expect a high species number per square kilometre on the western (high rainfall) edge of the wheatbelt (e.g. Tutanning Reserve, 22 spp/km²) with a steadily declining number of species as one moves east (Bendering, Tarin Rock, 6-9 spp/km²), to a low number in the desert region (no data available). It is hoped that future botanical surveys on wheatbelt reserves will clarify whether these trends exist.

Comparison of floristic diversity between formations at Bendering Reserve.

The total number of species recorded in each formation were:

mallee (not *E. burracoppinensis* dominated)—138 species (0.04 spp/ha)

woodland—97 (0.65 spp/ha)

heath—94 (0.23 spp/ha)

shrublands—78 (0.35 spp/ha)

E. burracoppinensis dominated mallee formations—73 (0.19 spp/ha)

The total number of species present does not reflect the diversity per hectare of formation. Woodlands are most diverse, having almost twice as many species per hectare of formation as the next most diverse, shrubland. Heath, commonly considered the most diverse formation, has one-third the number of plant species per hectare of formation of woodland and two-thirds that of shrubland. Mallee formations are the least diverse, but *E. burracoppinensis* dominated formations have about five times the number of plant species per hectare of formation as do other mallee dominated formations.

The number of species found *only* in a given formation (restricted species) are set out below:

mallee (not *E. burracoppinensis* dominated)—30 species (0.01 spp/ha)

heaths—22 (0.05 spp/ha)

woodland—17 (0.11 spp/ha)

shrubland—3 (0.01 spp/ha)

E. burracoppinensis dominated—14 (0.04 spp/ha)

Woodlands have the greatest number of restricted species, followed by heath and *E. burracoppinensis* mallee formations; both of which are about half as diverse as woodland. Shrublands and other mallee dominated formations have the least number of restricted species, both being about ten times less diverse than the woodlands.

Species found to be restricted to a particular formation type are listed below:

Woodland formations:

Acacia celastriifolia, *A. dermatophylla*, *A. graffiana*, *A. myrtifolia*, *Astroloma* sp., *Beyeria leschenaultii*, *Casuarina huegeliana*, *Coleanthera myrtoides*, *Daviesia teretifolia*, *Eucalyptus salubris*, Family indeterminate 1 (survey collection, S.C.), *Melaleuca* sp. 4 (SC), *Persoonia* sp. 1 (S.C.), *Rhagodia* sp. 1 (SC), *Thryptomene prolifera*, *Westringia cephalantha*, *Wilsonia humilis*.

E. burracoppinensis formations:

Acacia signata, *A. subsulcata*, *Calycopephus glomeratus*, *Cassyltha racemosa*, *Daviesia uniflora*, *Grevillea eriostachya*, *Hibbertia lineata*, *Leucopogon crassifolius*, *Petrophile scabriusculus*, *Phebalium ambiguum*, *Schoenus com-*

pressus, *Synaphaea petiolaris*, *Synaphaea* sp. indet. 1 (SC), *Verticordia chrysanthera*.

Other mallee formations:

Acacia affin. *andrewsii*, *A.* affin. *bidentata*, *A. mackayana*, *A. merrallii*, *A.* affin. *tamminensis*, *Actinostrobos arenarius*, *Baeckea* sp. nov. (SC), *Calytrix brachyphylla*, *Cryptandra* sp. indet. 10 (SC), *Eucalyptus annulata*, *E. celastroides*, *E. sheathiana*, *Gastrolobium trilobum*, *Grevillea* affin. *haplantha*, *Hakea incrassata*, *Hakea lehmanniana*, *Lepidosperma tuberculatum*, *Leucopogon minutifolius*, *Melaleuca cardiophylla*, *M. eleutherostachya*, *M. platycalyx*, *M. radula*, *M.* affin. *subtrigona*, *Olearia muelleri*, *Phebalium verrucosa*, Poaceae sp. 3 (SC), Poaceae sp. 4 (SC), Restionaceae sp. 1 (SC), Restionaceae sp. 8 (SC), Restionaceae sp. 9 (SC).

Shrubland formations:

Hibbertia uncinata, *Oxylobium* sp. indet. 1 (SC), *Petrophile squamata*.

Heath formations:

Boronia capitata, *Callistemon phoeniceus*, *Cassytha glabella*, *Casuarina humilus*, *Casuarina microstachya*, *Daviesia preissii*, *Dryandra* sp. A (SC), *Dryandra* sp. B (SC), Epacridaceae sp. 1 (SC), Family indeterminate 2 (SC), *Hemigenia diplanthera*, *Lepidosperma effusum*, *Lobelia heterophylla*, *Melaleuca erubescens*, *M. seriata*, *Philothea drummondita*, Poaceae sp. 1 (SC), Restionaceae sp. 5, *Stackhousia pubescens*, *Verticordia plumosa*, *V. picta*.

Soil

Generalisations extracted from the loc. descriptions are set out in Appendix 4.

All formations except mallee tend to occur on uniform soil profiles. *Eucalyptus burracoppinensis* mallees occur exclusively on gradational soil profiles, and other mallees on either gradational or uniform profiles. Sandy loam and clay loam textured soils carry all formations, even heaths, which normally tend to occur on lighter sandy soil.

Duplex soils are not common on the Reserve, but where present tend to carry 'unusual' formations e.g. loc. 1.26. Shrublands tend to occur on soils with a higher gravel content than other formations, and woodlands on more reddish soils.

Soil reaction trend shows firstly, that no shrublands were found on acid soil, and secondly, that no *E. burracoppinensis* formations were found on neutral soil, although other mallee dominated formations may occur on either acid or neutral soils.

None of the soils examined were calcareous (i.e. no carbonate detected), except loc. 2.2 which was slightly so. This is of particular interest as mallee formations, at least in eastern Australia, are generally found on calcareous soils of alkaline soil reaction trend (e.g. Wood 1929, Pryor 1959), although

Litchfield (1956) indicates that at least some species (e.g. *Eucalyptus in-crassata*) may occur on non-calcareous acid soils as well. De Silva (1934) further shows that when plant species distribution is not related to calcium carbonate content of the soil, it is commonly determined by Soil Reaction Trend. Woodlands are most prominent in well drained areas although they do occur in watercourses. Mallee, woodland or shrubland formations are never on excessively drained soils, but heaths occur on them occasionally.

As mentioned above, *Eucalyptus burracoppinensis* dominated mallee formations are found only on gradational acid soils, whereas the other mallee formations tend to be on uniform or gradational, acid or neutral soils. *E. burracoppinensis* formations also have yellower (10YR) soils exclusively, while only 80% of the other mallee formations have this colour grouping, the remainder having redder (7.5YR-16%, 5YR-4%) soils (Munsell 1954 notation used).

No major soil differences are apparent between *E. burracoppinensis* dominated formations and other mallee dominated formations apart from the profile type and colour variation. The physical characters listed do however, indicate some differences in soil chemistry which require further examination.

Fire, seral stage and plant species diversity

Airphotographs from 1962 and 1972 were examined in order to locate burn patterns of known age. Formations which spanned both burnt and unburnt areas were then sought. These formations were located in the field and 100m² quadrats set up, one in the burnt area and one in the unburnt. Care was taken to avoid the junction between stands of different ages. Number of species in each pair of quadrats and number of species common to both quadrats were recorded. Results are set out below:

	Nearest Location (Does not imply that data came from this location)	Age of stand at time of 1975 survey (approx.). Number in brackets are species common to both.			
		4½ years	10 years	>10 years	>20 years
Group 1	3.15-3.1	15	16(2)		
	1.5-north 1.25	8	11(3)		
	4.16-4.7	12	12(3)		
Group 2	4.26-4.25	11		7(2)	
	2.94-2.88	15		16(2)	
	5.10-5.1	12		10	
	2.92-2.93	8		11(3)	
Group 3	3.17-3.14			13	13(12)
	2.20-2.147			18	18(18)

It was generally found that shrubs as understory species or as heaths reach climax in 6-10 years. Shrubland formations probably require at least 15-20 years to reach climax, and mallees and woodlands probably much longer, although the understories may reach climax earlier.

The data shows that in Group 1 (containing woodland, shrubland and heath) nearly all pioneer species have been replaced after *ca* 6 years, the few species (*ca* 20%) which are present in both stands probably being those which persist by means of lignotubers rather than seeds.

Group 2 (mallee, heath and lithic complex) supports this, but the proportion of species persistent from pioneer to the >10 year stage has dropped to *ca* 16%. All pioneer species in the lithic complex have been replaced, suggesting that species regrowing from lignotuber in this formation are uncommon. Examination of the floristic list for loc. 5.1 supports this.

Group 3 (mallee and shrubland) suggests that after >10 years all pioneers have been replaced. Species composition of the stand remains constant and the formation is at climax.

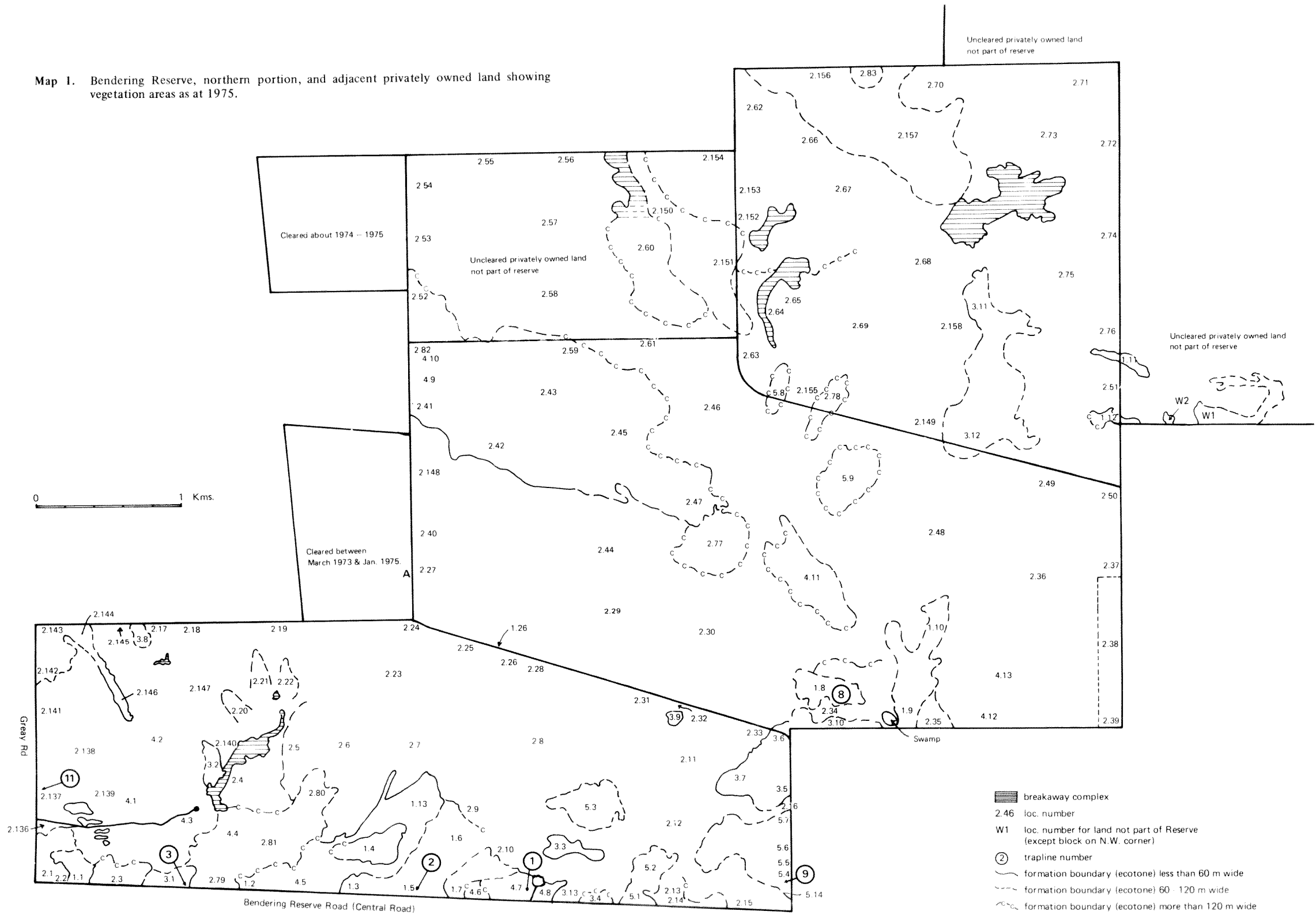
One can assume that an almost total replacement of the pioneer species indicates that the formation is well on its way to a climax situation. One can then assume that for woodlands, although the trees will not be at climax, the understory species may be, after *ca* 6 years. For mallee formations, understory species may be at climax after >6 years, and definitely are between 10 and 20 years. For shrublands, the *Acacia acuminata* or *Casuarina acutivalvis* over heath formation may approach climax, at least in the understory, after about 6-10 years.

In the *Acacia acuminata* shrublands with no understory, formations are likely to approach climax in >10 years but probably not completely until >20 years. This is supported by the immature appearance of the shrubs at loc. 3.17, 10-20 years old, compared to loc. 3.14 which has not been burnt for at least 20 years.

Heath vegetation almost certainly reaches climax between 6 and 10 years, as suggested by the senescent heath at loc. 4.7, burnt 10 years before this study. In shrub or heath-like areas surrounding lithic complexes, climax is almost certainly reached between 6 and 12 years. There also appears to be a slight decline in species number in lithic complex and heath following climax. Specht *et al.* (1958) noted a similar decline in species number after about 20 years in some heath formations.

At three pairs of locations (3.16/3.1, 1.5/north 1.25, 4.16/4.7) quadrats 30m² were set up in burnt and 'unburnt' vegetation, and the number of species and number of plants were counted. In each case the burnt area was 4½ years old, the 'unburnt' area *ca* 10 years old.

Map 1. Bending Reserve, northern portion, and adjacent privately owned land showing vegetation areas as at 1975.



Uncleared privately owned land
not part of reserve

Cleared about 1974 - 1975

Uncleared privately owned land
not part of reserve

Uncleared privately owned land
not part of reserve

Cleared between
March 1973 & Jan. 1975.

0 1 Kms.

Gray Rd

Bending Reserve Road (Central Road)

- breakaway complex
- 2.46 loc. number
- W1 loc. number for land not part of Reserve
(except block on N.W. corner)
- ② trapline number
- formation boundary (ecotone) less than 60 m wide
- formation boundary (ecotone) 60 - 120 m wide
- formation boundary (ecotone) more than 120 m wide

Swamp

	Location 3.16-3.1		Location 1.5-north 1.25		Location 4.16-4.7	
	'unburnt'	burnt	'unburnt'	burnt	'unburnt'	burnt
No. of individuals	63	119	85	235	141	199
Ave. no. sp/sq. m.	2.1	4.0	2.8	7.8	4.7	6.6

These data suggest that the number of individuals in newly burnt areas exceed those in unburnt by 30-70%, and that the number of species per square metre is about twice that of unburnt areas. A similar increase in numbers of plant species after a fire is documented by Adamson (1935), Braun-Blanquet (1932) and others. This is not surprising considering the changes in soil chemistry immediately after a fire (Hatch 1960). Plant species appearing after fire are generally fast-growing, short-lived, profusely flowering species, which after a time are crowded out by slower-growing, longer-lived species (Wilson 1974). One cannot assume that burning is essential or desirable simply because some animal species move into newly burnt areas to exploit the increased food resulting from invigorated flower and seed production.

Emlen (1970) showed that numbers of species of birds may not change significantly after the initial period following a fire, either because individual home range attachments keep the birds resident, or because the disruption is brief and accepted as a normal part of the regime in a fire-oriented ecosystem. Bornemizza, (in Vines 1975), suggests that even insect populations do not change greatly after a mild fire.

Dell (pers. comm.) found *ca* 30 species of birds on a 55 year old unburnt block near York in a 4-5 hour survey. He states that this number is comparable to any other wheatbelt area examined over roughly the same time and under similar conditions. Thus, the lack of burning did not appear to affect the suitability of this vegetation as a habitat for bird species.

Observations on fire succession.

Observation 1:

The area marked A on the north-west side of the northern part of the Reserve, was scrub-rolled, raked and burnt between March 1973 and January 1975. The area had not been sown with a crop or treated with fertilizer, but was allowed to regrow. The area was examined in February 1976 and compared with loc. 2.27 in the Reserve.

The vegetation and soils of loc. 2.27 are listed in the location descriptions. Soil type in area A was the same as loc. 2.27, but the vegetation was regrowth to 1m tall.

Apart from the mallee and *Melaleuca uncinata*, which regrew from lignotubers, other species prominent in the regrowth were: *Acacia sclerophylla*, *Dodonaea bursariifolia*, *Gastrolobium crassifolium*, *Grevillea hookerana*, *Pimelea microcephala*, *P. sylvestris*, *Stipa hemipogon*, *Streptoglossa* sp., *Velleia trinervis* and *Westringia* sp. 2 (survey collection).

The comparison of these two sites illustrates that:

1. species number has increased by 50%;
2. the only species present in both formations are those arising from lignotubers left in the soil of the cleared area;
3. two of the recruiting species are nitrogen fixers (*Acacia* and *Gastrolobium*);
4. grasses are abundant in the regrowth but entirely absent in the undisturbed bushland;
5. easily dispersed weed species (e.g. *Streptoglossa*) have gained a hold where they could not previously compete with the native vegetation on undisturbed ground.

Observation 2:

An area just east of loc. 2.120 near the breakaway in the southern portion of the Reserve was examined, as it had been burnt about 10 years previously and had good stands of young *Eucalyptus gardneri* trees. The vegetation profile was:

Stratum 1. *Eucalyptus gardneri* trees, immature, 5m tall, 30-70% canopy cover.

Stratum 2. *Melaleuca uncinata*, *Phebalium filifolium*, *Platysace maxwellii* shrubs, immature, 1-5m tall, 10-30% canopy cover.

Soil as described for loc. 1.1. Scattered throughout the understory were numerous burnt stumps and bushes of *Casuarina acutivalvis*, 1-2m tall, all killed by fire. Also present were remains of *E. gardneri* trees 7-10m tall, mostly dead and burnt, but a few with well-developed epicormic shoots.

The appearance of the stand suggested that the area was originally an *E. gardneri* woodland, possibly with *M. uncinata*, *Phebalium filifolium* and *Platysace maxwellii* in the understory, and that a successional change occurred in the understory which resulted in a seral stage with *C. acutivalvis* prominent. A fire followed which destroyed the original woodland; the *Casuarina* did not regenerate but was replaced with the *Melaleuca*, *Phebalium* and *Platysace* when the *E. gardneri* woodland regrew.

Observation 3:

Area containing loc. 2.38 and 2.39, eastern boundary of northern portion of Reserve. Original vegetation and soil believed to be as described for loc. 2.34. The regrowth 5-6 years after scrub rolling and burning differs from the original vegetation in that:

1. *Eucalyptus redunca* is present in regrowth, but *E. transcontinentalis* is replaced with *E. foecunda*;
2. *Casuarina acutivalvis* is entirely absent;
3. *Acacia sclerophylla* appears to have replaced *A. multispicata*;

4. *Cassytha* sp. B in entirely absent;
5. most of the other species listed in Appendix 2 under loc. 2.34 are absent or sparse.

Observation 4:

Located at B, on private land south of the Reserve, is a lateritic knoll which was not cleared when the rest of the paddock was cleared in January 1975. When the paddock was burnt an extremely hot fire passed through area W4 and B, destroying all but a few of the largest trunks and branches. The area around B (including W4) was then ploughed and planted with wheat around June 1975.

In February 1976, the areas around B and W4 were examined, and the regrowth was recorded to give a guideline to the succession which may follow an intense fire.

W4 Original description (Kitchener 1973, pers. comm.)

Eucalyptus annulata and *E. salubris* trees to 8m tall, 30-70% canopy cover. Occasional shrubs of *Dodonaea stenozyga* and *Melaleuca pauperiflora* to 2m tall, 2-10% canopy cover. Soil is dark reddish brown silty clay loam.

In February 1976:

Scattered *Eucalyptus* sp. regrowth, juvenile foliage resembles *E. redunca*, but may be *E. annulata* or *E. salubris*. Commonest shrubby species is *Velleia discophora* (Cabbage Poison), with *Dischisma* sp., *Grevillea hookerana*, *Gyrostemon ramulosus* and *Dampiera eriocephala* also present.

B Described from dead vegetation left after fire.

Original vegetation comprised *Eucalyptus burracoppinensis* mallee and abundant *Casuarina acutivalvis*, with scattered *Hakea multilineaata* and may have resembled something similar to loc. 2.159. *Melaleuca cordata* present in understory. Soil is dark reddish brown sandy clay loam with ca 60% laterite.

In February 1976:

E. burracoppinensis regrowth to 40cm tall. Low shrubby species to 20cm tall are *Acrotriche* affin. *cordata*, *Angianthus* sp., *Conospermum* sp., *Dampiera* sp. 1 (survey collection), *Gyrostemon* sp., *Hakea multilineaata*, *Halgania* sp., *Melaleuca cordata*, *Phebalium* sp.

Points of interest are:

1. *Velleia discophora* (Cabbage Poison) was not known from the area, but became very abundant after the fire;

2. the suite of species following the fire is characteristic of that seral stage, and contains several species which may be characteristic of very hot fires, e.g. *Gyrostemon* sp.;
3. although floristic diversity is much increased, most of the species involved were not found elsewhere on the Reserve, and are likely to be important to the fauna for only a short period, and generally in restricted areas.

Observation on effects of fertilizers

The farmland adjacent to the western side of the southern portion of Bendering Reserve has been cleared for 13 years. During this period, *ca* 100kg/ha/year of superphosphate was applied, until about 1973, then 50-70kg/ha/year after that. Some of this has leached into the verge soils and has affected the vegetation. The road camber, depth and width of gutters, soil type, etc. were checked to assure that differences between the vegetation of the verges were not due to moisture content or some factor other than fertilizers.

Hakea multilineata shrubs were selected for examination as they were abundant on both sides of the road and were all about the same height. Average foliage density of individual plants was 50% on the verge adjacent to the paddock and 28% on the Reserve. The number of fruit produced the previous season was scored. New season fruit are distinguished by their fawn, papery exteriors, which older fruit lose, leaving grey, woody surfaces. Average number of fruit was 313 per plant on the paddock verge and 103 per plant on the Reserve verge (ten plants were examined on each verge).

The floristics were also noted. The paddock verge comprised *Hakea multilineata* 40%, *Grevillea hookerana* 40% and the rest 20%, all 3.5-4m tall over *Casuarina acutivalvis*, *Acacia acuminata* and *Micromyrtus imbricata*, all to 1m tall. The Reserve verge had *Acacia acuminata* 80%, and *Casuarina acutivalvis* and *Hakea multilineata* 20%. Understorey comprised mostly *Micromyrtus imbricata* to 1.5m. This vegetation was similar to that throughout the association adjacent to the verge at this point.

Thus, the verge adjacent to the paddocks was denser, produced more nectar, pollen and seeds. It was different floristically from the other verge; *Grevillea hookerana* was present and *Acacia acuminata* less prominent, whereas the *Grevillea* was absent on the other side and the *Acacia* dominant.

The plants on the paddock verge may be younger (perhaps regrowth since the paddock was cleared), but they are of the same size as those on the Reserve verge probably owing to stimulated growth rates (Bradshaw *et al.* 1964, Driessche and Wareing 1966). The *Acacia* may be less prominent due to reduced ability to fix nitrogen: this in turn may be due to phosphate limiting the rate of nitrogen fixation (Beadle 1953). The *Acacia* may also be unable to compete with non-nitrogen fixing species which respond better to the higher nutrient levels (Allard 1942).

Disturbances

Road Verges—Observations on Bendering Reserve.

Road verges adjacent to the Reserve, drainage ditches and disturbed areas were examined to determine the interaction between these and adjacent vegetation. Sixteen areas were examined and at least one of these areas was adjacent to each major vegetation type found on the Reserve.

Eighty-five species of plants were found in these disturbed situations. Species found *only* on disturbed ground are listed below, and those marked* were recorded at one place only and probably represent species distributed by wind, animals or man from outside the Reserve area.

<i>Boronia</i> sp. indet*	<i>G. scapigera</i>
<i>Chorizema ericifolium</i> *	Goodeniaceae sp. 1
<i>Comesperma stoechadis</i> *	Goodeniaceae sp. 2
<i>Cryptandra miliaris</i> *	<i>Hakea crassifolia</i> *
<i>C. pungens</i> *	<i>Hypocalymma puniceum</i>
<i>Dampiera eriocephala</i>	<i>Inula graveolens</i> (Exotic sp.)
<i>D. sacculata</i> *	<i>Laxmannia</i> sp. 1*
<i>D. tomentosa</i> *	<i>Lechenaultia biloba</i>
<i>D. wellsiana</i> *	<i>Melaleuca pauperiflora</i> *
<i>Daviesia uniflora</i> *	Myrtaceae sp. 1*
<i>Dicrastylis</i> sp.	<i>Pityrodia axillaris</i>
<i>Eremophila</i> sp. 1*	<i>Ptilotus</i> sp. 1*
Family indeterminate 3*	Santalaceae affin. <i>Leptomeria</i> *
Family indeterminate 4*	<i>Sollya heterophylla</i> *
<i>Goodenia helmsii</i>	<i>Synaphaea polymorpha</i> *

On Bendering Reserve, plant species in disturbed situations were compared to those in the nearest adjacent location to determine the proportion of species which tend to grow back into the disturbance. Of the sixteen sites examined, only one (Loc. 2.142) had all the species in common with those of the adjacent undisturbed vegetation. Two locations (2.14, 2.164) had no species in common. At other sites, *ca* 35% of the species were also found in the adjacent vegetation.

