Chapter 4

VEGETATION

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Abstract

The vegetation of the Lesueur Area is shown to be structurally diverse, consisting mainly of shrublands and woodlands interspersed in a complex mosaic. Even greater complexity is evident when communities are identified on a floristic basis. Major vegetation units are numerous, they form an intricate mosaic, and they show a close relationship to landforms. Moreover, within the one vegetation type studied in greatest detail (heath on lateritic uplands), there are 11 distinct floristic sub-types within the Lesueur Area which are geographically identifiable and can be related to specific geological substrates and soil erosional processes.

The great diversity of communities reflects the complexity of underlying strata and unusually large array of habitats found in the Lesueur Area, particularly in the eastern area. Detailed mapping by Martinick and Associates (1988) identified a very fine-scale mosaic in the eastern landforms. Some communities in the eastern uplands are not found elsewhere.

4.1 INTRODUCTION

The vegetation of the Lesueur Area and surrounding areas has been mapped at the scale of 1:250 000 by Beard (1976, 1979). In preparing his maps, Beard used many of the major surface geological boundaries previously recognised by Lowry (1974), thus tacitly recognising the strong influence of geological substrate on vegetation.

At the broad scale used by Beard, the vegetation map of the Lesueur Area is little more than a description of what is growing on each major landform. The vegetation readily can be subdivided further. Blackwell and Griffin (1981) showed that this was possible, even without detailed analyses. However, once the detailed analyses are undertaken, the real complexity of the vegetation becomes obvious.

This Chapter provides a review of existing information about the vegetation of the Lesueur Area in the context of what is known of the vegetation of the region. Vegetation is described firstly in terms of structure, and then in relation to the landforms described in Section 3.3 and illustrated in Figure 3.3. This information is drawn from Beard (1979), Griffin (1982), Martinick and Associates (1988) and unpublished observations of E.A. Griffin.

4.2 VEGETATION STRUCTURE

There is a great variety of structural types in the Lesueur Area. The principal formations are woodlands and shrublands; the area also includes sedgelands and occasional herblands. Taken together, the various shrubland formations are the most extensive. They are often intermingled to form a complex, fine-scale mosaic.

There are significant areas of *Eucalyptus wandoo* Woodland (Low Forest A to Low Woodland A, *sensu* Muir 1977) in Cockleshell Gully. Around the salt lakes *Casuarina obesa* forms Forest. Along drainage lines are small patches of *Melaleuca preissiana* Woodland (Open Low Woodland B) or, occasionally, *Eucalyptus rudis* Woodland. Beneath the woodlands there is a quite variable shrub understorey from Dense Heath A to Low Heath D and Low Sedges. Marri (*Eucalyptus calophylla)* and powderbark wandoo (*Eucalyptus accedens*) occur as Open Low Woodland B (and as emergent trees) in a matrix of shrubs, normally Dense Low Heath C, also with taller shrubs. Illyarrie (*Eucalyptus erythrocorys*) forms small woodland groves on limestone. Other Open Low Woodlands (*Banksia attenuata, B. menziesii* and *Eucalyptus todtiana*) are present on some of the sandy areas. Although an Open Shrub Mallee formation (*Eucalyptus drummondii* Mallee Heath) occurs on some areas of laterite, mallees mainly occur as emergents in areas of Low Heath. Marri often occurs as an Open Tree Mallee.

The shrub-dominated communities are both extensive and variable. As mentioned above, many areas have patches of trees. Taller shrub communities are mainly along drainage lines and in patches in coastal areas, especially near the salt lakes. Shrub dominated drainage lines, however, vary from Dense Heath A (*Melaleuca rhaphiophylla*) to Low Heath C (*Hypocalymma angustifolium* Heath). In other areas, dense shrub-dominated vegetation types vary from Dense Thickets (*Acacia rostellifera*), Dense Heath B (or A) (*Melaleuca* aff. *acerosa* (E.A. Griffin 2436) Heath), to Dense Low Heath C (*Hakea undulata* Heath, *Hakea erinacea* Heath, *Petrophile seminuda* Heath) to Dense Low Heath D (*Petrophile chrysantha* Heath). More open communities include Heath A (*Allocasuarina campestris* Heath), Heath A and B (*Banksia tricuspis* Scrub Heath, *Hakea neurophylla* Heath, *Dryandra sessilis* Heath, *Calothamnus quadrifidus* Heath), Low Heath C and D (Sand Heath, *Eremaea beaufortioides* Heath, Mixed Sand Heath, Lateritic Heath, *Hakea undulata* Heath, *Petrophile chrysantha* Heath, *Hakea erinacea* Heath, *Melaleuca platycalyx* Heath, *Petrophile seminuda* Heath), and a mixture of Low Heath C and Low Sedges (*Ecdeiocolea* Heath).