Comparison was also made between the species in the disturbance adjacent to any given location and the species present in that location and in the locations either side of it. This may give an indication of the extent to which disturbance of the soil allows species to colonise soil types on which they normally do not occur. This raises the species in common to *ca* 45%, indicating that species moving into the disturbed zone do not generally penetrate the soil regions either side of where they originated.

Species found on the disturbance, and not occurring naturally in adjacent areas, rarely penetrated more than a few metres on to the undisturbed land. Weeds did not penetrate at all, and grasses rarely more than 5 or 6 metres from the verge.

Grasses were not common anywhere on the Reserve but were abundant adjacent to locs. M1, W1 and W3 on the extreme southwest of the Reserve adjacent to privately owned land. Even here, before clearing in 1975, grasses rarely penetrated more than 3m into the bushland, although the verge had *ca* 100% cover of several grass species including *Avena fatua* and *A. barbata* (wild oats) both prolifically seeding species. The grasses could not compete with the native vegetation provided the ground was not disturbed in any way.

Only one species of large exotic dicotyledon was found on verges, *Inula graveolens* (Stinkwort) a Mediterranean species common throughout the wheatbelt (Meadly 1965). It is at present restricted largely to the moist roadside ditches adjacent to locs. 2.3 and 2.14.

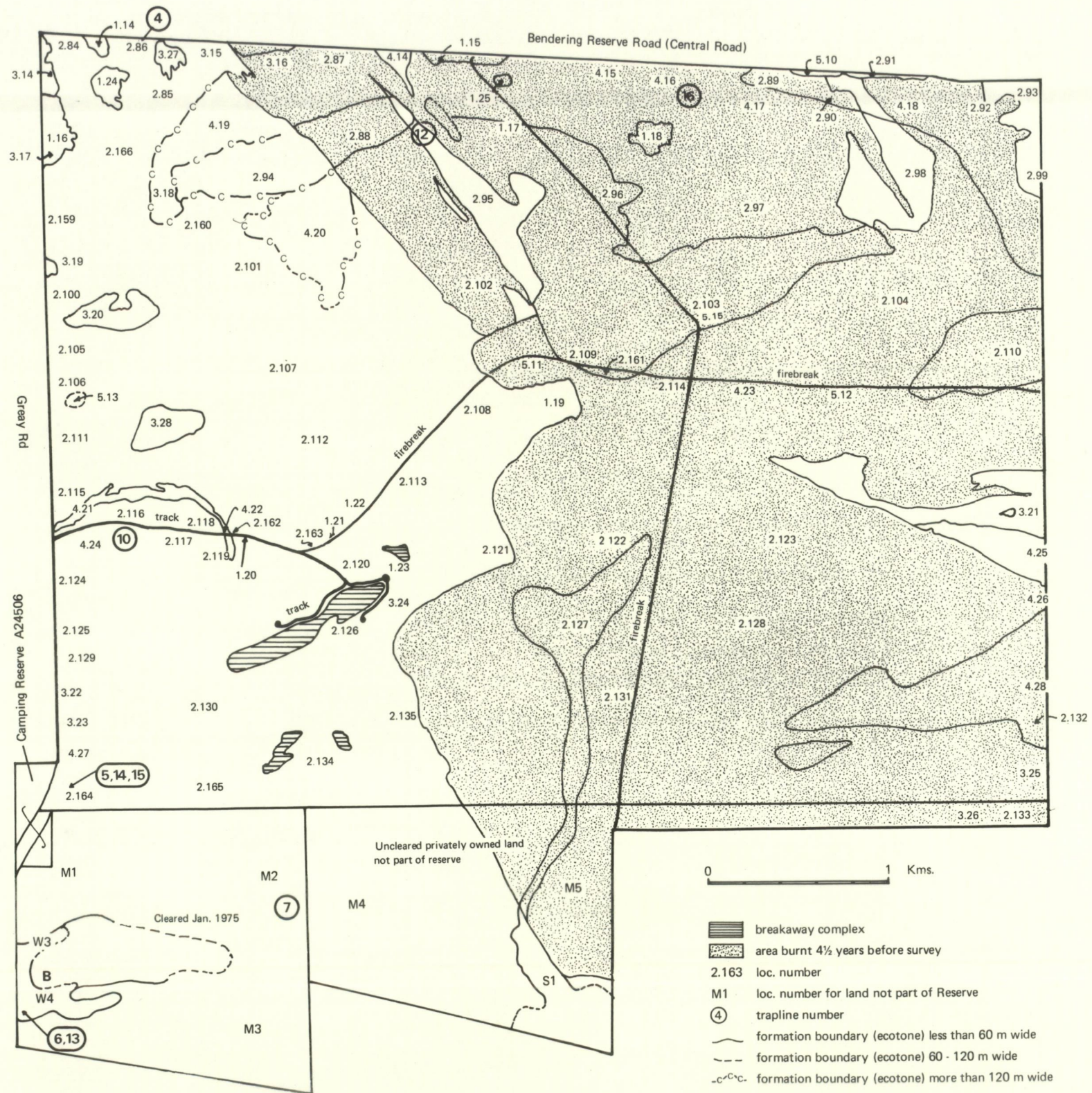
A plant of considerable interest is *Glyschrocaryon flavescens* (Haloragaceae), which is prolific on verges adjacent to locs. 1.3, 1.17, 2.1, 2.3, 4.5 and 5.1. The only place where it occurs off the verge is at loc. 1.17, and there it never penetrates beyond 4m from the verge. This area was burnt by an intense fire in 1971/72. In other wheatbelt areas this species has only been found on disturbed ground or in severely burnt areas, except for one location between York and Quairading which has not been burnt for at least 55 years. At this place it is a prominent species throughout the undergrowth in most formations. It would appear from these observations that *Glyschrocaryon flavescens* may have been widespread in old, climax vegetation which is now rare in the wheatbelt, and that it is now largely restricted to disturbed or burnt areas. It would suggest that postfire disturbed soils or soils beneath climax vegetation provide some particular need of the plant. If this is so, it may prove to be an indicator species for detecting vegetation which has been at climax for a long time.

Glyschrocaryon flavescens may eventually be restricted to road verges and burnt areas as fires will probably continue to be frequent. With improved fire management the incidence of very hot fires may decrease, perhaps leaving verges as the last stronghold for this species in the wheatbelt. This may be significant, for seeds from *Glyschrocaryon flavescens* form an important part of the diet of the Western Rosella, *Platycercus icterotis*, which is now becoming rare in the wheatbelt (Dell, pers. comm.).

In April 1975, firebreaks were made by the Fisheries and Wildlife Department in the positions shown on the vegetation maps. Rate of regrowth and recruitment of native plant species will be monitored in future. I also hope to examine dispersion of weeds and vermin along and adjoining these firebreaks and to determine their effect on the adjacent vegetation.

Rabbits and Stock:

West Bending Reserve (No. A25681), *ca* 10km west of Bending Reserve, in contrast to Bending, has abundant grasses in some associations. The probable explanation is that the West Bending Reserve has a long history of stock grazing prior to its reservation, but Bending has had



Map 2. Bending Reserve, southern portion, and adjacent privately owned land showing vegetation areas as at 1975.

minimal grazing due to the prevalence of poisonous plants. Trampling from stock forces seeds into the ground and breaks up the soil surface, thereby encouraging establishment of weed seedlings.

AIR-PHOTOGRAPHY PROJECT

A project involving air photography interpretation using the author's vegetation data as ground confirmation is being done concurrently with this vegetation and habitat study. The air photography interpretation project is being carried out by B. Uren, under supervision of Prof. D. O'Connor of Murdoch University, Western Australia, funded by Australian Biological Resources Study Interim Council Grant.

Colour and colour infra-red photography has been carried out at three scales: the whole Reserve at 1:10,000; a belt west from the gravel pit to about loc. 4.5 at 1:2,000; two belts covering from loc. 2.65 and loc. 2.155 west to about loc. 2.52 and loc. 4.9 at 1:5,000; and a belt from about loc. 2.50 north to loc. 2.76 at 1:5,000.

Although still in the preliminary stages, the project has shown these remote sensing techniques to have great application in habitat evaluation in the wheatbelt. It is believed that use of the infra-red photographs in particular would have halved the time spent in ground truthing by allowing the observer to differentiate between areas more rapidly, or by allowing a much greater depth of study in the same period of time.

At 1:10,000 scale, heathlands can be distinguished from shrublands, and mallees from trees much more easily than is possible with 1:40,000 black and white photographs, as supplied by Lands and Surveys Department. This is not only because of the differences in scale, but also because of the differences in colour signature of the species in the formations. It is also possible to distinguish several of the more prominent plant species by their infra-red colour signature. This facilitates not only more accurate definition of formation types but may indicate which soil types and seral stages are likely to exist there.

Of particular interest is the differentiation on the infra-red photographs of vegetation affected by superphosphate. On the road verge on the western side of the southern portion of Bendering Reserve (see 'Fertilizers'), the verge vegetation adjacent to the farmland has a brilliant red colour signature, indicating vigorous growth, while that on the Reserve is dull pink. Similarly in watercourses flowing off the Reserve on to the adjacent farmland the vegetation becomes progressively redder in colour signature as exposure to fertilizers increases with distance from the Reserve.

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APPENDIX 1
VEGETATION DESCRIPTIONS

WOODLAND FORMATIONS: NORTHERN PORTION

□ Loc. 1.1

Key Description

Low Forest A *over* Open Low Scrub A *over* Dwarf Scrub D *on* fine sandy loam.

Code eLAc.xSAr.xSDi/FSL

Loc. Details.

Stratum 1. 50% *Eucalyptus falcata*, 50% *E. gardneri* trees. Both species mature, stratum 6-8m tall, 30-70% canopy cover at sample point. Average foliage density 28%.

Stratum 2. *Santalum acuminatum*, *Hakea multilineata* and *Exocarpus aphyllus* shrubs. Several other species present, all senescent, stratum 1-2m tall, 2-10% canopy cover at sample point. Average foliage density 15%.

Stratum 3. *Phebalium verrucosa*, *Dodonaea bursariifolia* and *Platysace maxwellii* shrubs. Several other species present, all senescent. Stratum 0.2-0.5m tall, 10-30% canopy cover at sample point. Average foliage density 30%.

Comments

No evidence of recent fire but stand probably 10-20 years old. *Dodonaea bursariifolia* seedlings present. This area has been cut over for timber, probably about 30 years ago. *E. gardneri* extends through into loc. 2.1 but bypasses loc. 2.2.

Litter

Moderately abundant, mostly terete and broad leaves with some bark, twigs and large debris. Evenly distributed to 3cm deep. Distance between clumps 0-0.5m.

Soil

ca 30cm friable soil overlying compact laterite.

0-3cm soil plus organic dust, some plant roots.

4-17cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH6.7, pink, 7.5YR 7/4, fine sandy loam containing <5% ferruginous pebbles to 4mm diameter. Sand grains are quartz, subrounded, well sorted; plant roots present.

19-30cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH6.2, pink, 7.5YR 7/4, fine sandy loam as a matrix with ca 30-80% lateritic

pebbles to 40mm diameter. Sand grains are quartz and ferruginous fragments, subangular to subrounded, well sorted; plant roots present. 30cm onwards dense hard packed laterite with virtually no soil matrix—plant roots absent.

Comments

Soil reaction trend—acid, well drained, Northcote classification Ucl.41.

Loc. 1.2

Key Description

Open Low Woodland A over Heath A over Open Dwarf Scrub D on sandy clay loam.

Code eLAr.xSAc.xSDr/SCL

Loc. Details

Stratum 1. *Eucalyptus falcata* var. *costata* trees. Immature, stratum 4-6m tall, 2-10% canopy cover at sample point.

Stratum 2. *Hakea multilineata*, *Melaleuca cordata*, *Acacia acuminata* shrubs. Occasional *Leptospermum erubescens* shrubs present. All species immature, stratum 1-2m tall, 30-70% canopy cover at sample point.

Stratum 3. *Bertya cunninghami*, *Hibbertia enervia*, *Lepidospermum drummondii* and *Grevillea hookerana* shrubs and sedge. All species immature, stratum 0-0.5m tall, 2-10% canopy cover at sample point.

Comments

Burnt stumps indicate recent fire. This loc. passes through a narrow belt of *Eucalyptus foecunda* over *Melaleuca cordata*, *Choretrum glomeratum* and *Persoonia coriacea*, into loc. 4.5. Stand probably 10 years old.

Litter

Sparse, mostly broad leaves, clumped beneath vegetation to 1cm deep. Piles ca 1m apart. Some logs up to 30cm diameter are present.

Soil

Uniform profile, yellowish brown, 10 YR 5/4, sandy clay loam, soil reaction trend-acid; well drained.

Loc. 1.3

Key Description

Low Woodland B over Dwarf Scrub C over Dwarf Scrub D on fine sandy clay loam.

Code eLBi.xSCi.xSDi/FSCL

Loc. Details

Stratum 1. 60% *Eucalyptus falcata*, 40% *E. gardneri*. Both species immature,

but some mature *E. falcata* to 12m tall and 70cm circumference at breast height. Stratum 2-4m tall, 30% canopy cover at sample point. Average foliage density 41%.

Stratum 2. *Melaleuca uncinata*, *Hakea adnata* shrubs. Several other species present, all immature, stratum 0.5-1m tall, 10-30% canopy cover at sample point. Average foliage density 15%.

Stratum 3. *Cryptandra tomentosa*, *Platysace maxwellii* shrubs and *Lepidosperma gracile* sedge. All species immature, stratum 0-0.5m tall, 10-30% canopy cover at sample point. Average foliage density 15%.

Comments

Impression is that the emergent *E. falcata* represent the original woodland which has been partially destroyed by fire. The present main stand of *E. falcata* and *E. gardneri* is regrowth following this fire. There has been no recent fire, as much larger timber is on the ground, suspected of having been blown over by strong winds, as the logs tend to lie in a south easterly direction. Present age of stand probably 10-20 years. Also see notes loc. 4.5.

Litter

Moderately abundant, mostly broad leaves, bark, twigs and large debris. Litter clumps reach 5cm deep, the piles being *ca* 2m apart.

Soil

ca 40cm friable soil overlying compact laterite.

0-3cm soil plus organic dust; abundant plant roots.

5-20cm non-pedal, earthy, coherent, bleached, non-calcareous, pH 6.4, strong brown, 7.5 YR 5/6, sandy clay loam with <5% lateritic pebbles to 10mm diameter.

23-40cm non-pedal, earthy, coherent, bleached, non-calcareous, pH 6.5, reddish yellow, 7.5 YR 6/6, fine sandy clay loam as a matrix in a semi-compact (80%) laterite mass comprised of pebbles up to 12mm diameter; plant roots present.

41cm onwards. Densely packed laterite.

Comments

Soil reaction trend—neutral, well drained, Northcote classification Um 5.51.

Loc. 1.4

As for loc. 1.3.

Loc. 1.5 (TRAPLINE 2)

Key Description.

Low Forest A *over* Low Scrub A *over* Open Dwarf Scrub C *on* fine sandy loam.

Code eLAc.xSAi.xScR/FSL

Stratum 1. *Eucalyptus falcata* and *E. redunca* trees with scattered *E. salmonophloia* trees emergent. All species senescent, stratum 7-9m tall, emergents to 13m, 30-70% canopy cover at sample point. Average foliage density 30%.

Stratum 2. *Hakea multilineata*, *Casuarina acutivalvis* shrubs. Several other species present, all senescent, stratum 1.5-2m tall, 10-30% canopy cover at sample point. Average foliage density 30%.

Stratum 3. *Gastrolobium spinosum*, *Dryandra* aff. *cirsioides*, *Phebalium verrucosa* shrubs. Several other species present, all senescent, stratum 0.5-1m tall, 2-10% canopy cover at sample point. Average foliage density 30%.

Comments

No evidence of fire for a long time. Large trees up to 30cm diameter have been removed from this area, presumably for timber or charcoal production. The formation contains within it a mosaic of vegetation similar to loc. 1.6. The *Eucalyptus salmonophloia* trees do not reach 2% canopy cover. Stand almost 20 years old.

Litter

Abundant, terete and broad leaves, bark, twigs and large debris. Many large trees lie on the ground in a north/south orientation suggesting that a strong wind has probably been through the area since the last fire. Litter is fairly evenly distributed, with some clumping beneath vegetation. Average depth of clumps is 2cm, with the clumps continuous, or up to a maximum of 40cm apart.

Soil

ca 35cm friable soil overlying compact laterite.

0-5cm soil plus organic dust and some large particles, mostly twig fragments: fine plant roots present.

7-15cm slightly pedal, earthy, coherent, unbleached, non-calcareous, pH 5.3, very pale brown, 10 YR 7/4, fine sandy loam. Sand grains are quartz, subangular to subrounded, fairly well sorted; fine plant roots present.

17-33cm non-pedal, earthy, coherent, unbleached, non-calcareous, pH 5.4, very pale brown, 10 YR 7/4, fine sandy loam as a matrix with <30% ferruginous pebbles 0.5-3.0cm diameter. Sand grains are quartz and laterite fragments, subangular to subrounded, poorly sorted; fine plant roots present.

35cm onwards hard compact laterite with traces of matrix soil; no plant roots present.

Comments

Soil reaction trend—acid, well drained, Northcote classification Ucl.41.

□ Loc. 1.6

Key Description.

Low Forest A *over* Low Scrub A *over* Dwarf Scrub D *on* sandy loam.

Code eLAc.xSAi.xSDi/SL.

Loc. Details.

Stratum 1. *Eucalyptus falcata*, *E. redunca* trees. Both species mature, stratum 6-8m tall, 30-70% canopy cover at sample point. Average foliage density 40%.

Stratum 2. *Casuarina acutivalvis*, *Exocarpus aphyllus* and *Hakea multilineata* shrubs, all species senescent, stratum 1.5-2m tall, 10-30% canopy cover at sample point. Average foliage density 35%.

Stratum 3. *Platysace maxwellii*, *Dodonaea bursariifolia*, *Hibbertia verrucosa* shrubs, several other species present, all senescent, stratum 0.2-0.5m tall, 2-10% canopy cover at sample point. Average foliage density 20%.

Comments

Evidence of very old fire; no regeneration, weeds, grasses or human utilisation. Stand almost 20 years old.

Litter

Abundant, mostly broadleaves, bark, twigs and large debris, evenly distributed, with some clumping to 5cm deep; litter layer continuous.

Soil

ca 36cm friable soil overlying dense compact laterite.

0-5cm soil plus organic dust, fine plant roots present.

10-20cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH 7.0, reddish yellow, 7.5 YR 7/6 sandy loam, with <5% ferruginous pebbles up to 0.5cm diameter. Sand grains are quartz, subangular to subrounded, moderately well sorted; fine plant roots present.

25-35cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH 6.9, reddish yellow, 7.5 YR 7/6, sandy loam with <70% ferruginous pebbles 0.5 to 2cm diameter. Sand grains are quartz and ferruginous fragments, subangular to subrounded, very poorly sorted; plant roots present.

36cm onwards—compact laterite.

Comments

Soil reaction trend—neutral, well drained, Northcote classification Ucl.42.

□ **Loc. 1.7**

As for loc. 1.2, but *Acacia lasiocalyx*, *A. desertorum* and *Leptospermum erubescens* prominent in stratum 2.

Soil

ca 2cm deep, light yellowish brown, 10 YR 6/4 sandy clay loam. Extreme eastern side of loc. 1.7 (adjacent to loc. 2.10) has *Eucalyptus falcata*, 8-10m tall, 10-30% canopy cover over *Casuarina acutivalvis* and *Acacia acuminata* 3-4m tall, 30-70% canopy cover, over *Isopogon polycephalus*, *Melaleuca pungens*, and *Petrophile ericifolia*, 0-1m tall, 10-30% canopy cover. This represents an ecotone between locations 1.7, 2.10 and 4.7.

□ **Loc. 1.8 (TRAPLINE 8)**

Key Description.

Open Woodland over Open Shrub Mallee over Open Low Scrub A over Open Dwarf Scrub D on fine sandy loam.

Code eMr.eKSi.xSAr.nPr/FSL n= *Wilsonia humilis*

Loc. Details.

Stratum 1. *Eucalyptus salmonophloia* trees, senescent, stratum 18-22m tall, 2-10% canopy cover at sample point.

Stratum 2. *Eucalyptus eremophila*, *E. calycogona* shrub mallee, immature, stratum 5-7m tall, 10-30% canopy cover at sample point.

Stratum 3. *Acacia multispicata*, *Exocarpus aphyllus* shrubs, several other species present, immature, stratum 1-2m tall, 2-10% canopy cover at sample point.

Stratum 4. *Wilsonia humilis* mat plants, immature, stratum 0-0.1m tall, 2-10% canopy cover at sample point.

Comments

This association has been grouped with tree formations because the upper stratum exceeds 2%, although the dominant stratum in terms of canopy cover is the mallee. There is no evidence of fire in recent times. A few native tussock grasses are present. Stand probably close to 20 years old.

Litter

Sparse, mostly clumped beneath vegetation, bark, twigs and some large debris. Clumps 1cm deep, distance between piles 10-14m.

Soil

ca 30cm friable soil.

0-0.5cm soil plus organic dust.

1-13cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.3,

light brown, 7.5 YR 6/4, fine sandy loam; sand grains are quartz, angular to subrounded, poorly sorted; plant roots are present.

13-28cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.9, brown, 7.5 YR 5/4, sandy loam; sand grains are quartz, subangular to subrounded, moderately well sorted; plant roots present.

Comments

Soil reaction trend-neutral, drainage poor; Northcote classification Uc4.32.

Loc. 1.9

As for loc. 1.8.

Loc. 1.10

As for loc. 1.8.

Loc. 1.11

Key Description.

Low Forest A over Low Scrub A over Open Dwarf Scrub D on heavy clay.

Code eLAc.n₁SAi.n₂SDr/HC

n₁ = *Melaleuca adnata*

n₂ = *Acacia dermatophylla*

Loc. Details.

Stratum 1. *Eucalyptus salubris* and *E. salmonophloia* trees, the former immature, the latter senescent, stratum 4-6m tall, 30-70% canopy cover at sample point.

Stratum 2. *Hakea adnata*, *Melaleuca adnata* shrubs, mature, stratum 1-2m tall, 10-30% canopy cover at sample point.

Stratum 3. *Acacia* affin. *dermatophylla*, *A. graffiana* shrubs, mature, stratum 0-0.5m tall, 2-10% canopy cover at sample point.

Comments

No evidence of fire or seed regeneration, but *Eucalyptus salubris* are obviously younger than the *E. salmonophloia*. No evidence of weeds or human usage. Stand older than 10 years.

Litter

Abundant, mostly broad leaves and twigs, piled to 2cm deep, piles ca 1m apart.

Soil

ca 20cm friable soil overlying dense clays.

0-0.5cm soil plus organic dust; fine plant roots present.

1-6cm pedal, earthy, coherent, unbleached, non-calcareous, pH 6.2, reddish brown, 5 YR 4/4, sandy clay. Sand grains are quartz, subrounded, moderately well sorted; plant roots present.

7cm onwards pedal, earthy, coherent, unbleached, non-calcareous, pH 6.4, dark reddish brown, 5 YR 3/4, medium clay. Sand grains are quartz, subrounded, moderately well sorted; plant roots present.

Comments

Soil reaction trend-acid, poorly drained; Northcote classification Dr4.11.

Loc. 1.12

As for loc. 1.11.

Loc. 1.13

As for loc. 1.2.

WOODLAND FORMATIONS: SOUTHERN PORTION

Loc. 1.14 (PLATE 1)

Continuation of loc. 1.1.

Loc. 1.15

Continuation of loc. 1.3 and merging into loc. 1.5 to the east. An unburnt *Eucalyptus falcata* var. *costata* growing here is 16m tall, 122cm circumference at breast height. This probably represents the original stand. The understory is regrowth 1m tall. Prominent species are *Acacia celastrifolia* and *Goodenia scapigera*. Few of the species present in the original stand (see loc. 1.3) are present.

Loc. 1.16

Key Description.

Open Low Woodland A over Scrub over Open Dwarf Scrub C on fine sandy loam.

Code eLAr.xSi.xSCr/FSL

Loc. Details.

Stratum 1. *Eucalyptus gardneri* trees, senescent, stratum 12-14m tall, 2-10% canopy cover at sample point.

Stratum 2. *Casuarina acutivalvis*, *C. campestris* shrubs and *Santalum acuminatum* trees, several other species present, all senescent, stratum 6-8m tall, 10-30% canopy cover at sample point.

Stratum 3. *Melaleuca uncinata*, *Bertya cunninghami*, *Hakea scoparia* shrubs, several other species present, all senescent, stratum 0.5-1m tall, 2-10% canopy cover at sample point.

Comments

No evidence of regeneration, weeds or human usage. Occasional grasses present; no evidence of fire. Stand 10-20 years old.

Litter

Abundant, evenly distributed, plus clumping beneath vegetation to 5cm deep. Clumps continuous or up to 1m apart. Abundant logs and large debris present.

Soil

Pale brown, 10 YR 6/3, fine sandy loam; overlying compact laterite.

Loc. 1.17

Originally as loc. 1.5 but burnt in 1971/72 fire. Prominent regrowth species are *Acacia celastriifolia* (very abundant), *Dampiera* spp. 1 and 3 (survey collection), *Glyschrocaryon flavescens*, *Grevillea asteriscosa* and *Lepidosperma gracile*. Soil as for loc. 1.5.

1.18

Eucalyptus salmonophloia trees, mature to senescent, stratum 12-14m tall, 30-70% canopy cover. Some trees reach 115cm circumference at breast height. Code eLAc/SiC. No understory present; litter sparse, some large debris. Soil dark greyish brown, 10 YR 4/2 silty clay in shallow depression.

Loc. 1.19

As for loc. 1.15, eastern edge of loc. is burnt out.

Loc. 1.20

Eucalyptus gardneri trees, regenerating from coppice and seed. Stratum 1-4m tall, 70-100% canopy cover. No understory; on sandy loam soil. Code eLBd/SL.

Loc. 1.21

As for loc. 1.20. Stratum 3-4m tall, 30-70% canopy cover.

Loc. 1.22

Callitris canescens trees and occasional *Casuarina acutivalvis* shrubs. Stratum 3-5m tall, canopy cover varying from 10-80%. Trees grow opportunistically in depressions on small lateritic knoll.

Loc. 1.23 (PLATE 2)

Acacia lasiocalyx trees, stratum 2-4m tall, 10-30% canopy cover. Stratum 2 occasional *Acacia sedifolia*, *Grevillea asteriscosa* and *Goodenia pinifolia*, 0-1m tall, 2-10% canopy cover.

Soil

pH6.0, yellowish brown, 10 YR 5/4, fine sandy loam with >80% lateritic pebbles. In some places compact laterite rock outcrops.

Loc. 1.24

As for loc. 1.1.

□ Loc. 1.25

Originally as for loc. 1.5 but destroyed in 1971/72 fire. Regrowth species are *Acacia celastriifolia*, *Dampiera* spp. 1 and 3 etc. as per loc. 1.17. *Hakea lissocarpha* prominent in understory. Situated in shallow depression.

Soil

As for loc. 1.5.

□ Loc. 1.26

Area ca 50m diameter of *Callitris canescens*, 3-4m tall, 30-70% canopy cover.

Code gLBc/SL.

Soil

Light brown, 7.5 YR 6/4, sandy loam, pH6.2 for upper 18-20cm, passing into light red, 2.5 YR 6/6, heavy clay, pH6.0, (both highly pedal): soil is *in situ* decayed granite.

MALLEE FORMATIONS: NORTHERN PORTION

□ Loc. 2.1

Key Description.

Open Shrub Mallee over Scrub over Dwarf Scrub C on sandy clay loam.

Code eKSi.xSi.xSCi/KSCL

Loc. Details

Stratum 1. ca 60% *Eucalyptus redunca*, *E. transcontinentalis* shrub mallee, ca 30% *Casuarina acutivalvis* shrubs, plus some emergent *Callitris preissii* from stratum 2 and some *E. gardneri*. All species mature, stratum 3-5m tall, 10-30% canopy cover at sample point. Average foliage density 34%.

Stratum 2. *Exocarpus aphyllus*, *Melaleuca uncinata* shrubs prominent, *M. laxiflora* and *M. undulata* also present. All senescent, stratum 2-3m tall, 10-30% canopy cover at sample point. Average foliage density 15%.

Stratum 3. *Phebalium verrucosa*, *Dodonaea bursariifolia* shrubs. Several other species present, all senescent, stratum 0.5-1m tall, 10-30% canopy cover at sample point. Average foliage density 40%.

Comments

No evidence of fire or regeneration but very old burnt out stumps are present. Stand 10-20 years old. No weeds, grasses or human utilisation. *E. gardneri* occur in patches and as scattered trees becoming less frequent to west of formation.

Litter

Moderately abundant, mostly terete leaves and twigs with some broad

leaves and bark, mostly clumped beneath vegetation to 1.5cm deep, clumps *ca* 0.5m apart.

Soil

ca 35cm friable soil overlying compact laterite.

0-3cm soil plus organic dust; some plant roots present.

4-23cm non-pedal, earthy, coherent, unbleached, non-calcareous, pH 6.2, pink, 7.5 YR 7/4, sandy clay loam containing <10% ferruginous pebbles up to 8mm diameter; sand grains are quartz, subrounded, poorly sorted; plant roots absent.

25-30cm matrix of non-pedal, earthy, coherent, unbleached, non-calcareous, pH 7.0, reddish yellow, 7.5 YR 7/6 sandy loam. Pebbles to 8mm diameter >50% of total volume. Sand grains are quartz, subrounded, poorly sorted; plant roots absent.

31-50cm compact earthy to nodular laterite. Nodules 5-100mm diameter, from yellow 10 YR 7/6 to yellow 10 YR 8/8. Some nodules with visible quartz grains, outside commonly limonitic with haematitic spots or blotches.

Comments

Soil reaction trend-neutral; well drained, Northcote classification Gn2.22.

Loc. 2.2

Key Description.

Shrub Mallee, Thicket *over* Heath A *on* sandy clay loam.

Code eKSSc.amSAC/SCL

Loc. Details.

Stratum 1. *ca* 20% *Eucalyptus redunca*, 50% *Casuarina acutivalvis*, 20% *Hakea* sp. nov. shrub mallee and shrubs. All species mature to senescent, many of the *Hakea* sp. nov. 1 being completely dead, Stratum 2-3m tall, 30-70% canopy cover at sample point. Mallees are prominent part of association, although less abundant than other species.

Stratum 2. *Acacia assimilis* and *Melaleuca uncinata* shrubs. Several other species present. All species immature and more vigorous in the areas between stratum 1 clumps, stratum 1-2m tall, 30-70% canopy cover at sample point.

Comments

No evidence of regeneration from seed. This association is considered to be a variation of loc. 2.1, the mallees being omitted, and the *C. acutivalvis* becoming dominant, thus increasing the canopy cover in stratum 1 and leading to the deletion of stratum 3. Stand 10-20 years old.

Litter

Moderately abundant, mostly terete leaves and twigs with some broad leaves and bark, and abundant large debris. Leaf litter mostly clumped beneath vegetation to 1.5cm deep, piles *ca* 0.5m apart.

Soil

ca 35cm friable soil overlying compact laterite.

0-10cm soil plus organic dust, some plant roots.

11-15cm non-pedal, earthy, coherent, unbleached, slightly calcareous, pH5.9, brown, 10YR 5/3, sandy clay loam; grains are quartz, subrounded to rounded, moderately well sorted; plant roots present.

25-35cm non-pedal, earthy, coherent, unbleached, slightly calcareous, pH6.1, light yellow brown, 10YR 6/4 clay loam with <10% ferruginous pebbles to 18mm; grains are quartz, subrounded to rounded, moderately well sorted; plant roots present.

36cm onwards, compact laterite; plant roots absent.

Comments

Soil reaction trend—neutral, well drained, Northcote classification Gc1.22.

□ Loc. 2.3 (PLATE 3)

Key Description.

Open Tree Mallee *over* Heath A *over* Dwarf Scrub D *on* fine sandy loam.

Code eKTi.mSAC.xSDi/FSL

Loc. Details.

Stratum 1. *Eucalyptus redunca*, *E. transcontinentalis*, *E. pileata* tree mallee, all mature, stratum 9-10m tall, 30% canopy cover at sample point. Average foliage density 25%.

Stratum 2. *Melaleuca adnata*, *M. uncinata*, *Exocarpus aphyllus* shrubs prominent. Several other species present, all immature, stratum 1-2m tall, 30-70% canopy cover at sample point. Average foliage density 30%.

Stratum 3. *Phebalium verrucosa*, *Bertya cunninghami* shrubs prominent. Several other species present, all senescent, stratum 0.3-0.5m tall, 10-30% canopy cover at sample point. Average foliage density 20%.

Comments

No evidence of burning in recent times, or regeneration from seed. Transition to loc. 1.1 similar to loc. 2.3, but slightly sparser. Stand 10-20 years old.

Litter

Very sparse, mostly terete leaves, twigs and large debris. Litter clumps rarely exceed 2cm in depth and 1-2m apart.

Soil

ca 30cm friable soil overlying compact laterite.

0-4cm soil plus organic dust, plant roots present.

5-13cm highly pedal, earthy, coherent, unbleached, non-calcareous, pH 6.3, light yellowish brown, 10 YR 6/4, fine sandy loam with <10% ferruginous pebbles. Grains are quartz, subangular, very poorly sorted; plant roots present.

15-30cm highly pedal, earthy, moderately coherent, bleached, non-calcareous, pH 6.3, light grey, 10 YR 7/2, clay loam with 50% of soil composed of pisolitic laterite pebbles from 2mm to 10mm diameter. Matrix grains are quartz, subangular to subrounded, poorly sorted; plant roots present.

40cm onwards, hard compact laterite nodules and pisolitic gravel; plant roots absent.

Comments

Soil reaction trend—acid, well drained, Northcote classification Dg4.11.

Loc. 2.4

Key Description.

Open Shrub Mallee *over* Low Heath *on* sandy loam.

Code eKSc.mSCi/SL

Loc. Details.

Stratum 1. *Eucalyptus calycogona*, *E. eremophila* and *E. sheathiana* shrub mallee. Stratum 3-5m tall, 30-70% canopy cover at sample point.

Stratum 2. *Melaleuca undulata* shrubs, stratum 0.5-1m tall, 30-70% canopy cover at sample point.

Soil

Light brownish grey, 10 YR 6/2 sandy loam with some gravel.

Loc. 2.5

Key Description.

Open Shrub Mallee *over* Heath *on* sandy loam.

Code eKSc.mSBi/SL

Loc. Details.

Stratum 1. *Eucalyptus eremophila*, *E. foecunda*, shrub mallees. Stratum 3-5m tall, 30-70% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *M. undulata* and some *Callitris canescens*. Stratum 1-1.5m tall, 30-70% canopy cover at sample point.

Soil

Horizon A sample light brownish grey, 10 YR 6/2 sandy loam.

□ Loc. 2.6

As for loc. 2.5. but *Melaleuca uncinata* less prominent in stratum 2, and *Exocarpus aphyllus* becoming more frequent. Soil as for loc. 2.5.

□ Loc. 2.7

As for loc. 2.5 but *Callitris canescens* less prominent.

□ Loc. 2.8

As for loc. 2.24.

□ Loc. 2.9

Key Description.

Tree Mallee over Open Low Woodland B over Low Scrub A over Open Dwarf Scrub D on sandy clay loam.

Code e₁KTc.n₁LBr.xSAi.xSDr/SCL
e₁ = *Eucalyptus redunca*
n₁ = *Santalum acuminatum*

Loc. Details.

Stratum 1. *Eucalyptus redunca* tree mallee. Mature, stratum 8-9m tall, 30-70% canopy cover at sample point.

Stratum 2. *Santalum acuminatum* trees. Mature, stratum 2-3m tall, 2-10% canopy cover at sample point.

Stratum 3. *Melaleuca acuminata*, *Exocarpus aphyllus* and *Hakea adnata* shrubs. All species senescent, stratum 1-2m tall, 10-30% canopy cover at sample point.

Stratum 4. *Cryptandra tomentosa*, *Dodonaea bursariifolia* shrubs. Both senescent, stratum 0-0.5m tall, 2-10% canopy cover at sample point.

Comments

Occasional *E. redunca* mallee to 16m tall, 113cm circumference at breast height. These are always senescent, and probably represent the original stand, the mallees at present occupying stratum 1 probably being regrowth. Situated in shallow watercourse. No evidence of recent fire, weeds, grasses or evidence of human utilisation. Stand is about 20 years old.

Litter

Abundant, mostly broad leaves, bark, twigs and large debris, evenly distributed over ground to 3-5cm deep.

Soil

Alluvial clays derived from breakaway on southwest side of location. Yellowish brown 10 YR 5/3, sandy clay loam.

Loc. 2.10

Key Description.

Open Shrub Mallee *over* Low Scrub A *over* Open Dwarf Scrub D *on* sandy loam.

Code eKSi.xSAi.xSDr/SL

Loc. Details.

Stratum 1. *Eucalyptus transcontinentalis*, *E. redunca* and *E. eremophila* shrub mallee. All mature, stratum 4-5m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata* and occasional *Casuarina acutivalvis* shrubs, both immature, stratum 1-2m tall, 10-30% canopy cover at sample point.

Stratum 3. *Gastrolobium crassifolium*, *Platysace maxwellii* and *Melaleuca scabra* shrubs. All senescent, stratum 0-0.5m tall, 2-10% canopy cover at sample point.

Comments

No weeds, grasses or human utilisation. Burnt stumps indicate old burn. Stand is 10-20 years old.

Litter

Sparse, mostly terete leaves and broad leaves, clumped beneath vegetation to 1cm deep, clumps 1.5m apart.

Soil

Pale brown, 10 YR 6/3, sandy loam.

Comments

This loc. is at the bottom of a continuation of the breakaway for loc. 2.9.

Loc. 2.11

As for loc. 2.33.

Loc. 2.12

As for loc. 2.33.

Loc. 2.13

Key Description.

Very Open Shrub Mallee *over* Heath A *over* Low Heath D *on* sandy loam.

Code eKSr.xSAc.xSDc/SL

Loc. Details.

Stratum 1. *Eucalyptus foecunda*, *E. calycogona*, *E. transcontinentalis* shrub mallee, some *Acacia lasiocalyx* trees, often as emergents to 6m. *A. lasiocalyx* senescent, rest mature, stratum 4-5m tall, 2-10% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *Exocarpus aphyllus*, *Casuarina campestris* shrubs. All immature, stratum 1-2m tall, 30-70% canopy cover at sample point.

Stratum 3. *Daviesia acanthoclona*, *Lepidosperma tuberculatum*, *Astartea heteranthera* shrubs and sedges. All immature, stratum 0.1-0.5m tall, 30-70% canopy cover at sample point.

Comments

Evidence of very old fire, occasional *A. lasiocalyx* seedling present. No evidence of weeds. Mallees badly infested with leaf gall. Occasional tussock grass (Poaceae sp. 2). Location is transition zone between lithic complex loc. 5.1 and mallee loc. 2.14. Stand is 10-20 years old.

Litter

Moderately abundant, mostly terete and broad leaves, piled beneath vegetation to 2cm deep; piles ca 2m apart.

Soil

Horizon A sample light brownish grey, 10 YR 6/2, sandy loam.

□ Loc. 2.14

As for loc. 2.13 but *Eucalyptus transcontinentalis* more prominent in stratum 1, and *E. foecunda* absent. Scattered *Santalum acuminatum*, *E. eremophila* and *Hakea corymbosa* in Stratum 1.

□ Loc. 2.15

Key Description.

Shrub Mallee over Heath A over Dwarf Scrub D on sandy loam.

Code eKSc.mn₁SAc.mn₂SDi/SL
n₁ = *Hakea adnata*
n₂ = *Spartochloa scirpoidea*

Loc. Details.

Stratum 1. *Eucalyptus eremophila*, *E. transcontinentalis*, *E. pileata* shrub mallee. All mature, stratum 5-6m tall, 30-70% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *Hakea adnata* shrubs, both immature, stratum 1-2m tall, 30-70% canopy cover at sample point.

Stratum 3. *Melaleuca lateritia* shrubs and *Spartochloa scirpoidea* sedges, both immature, stratum 0.1-0.5m tall, 10-30% canopy cover at sample point.

Comments.

Occasional emergent *E. transcontinentalis* to 7.5m. Evidence of old fire damage. Some grasses, no weeds or human utilisation. Termite mounds abundant. Stand is 10-20 years old.

Litter

Moderately abundant, mostly broad leaves and bark, evenly distributed, piled beneath mallees to 2-3cm, piles *ca* 0.5m apart.

Soil

ca 1m of friable soil.

0-0.5cm soil plus organic dust.

1.0-13cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.3, light brown, 7.5 YR 6/4 fine sandy loam; grains are quartz, angular to subrounded, poorly sorted; plant roots present.

17-30cm highly pedal, sandy, coherent, unbleached, non-calcareous pH 7.3, pinkish grey, 7.5 YR 7/2, sandy loam, grains are quartz, angular to sub-angular, poorly sorted; plant roots present.

Comments

Soil reaction trend—neutral, drainage good but some localised pooling. Northcote classification Uc4.32.

Loc. 2.16

As for loc. 2.15.

Loc. 2.17

Key Description.

Very Open Shrub Mallee *over* Dense Thicket *over* Open Dwarf Scrub C *on* sandy clay loam.

Code eKSr.amSd.xSCr/SCL

Loc. Details.

Stratum 1. *Eucalyptus foecunda*, *E. eremophila* and some *E. pileata* shrub mallee. All immature, stratum 4-5m tall, 2-10% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *Acacia acuminata* shrubs prominent. A few *Santalum acuminatum* trees present, all immature, stratum 1-3m tall, 70-100% canopy cover at sample point.

Stratum 3. *Melaleuca cordata*, *Hakea scoparia*, *Acacia sulcata* shrubs, all immature, stratum 0.5-1m tall, 2-10% canopy cover at sample point.

Comments

Stratum 1 may be original vegetation and strata 2 and 3 post-fire regrowth. Burnt sticks indicate fire in recent times. Some seedlings of *A. acuminata* are present. Stand is 10-20 years old.

Litter

Moderately abundant, mostly terete and broad leaves, mostly clumped beneath vegetation to 1-2cm, clumps 1-1.5m apart.

Soil

Horizon A is yellowish brown, 10 YR 6/4, sandy clay loam.

Loc. 2.18

This loc. is a complex of three basic associations, arranged concentrically on a shallow granite soil. Area is on a slight rise, probably a hump of granite close to the surface, on which soil depth increases radially from the centre.

Central area *ca* 60m diameter, comprises *E. eremophila* and *E. calycogona* 4-5m tall, 30-70% canopy cover. There is no understory. Surrounding this is an annulus about 20m wide of *E. eremophila* in stratum 1 with an understory 0.5-1m tall of *Melaleuca undulata* present. Canopy cover is 10-30%. A third annulus 5-20m wide consists of a pure stand of *Callitris canescens* on the inner edge, with increasing numbers of *E. redunca* and *E. transcontinentalis* towards the outside, and which grades imperceptibly into the surrounding mallee which is indistinguishable from loc. 2.19. The central area has small patches of exposed, decayed granite rock with pockets of soil. Abundant pegmatite quartz pebbles are present.

The *E. eremophila*/*M. undulata* zone is on *ca* 10-20cm deep soil. The *C. canescens* is on 20-25cm deep soil which tends to be slightly more clayey.

Loc. 2.19

As loc. 2.24 with occasional patches of *Callitris canescens* where granite is closer to surface. Soil in *Callitris* stands is light yellowish brown, 10 YR 6/4 silty clay.

Loc. 2.20

As for loc. 2.5. Vegetation mostly senescent but seedlings numerous.

Loc. 2.21

As for loc. 2.5. *Callitris* and *M. undulata* immature.

Loc. 2.22

As for loc. 2.5.

Loc. 2.23

As for loc. 2.24.

Loc. 2.24

Key Description.

Open Shrub Mallee over Heath A over Low Heath C on sandy loam.

Code eKSi.mn₁SAc.mn₂SCc/SL
n₁ = *Exocarpus aphyllus*
n₂ = *Phebalium filifolium*

Loc. Details.

Stratum 1. *Eucalyptus redunca*, *E. transcontinentalis* and scattered *E. eremophila* shrub mallee, all mature approaching senescence, stratum 6-8m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *Exocarpus aphyllus* shrubs prominent. Several other species present, all senescent, stratum 1-2.5m tall, 30-70% canopy cover at sample point.

Stratum 3. *Melaleuca spicigera*, *Phebalium verrucosa* shrubs prominent. Several other species present, all senescent, stratum 0.5-1m tall, 30-70% canopy cover at sample point.

Comments

No evidence of recent fire, weeds, grasses, human utilisation or regeneration from seed. Stand approaches 20 years old.

Litter

Moderately abundant, mostly broad leaves and bark, evenly distributed or clumped to 2cm deep, clumps *ca* 0.5m apart.

Soil

ca 40cm friable soil overlying compact clays.

0-1cm soil plus organic dust.

1.5-20cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.4, light brownish grey, 10 YR 6/2 sandy loam.

23cm onwards highly pedal, earthy, coherent, bleached, non-calcareous, pH 6.8, light reddish brown, 5 YR 6/4 medium clay.

Comments

Soil reaction trend—neutral, moderately well drained, Northcote classification Dy5.12.

□ Loc. 2.25

Area 60-80m diameter of loc. 2.24 mallees on decayed granite rock soil. Understory of *Melaleuca lateritia* and *M. affinis scabra* 0.5-1m tall. Area is surrounded by a narrow belt of *Callitris canescens*.

□ Loc. 2.26

As for loc. 2.24 with *Exocarpus aphyllus* and *Melaleuca lateriflora* prominent in stratum 2.

□ Loc. 2.27

Key Description.

Open Shrub Mallee *over* Heath A *over* Low Heath C *on* sandy loam.

Code eKSi.mSAc.xSCc/SL

Loc. Details.

Stratum 1. *Eucalyptus redunca* shrub mallee, all mature, approaching senescence, stratum 6-8m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *M. eleutherostachya* shrubs. *Hakea adnata*, *Callitris verrucosa* and scattered *Santalum acuminatum* present. All senescent, stratum 1-2.5m tall, 30-70% canopy cover at sample point.

Stratum 3. *Melaleuca lateritia* and *Phebalium verrucosa* shrubs, both mature, stratum 0.5-1m tall, 10-30% canopy cover at sample point.

Comments

No evidence of recent fire, weeds, grasses, human utilisation or regeneration from seed. Stand approaches 20 years old.

Litter

Moderately abundant, mostly broad leaves and bark, evenly distributed or clumped to 2cm deep, clumps *ca* 0.5m apart.

Soil

ca 40cm friable soil overlying compact clays.

0-1cm soil plus organic dust.

1.5-20cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.4, light brownish grey, 10 YR 6/2, sandy loam.

23cm onwards highly pedal, earthy, coherent, bleached, non-calcareous, pH 6.8, light reddish brown, 5 YR 6/4, medium clay.

Comments

Soil reaction trend—neutral, moderately well drained, Northcote classification Dy 5.12.

Loc. 2.28

As for loc. 2.24 with *Exocarpus aphyllus* and *Melaleuca lateriflora* prominent in stratum 2.

Loc. 2.29

As for loc. 2.24, watercourse with scattered *Callistemon phoeniceus* and *Hakea corymbosa*. Soil as for loc. 2.24 with seasonally poor drainage.

Loc. 2.30

As for loc. 2.24.

Loc. 2.31

As for loc. 2.24 with *Eucalyptus eremophila* prominent in stratum 1. Stratum 3 is replaced by *Spartochloa scirpoidea* sedge to 0.5m tall, 30-70% canopy cover. Location follows a shallow watercourse. Soil is reddish brown 5 YR 5/4 sandy loam. Code is eKSi.mn₁SAc.n₂VLC/SL n₁ = *Exocarpus aphyllus*, n₂ = *Spartochloa scirpoidea*.

□ Loc. 2.32

As for loc. 2.33 but *Casuarina acutivalvis* makes up 10-20% of stratum 1. Stratum is 4-6m tall, 10-30% canopy cover. Stratum 2 has *Isopogon polycephalus*, *Hakea falcata*, *Calothamnus quadrifidus* and *Petrophile ericifolia* prominent. Stratum 0.5-1.5m tall, 30-70% canopy cover. Stratum 3 is absent. Soil is light grey, 10 YR 7/2, clayey sand. Code is eKSi.xSBi/CLS.

□ Loc. 2.33

Key Description.

Open Shrub Mallee over Low Scrub B over Low Heath C on sandy loam.

Code eKSi.mSBi.mSCc/SL

Loc. Details.

Stratum 1. *Eucalyptus redunca*, *E. transcontinentalis* and occasional *E. eremophila* shrub mallee. All mature, stratum 4-7m tall, 10-30% canopy cover at sample point, average foliage density 30%.

Stratum 2. *Melaleuca uncinata*, *M. spicigera*, *Exocarpus aphyllus* shrubs, all mature, stratum 1.0-1.5m tall, 10-30% canopy cover at sample point, average foliage density 40%.

Stratum 3. *Melaleuca spicigera*, *M. lateriflora* shrubs prominent, several other species present. All mature, stratum 0.5-1m tall, 30-70% canopy cover at sample point, average foliage density 20%.

Comments.

Evidence of very old fire, no regeneration from seed apparent although *M. spicigera* occurs in both strata 2 and 3. No weeds or grass. Stand approaches 20 years old.

Litter.

Sparse, mostly terete and broad leaves and twigs. Mostly clumped beneath vegetation to 1cm deep, clumps 1-1.5m apart.

Soil.

ca 15cm friable soil overlying hard packed clay.

0-2cm soil plus organic dust; plant roots present.

3-7cm highly pedal, earthy, coherent, unbleached, non-calcareous, pH 6.4, light brownish grey, 10 YR 6/2, sandy loam; grains quartz, subangular, very poorly sorted; plant roots present.

10-12cm highly pedal, earthy, coherent, mottled bleached, non-calcareous, pH 6.8, light reddish brown, 5 YR 6/4, heavy clay; quartz grains to 3mm angular, poorly sorted, embedded within clay matrix; plant roots present.

Comments.

Both A and B horizons show the parent granite structure very clearly. Soil reaction trend—neutral, poorly drained; Northcote classification Dy 5.12.

Loc. 2.34

Key Description.