4.3 MAJOR VEGETATION UNITS

Within the northern kwongan region it has been demonstrated that vegetation is strongly related to soil types (Hnatiuk and Hopkins 1981; Bell and Loneragan 1985; Froend 1987). A similar relationship can be identified in the Lesueur Area and forms the basis of the descriptions given below.

4.31 Quindalup Dunes and Salt Lakes

Two vegetation systems, Guilderton and Cliff Head, are mapped by Beard (1976, 1979) on the sands and associated lacustrine deposits which make up this unit. In the Lesueur Area, the two vegetation systems are very similar in composition. The dunes support low heath, often dominated by *Melaleuca acerosa* and *Acacia lasiocarpa*. The interdunal areas, where there is a shallow layer of sand over the limestone pavement, generally have taller shrubs (e.g. *Acacia rostellifera, Melaleuca cardiophylla* and *M. huegelii*) forming thickets or tall heath.

A feature of these two vegetation systems in the area of the Lesueur Area is the presence of extensive salt lakes. Fringing the lakes are trees, sometimes forming woodlands, mainly of *Casuarina obesa* but also of *Melaleuca lanceolata*. Areas of samphire are prominent on lake margins; in some cases they completely cover the lake bed.

4.32 Spearwood Dunes

The older limestone deposits support Beard's (1976, 1979) Jurien and Illyarrie Systems. These are little different from each other in composition in the Lesueur Area. The vegetation types vary mainly according to the amount of yellow or brown siliceous sand covering the limestone. In places where little sand is present, there is a low heath dominated by *Acacia spathulifolia* and *Jacksonia spinosa*. In this heath, *Dryandra sessilis* is a common emergent, or sometimes the dominant species in which case it forms a tall shrubland. Deeper sands support either a dense low heath dominated by *Banksia leptophylla* and *Calothamnus quadrifidus* or a low woodland of *Banksia prionotes* with a low shrub understorey of *Allocasuarina humilis, Chamelaucium uncinatum, Hibbertia hypericoides* and *Eremaea beaufortioides*, to name a few.

Illyarrie (*Eucalyptus erythrocorys*) forms small woodland groves, but this species occurs mainly north of the Green Head Road. There is usually exposed limestone present in these groves but there is no obvious explanation for the occurrences of the discrete patches of Illyarrie. Areas of alluvium near Cockleshell Gully support *Acacia rostellifera* thickets alone, or such thickets in association with *Eucalyptus rudis* woodlands.

4.33 Bassendean Dunes

This dune system is at its northern limit in the Lesueur Area tapering out just north of Cockleshell Gully. The *Banksia* low woodlands typical of the Bassendean Dunes occupy only a minor portion of the Lesueur Area. Small patches of dense heath occur along an ephemeral drainage line. There are extensive areas of low heath typical of the colluvial sands and gravels of the adjacent Peron Slopes.

4.34 Peron Slopes

Low heath formations dominate the Peron Slopes. *Xanthorrhoea drummondii* indicates the presence of lateritic gravel at or near the surface. In this habitat it is conspicuously taller than other species, but rarely does it or any other species dominate. Shrubs form a low heath about 0.5m tall. Common species include *Allocasuarina humilis, Calothamnus sanguineus, Hakea conchifolia* and *Lambertia multiflora*.