Very Open Tree Mallee *over* Low Scrub A *over* Dwarf Scrub D *over* Open Herbs *on* sandy clay loam.

Code eKTr.mcSAi.xSDi.nJi/SCL
n = *Borya nitida*

Loc. Details.

Stratum 1. *Eucalyptus redunca*, *E. transcontinentalis* tree mallee, both senescent, stratum 8-10m tall, 2-10% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *Casuarina acutivalvis* shrubs. Several other species present, all immature, stratum 1-2m tall, 10-30% canopy cover at sample point.

Stratum 3. *Hakea falcata*, *Hibbertia verrucosa* shrubs. Several other species present, all immature, stratum 0.3-0.5m tall, 10-30% canopy cover at sample point.

Stratum 4. *Borya nitida* herbs. Immature, stratum 0-10cm tall, 10-30% canopy cover at sample point.

Comments

No evidence of recent fire, weeds, grasses or regeneration from seed. Stand about 20 years old.

Litter

Sparse, mostly terete and broad leaves, clumped to 10cm deep beneath shrubs, clumps *ca* 3m apart.

Soil

Sandy clay loam.

Loc. 2.35

As for loc. 2.33; scattered clumps pass into loc. 4.12.

Loc. 2.36

As for loc. 2.34.

2.37

As for loc. 2.34.

Loc. 2.38

Understory as for loc. 2.34, all species immature. Mallees regrown 2-3m tall, *E. foecunda* and *E. redunca*. Land cleared by scrub rolling 5-6 years before

survey when adjacent farm boundary was not known accurately. Area ca 140m into reserve, and north to loc. 2.38 was cleared. Boundary later located, and land never ploughed or cropped but allowed to regrow.

□ **Loc. 2.39**

Originally as loc. 2.34, now as loc. 2.38. *Acacia sclerophylla* prominent in understory, not noted in older areas of loc. 2.35 and 2.34. Soil is brown, 10 YR 5/3 sandy clay loam with a high organic content due to rotting debris. Traces of charcoal in soil.

□ **Loc. 2.40**

Similar to loc. 2.18.

Area of rotten granite 120m by 60m (long axis north-south) with *Melaleuca undulata*, *Cryptandra* sp. indet. II and *Gastrolobium trilobum* shrubs to 1m tall, 2-10% canopy cover. Soil in fractures carries *E. eremophila* shrub mallee and *E. calycogona* trees together with *Melaleuca lateriflora* and *M. adnata* shrubs to 1m tall and *Baekkea* sp. nov. shrubs 0.5m tall. Where soils deepen, on the periphery of the granite zone, *Callitris canescens* is prominent. Some of the *E. calycogona* trees reach 10-13m tall and 60cm circumference at breast height. These trees have probably been protected from fire by the open nature of the granite area around them. Soil, where it occurs, is very gritty, light grey, 10 YR 7/2 clayey sand containing large pebbles and boulders of pegmatitic quartz.

□ **Loc. 2.41**

Key Description.

Open Shrub Mallee over Low Heath C over Open Dwarf Scrub D on gravelly sandy loam.

Code eKSi.mSCc.xSDr/KSL

Loc. Details.

Stratum 1. *Eucalyptus transcontinentalis*, *E. sheathiana* shrub mallees with scattered *Santalum acuminatum* trees. All immature, stratum 3-4m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata* shrubs, no other species present, immature, stratum 0.5-1m tall, 30-70% canopy cover at sample point.

Stratum 3. *Platysace maxwellii*, *Phebalium verrucosa*, *Daviesia colletioides* shrubs, all mature, stratum 0.1-0.4m tall, 2-10% canopy cover at sample point.

Comments

Area gives impression of being recent post-fire regeneration, although burnt timber, charcoal etc. is not apparent. Scattered tussock grasses present, no evidence of weeds. Stand is about 10 years old.

Litter

Sparse, mostly terete leaves, clumped to 1cm beneath shrubs, clumps *ca* 1m apart.

Soil

Pale brown, 10 YR 6/3, sandy loam with >80% gravel.

Loc. 2.42

As for loc. 2.24.

Loc. 2.43

As for loc. 2.41.

Loc. 2.44

As for loc. 2.40 but *Eucalyptus calycogona* do not exceed 4-5m in height.

Loc. 2.45

As for loc. 2.41.

Loc. 2.46

As for loc. 2.24; *Cryptandra parvifolia* prominent in stratum 3.

Loc. 2.47

As for loc. 2.41; scattered *E. foecunda*, *E. transcontinentalis* and *E. redunca* present. *E. sheathiana* absent.

Loc. 2.48

As for loc. 2.33 but only 4-5m tall. Stratum 2 is *ca* 60% *Melaleuca uncinata*.

Loc. 2.49

As for loc. 2.33. In some areas *Melaleuca uncinata* is replaced by *Acacia acuminata*. *M. uncinata* area soil as loc. 2.33 A horizon. *A. acuminata* area soil as loc. 2.33 B horizon.

Loc. 2.50

As for loc. 2.33, but 4-5m tall. Stratum 2 contains *ca* 80% *Melaleuca uncinata*. Scattered *E. salmonophloia* present.

Loc. 2.51

As for loc. 2.33.

Loc. 2.52

As for loc. 2.42.

Loc. 2.53

As for loc. 2.24. Scattered *Eucalyptus burracoppinensis* shrub mallee present.

Loc. 2.54

As for loc. 2.24. Scattered *Eucalyptus burracoppinensis* shrub mallee present.

□ **Loc. 2.55**

As for loc. 2.54.

□ **Loc. 2.56**

As for loc. 2.54.

□ **Loc. 2.57**

As for loc. 2.54.

□ **Loc. 2.58**

As for loc. 2.54.

□ **Loc. 2.59**

As for loc. 2.41; clumps of scattered *Eucalyptus burracoppinensis* and large areas of immature heath.

□ **Loc. 2.60**

As for loc. 2.24 but *Melaleuca undulata* and *M. adnata* prominent in Stratum. 2. Occasional *Gastrolobium spinosum* present.

□ **Loc. 2.61**

As for loc. 2.24; scattered *Eucalyptus burracoppinensis* shrub mallee present.

□ **Loc. 2.62**

Key Description.

Shrub Mallee over Dwarf Scrub C on medium clay.

Code eKSc.xSCi/MC

Loc. Details.

Stratum 1. *Eucalyptus transcontinentalis*, with scattered *E. calycogona* and *E. foecunda*. All immature, stratum 4-5m tall, 30-70% canopy cover at sample point.

Stratum 2. *Dodonaea bursariifolia*, *Melaleuca adnata* and *M. undulata* shrubs, all immature, stratum 0.5-1m tall, 10-30% canopy cover at sample point.

Comments

No evidence of recent fire, grasses or weeds. Mallees tend to be clumped into a large scale mosaic, clumps ca 30m across, 60-90m apart. *M. undulata* more prominent between clumps. Stand is about 10 years old.

Litter

Moderately abundant, mostly terete and broad leaves and twigs, clumped to 2cm deep beneath shrubs. Clumps 2m apart, except in mallee clumps, where it is continuous.

Soil

Brown, 10 YR 5/3 medium clay.

Loc. 2.63

As for loc. 2.33.

Loc. 2.64.

As for loc. 2.33.

Loc. 2.65

As for loc. 2.33.

Loc. 2.66

As for loc. 2.24 but scattered *Eucalyptus burracoppinensis* shrub mallee present.

Loc. 2.67

As for loc. 2.66.

Loc. 2.68

As for loc. 2.66.

Loc. 2.69

As for loc. 2.33 with scattered patches of loc. 2.137.

Loc. 2.70

As for loc. 2.69.

Loc. 2.71

As for loc. 2.69.

Loc. 2.72

As for loc. 2.33.

Loc. 2.73

As for loc. 2.24 with scattered *Eucalyptus burracoppinensis*.

Loc. 2.74

As for loc. 2.33.

Loc. 2.75

As for loc. 2.33. *Exocarpus aphyllus* prominent in stratum 2. Scattered *Melaleuca lateriflora* present.

Loc. 2.76

As for loc. 2.33.

Loc. 2.77

Key Description.

Shrub Mallee over Open Low Sedges over Herbs on sandy loam.

Code eKSc.nVLc.xJc/SL
n = *Spartochloa scirpoidea*

Loc. Details.

Stratum 1. *Eucalyptus eremophila* and scattered *E. foecunda* shrub mallee, both immature, stratum 2-3m tall, 30-70% canopy cover at sample point.

Stratum 2. *Spartochloa scirpoidea* sedge as an almost pure stand, immature, stratum 0-1m tall, 10-30% canopy cover at sample point.

Stratum 3. Restionaceae sp. 1 and Poaceae sp. 3, both senescent (mid-winter sample) stratum 0-20cm tall, 30-70% canopy cover at sample point.

Comments

This location and loc. 2.78 are unique on the Reserve as they have the only pure stands of *E. eremophila*, are the only locations apart from loc. 4.5 which have the second stratum dominated by a sedge and the third by Restionaceae and Poaceae. There is evidence of an old fire; no weeds are present. Stand is about 10 years old.

Litter

Sparse, mostly broad leaves, clumped beneath mallees to 2cm deep, piles ca 4m apart.

Soil

ca 30cm friable soil overlying compact clays.

0-1cm soil plus organic dust.

1.5-23cm highly pedal, sandy, strongly coherent, unbleached, non-calcareous, pH 6.4, light brownish grey, 10 YR 6/2, sandy loam. Grains are quartz, subangular to subrounded, poorly sorted; plant roots present.

25-30cm soil as above, slightly paler (=A2?); plant roots present.

30cm onwards dense, compact medium clay.

Comments

Soil reaction trend—acid, some pooling of water, Northcote classification (friable soil only) Uc.4.3.

Loc. 2.78

As for loc. 2.77.

Loc. 2.79

Key Description.

Open Tree Mallee over Heath A over Dwarf Scrub D on sandy clay loam.

Code eKTi.xSAc.xSDi/SCL

Loc. Details.

Stratum 1. 40% *Eucalyptus redunca*, 40% *E. falcata* and 20% *E. pileata* tree mallees and trees, all mature, stratum 8-10m tall, 30% canopy cover at sample point, average foliage density 35%.

Stratum 2. *Exocarpus aphyllus*, *Santalum acuminatum* and *Hakea scoparia* shrubs, all immature, stratum 1.5-2m tall, 30% canopy cover at sample point, average foliage density 40%.

Stratum 3. *Cryptandra parvifolia*, *Phebalium filifolium* and *verrucosa* hybrid, *Dodonea bursariifolia* shrubs, all immature, stratum 0.2-0.5m tall, 10-30% canopy cover at sample point, average foliage density 25%.

Comments

No evidence of burning in recent times. No evidence of weeds, grasses or human usage. See comments under loc. 1.2 and 4.5. Probably 10-20 years old.

Litter

Sparse, terete and broad leaves, twigs and bark, evenly distributed, with some clumping beneath vegetation to 2cm deep, clumps 1m apart.

Soil

ca 23cm friable soil overlying compact laterite.

0-2cm soil plus organic dust, some plant roots present.

3-19cm non-pedal, earthy, moderately coherent, unbleached, non-calcareous, pH 6.3, very pale brown, 10 YR 7/4 sandy clay loam containing occasional ferruginous pebbles to 10mm. Grains are quartz, subangular to sub-rounded, well sorted; plant roots present.

22-25cm as above, but proportion of gravel pebbles rises to 70-90%, and size ranges from 5mm to 30cm diameter; fine plant roots present.

25cm onwards compact laterite; plant roots absent.

Comments

Soil reaction trend—acid, well drained, Northcote classification Um1.21.

□ Loc. 2.80

As for loc. 2.5 with *Melaleuca uncinata* less prominent and *Exocarpus aphyllus* and *M. adnata* becoming more frequent.

□ Loc. 2.81

As for loc. 2.79.

□ Loc. 2.82

As for loc. 4.10, with scattered *Eucalyptus redunca* and *E. eremophila* to ca 3%.

□ Loc. 2.83

As for loc. 2.33 with scattered patches of *Eucalyptus burracoppinensis*.

MALLEE FORMATIONS: SOUTHERN PORTION

Loc. 2.84 (PLATE 1)

As for loc. 2.1.

Loc. 2.85

As for loc. 2.1.

Loc. 2.86 (TRAPLINE 4)

As for loc. 2.3.

Code eKSi.mSAc.xSDi/FSL

Loc. 2.87

Regrowth shoots on mallee to 0.5m tall. Understory regrowth to maximum of 40cm tall. Prominent species are *Adenanthos argyreae*, *Choretrum glomeratum*, *Cryptandra* sp. 2, *Dryandra cirsioides*, *Grevillea hookerana*, and several other species. Scattered *Conospermum amoenum* present. Average foliage density of regrowth 30%. Original vegetation probably similar to loc. 2.3. Soil as for loc. 2.3.

Loc. 2.88

As for loc. 2.87.

Loc. 2.89

As for loc. 2.87.

Loc. 2.90

As for loc. 2.87 with mallee regrowth to 1m tall (probably *E. foecunda*). Average foliage density 28%.

Loc. 2.91

As for loc. 2.87 with mallee regrowth to 1m tall (probably *E. foecunda*) but scattered *E. transcontinentalis* also present.

Loc. 2.92

As for loc. 2.87; original vegetation probably as for loc. 2.15.

Loc. 2.93

As for loc. 2.15.

Loc. 2.94

Similar to loc. 4.7 but upper stratum of *Eucalyptus foecunda* 2-3m tall, 10-30% canopy cover.

Code eKSi.xSr.xSBi/SCL

Loc. 2.95 (TRAPLINE 12)

As for loc. 2.94.

□ Loc. 2.96

As for loc. 2.87 but mallee probably *E. foecunda*.

□ Loc. 2.97

As for loc. 2.87; possibly two species of mallee in regrowth.

□ Loc. 2.98

Similar to 2.13 in northern part, passing into a heath similar to loc. 4.7 dominated by *E. foecunda* and *E. transcontinentalis* towards the south.

□ Loc. 2.99

As for loc. 2.15.

□ Loc. 2.100

As for loc. 2.24 but dominant mallee is *E. redunca*. Understory is almost wholly *Melaleuca uncinata*. A solitary specimen of *Actinostrobus arenarius* was found here. Soil is yellowish brown, 10 YR 5/4, sandy clay loam.

□ Loc. 2.101

As for loc. 2.94.

□ Loc. 2.102

As for loc. 2.87.

□ Loc. 2.103

Regrowth as for loc. 2.87. Scattered patches of regrowing mallee.

□ Loc. 2.104

As for loc. 2.87 with *Dryandra ferruginea*, *Dampiera* sp. 1, *Grevillea eryngioides* and *Melaleuca lateritia* prominent in regrowth. Soil as loc. 2.3.

□ Loc. 2.105

Key Description.

Dense Shrub Mallee over Open Low Scrub A on sandy clay loam.

Code eKSd.mSAr/SCL

Loc. Details.

Stratum 1. *Eucalyptus incrassata* and *E. cylindriflora* shrub mallee, both immature, stratum 4-6m tall, 70-100% canopy cover at sample point.

Stratum 2. *Melaleuca undulata* and *M. eleutherostachya* shrubs, both senescent, stratum 1-2m tall, 2-10% canopy cover at sample point.

Comments

Occasional senescent *E. redunca* shrub mallee present, average height 10-12m. No evidence of weeds, grasses or human usage. Evidence of very old fire scars on *E. redunca*. Stand is about 10 years old.

Litter

Abundant, evenly distributed, clumped beneath mallee and shrubs to 1cm deep. All components and considerable quantities of large debris present. Litter piles continuous.

Soil

ca 30cm friable soil overlying compact laterite.

0-30cm highly pedal, sandy, coherent, mottled bleached, non-calcareous, pH 6.5, brown, 10 YR 5/3, sandy clay loam. Grains are quartz, poorly sorted, subrounded; plant roots present.

30cm onwards compact laterite.

Comments

Soil reaction trend—acid, poorly drained.

Loc. 2.106

As for loc. 2.24 with modifications of 2.100.

Loc. 2.107

As for loc. 2.24 with modifications of 2.100.

Loc. 2.108

As for loc. 2.24 but *Melaleuca uncinata* in understory largely replaced by *M. spicigera*. Soil as for loc. 2.24.

Loc. 2.109

As for loc. 2.87 *Conospermum amoenum* absent. Original vegetation probably as for loc. 2.33.

Loc. 2.110

Regrowth as for loc. 2.87. Original vegetation probably similar to loc. 3.1 with many scattered patches of *Eucalyptus eremophila* and *E. burra-coppinensis*. *Beaufortia orbifolia* common in regrowth. Soil as for loc. 2.3 A horizon but >80% gravel. Passes into compact laterite at 15-20cm.

Loc. 2.111

As for loc. 2.24.

Loc. 2.112.

As for loc. 2.24 with modifications of loc. 2.100.

Loc. 2.113

As for loc. 2.33. Stratum 2 with prominent *Melaleuca uncinata*. Soil as for loc. 2.1.

Loc. 2.114

As for loc. 2.33 with scattered *Casuarina acutivalvis* and some *Dryandra cirsioides* where laterite content of soil increases.

□ Loc. 2.115

Immature *Eucalyptus transcontinentalis* and *E. foecunda* shrub mallee, stratum 2-3m tall, 10-30% canopy cover. Virtually no understory except a few heathy species of the types found in loc. 2.24. Regrowth to 0.5m tall. Some areas with *Melaleuca uncinata* and *Hakea scoparia* prominent in understory. Area burnt in summer of 1961/62. Soil is pH 6.5, 10 YR 6/4, sandy clay loam; ca 20cm deep over laterite.

□ Loc. 2.116

As for loc. 2.115 but *E. annulata* also present. *Melaleuca uncinata* and *Hakea lissocarpa* prominent in understory.

□ Loc. 2.117

Transition between loc. 2.116 and loc. 2.118.

□ Loc. 2.118

Key Description.

Open Shrub Mallee over Dwarf Scrub C on sandy loam.

Code eKSi.mSCi/SL

Loc. Details.

Stratum 1. *Eucalyptus foecunda* and *E. transcontinentalis* shrub mallee, both immature, stratum 2-3m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata* and *M. cordata* shrubs. Occasional *Cryptandra parvifolia* present, all immature, stratum 0-1m tall, 10-30% canopy cover at sample point.

Comments

Some of the *Melaleuca* are regenerated from seed. No evidence of weeds, grass or human usage. Stand is about 10-14 years old.

Litter

Moderately abundant, mostly broad leaves, clumped beneath vegetation to 3cm deep, clumps ca 2m apart.

Soil

Light brown 7.5 YR 6/4, sandy loam.

□ Loc. 2.119

Eucalyptus celastroides and *E. transcontinentalis* shrub mallee, 10-30% canopy cover, with scattered *E. gardneri* trees 4-5m tall, over *Melaleuca uncinata* and *M. undulata* shrubs 1.5m tall, 10-30% canopy cover. Located on slight ridge with lateritic clay loam soil.

Code eKSi.mSBi/KCL



Plate 1. Transition between loc. 1.14 and 2.84 showing *Eucalyptus gardneri* trees which penetrate a short way into the mallee area (to right of picture). Understorey species comprise *Hakea multilineata* (emergent, derived from loc. 2.2), *Melaleuca laxiflora* (blue-grey foliage), *Melaleuca uncinata* (pale green) and *Exocarpos aphyllus* (hemi-parasite, yellow foliage in left foreground).



Plate 2. *Acacia lasiocalyx* stand at loc. 1.23. Although only 2-4m tall, the tree life-form is obvious. The stand is only 10-30% canopy cover although the general appearance is of a much denser canopy cover. Understory species are *Acacia sedifolia* and *Grevillea asteriscosa*.



Plate 3. Loc. 2.3 showing a mallee association typical of a large portion of the Reserve. The canopy comprises *Eucalyptus redunca*, *E. transcontinentalis* and some *E. pileata* (yellow-green foliage) mallee. Understory species are *Melaleuca uncinata* (green foliage) and *Exocarpus aphyllus* (yellow foliage). In the foreground are a grey foliated *M. laxiflora* and a darker *M. adnata*.

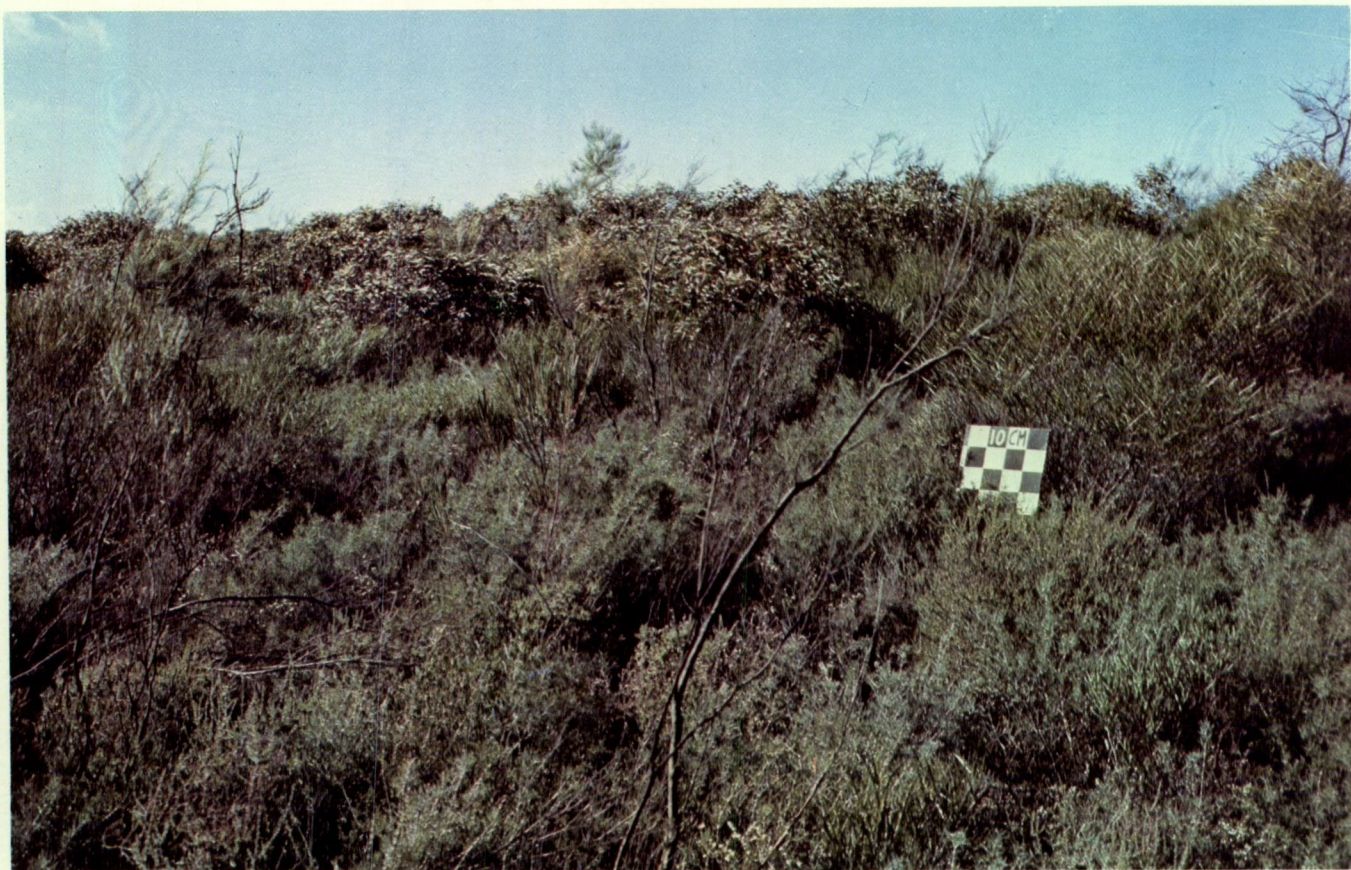


Plate 4. Loc. 2.164, illustrating a typical *Eucalyptus burracoppinensis* mallee association on Bendering Reserve. Numerous clumps of *E. burracoppinensis* are scattered over a heath-like understory of many species of shrubs. Occasional *Grevillea eriostachya* or *Hakea coriacea* stand above the mallee stratum at this loc.



Plate 5. A *Casuarina acutivalvis* dominated shrubland at loc. 3.1. Occasional scattered *Eucalyptus foecunda* mallee are present. The understory in this type of association is commonly heath-like and is dominated by species with blue-green foliage, particularly *Isopogon polycephalus* (shown in right foreground).



Plate 6. Loc. 4.7 illustrating a heath of the type found on shallow lateritic soils. The sparse yellow-green trees in the left background are *Acacia lasiocalyx*; the dense tree on the right *Santalum acuminatum*.

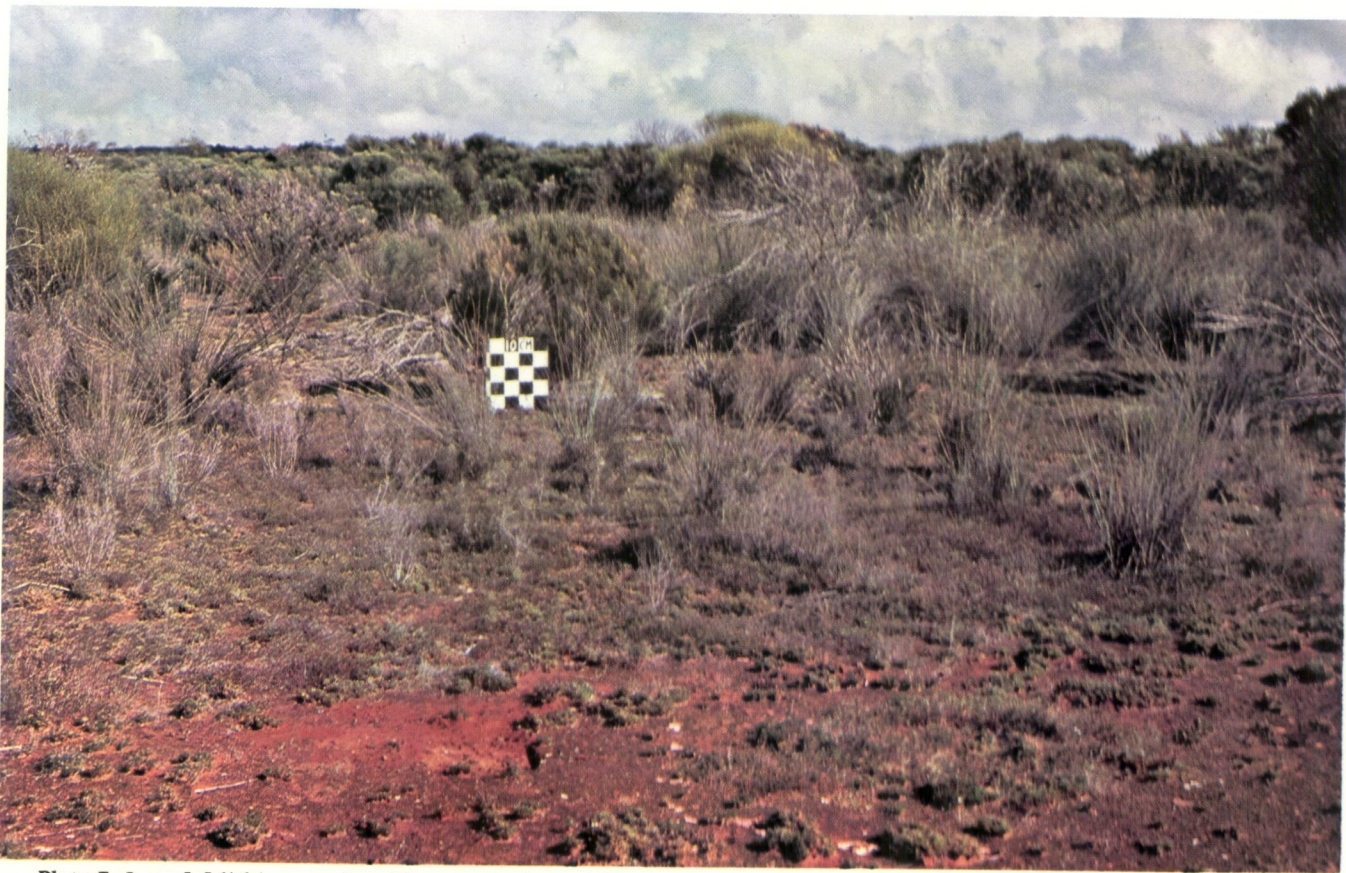


Plate 7. Loc. 5.5 lithic complex. The grass is *Spartochloa scirpoidea*, the dark green shrubs *Casuarina campestris* and the bright green shrubs are stunted, densely foliated *Acacia lasiocalyx*. In the foreground is *Borya nitida*.



Plate 8. Breakaway complex near loc. 4.3. This profile and structure is typical of breakaway complexes on Bending Reserve. The tree is *Callitris verrucosa* and most of the shrubs *Grevillea huegellii*. The dense, blue green foliated shrubs are *Melaleuca undulata*. The pallid zone of kaolinised granite lies beneath a crust of laterite 1-1.5m thick. Almost all soils on Bending Reserve are derived from either the pallid zone clays or the laterite, or mixtures of both.

Loc. 2.120

As loc. 2.118 with scattered *Eucalyptus gardneri* trees 2-5m tall; occasional *Callitris canescens* present.

Loc. 2.121

As loc. 2.118. Mallees may reach 5-6m tall, and up to 30-70% canopy cover. Scattered *Eucalyptus salmonophloia* present.

Loc. 2.122

Regrowth shoots on mallees to 0.5m tall, understory regrowth 30-40cm tall. *Choretrum glomeratum*, *Cryptandra* sp. 1, *Dryandra cirsioides*, *Grevillea integrifolia*, *Hakea ambigua*, *H. falcata*, *H. lissocarpha*, *Lepidosperma gracile*, *Melaleuca spathulata*, and *M. uncinata* shrubs. Most abundant fire induced species is *Dampiera* sp. 1. Basically as for loc. 2.87. Soil as for loc. 2.3.

Loc. 2.123

As for loc. 2.122.

Loc. 2.124

Eucalyptus redunca shrub mallee 10-30% canopy cover and occasional *E. gardneri* and *Santalum acuminatum* trees over an understory similar to that described for stratum 2 of loc. 3.14. Soil fine sandy loam.

Code eKSi.xSCr/FSL.

Loc. 2.125

As for loc. 2.33.

Loc. 2.126

Eucalyptus eremophila and scattered *E. redunca* shrub mallee over *Melaleuca cardiophylla* and *M. affin scabra* shrubs. All species growing opportunistically in soil filled crevices or in depressions on the granite where soil has accumulated. Much rotten granite outcropping beneath and between trees, some with shallow soil filled depressions supporting *Drosera* spp. and mosses in the wet season.

Loc. 2.127

As for loc. 2.122.

Loc. 2.128

As for loc. 2.122.

Loc. 2.129

Basically as for loc. 2.24 with *Eucalyptus redunca*, *E. transcontinentalis*, *E. annulata*, and occasional *E. calycogona* over an understory in which *Melaleuca uncinata* is prominent. Soil as for loc. 2.24.

Loc. 2.130

As for loc. 2.24.

Loc. 2.131

As for loc. 2.122.

Loc. 2.132

As for loc. 2.87.

Loc. 2.133

As for loc. 2.87.

Loc. 2.134

As for loc. 2.24.

Loc. 2.135

As for loc. 2.24.

EUCALYPTUS BURRACOPPINENSIS MALLEE FORMATIONS:
NORTHERN PORTION

Loc. 2.136

Key Description.

Open Shrub Mallee *over* Dense Low Heath *on* fine sandy loam.

Code eKSi.mSCd/FSL

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis*, *E. foecunda* shrub mallee with occasional *Acacia desertorum* trees and *E. pileata* mallee. All species immature, stratum 2-3m tall, 10-30% canopy cover at sample point.

Stratum 2. *Melaleuca uncinata*, *M. spathulata* shrubs with occasional *Gastrolobium spinosum* shrubs, all immature, stratum 0.2-1m tall, 70-100% canopy cover at sample point.

Comments

Many coppiced regrown plants and seedlings, no weeds, grasses or human utilisation. Stand is about 10 years old.

Litter

Sparse, mostly terete leaves, clumped beneath vegetation to 0.5cm deep, clumps *ca* 0.5m apart.

Soil

Brownish yellow, 10 YR 6/6, fine sandy loam.

□ Loc. 2.137 (TRAPLINE 11)

Key Description.

Very Open Shrub Mallee over Dense Low Heath D on fine sandy loam.

Code eKSr.xSDd/FSL.

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis* shrub mallee, and *Acacia desertorum* trees. *Santalum acuminatum* and *Micromyrtus imbricata* emergent from stratum 2. All species immature, stratum 1-2m tall, 2-10% canopy cover at sample point. Average foliage density 15%.

Stratum 2. *Dryandra ferruginea*, *Petrophile seminuda* and *Melaleuca pungens* shrubs. Many other species present, all immature, stratum 0.1-0.5m tall, 70-100% canopy cover at sample point. Average foliage density 60%.

Comments

No evidence of fire, regeneration from seed, weeds, grasses or human utilisation. *Dryandra* affin. *cirsioides* becomes more abundant where laterite closer to surface. Stand is about 10 years old.

Litter

Sparse, mostly terete leaves and twigs, clumped beneath vegetation to 0.5cm, clumps 0.5m apart.

Soil

ca 23cm friable soil overlying compact laterite.

0-0.5cm soil plus organic dust; plant roots absent.

1-22cm pedal, earthy, moderately coherent, unbleached, non-calcareous, pH 5.9, brownish yellow, 10 YR 6/6 fine sandy loam. Grains are quartz, subangular to subrounded, poorly sorted. fine plant roots present. Laterite gravel <10%.

24cm onwards earthy to nodular ferruginous pebbles and boulders, virtually impenetrable. No plant roots present.

Comments

Soil reaction trend—acid, poorly drained, Northcote classification of friable soil Uc4.12.

□ Loc. 2.138

As for loc. 2.137.

□ Loc. 2.139

As for loc. 2.137.

□ Loc. 2.140

Stratum 1 as for loc. 2.137. Stratum 2 with *Melaleuca uncinata*, *M.* affin.

scabra, *Dryandra cirsioides* and *M. spathulata* prominent. Occasional *E. cylindriflora* and *E. celastroides* present.

Loc. 2.141

As for loc. 2.137.

Loc. 2.142

Key Description.

Shrub Mallee over Dwarf Scrub C over Dwarf Scrub D on fine sandy loam.

Code eKSc.xSCi.xSDi/FSL.

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis*, *E. foecunda* shrub mallees, *Melaleuca uncinata* and *Casuarina acutivalvis* shrubs, all immature, stratum 2-3m tall, 30-70% canopy cover at sample point.

Stratum 2. *Grevillea hookerana*, *Melaleuca pungens*, *Gastrolobium spinosum* and *Hakea falcata* shrubs. All species immature, stratum 0.5-1m tall, 10-30% canopy cover at sample point.

Stratum 3. *Melaleuca spathulata*, *Beaufortia bracteosa* and *Daviesia aphylla* shrubs, all immature, stratum 0-0.5m tall, 10-30% canopy cover at sample point.

Comments

No evidence of recent fire, although all vegetation appears immature. No weeds, grasses or human utilisation. Stand is about 10 years old.

Litter

Sparse, mostly terete and broad leaves, clumped beneath vegetation to 0.5cm deep, clumps 2-3m apart.

Soil

Light yellowish brown, 10 YR 6/4, fine sandy loam.

Loc. 2.143

As for loc. 2.142 with some *Eucalyptus redunca* and *E. transcontinentalis* shrub mallee present in stratum 1. Mallees reach 5m tall in north-west corner and probably represent edge of transition zone from the *E. burracoppinensis* dominated association on the Reserve to a *E. redunca*/*E. transcontinentalis* shrub mallee, which was located where the road and cleared paddocks now stand.

Loc. 2.144

Key Description.

Very Open Shrub Mallee over Dense Thicket over Dwarf Scrub C on sandy clay loam.

Code eKSr.aSd.xSCi/SCL

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis*, *E. pileata* shrub mallee and *Casuarina acutivalvis* shrubs. Some *Acacia acuminata* emergents from stratum 2. All species immature, stratum 4-5m tall, 2-10% canopy cover at sample point.

Stratum 2. *Acacia acuminata* shrubs, immature, stratum 1-3m tall, 70-100% canopy cover at sample point.

Stratum 3. *Melaleuca cordata*, *Hakea scoparia*, *Acacia subsulcata* shrubs, all immature, stratum 0-1m tall, 10-30% canopy cover at sample point.

Comments

Evidence of recent fire in area; scrub is regrowth with some seed regeneration. No weeds or grasses present. Small bare area within this location contains *Melaleuca cuticularis* only. Stand is 10-20 years old.

Litter

Moderately abundant, mostly broadleaves and twigs, clumped beneath vegetation to 2cm deep, clumps 1-1.5m apart.

Soil

Light yellowish brown 10 YR 6/4 sandy clay loam.

Loc. 2.145

As for loc. 2.144. Between loc. 2.144 and loc. 2.145 is a small belt of *Eucalyptus foecunda* and *E. eremophila* shrub mallee, 4-5m tall, 2-10% canopy cover over *Acacia acuminata*, *Melaleuca uncinata* shrubs 1-3m tall, 70-100% canopy cover. Scattered *Santalum acuminatum* present. Soil here is light yellowish brown, 10 YR 6/4 sandy clay loam.

Loc. 2.146

As for loc. 2.144. Some *Acacia acuminata* regrowth. Soil as for loc. 2.144.

Loc. 2.147

As for loc. 2.137.

Loc. 2.148

Key Description.

Very Open Shrub Mallee over Scrub over Dwarf Scrub C over Open Dwarf Scrub D on fine sandy loam.

Code eKSr.xSi.xSCi.xSDr/FSL

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis* shrub mallees, with some *Acacia acuminata* trees, and *Casuarina acutivalvis* shrubs and occasional *Santalum acuminatum* trees. All senescent, stratum 3-4m tall, 2-10% canopy cover at sample point.

Stratum 2. *Hakea adnata*, *H. scoparia* and *Grevillea hookerana* shrubs, several other species present, all immature, stratum 2-3m tall, 10-30% canopy cover at sample point.

Stratum 3. *Melaleuca pungens*, *M. cordata* and *Beaufortia bracteosa* shrubs. Several other species present, all senescent, stratum 0.5-1m tall, 10-30% canopy cover at sample point.

Stratum 4. *Astartea heteranthera*, *Verticordia chrysanthera* shrubs. *Hibbertia lineata* and *Gastrolobium spinosum* shrubs also present, all immature, stratum 0-0.5m tall, 2-10% canopy cover at sample point.

Comments

No evidence of recent fire, or regeneration. No weeds, grasses or evidence of human utilisation. Stand is almost 20 years old.

Litter

Abundant, mostly terete leaves and large debris clumped beneath vegetation to *ca* 2cm deep, clumps 1-2m apart.

Soil

Brownish yellow, 10 YR 6/6 fine sandy loam.

□ Loc. 2.149

As for loc. 2.137 but *Acacia desertorum* absent from stratum 1. Occasional *Dryandra* affin. *cirsioides* present in stratum 2. Between this loc. and loc. 2.155 are a few low gravelly knolls with *Casuarina acutivalvis* prominent. Soil at loc. 2.149 as for loc. 2.137 but laterite content *ca* 30%.

□ Loc. 2.150

Basically as for loc. 2.137 but without the *Acacia desertorum* and *Santalum acuminatum* in stratum 1. *Dryandra* affin. *cirsioides* abundant in stratum 2. Soil as for loc. 2.137. Gravel content *ca* 50%.

□ Loc. 2.151

As for loc. 2.137 but with modifications of loc. 2.150.

□ Loc. 2.152

As for loc. 2.148 with *Gastrolobium spinosum* and *Grevillea hookerana* prominent in lower strata. Soil as for loc. 2.148.

□ Loc. 2.153

As for loc. 2.148.

□ Loc. 2.154

As for loc. 2.137 with modifications of loc. 2.150.

□ Loc. 2.155

As for loc. 2.137 but omitting *Acacia desertorum* in stratum 1. Occasional

Dryandra affin. *cirsioides* in stratum 2. *Eucalyptus burracoppinensis* thins out, and area becomes heathlike in small areas on gravelly knolls.

□ Loc. 2.156

As for loc. 2.137 as a mosaic with large areas of type 2.24 mallee.

□ Loc. 2.157

As for loc. 2.137 as a mosaic with large areas of type 2.24 mallee.

□ Loc. 2.158

As for loc. 2.137 with modifications of loc. 2.149.

**EUCALYPTUS BURRACOPPINENSIS MALLEE FORMATIONS:
SOUTHERN PORTION**

□ Loc. 2.159

Key Description.

Shrub Mallee over Low Scrub A on fine sandy clay loam.

Code eKSc.xSAi/FSCL.

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis* shrub mallee and *Casuarina acutivalvis* shrubs, both senescent, stratum 6-8m tall, 30-70% canopy cover at sample point. Average foliage density 15%.

Stratum 2. *Gastrolobium spinosum*, *Hakea falcata* and *Melaleuca uncinata* shrubs, many other species present, all senescent, stratum 1-2m tall, 10-30% canopy cover at sample point. Average foliage density 25%.

Comments

Some *Hakea falcata* regenerating from seed. No weeds present but occasional grasses (Poaceae sp. 2). Evidence of old fire scars. Stand is 10-20 years old.

Litter

Abundant, comprising terete and broad leaves, bark, twigs and large debris. Litter clumped beneath vegetation to ca 2cm deep, clumps 1m apart.

Soil

ca 70cm friable soil overlying laterite.

0-2cm soil plus organic dust.

4-20cm highly pedal, earthy, moderately coherent, bleached (3-5mm blotches), non-calcareous, pH 5.9, brownish yellow, 10 YR 6/6, fine sandy clay loam. Coarse fraction (ca 10%) of large quartz grains, ferruginous sandy nodules and carbonised root fragments. Grains are quartz and ferruginous particles, subangular to rounded, poorly sorted; plant roots present.

22-40cm as above, but pH 5.6 and containing *ca* 60% lateritic pebbles from 0.5 to 5cm diameter. Grains are quartz and limonitic particles subangular to rounded, very poorly sorted; plant roots present.

40cm onwards, as above, with laterite pebble content increasing with depth.

Comments

Soil reaction trend—acid, well drained, Northcote classification Um6.23.

Loc. 2.160

As for loc. 2.159.

Loc. 2.161

As for loc. 2.87 regrowth area but mallee regrowth is *Eucalyptus burracoppinensis* to 0.5m tall. *Hakea scoparia*, *Goodenia pinifolia*, *Petrophile scabriuscula*, *Casuarina acutivalvis* and *Melaleuca uncinata* prominent in regrowth understory. *H. scoparia* and *G. pinifolia* with most rapid recruitment. Soil as loc. 2.3 with laterite content of A horizon about 30-40%.

Loc. 2.162

Eucalyptus burracoppinensis and some *Grevillea eriostachya* prominent in stratum 1.

Loc. 2.163

As for loc. 2.137. Occasional small lateritic knolls with abundant *Dryandra* affin. *cirsioides*.

Loc. 2.164 (TRAPLINES 5, 14, 15) (PLATE 4)

Key Description.

Open Shrub Mallee over Low Heath C on light sandy clay loam.

Code eKSi.xSCc/SCL

Loc. Details.

Stratum 1. *Eucalyptus burracoppinensis* shrub mallee, *Hakea coriacea* and *Santalum acuminatum* trees, *Casuarina acutivalvis* and *Acacia signata* shrubs. All immature, stratum 1.5-2.5m tall, 10-30% canopy cover at sample point. Average foliage density 20%.

Stratum 2. *Melaleuca pungens* and *M. spathulata* shrubs, several other species present, all immature, stratum 0.5-1m tall, 30-70% canopy cover at sample point. Average foliage density 25%.

Comments

No evidence of weeds, grasses or human utilisation. Evidence of recent fire scars. All species immature in appearance, except *Grevillea eriostachya*, which is senescent. Occasional *Hakea multilineata* and *G. eriostachya* emergent above stratum 1. Stand is about 10 years old.

Litter

Abundant, mostly terete and broad leaves and twigs, clumped beneath vegetation to *ca* 2cm deep, clumps *ca* 1m apart.

Soil

ca 60cm friable soil.

0-2cm soil plus organic dust.

3-10cm highly pedal, sandy, coherent, unbleached, non-calcareous, pH 6.1, brownish yellow, 10 YR 6/6, sandy clay loam. Grains are quartz, subrounded, well sorted; plant roots present.

13-50cm moderately pedal, sandy, coherent bleached (circular patches 1-2.5cm diameter) non-calcareous, pH 5.6, yellow, 10 YR 7/6, light sandy clay loam. Grains are quartz and limonitic fragments, subrounded, well sorted; plant roots present.

Comments

Soil reaction trend—acid, excessively well drained, Northcote classification Gn4.81.

Loc. 2.165

As for loc. 2.164.

Loc. 2.166

As for loc. 2.159.

SHRUBLAND FORMATIONS: NORTHERN PORTION

Loc. 3.1 (TRAPLINE 3) (PLATE 5)

Key Description.

Scrub *over* Low Scrub A *over* Low Heath D *over* Very Open Mat Plants on sandy clay loam.

Code cSi.xSAi.xSDc.n₁Pr/SCL
n₁ = Cyperaceae gen. nov.

Loc. Details.

Stratum 1. *Casuarina acutivalvis* shrubs and some *Eucalyptus foecunda* shrub mallee, both species immature, stratum 2-4m tall, 10-30% canopy cover at sample point. Average foliage density 32%.

Stratum 2. *Hakea falcata*, *Petrophile ericifolia*, *Persoonia striata* and *Grevillea hookerana* shrubs. Several other species present, all immature, stratum 1-2m tall, 10-30% canopy cover at sample point. Average foliage density 25%.

Stratum 3. *Melaleuca pungens*, *Dryandra ferruginea*, *Daviesia acanthoclona* and *Micromyrtus imbricata* shrubs. Several other species present, all immature, stratum 0.3-0.5m tall, 30-70% canopy cover at sample point. Average foliage density 35%.

Stratum 4. Cyperaceae gen. nov. mat plants and *Harperia lateriflora* sedge immature, stratum 0-10cm tall, 2-10% canopy cover at sample point. Compact cushionlike mats of interwoven plants.

Comments

No evidence of fire in recent times. Some indications of *Eucalyptus foecunda* regenerated from seed. Occasional *E. foecunda* and *Casuarina acutivalvis* emergent to 6m. Weeds and grasses absent. Stand is 10-20 years old.

Litter

Moderately abundant, mostly terete leaves and twigs clumped beneath vegetation to 1cm deep, clumps ca 0.5m apart.

Soil

ca 15cm friable soil overlying compact laterite.

0-1cm soil plus organic dust, some plant roots.

2-15cm non-pedal, earthy, moderately coherent, unbleached, non-calcareous, pH 6.6, light yellowish brown, 10 YR 6/4, sandy clay loam; grains are quartz, angular to subangular, poorly sorted; plant roots present.

17cm onwards hard compact laterite with abundant coarse quartz grains; plant roots absent.

Comments

Soil reaction trend—neutral, poorly drained, Northcote classification Um1.41.

Loc. 3.2

As for loc. 3.6 but *Melaleuca uncinata* and *Casuarina acutivalvis* prominent in stratum 1. Stratum 1 30-70% canopy cover. Lower strata and soil as for loc. 3.6.

Loc. 3.3

As for loc. 3.6. Some *Callitris canescens* present. Southern boundary of this loc. with *Acacia sedifolia* and *Acacia* sp. 1 in transition zone. Soil as loc. 3.6.

Loc. 3.4

As for loc. 3.1 with *Casuarina acutivalvis*, *Grevillea hookerana*, *Hakea multilinea* and *Acacia lasiocalyx* in stratum 1. *A. lasiocalyx* appears to be recent seed regeneration. Soil as for loc. 3.1.

□ Loc. 3.5

As for loc. 3.1 but stratum 1 exclusively *Casuarina acutivalvis* 70-100% canopy cover. Soil as for loc. 3.1 but ca 50% laterite in A horizon.

□ Loc. 3.6

Key Description.

Dense Thicket over Dwarf Scrub C over Very Open Mat Plants on sandy loam.

Code eSd.mSCi.n₁Pr/SL
n₁ = Cyperaceae gen. nov.

Loc. Details.

Stratum 1. *Casuarina acutivalvis* and occasional *C. campestris* shrubs, both immature stratum 1-4m tall, 30-70% canopy cover at sample point. Average foliage density 40%.

Stratum 2. *Melaleuca spicigera* shrubs, several other species present, all senescent, stratum 0.3-0.8m tall, 10-30% canopy cover at sample point. Average foliage density 15%.

Stratum 3. Cyperaceae gen. nov. mat plants. Senescent, stratum 0-20cm tall, 2-10% canopy cover at sample point.

Comments

Evidence of recent fire, some *Casuarina acutivalvis* regenerated from seed. No weeds, grasses or evidence of human utilisation. Stand is about 20 years old.

Litter

Sparse, terete leaves and twigs, mostly clumped beneath vegetation to ca 2cm deep. Clumps ca 1-2m apart.

Soil

ca 20-25cm friable soil overlying dense compact laterite.

0-1cm soil plus organic dust; some plant roots.

5-10cm pedal, earthy, moderately coherent, unbleached, non-calcareous pH 6.6, pale brown, 10YR 6/3, sandy loam. Grains are quartz and small rock fragments subrounded to rounded, poorly sorted; plant roots present.

15cm onwards, ferruginous pebbles to 15mm, >90% with 5-10cm zone soil as matrix. The laterite percentage increases with depth to 100%; plant roots absent.

Comments

Soil reaction trend - neutral, poorly drained, Northcote classification Uml.4l.

Loc. 3.7

As for loc. 3.6 with *Casuarina campestris* a little more abundant. *Acacia acuminata* and scattered *Eucalyptus burracoppinensis*. This area has been at climax for some time.

Loc. 3.8

As for loc. 3.1 with scattered *Callitris canescens* shrubs and *E. cylindriflora* mallees. Situated on slight rise. Soil with abundant quartz pebbles.

Loc. 3.9

As for loc. 3.6.

Loc. 3.10

As for loc. 3.6 but with *Casuarina corniculata* prominent. *Santalum acuminatum* abundant in boundary zone between loc. 3.10 and loc. 2.34.

Loc. 3.11

As for loc. 3.12.

Loc. 3.12

Key Description.

Dense Thicket over Dwarf Scrub C on sandy clay loam.

Code aSd.xSCi/SCL

Loc. Details.

Stratum 1. *Acacia acuminata* shrubs, immature, stratum 1-3m tall, 70-100% canopy cover at sample point.