In the sandy areas the heath is up to 1.5 m tall. The dominant species vary, apparently in response to the depth of sand. In shallow sands *Banksia candolleana* is very common. Deeper sands support *Adenanthos cygnorum* and the shrub forms of *Banksia attenuata* and *B. menziesii*. Conspicuous species are *Allocasuarina humilis, Melaleuca scabra, Conospermum* aff.

triplinervium (E.A. Griffin 5262) and *Hibbertia hypericoides.*

4.35 Lesueur Dissected Uplands

This landform has less laterite present than the Peron Slopes. There are two distinct types. The laterite on the upland rim is mostly duricrust whereas the slopes are principally lateritic gravel. They both share many species in common with the Peron Slopes but there are some differences. On the tops of Mt Lesueur and Mt Michaud, *Dryandra sessilis* and *Banksia tricuspis* form Heath up to 2m tall. This formation is quite unusual on laterite in this area. The slopes have a low heath about 0.5m tall. The sands include a similar combination of heath species to the Peron Slopes, but areas of deeper sand support low trees such as *Banksia attenuata, B. menziesii* and *Eucalyptus todtiana*. These areas are mainly near the bottom of Cockleshell Gully surrounding the alluvial deposits into which the current drainage line is incised.

The alluvial deposits around Cockleshell Gully have a clayey profile near to the surface and support a low heath usually dominated by *Verticordia densiflora* and *Calothamnus hirsutus*. Occasionally a few *Banksia grandis* and *Melaleuca preissiana* trees grow with the other banksias at the interzone between the alluvial deposits and the sands.

The drainage channel of Cockleshell Gully is dominated by *Eucalyptus rudis*. In places it forms a low forest but mostly it is a narrow band of trees. The coarse, sandy channels have a distinct flora including *Melaleuca rhaphiophylla, Acacia saligna* and *Jacksonia sternbergiana.*

A distinctive feature of the Lesueur Dissected Uplands is the numerous areas lacking either colluvium or alluvium. Here yellow sandy clays or mottled sandy clays support several vegetation types. These have not been documented but the common ones are heaths of 1-2 m in height dominated by species such as *Hakea neurophylla, Hakea undulata* and *Melaleuca* aff. *acerosa* (E.A. Griffin 2436). Low heaths are dominated by *Petrophile chrysantha* and other species. Such areas have several interesting species including the majority of the known populations of *Andersonia longifolia*, a locally endemic species.

4.36 Gairdner Dissected Uplands

The Gairdner Dissected Uplands landform is an area of varied relief which contains a wide range of vegetation types. The strongly dissected landscape and the narrow bands of different rock types has resulted in a fine-scale mosaic of abruptly changing vegetation. Only a small portion of the area has either Lateritic Heath or Sand Heath as described for the previous landform units. Its predominantly clayey soils support an array of vegetation types unusual in the northern kwongan. These are distinct from each other and are often dominated by a single species. These two features are also unusual for the northern kwongan.

The species which dominate separate heath types on clay or gravelly clay soils include *Calothamnus quadrifidus, Melaleuca platycalyx, Petrophile seminuda* and *Hakea erinacea.* Small patches of heavier clays have *Melaleuca hamulosa* or *M. uncinata* forming taller thickets. Marri (*Eucalyptus calophylla*) is a common species in clayey areas. Here it occurs as scattered trees and occasionally an open woodland. In gravelly soils *Hakea undulata* dominates a heath type while *Petrophile chrysantha* dominates a low heath.

The lateritic gravel in the Gairdner Dissected Uplands appears to be distinct from other laterites because it has a more loamy matrix. Some species relatively common on other laterites are absent or uncommon here, e.g. *Hakea conchifolia, Daviesia pedunculata* and *Dryandra shuttleworthiana.* The Gairdner Dissected Uplands apparently is the only area where *Dryandra fraseri* grows in the Lesueur Area.

The small patches of shallow sandy soil (over clays) may contain *Ecdeiocolea monostachya*, a tussock forming plant, in combination with shrub species. Frequently *Eucalyptus gittinsii*, a mallee, occurs in similar habitats.