Stratum 2. *Melaleuca cordata*, *Hakea scoparia* and *Acacia sulcata* shrubs, all immature, stratum 0-1m tall, 10-30% canopy cover at sample point.

Comments

Burnt sticks indicate recent fire. *Acacia acuminata* probably represents post-fire regeneration. Few scattered *Eucalyptus burracoppinensis* present. Stand is 10-15 years old.

Litter

Moderately abundant, mostly broad leaves, clumped beneath vegetation to 1-2cm deep, clumps 1-1.5m apart.

Soil

Light yellowish brown, 10 YR 6/4 sandy clay loam. Uniform profile, neutral soil reaction trend.

Loc. 3.13

As for loc. 3.1, with *Grevillea hookerana*, *Casuarina acutivalvis*, *Hakea multilineaata* and *Acacia lasiocalyx* prominent. Soil as for loc. 3.1.

SHRUBLAND FORMATIONS: SOUTHERN PORTION

□ Loc. 3.14

Key Description.

Thicket *over* Open Dwarf Scrub C *on* fine sandy loam.

Code aSc.xScR/FSL

Loc. Details.

Stratum 1. *Acacia acuminata*, *Casuarina acutivalvis*, and *C. corniculata* shrubs. Occasional *Hakea multilineata* trees present. All species senescent, stratum 2-3m tall, 70-100% canopy cover at sample point. Average foliage density 32%.

Stratum 2. *Phebalium verrucosa* and *Bertya cunninghami* shrubs. Several other species present, all senescent, stratum 0.5-1m tall, 2-10% canopy cover at sample point. Average foliage density 25%.

Comments

Occasional *Eucalyptus gardneri* trees scattered throughout location. Some *Casuarina acutivalvis* and *Hakea multilineata* emergent from stratum 1. No weeds, grasses or human utilisation. Evidence of very old fire scars visible. Stand is older than 20 years.

Litter

Abundant, evenly distributed with some clumping to 2cm deep beneath vegetation. Mostly broad leaves and twigs with some large debris.

Soil

>60cm friable soil.

0-2cm soil plus organic dust.

3-60cm yellowish brown, 10 YR 5/6 fine sandy loam.

Comments

Soil reaction trend—neutral, well drained, soil profile uniform.

□ Loc. 3.15

As for loc. 3.1.

□ Loc. 3.16

Originally as for loc. 3.1, now with regrowth similar to loc. 2.87 with the mallees absent. *Isopogon polycephalus* prominent in regrowth. No evidence of *Casuarina* regrowth.

□ Loc. 3.17

Key Description.

Thicket *over* Open Low Scrub B *on* fine sandy loam.

Code aSc.xSBr/FSL

Loc. Details.

Stratum 1. *Acacia acuminata*, *Hakea scoparia*, *Casuarina acutivalvis* shrubs. Occasional *Hakea multilineata* trees present. All species immature, stratum 3-4m tall, 30-70% canopy cover at sample point. Average foliage density 20%.

Stratum 2. *Thryptomene* affin. *australis*, *Phebalium filifolium* and *Bertya cunninghami* shrubs. Several other species present, stratum 0.5-1m tall, 2-10% canopy cover at sample point. Average foliage density 25%.

Comments

As for loc. 3.14.

Litter

As for loc. 3.14.

Soil

As for loc. 3.14.

Loc. 3.18

As for loc. 3.17 with *Casuarina acutivalvis* prominent. Soil as for loc. 3.14.

Loc. 3.19

As for loc. 3.14.

Loc. 3.20

Key Description.

Thicket over Heath A on fine sandy loam.

Code aSc.xSAC/FSL

Loc. Details.

Stratum 1. *Acacia acuminata* shrubs, immature, stratum 2-3m tall, 30-70% canopy cover at sample point.

Stratum 2. *Melaleuca lateriflora*, *Hakea falcata* shrubs, both senescent, stratum 1-2m tall, 30-70% canopy cover at sample point.

Comments

No third stratum present but scattered *Lepidosperma brunonianum* and *Stygidium repens* are present. Their canopy cover is probably about 1%. No evidence of weeds, grasses or human utilisation. Old fire scars are visible. Stand is 10-15 years old.

Litter

Abundant, fairly evenly distributed, mostly narrow *Acacia acuminata* leaves, clumped to 2cm deep.

Soil

Pale brown, 10 YR 6/3 fine sandy loam. Soil reaction trend—neutral, uniform profile.

□ Loc. 3.21

Casuarina acutivalvis and occasional *Grevillea hookerana* shrubs, 2-3m tall, 10-30% canopy cover over *Melaleuca cordata*, *M. uncinata* and some *Calothamnus quadrifidus* shrubs to 1m tall, 10-30% canopy cover. Scattered *Borya nitida* clumps present, 2-10% canopy cover. Association has appearance of being regrowth which has just matured. Code xSi.mSci.n₁Jr/SCL n₁ = *Borya nitida*. About 100m west of loc. 3.21 is a bare claypan ca 60-100m in diameter.

□ Loc. 3.22

Watercourse arising in the breakaway near loc. 2.126 and draining west into the cleared farmland adjacent to the Reserve. The channel is unusual in that a surface layer 2-5cm thick of medium clay has formed over a soil of sandy clay loam. Water movement over the clay has caused the crust to break away, eroding the subsoil into small basins, 1-3m long by 0.5-1.5m wide, connected by raised areas where the clay is intact. The result is a string of basins, each disconnected from adjacent ones when the water is not flowing. The vegetation is a shrubland of varying density, comprising mostly *Melaleuca lateriflora* and *M. acuminata* shrubs to 2m tall, up to 100% canopy cover, with an understory of scattered *Acacia acanthoclada* shrubs to 0.5m tall, 2-10% canopy cover. A few *Eucalyptus salmonophloia* are associated with the watercourse where it flows onto the farmland. None are present on the Reserve at this location. Possible code is mSA<d.aScr/SCL.

□ Loc. 3.23

Lateritic knoll ca 100m diameter with vegetation as for loc. 3.1.

□ Loc. 3.24

Casuarina acutivalvis shrubs and some *Acacia lasiocalyx* trees 2-4m tall, 30-70% canopy cover at sample point. Soil is gravelly sandy clay loam.

□ Loc. 3.25

Probably *Acacia lasiocalyx* shrubs or low trees over *Lepidosperma* spp. sedges. Whole area now burnt out, virtually no regrowth.

□ Loc. 3.26

Original vegetation probably *Acacia acuminata* and some *Casuarina acutivalvis* shrubs. Occasional *Eucalyptus burracoppinensis* mallee present but <2%. Burnt out, little evidence of regrowth. Situated on gravelly ridge.

□ Loc. 3.27

As for loc. 3.1 on northern side, passing gradually into loc. 3.14 type to the south where soil becomes less gravelly and yellower in colour.

□ Loc. 3.28

As for loc. 3.20.

HEATH FORMATIONS: NORTHERN PORTION

□ Loc. 4.1.

As for loc. 4.7 with scattered *Eucalyptus foecunda* and *E. pileata* to 3m.

□ Loc. 4.2

As for loc. 4.7 with scattered *Eucalyptus foecunda* and modifications of loc. 4.8.

□ Loc. 4.3

As for loc. 4.7.

□ Loc. 4.4

As for loc. 4.7 with scattered *Eucalyptus gardneri* and *E. falcata* trees, and *E. foecunda* shrub mallee. Modified similar to loc. 4.8.

□ Loc. 4.5

Key Description.

Low Heath C over Open Dwarf Scrub D on sandy loam.

Code cmSCc.xSDi/SL

Loc. Details.

Stratum 1. 60% *Casuarina acutivalvis*, 40% *Melaleuca uncinata* and *M. cordata* shrubs, very immature, stratum 0.3 to 0.6m tall, with some individuals reaching 1.0m. 30-70% canopy cover at sample point.

Stratum 2. *Verticordia brownii*, *Calytrix fraseri*, *Daviesia aphylla* shrubs and *Lepidosperma drummondii* sedges, all immature, stratum 0-0.2m tall, 2-10% canopy cover at sample point.

Comments

Evidence of recent fire; stand is 10 years old; whole vegetation is regrowth. No evidence of weeds, grasses. See comments under loc. 1.2 for transition between that loc. and loc. 4.5. Between loc. 4.5 and loc. 1.3 there is a progressive increase in *Eucalyptus foecunda* mallee, with associated *Gastrolobium spinosum*, on light yellowish brown 10 YR 6/4 fine sandy loam, and scattered clumps ca 60m diameter of *E. transcontinentalis* on light yellowish brown, 10 YR 6/4 fine sandy loam. On the boundary between the *E. foecunda* area and loc. 1.3 is an *E. falcata*/*E. incrassata* stand on yellowish brown, 10 YR 5/4 sandy clay loam.

Litter

Sparse, mostly terete leaves clumped beneath shrubs to 0.5cm deep, clumps ca 1m apart.

Soil

Pale brown, 10 YR 6/3 sandy loam. Soil reaction trend—acid, uniform profile.

Loc. 4.6

Key Description.

Low Heath C over Low Heath D on loamy sand.

Code xSCc.xSDc/LS

Loc. Details.

Stratum 1. *Petrophile ericifolia*, *Melaleuca spathulata* shrubs. Several other species present, all mature, some becoming senescent, stratum 0.5-1m tall, 30-70% canopy cover at sample point. Average foliage density 40%.

Stratum 2. *Persoonia coriacea*, *Leucopogon blepharolepis* prominent. Several other species present, all mature, stratum 0.2-0.5m tall, 30-70% canopy cover at sample point. Average foliage density 25%.

Comments

Occasional emergent *Acacia lasiocalyx*, *Acacia assimilis* and *Leptospermum erubescens* above stratum 1 but so sparse they were not sampled by transect. No evidence of weeds or grasses. Evidence of old fire scars. Stand is 10 years old.

Litter

Sparse, mostly terete leaves and twigs, clumped beneath vegetation to 1cm deep, clumps 1m apart.

Soil

>50cm friable soil.

0-5cm soil plus organic dust; some plant roots.

6-11cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH 6.4, light grey, 10 YR 7/2, loamy sand, grains are quartz, subangular to subrounded, poorly sorted; plant roots present.

12-50cm non-pedal, sandy, coherent, unbleached, non-calcareous, pH 6.1, very pale brown, 10 YR 8/4, sand, grains are quartz, subrounded, moderately well sorted; plant roots present.

Comments

Soil reaction trend—acid, drainage excessive, Northcote classification Uc.1.41.

Loc. 4.7 (TRAPLINE 1) (PLATE 6)

Key Description.

Low Scrub B on sandy clay loam.

Code xSBI/KSCL

Loc. Details.

Unstratified *Isopogon scabriusculus*, *Petrophile ericifolia*, *Dryandra* affin. *cirsioides* and *Verticordia brownii* shrubs. Many other species present, all senescent, stratum 1.0-1.5m tall, 10-30% canopy cover at sample point. Average foliage density 30%.

Comments

Evidence of fire in recent times, but any regrowth from seed is now mature. No evidence of weeds or grasses. *Leucopogon blepharolepis* prominent in transition zone between this loc. and loc. 4.6. Scattered over whole area are occasional *Casuarina acutivalvis*, *Acacia assimilis*, *A. lasiocalyx* and *Leptospermum erubescens* shrubs, all senescent, 2-3m tall. Where laterite becomes a little more prominent these may increase to ca 7% canopy cover, but over most of the area they do not constitute a stratum. Stand is 10 years old.

Litter

Sparse, mostly terete leaves, clumped beneath vegetation to 0.5cm deep, clumps 0.5m apart. Rubbish comprising tins, bottles, cardboard boxes, newspapers near gravel pit. Rubbish mostly fresh, paper disintegrating; pile 3m diameter.

Soil

ca 20cm friable soil overlying dense, compact laterite.

0-3cm soil plus organic dust; fine plant roots present.

5-15cm slightly pedal, earthy, coherent, unbleached, non-calcareous, pH 5.0, very pale brown, 10 YR 7/4 sandy clay loam. Grains are quartz, sub-rounded, moderately well sorted; gravel pebbles <5%; plant roots present.

20-23cm non-pedal, earthy, poorly coherent, unbleached, non-calcareous, pH 4.6, very pale brown, 10 YR 7/4, sandy clay loam. Laterite pebbles 5mm to 40mm diameter ca 10-20%, proportion increasing with depth. Grains are quartz and ferruginous particles, subangular to subrounded, poorly sorted; plant roots absent.

25cm onwards hard-packed laterite.

Comments

Soil reaction trend—acid, excessively well drained, Northcote classification KUm4.11.

□ Loc. 4.8

As for loc. 4.7 but with abundant *Dryandra* affin. *cirsioides*. Scattered patches ca 10m in diameter of *Eucalyptus transcontinentalis* over *Melaleuca uncinata* and *M. spicigera*. Small patches of *E. foecunda* over *Gastrolobium spinosum* and *Isopogon polycephalus* also present. Soil as for loc. 4.7.

□ Loc. 4.9

As for loc. 4.7 with scattered patches of loc. 2.41 mallee. Not all regrowth is mature.

□ Loc. 4.10

As for loc. 4.7 with scattered *Eucalyptus burracoppinensis* mallee, *Santalum acuminatum* trees and *Melaleuca uncinata* and *Casuarina acutivalvis* shrubs. These plants are so sparse as not to constitute a stratum. Soil as for loc.4.7 with lateritic pebbles ca 10% of horizon A, 30-40% of horizon B.

□ Loc. 4.11

Key Description.

Heath B over Dwarf Scrub C over Mat Plants on clay loam.

Code mSBc.xSCi.xPc/CL

Loc. Details.

Stratum 1. *Melaleuca uncinata*, *Casuarina acutivalvis*, *Hakea ambigua* and *Banksia sphaerocarpa* shrubs, all immature, stratum 1.0-1.5m tall, 30-70% canopy cover at sample point.

Stratum 2. *Leucopogon hamulosus*, *Melaleuca seriata*, *Xanthorrhoea nana* shrubs, all immature, stratum 0.5-1m tall, 10-30% canopy cover at sample point.

Stratum 3. Cyperaceae gen. nov. mat plants, and *Borya nitida* herbs, all immature, stratum 0-0.2m tall, 30-70% canopy cover at sample point.

Comments

Evidence of recent fire, all species are regrowth. No weeds or grasses. Stand is 10 years old.

Litter

Moderately abundant, mostly terete leaves, clumped beneath vegetation to 0.5cm, clumps ca 3m apart.

Soil

Light yellowish brown, 10 YR 6/4 clay loam. Soil reaction trend—acid, profile uniform.

□ Loc. 4.12

Key Description.

Open Scrub over Dwarf Scrub C over Very Open Herbs on clay loam.

Code cSr.xSCi.nJr/CL

Loc. Details.

Stratum 1. *Hakea scoparia*, *Melaleuca spicigera* and *Acacia dielsii* shrubs, senescent, stratum 0.3-1.0m tall, 10-30% canopy cover at sample point.

Stratum 2. *Borya nitida* herbs, Cyperaceae gen. nov. mat plants, senescent, stratum 0-0.2m tall, 2-10% canopy cover at sample point.

Comments

Some *Casuarina acutivalvis* and *C. campestris* shrubs, immature, 2-3m tall emergent from Stratum 1. Evidence of recent fire, but no apparent regeneration from seed. No weeds or grasses. Stand is almost 20 years old.

Litter

Sparse, mostly terete leaves, clumped beneath vegetation to 1cm deep, clumps 2m apart.

Soil

Light yellowish brown, 10 YR 6/4 clay loam. Soil reaction trend-acid, profile uniform.

Loc. 4.13

As for loc. 4.12.

HEATH FORMATIONS: SOUTHERN PORTION

Loc. 4.14

Similar to loc. 4.5, with *Leptospermum erubescens* and *Grevillea hookerana* shrubs standing above the heath strata to 2m tall. Scattered *Eucalyptus foecunda* present. Soil as for loc. 4.5.

Loc. 4.15

Originally similar to loc. 4.6 but now burnt out. Prominent regrowth species are *Adenanthos argyraea*, *Cryptandra polyclada*, *Choretrum glomeratum*, *Dampiera* sp. 3, *Dryandra cirsioides*, *D. ferruginea*, *Grevillea eryngioides*, *G. hookerana*, *Hakea adnata*, *H. multilineata* and *Melaleuca lateritia*. Average foliage density 30%. Soil as for loc. 4.6.

Loc. 4.16 (TRAPLINE 16)

Originally similar to loc. 4.7 as gravel content is higher than at loc. 4.15. Regrowth species as for loc. 4.15. Original code xSBI/KSCL. Post-fire code is xSDr/KSCL.

Loc. 4.17

As for loc. 4.16. Average foliage density 32%.

Loc. 4.18

Similar to loc. 4.16 with *Grevillea eryngioides*, *G. integrifolia*, *Hakea ambigua*, *H. falcata* and *Isopogon polycephalus* prominent in regrowth. Soil is gravelly, sandy clay loam.

Loc. 4.19

As for loc. 4.7.

□ Loc. 4.20

As for loc. 4.7 with scattered *Eucalyptus foecunda* shrub mallee.

□ Loc. 4.21

Melaleuca cordata shrubs and *Lepidosperma effusum* sedge dominant along edges of watercourse. Small area of *Callistemon phoeniceus* present. Formation virtually unstratified, ca 1m tall, 70-100% canopy cover in wettest parts, grading out to loc. 2.24 vegetation on edges. Transition between loc. 4.21 and loc. 2.24 contains *Acacia acuminata* shrubs 1m tall.

□ Loc. 4.22

As for loc. 4.21 but *Callistemon phoeniceus* absent, occasional *Acacia desertorum* scattered throughout. Soil as loc. 2.24.

□ Loc. 4.23

Shallow depression in sandy soil which approaches, near the bottom, the underlying laterite. This results in a radial decrease in gravel soil from the centre outwards. Central area contains prominent *Callitris canescens*, *Petrophile seminuda* and *Dryandra* affin. *cirsioides*. Towards the edges, *Casuarina acutivalvis* becomes dominant, the *Callitris* is absent and the *Dryandra* and *Petrophile* less prominent. Basically similar to loc. 4.7. Surrounded by 1971/72 fire but not burnt.

□ Loc. 4.24 (TRAPLINE 10)

Key Description.

Low Heath C on sandy clay loam.

Code mSCc/SCL

Loc. Details.

Unstratified shrub assemblage with *Melaleuca spathulata*, *M. cordata* and *M. uncinata* shrubs and *Lepidospermum brunonianum* sedges. All species immature, 0-1m tall, 30-70% canopy cover at sample point.

Comments

Occasional *Eucalyptus burracoppinensis* and *E. foecunda* shrub mallee present, both immature 1-2m tall, ca 1% canopy cover. Considered to be too sparse to be of much significance to the overall nature of the formation. No evidence of weeds, grasses or human usage. Burnt sticks and scars on mallee trunks suggest recent fire. Abundant *Cassytha* sp. on most shrubs. Stand is about 10 years old.

Litter

Sparse, mostly terete leaves. No clumping.

Soil

ca 40cm friable soil overlying laterite.

0-0.5cm soil plus organic dust.

1.0-15cm pedal, sandy, coherent, unbleached, non-calcareous, pH 6.5, light yellowish brown, 10 YR 6/4 sandy clay loam. Grains are quartz, sub-angular to subrounded, moderately well sorted; plant roots present.

16-22cm pedal, sandy, coherent, unbleached, non-calcareous, pH 6.0, very pale brown, 10 YR 8/4, sandy clay loam. Grains are quartz, subangular, poorly sorted; plant roots present.

25cm onwards as for 16-22cm horizon as a matrix between *ca* 70% lateritic pebbles, from 0-5cm to 3cm diameter.

Comments

Soil reaction trend—acid, poorly drained. Northcote classification Um6.14.

Loc. 4.25

Key Description.

Low Heath D over Very Open Low Sedges on fine sandy loam.

Code xSDc.n₁VLR/FSL
n₁= Cyperaceae gen. nov.

Loc. Details.

Stratum 1. *Hakea falcata*, *Petrophile ericifolia*, *Melaleuca spathulata*, *Dryandra ferruginea* and *D. cirsioides* shrubs. All immature, stratum 0.2-0.5m tall, 30-70% canopy cover at sample point.

Stratum 2. Cyperaceae gen. nov. sedge with occasional *Borya nitida* herbs. Both species immature, stratum 0-10cm tall, 2-10% canopy cover at sample point.

Comments

No evidence of regeneration from seed, weeds, grasses or human utilisation. Burnt twigs indicate recent fire. Stand is 10-15 years old.

Litter

Sparse, mostly narrow leaves, clumped beneath vegetation to 0.5cm deep, clumps *ca* 1m apart.

Soil

Light yellowish brown, 10 YR 6/4 fine sandy loam.

Loc. 4.26

Burnt out, regrowth as for loc. 4.15. Original vegetation probably sparse *Melaleuca uncinata* shrubs over loc. 4.7 heath.

Loc. 4.27

As for loc. 2.164, without the upper stratum.

Loc. 4.28

Burnt out, regrowth as for loc. 4.15. Original vegetation probably similar to loc. 4.7.

LITHIC COMPLEX

□ Loc. 5.1

Key Description.

Open Low Woodland B over Thicket over Dwarf Scrub D on sandy loam.

Code aLBr.cnSc.xSDi/SL
n = *Calothamnus quadrifidus*

Loc. Details.

Stratum 1. *Acacia lasiocalyx* trees. Senescent, 4-5m tall, 2-10% canopy cover at sample point. Average foliage density 1%.

Stratum 2. *Casuarina campestris*, *Calothamnus quadrifidus* shrubs prominent. Occasional *Melaleuca* affin. *scabra* shrubs present. All mature, stratum 1-2.5m tall, 30-70% canopy cover at sample point. Average foliage density 35%.

Stratum 3. *Verticordia serrata* shrubs and *Lepidosperma drummondii* sedge prominent. *Micromyrtus imbricata* and *Astartea heteranthera* also present. All immature, stratum 0.1-0.5m tall, 10-30% canopy cover at sample point. Average foliage density 10%.

Comments

Evidence of burnt sedges indicate fire in recent times, but vegetation is near climax at present. No evidence of weeds, grasses or human utilisation. Stand is 10-20 years old.

Litter

Moderately abundant, mostly terete leaves with a few twigs, mostly clumped beneath vegetation to 1cm deep, clumps 2m apart.

Soil

ca 35cm friable soil overlying dense packed granitic grit.

0-4cm soil plus organic dust; plant roots absent.

5-27cm slightly pedal (<10%) sandy, coherent, bleached, non-calcareous, pH 6.6, light yellowish brown, 10 YR 6/4, sandy loam. Grains are quartz and feldspar (to 5mm diameter) plus muscovite mica flakes; grains angular, very poorly sorted; some plant roots present.

30-37cm as for 5-27cm zone, pH 6.8, but garnet and hornblende granules present, all angular, very poorly sorted, plus rock fragments to 8mm diameter as a matrix between pebbles to 30mm diameter, or greater; plant roots present.

Comments

Soil is a thin superficial layer over decaying granite. Soil reaction trend—neutral, well drained, Northcote classification Uc6.11.

□ **Loc. 5.2**

As for loc. 5.1.

□ **Loc. 5.3**

As for loc. 5.1 but the *Acacia lasiocalyx* in upper stratum is absent.

□ **Loc. 5.4 (TRAPLINE 9)**

Basically as for loc. 5.1, but each stratum a little less dense, but in the same density classes. Scattered *Santalum acuminatum* and *Grevillea hookerana* are present. Scattered clumps of *Spartochloa scirpoidea* throughout. Soil as for loc. 5.1 but drainage not quite as good.

□ **Loc. 5.5 (PLATE 7)**

Small area, ca 20m diameter where granite comes close to surface. Major species are *Spartochloa scirpoidea* grass 0.5m tall, density increasing radially away from centre of area, over *Borya nitida* to 0.2m tall, density increasing radially towards the centre. The annual species *Stylidium repens* is abundant throughout the area. Soil is 0-15cm deep, yellowish red, 5 YR 4/8 light medium clay, pH 6.8.

□ **Loc. 5.6**

As for loc. 5.4. Directly west from this location on western edge of lithic complex are several fairly large exposures of bare rock.

□ **Loc. 5.7**

As for loc. 5.4 but *Casuarina acutivalvis* is taller (3m) and slightly denser.

□ **Loc. 5.8**

As for loc. 5.3. Some *Banksia sphaerocarpa* and *Callitris verrucosa* present. Southern end passes into outwash zone with *Melaleuca undulata*. Granite very broken and shrubs clumped.

□ **Loc. 5.9**

As for loc. 5.1 with exposures of bare granite and abundant *Spartochloa scirpoidea*.

□ **Loc. 5.10**

Burnt out, regrowth species as for loc. 4.15 with some *Calothamnus quadrifidus* present. Original vegetation probably as loc. 5.1. Soil as loc. 5.1.

□ **Loc. 5.11**

Burnt out, regrowth is *Casuarina campestris* shrubs with occasional *Acacia sedifolia* shrubs to 0.4m tall. Original vegetation probably as loc. 5.1. Soil as for loc. 5.1.

□ **Loc. 5.12**

Small granitic knoll with scattered *Callitris preissii* shrubs. Not burnt in 1971/72 fire.

□ **Loc. 5.13**

Small granitic knoll with *Casuarina acutivalvis* shrubs to 4m tall.