This landform has the largest area of *Eucalyptus wandoo* woodlands in the Lesueur Area. These occur as patches often delineated by topography. However, there are places where the boundaries of the wandoo woodlands are clearly associated with changes in rock type. Wandoo appears to be confined to certain, possibly younger soils, especially areas with rejuvenated drainage with steep V-shaped gullies with clayey soil. In these areas *Trymalium floribundum* and *Grevillea thelemanniana* ssp. *delta* form a dense heath or even thicket, one of the several distinct understorey types associated with wandoo. On flatter slopes, different wandoo woodland types have understoreys dominated by *Melaleuca undulata, M. uncinata, Thomasia foliosa* or sometimes *Baeckea camphorosmae.*

The majority of the sandstone exposures in the Lesueur Area occur in this landform. The Lesueur Area contains the only exposures of the Lesueur Sandstone and Cockleshell Gully Formation in the region. Very little laterite remains on this rock type; mostly it has been stripped away leaving bare sandstone on relatively level areas or slopes made up of sandstone gravel. In both cases a distinctive set of vegetation types occurs. *Banksia tricuspis*, sometimes accompanied by

Eucalyptus drummondii, forms a scrub heath on the bare sandstone, a remarkable feat for a small tree to penetrate cracks in the sandstone. Also present with a high degree of constancy and fidelity are *Hakea neurophylla* and *Beaufortia* aff. *bracteosa* (E.A. Griffin 1176). *Actinostrobus acuminatus, Astroloma glaucecsens* and *Isopogon dubius* are common but also occur in other vegetation types. *Hakea neurophylla* is very common on the steeper slopes where it may be completely dominant forming a heath up to 2 m tall. *Banksia tricuspis* does not occur in these areas. However, some species grow almost nowhere else (e.g. *Gastrolobium ilicifolium*).

In some places, shallow sand has accumulated over the sandstone. Here, two species are dominant: *Hakea undulata* in shallow sand and *Melaleuca* aff. *acerosa* (E.A. Griffin 2436) in deeper sand. *Melaleuca* aff. *acerosa* may form, in places, a special type of sand heath with species such as *Eucalyptus todtiana* and *Petrophile macrostachya.*

Distinctive drainage line vegetation types are very limited in area because the lines themselves are so narrow. *Calothamnus quadrifidus* frequently dominates these narrow drainage lines where they pass through clayey areas. Common here are *Alyogyne hakeifolia* and *Viminaria juncea,* especially in the first years following fire. In places where the drainage line is less deeply incised, narrow stands of *Melaleuca hamulosa,* usually fringed by *M. platycalyx* occur. Sandy drainage lines are often dominated by *Melaleuca* aff. *acerosa.* When these are wider, *Melaleuca rhaphiophylla* and even *Eucalyptus rudis* become common.

4.37 Banovich Uplands

The principal vegetation types in the Banovich Uplands are Lateritic Heath and Sand Heath. Both are similar structurally to those described for the Peron Slopes but there are important floristic differences. For example the laterites of the Banovich Uplands are the main area for *Hakea megalosperma* and *Acacia teretifolia*. Several species common to laterite are sparse or absent here (e.g. *Melaleuca trichophylla, Tetratheca confertifolia* and *Conostylis androstemma*).

Some eastern lateritic uplands have a different type of laterite heath. Here there are some areas with clear cover dominance by one or two *Dryandra* species (*D.* aff. *falcata* (E.A. Griffin 3489) and *D. carlinoides.*

The Banovich Uplands landform has a greater number of vegetation types growing on sand than appear to occur on the Peron Slopes. It has extensive areas of *Banksia* woodlands, compared with the very limited areas on the Peron Slopes. (The Lesueur Dissected Uplands have some along Cockleshell Gully and around Mt Lesueur). The sand heath dominated by *Eremaea beaufortioides* is mainly confined to the Banovich Uplands. The only areas of *Hakea obliqua* Heath in the Lesueur Area occur in the south-eastern part of the Banovich Uplands.

There are a number of patches of heavy soil in the Banovich Uplands. These are related to Martinick and Associates' (1989a) Coomallo Soil Association. These areas have patches of low heath, mainly dominated by *Petrophile chrysantha*. Also, there are some small areas of *P. seminuda* and *Hakea erinacea.*

The drainage lines are principally sands overlying a clay pan which is close to the surface. They are filled with sand and are of a type which is poorly represented elsewhere in the Lesueur Area. Typically they support low heath of *Verticordia densiflora* and open woodland of *Melaleuca preissiana*. While similar heaths and woodlands are present elsewhere to a limited extent (e.g. along Cockleshell Gully), here they are best developed here because the drainage lines are shallow.

4.38 Bitter Pool Rises

The north-eastern part of the Lesueur Area has relatively low relief. This is in contrast with the adjacent Gairdner Dissected Uplands. Thus, although the two landforms have many similar substrates supporting vegetation types that are structurally similar, there are important floristic differences between them. The area is not well known, having received little study, partly because of fires which burnt out much of it in 1984 and 1985. Its landform is unique representing a mature U-shaped valley with clayey soils. This is unusual also because it is probably a drainage line which has had its direction of flow reversed in response to the tectonic adjustments in the central part of the Perth Sedimentary Basin.

There are predominantly clayey soils with accompanying species forming vegetation complexes (e.g. *Calothamnus quadrifidus, Petrophile seminuda, Melaleuca platycalyx, M. uncinata, Hakea erinacea* and *Petrophile chrysantha*). Because of the reduced relief, the first three species are relatively more common in this area than in the Gairdner Dissected Uplands. Here are a large number of very clayey pockets ("crab holes") which are distinguished on the ground by the presence of *Melaleuca uncinata* emerging from an area usually dominated by *Calothamnus quadrifidus.* From the air during spring the "crab holes" appear as numerous spots of standing water. Because of the greater dissection in the Gairdner Dissected Uplands, these features are much less abundant there.

Marri also occurs in the Bitter Pool Rises, but is less common here than in the Gairdner Dissected Uplands.

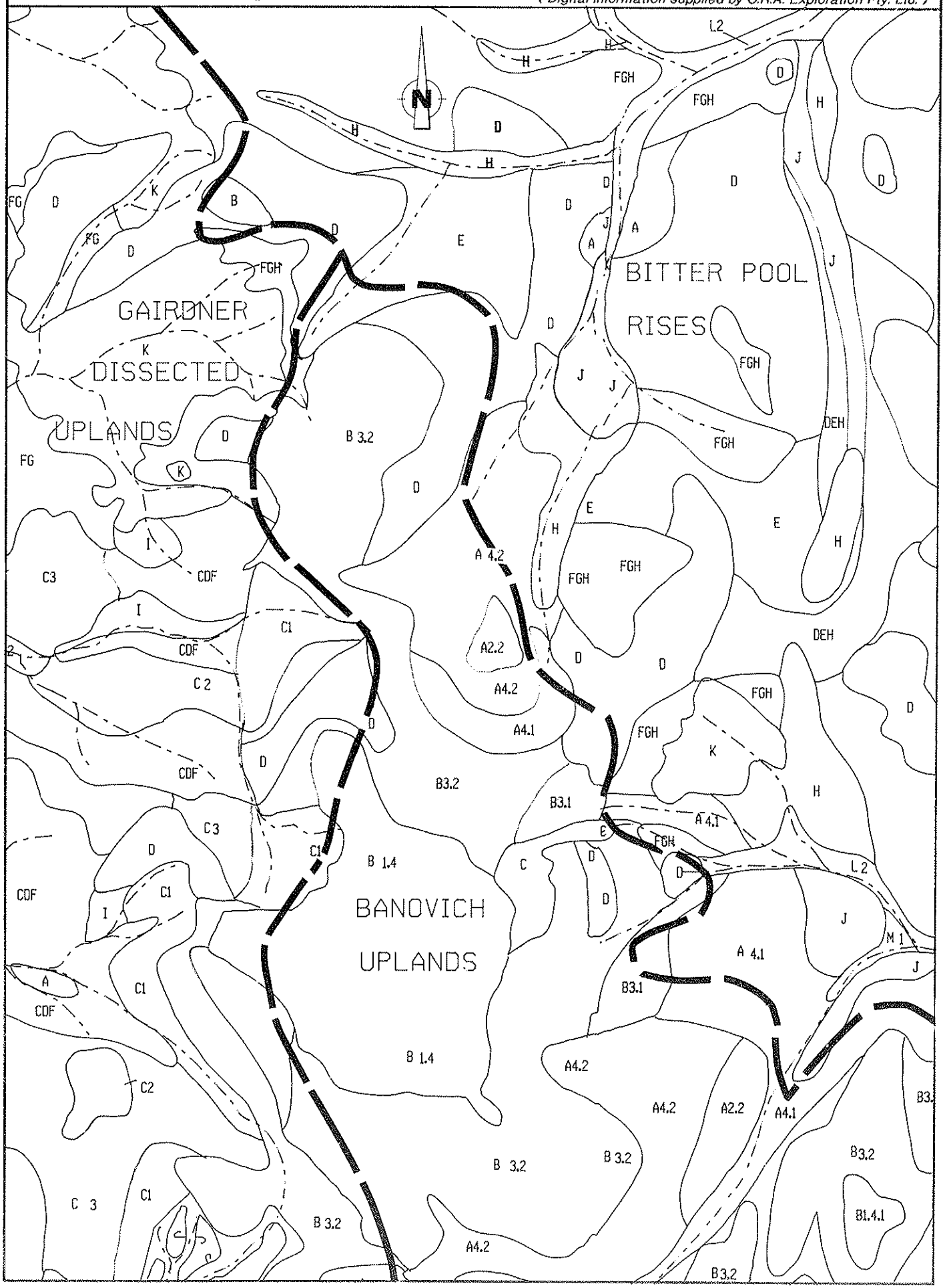
FIG. 4.1
EXAMPLE OF VEGETATION MAP PREPARED BY MARTINICK AND ASSOC (1988)