□ **Loc. 5.14**

As for loc. 5.1. Colour and texture changes in soil over boundary between loc. 2.15 (northern eastern corner) and loc. 5.4 were:

Loc. 2.15 (mallee over *Melaleuca uncinata*) light grey 10 YR 7/1 sandy loam; Transition (mallee absent, *M. uncinata* only) pale brown 10 YR 6/3 sandy clay loam; Loc. 2.14 (lithic complex) brown 10 YR 5/3 sandy loam.

□ **Loc. 5.15**

Granite outcrop; exposures of bare rock, with numerous exfoliations which harbour lizards. Lichens (mostly *Parmelia* sp.) on surface. Runoff from rock has encouraged dense thickets of *Acacia lasiocalyx* to 4m tall, over *Grevillea paniculata* and scattered *Diplolaena microcephala* to 1m tall. Leaf litter very densely packed beneath bushes to 3-4cm deep. Open nature of rock has protected some areas from fire for a long time. Soil where it occurs is decayed granite.

BREAKAWAY COMPLEX (PLATE 8)

Virtually no vegetation is present on the steeply sloping sides of the breakaway where the pallid zone of the decayed granite is exposed. Where laterite gravel or boulders have bound the pallid soil and formed a gravelly crust on it, a few shrubs may establish a foothold. Most of the vegetation is, however, on the breakaway floor, its distribution depending on the amount of water wash, flooding, and rubble content of the soil. Clumps of mallee may occasionally grow on higher areas of the breakaway floor. The floor itself is commonly occupied by *Callitris canescens* trees 0.5-5m tall, of varying degrees of vigour according to the soil depth. Beneath and between the *Callitris* are scattered shrubs usually 0.5 to 1m tall. Commonest species are *Melaleuca undulata* and *Grevillea heugellii*. As soil depth increases towards the centre, or near the outwash areas of the breakaway, other species common to the surrounding vegetation become established.

A typical breakaway profile found on the Reserve is as below:

- ca 0-1m ferruginous pebbles or boulders merging into massive laterite.
- ca 1-2m transition zone between laterite and granite. All stages of ferruginisation of granite are visible indicating lateritisation *in situ*.
- ca 2m onwards pallid zone comprising decayed kaolinised granite, still retaining its original structure. Generally pure white with dusky red, 5R 3/3 to 5R 3/4 mottlings and patches of variable size. Passes gradually, with depth, into undecayed granite.

OTHER FORMATIONS

WETLAND

Part of a watercourse which is physiognomically a shrubland, and is located near loc. 1.9, is the only area on the Reserve likely to carry water for any length of time and is even damp below the surface in mid-summer.

Roughly circular, ca 60m diameter, comprising three distinct zones.

The central zone, in the lowest part of the wetland, contains *Spartochloa scirpoidea* sedge to 1m tall, canopy cover ranging from 70% to 20%, decreasing radially from the centre. This zone is ca 10m in diameter. Surrounding this is an annulus ca 10-15m in width of *Melaleuca uncinata* shrubs, 2m tall and *S. scirpoidea* sedges, the *M. uncinata* becoming shorter radially outwards, and the *S. scirpoidea* decreasing in canopy cover radially.

Outside this is another annulus ca 30-40m in width of *Borya nitida* herbs and scattered *Acacia dielsii* shrubs. This zone then merges into the surrounding vegetation, namely loc. 2.34 on the western side, and loc. 1.9 on the east.

The wetland is part of a watercourse draining the eastern parts of the northern half of the Reserve, and feeding into a shallow river system on farmland to the southeast.

Soil in central zone is yellowish brown, 10 YR 5/4, sandy loam with a high organic content.

UNCLEARED LAND CONTIGUOUS WITH THE RESERVE

Descriptions of areas not on Bendering Reserve, but contiguous with it, and considered important (excluding the block adjacent to the north-west corner of the northern portion of the Reserve, as this block is dealt with in the detailed descriptions).

Northern Portion

W1

As for loc. 1.11 and 1.12. After the clearing of area W4 on the southern end of the Reserve, this area and W2 remain the only *Eucalyptus salubris* stands near the Reserve. Code eLAc.xSAi.xSDr/HC.

W2

As for loc. 1.11 and 1.12.

Southern Portion

Descriptions are from Kitchener, Chapman and Dell (pers. comm.) plus airphotograph interpretation (1972 series). Areas M1, M2, M3, W1 and W2 cleared January 1975.

W3

Eucalyptus falcata and scattered *E. kondininensis* trees with shrub understory.

W4 (TRAPLINE 6, 13)

Eucalyptus annulata and *E. salubris* trees to 8m tall, 30-70% canopy cover. Occasional shrubs of *Dodonaea stenozyga* and *Melaleuca pauperiflora* to 2m tall, 2-10% canopy cover. Leaf litter absent. Code eLAc.xSAr/SiCL. Soil is dark reddish brown silty clay loam.

M1

Basically as for loc. 2.164, with scattered *Casuarina acutivalvis*. Code eKSi.xSCc/SCL.

M2 (TRAPLINE 7)

Eucalyptus pileata, *E. eremophila*, *E. flocktoniae* and *E. calycogona* shrub mallee, to 6m tall, 70-100% canopy cover. *Melaleuca undulata*, *Exocarpus aphyllus*, *Acacia mackayana*, *Acacia sclerophylla*, *Casuarina campestris* and *Callitris canescens* shrubs to 3m, 2-10% canopy cover. Leaf litter absent. Code eKSd.xSr/SL. Soil is brown sandy loam.

M3

Described as 'low mallee over moderate height scrub'. This may mean vegetation similar to loc. 2.33, as the soil, drainage and aspect are similar to that location.

M4

As for area M2.

M5

As for loc. 2.122.

S1

Casuarina campestris shrubs 2-3m tall, 70-100% canopy cover. No understory present. Soil gravelly, probably sandy loam.

APPENDIX 2

LIST OF PLANT SPECIES RECORDED AT VARIOUS LOCATIONS

Only locations with detailed ecological data are listed.

Meanings of codes following names:

- (E) – collected in ecotone associated with location under which species are listed.
- (+E) – collected in major part of location and also in associated ecotone.
- (D) – collected on disturbed ground e.g. firebreak, gravel pit, road verge associated with location under which species is listed.
- (+D) – collected in major part of location and also in associated disturbance.
- (SC) – specimen unidentified and lodged in the Western Australian Museum survey collection, to be transferred to the Western Australian Herbarium when Wheatbelt Survey is complete.

Loc. 1.1

<i>Acacia pulchella</i> (D)	<i>H. multilineata</i>
<i>A. sclerophylla</i> var. <i>teretiuscula</i> (+D)	<i>H. scoparia</i>
<i>Bertya cunninghami</i>	<i>Melaleuca adnata</i>
<i>Callitris canescens</i>	<i>M. laxiflora</i>
<i>Cryptandra</i> affin. <i>tomentosa</i>	<i>M. spicigera</i>
<i>Dodonaea bursariifolia</i>	<i>M. uncinata</i>
<i>Eucalyptus falcata</i>	<i>Phebalium verrucosa</i>
<i>E. gardneri</i>	<i>Platysace maxwellii</i> (+D)
<i>Exocarpus aphyllus</i>	<i>Persoonia</i> sp. indet 1. (SC)
<i>Gastrolobium crassifolium</i> (+D)	<i>Santalum acuminatum</i>
<i>Hakea adnata</i>	

Loc. 1.2

<i>Acacia acuminata</i>	<i>Hakea multilineata</i>
<i>Bertya cunninghami</i>	<i>Hibbertia enervia</i>
<i>Choretrum glomeratum</i> (E)	<i>Lepidosperma drummondii</i>
<i>Eucalyptus falcata</i> var. <i>costata</i>	<i>Leptospermum erubescens</i>
<i>E. foecunda</i> (E)	<i>Melaleuca cordata</i> (+E)
<i>Grevillea hookerana</i>	<i>Persoonia coriacea</i> (E)

Loc. 1.3

<i>Beyeria leschenaultii</i>	<i>Dodonaea bursariifolia</i>
<i>Callitris roei</i>	<i>Eucalyptus falcata</i>
<i>Casuarina acutivalvis</i>	<i>E. gardneri</i>
<i>Cryptandra tomentosa</i>	<i>Exocarpus aphyllus</i>
<i>Daviesia acanthoclona</i>	<i>Gastrolobium spinosum</i>

Glyschrocaryon flavescens (D)
Hakea multilineata
Lepidosperma gracile
Melaleuca uncinata
Phebalium verrucosa

Loc. 1.5

Acacia acanthoclada
A. multispicata
A. myrtifolia
A. sclerophylla
Astartea heteranthera
Astroloma sp. indet. (SC)
Bertya cunninghami
Boronia ternata (+D)
Cassutha sp. A (SC)
C. sp. B (SC)
Casuarina acutivalvis
Cryptandra sp. 11 (SC)
Dampiera sp. indet. 1 (SC)
Dodonaea bursariifolia
Dryandra affin. *cirsioides*
Eucalyptus falcata
E. redunca
E. salmonophloia
Gastrolobium spinosum

Platysace maxwellii (+D)
Santalum acuminatum
Sterculiaceae gen. indet. (SC)
Westringia sp. indet. 1 (SC)
W. cephalantha

Goodenia pinifolia (+D)
G. scapigera (D)
Grevillea asteriscosa
Hakea lissocarpha
H. multilineata
H. subsulcata
Hibbertia enervia (+D)
H. verrucosa
Isopogon polycephalus
Lepidosperma drummondii (D)
L. gracile (+D)
Melaleuca affin. *scabra*
M. sp. indet. 4 (SC)
M. uncinata
Petrophile ericifolia
Phebalium verrucosa
Santalum acuminatum
Thryptomene affin. *prolifera*

Loc. 1.6

Acacia myrtifolia
Astartea heteranthera
Bertya cunninghami
Callitris roei
Casuarina acutivalvis
Dianella revoluta
Dodonaea bursariifolia
Eremaea pauciflora
Eucalyptus falcata
E. redunca
Exocarpus aphyllus
Fam. indet. 1 (SC)

Hakea adnata
H. lissocarpha
H. multilineata
Hibbertia verrucosa
Isopogon polycephalus
Lepidosperma affin. *gracile*
Melaleuca laxiflora
M. uncinata
Phebalium verrucosa
Platysace maxwellii
Santalum acuminatum

Loc. 1.7

Acacia acuminata (E)
A. desertorum
A. lasiocalyx (+E)
Casuarina acutivalvis (E)

Dryandra cirsioides (E)
Eucalyptus falcata (E)
E. foecunda (E)
Gastrolobium spinosum (E)

Hakea multilineata (E)
H. scoparia (E)
Isopogon polycephalus (E)

Leptospermum erubescens
Melaleuca pungens (E)
Petrophile ericifolia (E)

Loc. 1.8

Acacia graffiana
A. multispicata
Daviesia teretifolia
Eremaea woolsiana
Eucalyptus calycogona
E. eremophila
E. salmonophloia

Exocarpus aphyllus
Grevillea huegelii
Melaleuca adnata
M. lateriflora
Rhagodia sp. indet. (SC)
Wilsonia humilis

Loc. 1.11

Acacia affin. *dermatophylla*
A. graffiana
Eucalyptus ovularis
E. salmonophloia

E. salubris
Hakea adnata
Melaleuca adnata

Loc. 1.15

Eucalyptus falcata var. *costata*

Loc. 1.16

Acacia acuminata
Astroloma serratifolium
Bertya cunninghami
Boronia ternata (D)
Brachyloma concolor (+D)
Callitris preissii
Calytrix fraseri
Casuarina acutivalvis
C. campestris
C. affin. huegeliana
Coleanthera myrtoides
Eucalyptus burracoppinensis
E. gardneri
Exocarpus aphyllus
Goodenia pinifolia (D)

Hakea scoparia
H. sp. nov. (SC)
H. sp. 1 (SC)
Hibbertia verrucosa
Jacksonia affin. *racemosa* (+D)
Melaleuca acuminata
M. hamulosa
M. uncinata
Persoonia coriacea
P. affin. saundersiana (D)
Phebalium verrucosa
Pimelea sylvestris
Platysace maxwellii
Poaceae sp. indet. 6 (SC)
Poaceae sp. indet. 7 (SC)
Santalum acuminatum

Loc. 1.17

Acacia celastrifolia
Dampiera sp. indet. 1 (SC)
D. sp. indet. 3 (SC)

Glyschrocaryon flavescens
Grevillea asteriscosa
Lepidosperma gracile

Loc. 1.18

Eucalyptus salmonophloia

Loc. 1.20

Eucalyptus gardneri

Loc. 1.23

Acacia lasiocalyx
A. sedifolia

Goodenia pinifolia
Grevillea asteriscosa

Loc. 1.25

Hakea lissocarpha

Loc. 1.26

Callitris canescens

Loc. 2.1

Acacia acanthoclada (D)
A. acuminata (D)
A. mackayana
A. merrallii
A. sclerophylla (D)
Alyxia buxifolia (D)
Callitris canescens
C. preissii
Cassytha sp. B (SC)
Casuarina acutivalvis
C. campestris
Cryptandra sp. indet. 10 (D, SC)
C. sp. indet. 11 (SC)
Dampiera eriocephala (D)
Dodonaea bursariifolia
Eucalyptus gardneri
E. redunca
E. transcontinentalis
Exocarpus aphyllus
Fam. indet. 3 (D, SC)
Gastrolobium crassifolium (D)
Glyschrocaryon flavescens (D)

Goodenia pinifolia (D)
Grevillea huegelii
Hakea adnata (+D)
H. falcata (+D)
H. lissocarpha
H. multilineaata (+D)
H. scoparia
Hibbertia verrucosa (D)
Hypocalymma puniceum (D)
Isopogon polycephalus
Melaleuca acuminata
M. adnata
M. laxiflora
M. radula
M. uncinata
M. undulata
Micromyrtus imbricata
Myrtaceae sp. indet. 1 (D, SC)
Olearia muelleri
Persoonia striata (D)
Phebalium verrucosa (+D)
Platysace maxwellii

Loc. 2.2

Acacia acuminata
A. assimilis
Callitris preissii
Casuarina acutivalvis
C. campestris
C. corniculata

Hakea multilineaata
H. scoparia
H. sp. nov. (SC)
Melaleuca laxiflora
M. uncinata
Persoonia striata

Loc. 2.3

Acacia dielsii
Bertya cunninghami
Callitris canescens
Cryptandra tomentosa (D)
Dampiera sacculata (D)
D. sp. indet. 1. (D, SC)
D. sp. indet. 3. (D, SC)
Dodonaea bursariifolia (+D)
Eremaea pauciflora (D)
Eremophila saundersiana (D)
Eucalyptus pileata
E. redunca
E. transcontinentalis
Exocarpus aphyllus
Gastrolobium crassifolium (D)
Glyschrocaryon flavescens (D)

Goodenia pinifolia (D)
Grevillea huegelii
Hakea adnata
H. lissocarpa
H. subsulcata
Inula graveolens (D)
Lechenaultia biloba (D)
Melaleuca adnata
M. lateritia
M. laxiflora
M. uncinata (+D)
Phebalium verrucosa (D)
Platysace maxwellii
Poaceae sp. indet. 2 (D, SC)
Santalum acuminatum
Sollya heterophylla (D)

Loc. 2.4

Eucalyptus calycogona
E. eremophila

E. affin. sheathiana
Melaleuca undulata

Loc. 2.5

Callitris canescens
Eucalyptus eremophila
E. foecunda

Melaleuca uncinata
M. undulata

Loc. 2.6

Exocarpus aphyllus

Melaleuca uncinata

Loc. 2.9

Cryptandra tomentosa
Dodonaea bursariifolia
Eucalyptus redunca
Exocarpus aphyllus

Hakea adnata
Melaleuca acuminata
Santalum acuminatum

Loc. 2.10

Casuarina acutivalvis
Eucalyptus eremophila
E. redunca
E. transcontinentalis

Gastrolobium crassifolium
Melaleuca scabra
M. uncinata
Platysace maxwellii

Loc. 2.13

Acacia dielsii
A. lasiocalyx
Astartea heteranthera

Callitris roei
Cassytha sp. B (SC)
Casuarina campestris

Choretrum pritzellii
Daviesia acanthoclona
Dicrastyles sp. (D, SC)
Eucalyptus calycogona
E. eremophila
E. foecunda
E. transcontinentalis
Exocarpus aphyllus
Goodeniaceae gen. indet. 1 (D, SC)
Hakea adnata
H. ambigua
H. corymbosa
H. falcata
H. lissocarpa
H. scoparia
Inula graveolens (D)

Jacksonia affin. *racemosa*
Lepidosperma gracile
L. tuberculatum
Leptospermum erubescens
Leucopogon hamulosus
Melaleuca affin. *densa*
M. affin. subtrigona
M. uncinata
Persoonia striata
Petrophile seminuda
Phebalium verrucosa
Poaceae sp. indet. 2 (SC)
Poaceae sp. indet. 6 (D, SC)
Santalum acuminatum
Sterculiaceae gen. indet. 1 (D, SC)
Stylidium repens

Loc. 2.14

Callitris preissii
Dicrastyles sp. 1 (D, SC)
Eucalyptus eremophila
E. transcontinentalis
Goodeniaceae gen. indet. 1 (D, SC)

Hakea corymbosa
Inula graveolens (D)
Poaceae sp. 6 (D, SC)
Santalum acuminatum
Sterculiaceae gen. indet. 1 (D, SC)

Loc. 2.15

Calytrix brachyphylla
Eucalyptus eremophila
E. pileata
E. transcontinentalis

Hakea adnata
Melaleuca lateritia
M. uncinata
Spartochloa scirpoidea

Loc. 2.17

Acacia acuminata
A. sulcata
Eucalyptus eremophila
E. foecunda
E. pileata

Hakea scoparia
Melaleuca cordata
M. uncinata
Santalum acuminatum

Loc. 2.18

Callitris canescens
Eucalyptus calycogona
E. eremophila

E. redunca
E. transcontinentalis
Melaleuca undulata

Loc. 2.19

Callitris canescens

Loc. 2.21

Callitris canescens
Melaleuca undulata

Loc. 2.24

Eucalyptus eremophila
E. redunca
E. transcontinentalis
Exocarpus aphyllus

Melaleuca spicigera
M. uncinata
Phebalium verrucosa

Loc. 2.25

Callitris canescens
Melaleuca lateritia
M. affin. scabra

Loc. 2.27

Callitris verrucosa
Eucalyptus redunca
Hakea adnata
Melaleuca eleutherostachya

M. lateritia
M. uncinata
Phebalium verrucosa
Santalum acuminatum

Loc. 2.28

Exocarpus aphyllus
Melaleuca lateriflora

Loc. 2.29

Callistemon phoeniceus
Hakea corymbosa

Loc. 2.31

Eucalyptus eremophila
Spartochloa scirpoidea

Loc. 2.32

Calothamnus quadrifidus
Casuarina acutivalvis
Hakea falcata

Isopogon polycephalus
Petrophile ericifolia

Loc. 2.33

Cassytha sp. A. (SC)
Cryptandra parvifolia
Daviesia colletioides
Eucalyptus eremophila
E. redunca
E. transcontinentalis
Exocarpus aphyllus
Gastrolobium crassifolium
Hakea lissocarpa

H. scoparia
Lepidosperma gracile
Melaleuca cordata
M. affin. cuticularis
M. affin. densa
M. lateriflora
M. spicigera
M. uncinata
M. undulata

Loc. 2.34

Acacia multispicata
Borya nitida
Cassytha sp. B (SC)
Casuarina acutivalvis
Eucalyptus redunca
E. transcontinentalis
Grevillea hookerana
Hakea falcata
H. incrassata
Hibbertia verrucosa

Lepidosperma drummondii
Leucopogon dielsianus
L. minutifolius
Melaleuca platycalyx
M. uncinata
Petrophile seminuda
Phebalium verrucosa
Spartochloa scirpoidea
Xanthorrhoea nana

Loc. 2.38

Eucalyptus foecunda
E. redunca

Loc. 2.39

Acacia sclerophylla
Eucalyptus foecunda
E. redunca

Loc. 2.40

Baekkea sp. nov. (SC)
Callitris canescens
Eucalyptus calycogona
E. eremophila

Gastrolobium trilobum
Melaleuca adnata
M. lateriflora
M. undulata

Loc. 2.41

Acacia affin. *andrewsii*
A. affin. bidentata
A. pulchella
Bertya cunninghami
Calytrix brachyphylla
Daviesia acanthoclona
D. colletioides
Eucalyptus sheathiana
E. transcontinentalis
Grevillea huegelii

Hakea falcata
Isopogon polycephalus
Lepidosperma gracile
Leucopogon blepharolepis
Melaleuca laxiflora
M. affin. scabra
Phebalium verrucosa
Pimelea sylvestris
Platysace maxwellii

Loc. 2.46

Cryptandra parvifolia

Loc. 2.47

Eucalyptus foecunda
E. redunca
E. transcontinentalis

Loc. 2.48

Melaleuca uncinata

Loc. 2.49

Acacia acuminata
Melaleuca uncinata

Loc. 2.50

Eucalyptus salmonophloia
Melaleuca uncinata

Loc. 2.53

Eucalyptus burracoppinensis

Loc. 2.60

Gastrolobium spinosum
Melaleuca adnata
M. undulata

Loc. 2.62

Acacia sp. indet. 1 (SC)
Dodonaea bursariifolia
Eucalyptus calycogona
E. foecunda

E. transcontinentalis
Jacksonia affin. *racemosa*
Melaleuca adnata
M. undulata

Loc. 2.69

Eucalyptus burracoppinensis

Loc. 2.75

Exocarpus aphyllus
Melaleuca lateriflora

Loc. 2.77

Acacia acanthoclona
A. affin. *tamminensis*
Eucalyptus eremophila
E. foecunda
Exocarpus aphyllus
Grevillea hookerana
Hakea corymbosa
Melaleuca affin. *subtrigona*

M. uncinata
Platysace maxwellii
Poaceae sp. indet. 3 (SC)
Poaceae sp. indet. 4 (SC)
Restionaceae sp. indet. 9 (SC)
Santalum acuminatum
Spartochloa scirpoidea

Loc. 2.79

Astartea heteranthera
Astroloma serratifolium (D)
Callitris preissii
Calothamnus quadrifidus
Cassytha sp. indet. A (SC)

C. sp. indet. B (SC)
Casuarina acutivalvis
Cryptandra parvifolia
C. polyclada
Dodonaea bursariifolia (+D)

Dryandra ferruginea (D)
Eucalyptus falcata
E. pileata
E. redunca
Exocarpus aphyllus
Goodeniaceae sp. indet. 1 (D, SC)
Goodenia helmsii (D)
G. spicigera (D)
Hakea affin. *crassifolia* (D)
H. falcata (+D)
H. lissocarpha (D)
H. multilineata (+D)
H. scoparia (+D)
H. sp. indet. 2 (SC)
Isopogon scabriusculus

Loc. 2.80

Exocarpus aphyllus
Melaleuca adnata
M. uncinata

Loc. 2.87

Adenanthos argyraea
Choretrum glomeratum
Conospermum amoenum
Cryptandra sp. indet. 10 (SC)
Dryandra cirsioides
Grevillea hookerana
G. integrifolia

Lepidosperma gracile
Melaleuca affin. *densa*
M. laxiflora
M. uncinata
Olearia muelleri
Persoonia striata
Phebalium verrucosa
P. filifolium X *verrucosa* hybrid
Pimelea nervosa (D)
Platysace maxwellii (+D)
Poaceae sp. indet. 2 (D, SC)
Ptilotus sp. indet. 1 (D, SC)
Santalum acuminatum (+D)
Westringia sp. indet. 1 (D, SC)

Hakea ambigua
H. lissocarpha
Lepidosperma gracile
Loxocarya sp. 1 (SC)
Melaleuca spathulata
M. spicigera

Loc. 2.100

Actinostrobus arenarius
Eucalyptus redunca
Melaleuca uncinata

Loc. 2.104

Dampiera sp. indet. 1 (SC)
Dryandra ferruginea

Grevillea eryngioides
Melaleuca lateritia

Loc. 2.105

Cryptandra polyclada
Eucalyptus cylindriflora
E. incrassata

E. redunca
Melaleuca eleutherostachya
M. undulata

Loc. 2.108

Melaleuca spicigera
M. uncinata

Loc. 2.110

Beaufortia orbifolia
Eucalyptus burracoppinensis
E. eremophila

Loc. 2.113

Melaleuca uncinata

Loc. 2.115

Eucalyptus foecunda
E. transcontinentalis

Hakea scoparia
Melaleuca uncinata

Loc. 2.116

Eucalyptus annulata
Hakea lissocarpa
Melaleuca uncinata

Loc. 2.118

Cryptandra parvifolia
Eucalyptus foecunda
E. transcontinentalis

Melaleuca cordata
M. uncinata

Loc. 2.119

Eucalyptus celastroides
E. gardneri
E. transcontinentalis

Melaleuca uncinata
M. undulata

Loc. 2.120

Callitris canescens
Eucalyptus gardneri

Loc. 2.121

Eucalyptus salmonophloia

Loc. 2.122

Choretrum glomeratum
Cryptandra sp. indet. 11 (SC)
Dryandra cirsioides
Dampiera sp. indet. 1 (SC)
Grevillea integrifolia
Hakea ambigua

H. falcata
H. lissocarpa
Lepidosperma gracile
Melaleuca spathulata
M. uncinata

Loc. 2.124

Eucalyptus gardneri
E. redunca
Santalum acuminatum

Loc. 2.126

Eucalyptus eremophila
E. redunca

Melaleuca cardiophylla
M. affin. scabra

Loc. 2.129

Eucalyptus annulata
E. calycogona
E. redunca

E. transcontinentalis
Melaleuca uncinata

Loc. 2.136

Acacia desertorum
Eucalyptus burracoppinensis
E. foecunda
E. pileata

Gastrolobium spinosum
Melaleuca spathulata
M. uncinata

Loc. 2.137

Acacia desertorum
Adenanthos argyraea
Banksia sphaerocarpa
Beaufortia bracteosa
Cassytha sp. indet. B (SC)
Casuarina acutivalvis (D)
Cyperaceae gen. nov. (SC)
Dampiera sp. indet. 1 (SC)
D. sp. indet. 3 (SC)
Daviesia uniflora (D)
Dryandra affin. *cirsioides*
D. ferruginea (+D)
Eucalyptus burracoppinensis
Gastrolobium spinosum
Goodeniaceae sp. indet. 2 (D)
Goodenia pinifolia (+D)
Grevillea integrifolia
Hakea falcata (+D)

H. scoparia
Hypocalymma puniceum (+D)
Isopogon scabriusculus
Jacksonia affin. *racemosa*
Lepidosperma drummondii
L. gracile
Leucopogon crassifolius
Melaleuca cordata (+D)
M. pungens (+D)
M. spathulata (+D)
Micromyrtus imbricata
Petrophile divaricata
P. ericifolia (D)
P. seminuda (+D)
Santalum acuminatum
Schoenus compressus (+D)
Synaphaea petiolaris

Loc. 2.142

Beaufortia bracteosa
Casuarina acutivalvis
Cyperaceae gen. nov. (SC)
Daviesia acanthoclona (+D)
D. aphylla (+D)
Eucalyptus burracoppinensis
E. foecunda

Gastrolobium spinosum
Grevillea hookerana
Hakea falcata
Melaleuca pungens
M. spathulata (+D)
M. uncinata
Synaphaea sp. indet. 1 (+D, SC)

Loc. 2.144

Acacia acuminata
A. subsulcata
Casuarina acutivalvis
Eucalyptus burracoppinensis

E. pileata
Hakea scoparia
Melaleuca cordata
M. cuticularis

Loc. 2.145

Acacia acuminata
Eucalyptus eremophila
E. foecunda

Melaleuca uncinata
Santalum acuminatum

Loc. 2.146

Acacia acuminata

Loc. 2.148

Acacia acuminata
Astartea heteranthera
Beaufortia bracteosa
Cassytha sp. indet. A (SC)
C. racemosa
Casuarina acutivalvis
Eucalyptus burracoppinensis
Gastrolobium spinosum
Grevillea hookerana
G. integrifolia var. *eremophila*
Hakea adnata
H. falcata
H. scoparia

Hibbertia lineata
Isopogon polycephalus
I. scabriusculus
Leptospermum erubescens
Melaleuca cordata
M. pungens
M. spathula
M. uncinata
Persoonia striata
Phebalium verrucosa
Santalum acuminatum
Verticordia chrysanthera

Loc. 2.149

Dryandra affin. *cirsioides*

Loc. 2.150

Dryandra affin. *cirsioides*

Loc. 2.152

Gastrolobium spinosum
Grevillea hookerana

Loc. 2.159

Astroloma serratifolium
Beaufortia bracteosa
Calycopeplus glomeratus
Calytrix empetrioides
Casuarina acutivalvis
Eucalyptus burracoppinensis
Gastrolobium spinosum

Hakea falcata
Hibbertia stricta
Lepidosperma gracile
Melaleuca cordata
M. uncinata
Persoonia coriacea
P. striata

Petrophile ericifolia
Phebalium ambiguum

P. verrucosa
Schoenus compressus

Loc. 2.161

Casuarina acutivalvis
Eucalyptus burracoppinensis
Goodenia pinifolia

Hakea scoparia
Isopogon scabriusculus
Melaleuca uncinata

Loc. 2.163

Dryandra affin. cirsioides

Loc. 2.164

Acacia desertorum (D)
A. signata
Beaufortia bracteosa
Bertya cunninghami
Boronia ternata var. *foliosa*
Cassytha sp. indet. B (SC)
Casuarina acutivalvis
Chamelaucium sp. nov. (SC)
Eucalyptus burracoppinensis
Goodenia pinifolia (D)
Grevillea eriostachya

Hakea coriacea
H. multilineata
H. sp. nov. (SC)
Isopogon scabriusculus
Melaleuca cordata
M. pungens
M. spathulata
Phebalium ambiguum
P. verrucosa
Pimelea sylvestris
Santalum acuminatum

Loc. 3.1

Acacia acuminata
A. assimilis (+D)
Adenanthos argyraea
Beaufortia bracteosa
Cassytha sp. indet. B (SC)
Casuarina acutivalvis
Chamelaucium sp. nov. (D, SC)
Choretrum pritzellii (+D)
Conospermum amoenum (D)
Cyperaceae gen. nov. (SC)
Dampiera eriocephala (D)
D. sp. indet. 1 (D, SC)
D. tomentosa (D)
Daviesia acanthoclona
D. brevifolia
D. cardiophylla
D. colletioides
Dryandra affin. cirsioides
D. ferruginea
Eucalyptus foecunda
Exocarpus aphyllus

Gastrolobium spinosum
Grevillea hookerana
Hakea falcata
Harperia lateriflora
Hibbertia stricta
Isopogon polycephalus
I. scabriusculus
Laxmannia sp. indet (D, SC)
Lepidosperma drummondii
Leptospermum erubescens
Melaleuca cordata
M. pungens
M. spathulata
M. uncinata
Micromyrtus imbricata
Oxylobium sp. indet 1 (SC)
Persoonia coriacea
P. striata
Petrophile conifera
P. ericifolia
P. seminuda

Phebalium verrucosa
Pityrodia axillaris (D)
Santalum acuminatum
Schoenus brevifolius

Synaphaea polymorpha (D)
Verticordia brownii
Westringia sp. indet. 1 (SC)

Loc. 3.2

Casuarina acutivalvis
Melaleuca uncinata

Loc. 3.3

Acacia sedifolia
A. sp. indet. 1 (SC)
Callitris canescens

Loc. 3.4

Acacia lasiocalyx
Casuarina acutivalvis

Grevillea hookerana
Hakea multilineata

Loc. 3.5

Casuarina acutivalvis

Loc. 3.6

Astroloma serratifolium
Calytrix fraseri
Cassytha sp. indet. B (SC)
Casuarina acutivalvis
C. campestris
Choretrum pritzellii
Cyperaceae gen. indet. (SC)
Dryandra affin. *cirsioides*
Hakea falcata
H. scoparia

Hibbertia uncinata
Leucopogon blepharolepis
L. dielsianus
Lysinema ciliatum
Melaleuca spicigera
Petrophile divaricata
P. seminuda
P. squamata
Verticordia brownii
V. serrata

Loc. 3.8

Callitris canescens
Eucalyptus cylindriflora

Loc. 3.12

Acacia acuminata
A. sulcata
Eucalyptus burracoppinensis

Hakea scoparia
Melaleuca cordata

Loc. 3.13

Acacia lasiocalyx
Casuarina acutivalvis

Grevillea hookerana
Hakea multilineata

Loc. 3.14

Acacia acuminata
Bertya cunninghami
Boronia ternata var. *foliosa*
Brachyloma concolor
Casuarina acutivalvis
C. corniculata
Eucalyptus gardneri

Goodenia pinifolia
Hakea multilineata
Jacksonia affin. *racemosa*
Melaleuca hamulosa
Persoonia affin. *saundersiana*
Phebalium verrucosa

Loc. 3.16

Isopogon polycephalus

Loc. 3.17

Acacia acuminata
Bertya cunninghami
Casuarina acutivalvis
Hakea multilineata

H. scoparia
Phebalium filifolium
Thryptomene australis

Loc. 3.18

Casuarina acutivalvis

Loc. 3.20

Acacia acuminata
Hakea falcata
Lepidosperma brunonianum

Melaleuca lateriflora
Stylidium repens

Loc. 3.21

Borya nitida
Calothamnus quadrifidus
Casuarina acutivalvis
Grevillea hookerana

Melaleuca cordata
M. fulgens
M. uncinata

Loc. 3.22

Acacia acanthoclada
Comesperma volubile
Eucalyptus salmonophloia

Melaleuca acuminata
M. lateriflora

Loc. 3.24

Acacia lasiocalyx
Casuarina acutivalvis

Loc. 4.5

Acacia acuminata (D)
Adenanthos argyreae (D)
Calytrix fraseri
Cassytha sp. indet. B (D, SC)
Casuarina acutivalvis

Chorizema ericifolium (D)
Cryptandra miliaris (D)
Cyperaceae gen. indet. (SC)
Daviesia aphylla
Eucalyptus foecunda (E)

E. incrassata (E)
E. transcontinentalis (E)
Gastrolobium spinosum (E)
Glyschrocaryon flavescens
 Goodeniaceae sp. indet. 1 (D, SC)
Goodenia helmsii (D)
G. scapigera (D)
Hakea lissocarpha (D)
Isopogon polycephalus (D)
I. scabriusculus (D)

Lechenaultia biloba (D)
Lepidosperma drummondii
L. gracile (+D)
Melaleuca cordata
M. spathulata (D)
M. uncinata (+D)
Persoonia teretifolia (D)
 Santalaceae affin. *Leptomeria* sp. (D)
 Sterculiaceae gen. indet. (D)
Verticordia brownii

Loc. 4.6

Acacia assimilis (+D)
A. lasiocalyx (+D)
A. pulchella (D)
Boronia capitata
Calothamnus quadrifidus
Calytrix empetrioides
Cassytha glabella
Conospermum stoechardis (D)
Cryptandra pungens
Daviesia brevifolia
Dryandra affin. *cirsioides*
D. sp. indet. A (+D, SC)
D. sp. indet. B (SC)
 Epacridaceae gen. indet. 1 (SC)
Eremaea pauciflora (D)
 Goodeniaceae gen. indet. 1 (D)
Grevillea integrifolia
Hakea ambigua
H. corymbosa
H. falcata (+D)

H. lehmanniana
Harperia lateriflora
Leptospermum erubescens (+D)
Leucopogon blepharolepis
L. dielsianus
Lobelia heterophylla
Melaleuca affin. *laxiflora*
M. pauperiflora (D)
M. pungens (D)
M. spathulata (+D)
Persoonia coriacea
Petrophile ericifolia (+D)
Pityrodia axillaris (+D)
Platysace maxwellii (D)
Santalum acuminatum
Stackhousia pubescens
Verticordia picta (D)
V. plumosa
V. serrata

Loc. 4.7

Acacia acuminata
A. assimilis
A. lasiocalyx
Adenanthos argyraea
Banksia sphaerocarpa
Beaufortia bracteosa
Cassytha sp. indet. B. (SC)
Casuarina acutivalvis
C. humilis
Chamelaucium megalopetalum
Choretrum glomeratum

Dampiera eriocephala (D)
D. sp. indet. 1 (D, SC)
Daviesia cardiophylla
D. affin. decurva
D. affin. preissii
Dryandra affin. *cirsioides*
D. ferruginea
D. sp. indet. A. (SC)
D. sp. indet. B (SC)
Eremophila sp. indet. 1 (D, SC)
 Fam. indet. 2 (SC)

Fam. indet. 4 (D, SC)
Gastrolobium spinosum
Goodeniaceae sp. indet. 2 (+D, SC)
Goodenia pinifolia
Grevillea hookerana
Hakea ambigua
H. baxteri (+D)
H. falcata
Hibbertia stricta (D)
Isopogon polycephalus
I. scabriusculus
Lepidosperma gracile
Leptospermum erubescens
Leucopogon blepharolepis
Melaleuca cordata

M. pungens
M. spathulata
M. spicigera
Micromyrtus imbricata
Persoonia coriacea
Petrophile conifera
P. ericifolia
P. seminuda
Philothea drummondita
Poaceae sp. indet. 1 (SC)
Santalum acuminatum
Verticordia brownii
V. plumosa
V. serrata

Loc. 4.8

Dryandra affin. *cirsioides*
Eucalyptus foecunda
E. transcontinentalis
Gastrolobium spinosum

Isopogon polycephalus
Melaleuca spicigera
M. uncinata

Loc. 4.10

Casuarina acutivalvis
Eucalyptus burracoppinensis

Melaleuca uncinata
Santalum acuminatum

Loc. 4.11

Banksia sphaerocarpa
Borya nitida
Casuarina acutivalvis
Cyperaceae gen. nov. (SC)
Eremaea pauciflora
Hakea ambigua

Leucopogon hamulosus
Melaleuca cordata
M. seriata
M. uncinata
Xanthorrhoea nana

Loc. 4.12

Acacia dielsii
Borya nitida
Casuarina acutivalvis
C. campestris
C. microstachya

Cyperaceae gen. nov. (SC)
Hakea scoparia
Lepidosperma gracile
Melaleuca spicigera
Xanthorrhoea nana

Loc. 4.14

Eucalyptus foecunda
Grevillea hookerana
Leptospermum erubescens

Loc. 4.15

Adenanthos argyraea
Choretrum glomeratum
Cryptandra polyclada
Dampiera sp. indet 3 (SC)
Dryandra cirsioides
D. ferruginea

Grevillea eryngioides
G. hookerana
Hakea adnata
H. multilineata
Hemigenia diplanthera
Melaleuca lateritia

Loc. 4.18

Grevillea eryngioides
G. integrifolia
Hakea ambigua

H. falcata
Isopogon polycephalus

Loc. 4.21

Callistemon phoeniceus
Lepidosperma effusum
Melaleuca cordata

Loc. 4.22

Acacia desertorum

Loc. 4.23

Callitris canescens
Casuarina acutivalvis

Dryandra affin. *cirsioides*
Petrophile seminuda

Loc. 4.24

Cassyltha sp. indet. A (SC)
Eucalyptus burracoppinensis
E. foecunda
Lepidosperma brunonianum

Melaleuca cordata
M. spathulata
M. uncinata

Loc. 4.25

Borya nitida
Cyperaceae gen. nov. (SC)
Dryandra cirsioides
D. ferruginea

Hakea falcata
Melaleuca spathulata
Petrophile ericifolia

Loc. 5.1

Acacia lasiocalyx
Astartea heteranthera
Calothamnus quadrifidus
Casuarina campestris
Dampiera eriocephala (D)
D. wellsiana (D)
Dodonaea bursariifolia (D)
Gastrolobium crassifolium (D)
Glyschrocaryon flavescens (D)

Goodenia helmsii (D)
Hakea multilineata (D)
H. scoparia (D)
Hibbertia verrucosa (D)
Isopogon polycephalus (D)
Lepidosperma drummondii (D)
Leptospermum erubescens (D)
Melaleuca laxiflora (D)
M. affin. *scabra*

M. uncinata (D)
Micromyrtus imbricata
Petrophile seminuda (D)
Poaceae sp. indet. 2 (D, SC)

Poaceae sp. indet. 7 (SC)
Stylidium repens
Verticordia serrata

Loc. 5.4

Grevillea hookerana
Santalum acuminatum
Spartochloa scirpoidea

Loc. 5.5

Borya nitida
Spartochloa scirpoidea
Stylidium repens

Loc. 5.10

Calothamnus quadrifidus

Loc. 5.11

Acacia sedifolia
Casuarina campestris

Loc. 5.13

Casuarina acutivalvis

Breakaway complex

Callitris canescens
Grevillea huegellii
Melaleuca undulata

Other associations – Wetland

Acacia dielsii
Borya nitida
Melaleuca uncinata
Spartochloa scirpoidea

APPENDIX 3

Family, genus and species distribution of the Bending Reserve flora.

Family and genus	Number of species found
AMARANTACEAE	
<i>Ptilotus</i>	1
APIACEAE	
<i>Platysace</i>	1
APOCYNACEAE	
<i>Alyxia</i>	1
ASTERACEAE	
<i>Olearia</i>	1
CASUARINACEAE	
<i>Casuarina</i>	6
CHENOPODIACEAE	
<i>Rhagodia</i>	1
CONVOLVULACEAE	
<i>Wilsonia</i>	1
CUPRESSACEAE	
<i>Actinostrobus</i>	1
<i>Callitris</i>	3
CYPERACEAE	
<i>Lepidosperma</i>	4
<i>Mesomelaena</i>	1
<i>Schoenus</i>	2
Genus indeterminate	1
DICRASTYLIDACEAE	
<i>Dicrastyles</i>	1
<i>Pityrodia</i>	1
DILLENIACEAE	
<i>Hibbertia</i>	5
EPACRIDACEAE	
<i>Astroloma</i>	2
<i>Brachyloma</i>	1
<i>Coleanthera</i>	1
<i>Leucopogon</i>	5
<i>Lysinema</i>	1
Genus indeterminate	1

Family and genus	Number of species found
EUPHORBIACEAE	
<i>Bertya</i>	1
<i>Beyeria</i>	1
<i>Calycopeplus</i>	1
FABACEAE	
<i>Chorizema</i>	1
<i>Daviesia</i>	9
<i>Gastrolobium</i>	3
<i>Jacksonia</i>	1
<i>Oxylobium</i>	1
GOODENIACEAE	
<i>Dampiera</i>	6
<i>Goodenia</i>	4
<i>Lechenaultia</i>	1
Genus indeterminate	2
HALORAGACEAE	
<i>Glyschrocaryon</i>	1
LAMIACEAE	
<i>Hemigenia</i>	1
<i>Westringia</i>	2
LAURACEAE	
<i>Cassytha</i>	4
LOBELIACEAE	
<i>Lobelia</i>	1
LILIACEAE	
<i>Borya</i>	1
<i>Dianella</i>	1
<i>Laxmannia</i>	1
MIMOSACEAE	
<i>Acacia</i>	23
MYOPORACEAE	
<i>Eremophila</i>	2
MYRTACEAE	
<i>Astartea</i>	1
<i>Baeckea</i>	1
<i>Beaufortia</i>	2
<i>Callistemon</i>	1
<i>Calothamnus</i>	1
<i>Calytrix</i>	3

Family and genus	Number of species found
<i>Chamelaucium</i>	1
<i>Eremaea</i>	1
<i>Eucalyptus</i>	17
<i>Hypocalymma</i>	1
<i>Leptospermum</i>	1
<i>Melaleuca</i>	23
<i>Micromyrtus</i>	1
<i>Thryptomene</i>	1
<i>Verticordia</i>	5
Genus indeterminate	1
PITTOSPORACEAE	
<i>Sollya</i>	1
POACEAE	
<i>Spartochloa</i>	1
Genus indeterminate	6
POLYGALACEAE	
<i>Comesperma</i>	1
PROTEACEAE	
<i>Adenanthos</i>	1
<i>Banksia</i>	1
<i>Conospermum</i>	1
<i>Dryandra</i>	4
<i>Grevillea</i>	8
<i>Hakea</i>	14
<i>Isopogon</i>	2
<i>Persoonia</i>	5
<i>Petrophile</i>	6
<i>Synaphaea</i>	3
RESTIONACEAE	
<i>Loxocarya</i>	2
Genus indeterminate	3
RHAMNACEAE	
<i>Cryptandra</i>	7
RUTACEAE	
<i>Boronia</i>	3
<i>Diplolaena</i>	1
<i>Phebalium</i>	4
<i>Philothea</i>	1
SANTALACEAE	
<i>Choretrum</i>	2

Family and genus	Number of species found
<i>Exocarpus</i>	1
<i>Santalum</i>	1
Genus indeterminate	1
SAPINDACEAE	
<i>Dodonaea</i>	1
STACKHOUSIACEAE	
<i>Stackhousia</i>	1
STERCULIACEAE	
Genus indeterminate	1
STYLIDIACEAE	
<i>Stylidium</i>	1
THYMELIACEAE	
<i>Pimelia</i>	2
XANTHORRHOEACEAE	
<i>Xanthorrhoea</i>	1
FAMILY INDETERMINATE	4
ANNUAL SPECIES	
ASTERACEAE	
<i>Angianthus</i>	2
<i>Helipterum</i>	1
<i>Waitzia</i>	1
CENTROLEPIDACEAE	
Genus indeterminate	1
DROSERACEAE	
<i>Drosera</i>	ca8
ORCHIDACEAE	
Genus indeterminate	ca6
STYLIDIACEAE	
<i>Levenhookia</i>	ca2
<i>Stylidium</i>	ca2
'Yams'—family indeterminate	2
EXOTIC SPECIES	
ASTERACEAE	
<i>Inula</i>	1

APPENDIX 4
Trends in soil data

Generalised Trends in Soil Characters of Each Formation—A

Formation	Principal Profile Form	Texture	Gravel Content	Munsel Colour (Hue)	Soil Reaction Trend	Calcareous	Drainage
Woodland	Uniform	Sandy loam	High	7.5 or 10 YR	Acid or neutral	No	Good
<i>Eucalyptus burracoppinensis</i> dominated mallee	Gradational	Sandy loam or clay loam	Low	10YR	Acid	No	Good or poor
Other species of mallee dominated	Uniform or gradational	Sandy loam or clay loam	Low	10YR	Acid or neutral	No	Good or poor
Shrublands	Uniform	Sandy loam or clay loam	High	10YR	Neutral	No	Good or poor
Heath	Uniform	Clay loam	Low	10YR	Acid or neutral	No	Excessive good or poor

Generalised Trends of Soil Characters of Each Formation—B

Formation	Pedality	Sandy or Earthy	Coherence	Bleaching	Grain Angularity	Sorting
Woodland	Mostly low	Both	Good	Unbleached	Subangular to subrounded	Moderate to good
<i>Eucalyptus burracoppinensis</i> dominated mallee	All high	Both	Good	Sometimes mottled	Subangular to subrounded	Moderate
Other mallee dominated formations	Mostly high	Both	Sometimes high	Unbleached	Subangular to subrounded	Mostly poor
Shrublands	Non-pedal to high	Earthy	Moderate	Unbleached	Angular to rounded	Poor
Heaths	Mostly low	Both, but mostly sandy	Good	Unbleached	Subangular to subrounded	Poor to moderate

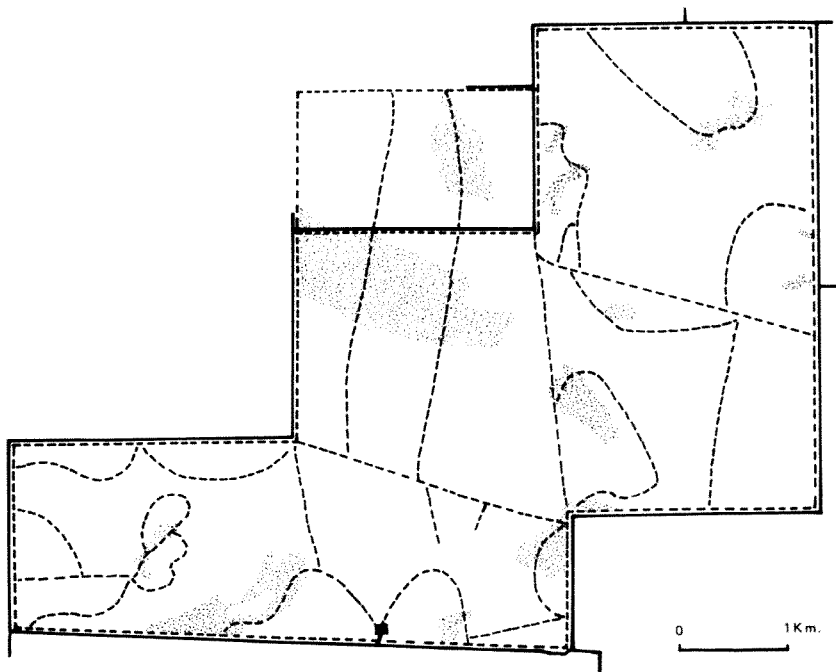


Fig. 5. Bendering Reserve, northern portion, showing position of survey traverses.

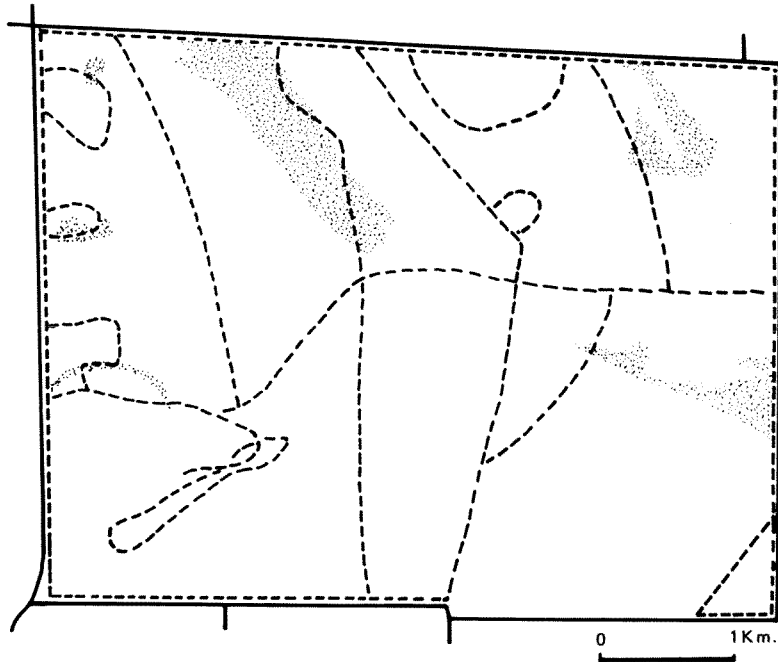


Fig. 6. Bendering Reserve, southern portion, showing position of survey traverses.