LANDFORM BOUNDARIES
MAJOR VEGETATION UNITS (eg C)
SUB UNITS (eg B3.1)
FGH COMPLEXES

Note : For location see Fig. 3.3

0 200 400 600 800 m
SCALE 1:10 000

(Digital Information supplied by C.R.A. Exploration Pty. Ltd.)



Only along the slopes of the slightly incised drainage lines does it occur as trees. In most other areas it is absent or occurs only as a stunted tree-mallee form.

There are several gravelly and lateritic areas which support heath and mallee-heath vegetation types, some of which are absent or uncommon in other parts of the Lesueur Area.

The areas of *Ecdeiocolea* Heath are very limited in the Lesueur Area as a whole. The Bitter Pool Rises landform contains the best examples of this unit (mainly at the boundary with the Banovich Uplands). A particular type of lateritic heath appears only to occur on some of the low rises in this area. The common species *Eucalyptus drummondii* and *Dryandra* aff. *patens* (E.A. Griffin 1507) are not represented on any other lateritic upland in the Lesueur Area (*E. drummondii* does occur on other soil types). The *Dryandra* has very specific habitat requirements, and because few of its patchily distributed populations occur on conservation reserves, this occurrence is significant.

The drainage line communities are mainly on clay. Some drainage lines are broad with no defined channel, especially in their upper reaches. Here there are areas which include heaths of *Melaleuca hamulosa* interspersed with patches of sedges. Although *Melaleuca hamulosa* occurs in other parts of the

Table 4.1

Distribution of major vegetation units within landforms of the proposed Lesueur National Park.

Code[#]	Name	Landforms PS	LDU	GDU	BU	BPR
A	Sand Heath	A	A	M	A	-
B	Lateritic Heath	A	A	M	A	-
C	Sandstone Heath	-	M	I	-	-
D	Gravel Heath	-	M	M	M	M
E	*Ecdeiocolea* Heath	-	-	M*	-	M
F	*Hakea erinacea* Heath	-	-	I*	-	I*
G	*Melaleuca platycalyx* Heath	-	-	I*	-	I*
H	*Petrophile seminuda* Heath	-	-	I*	M*	I*
I	*Gastrolobium spinosum* Scrub	-	-	-	-	-
J	*Calothamnus quadrifidus* Heath	-	-	I*	M*	I*
K	*Eucalyptus wandoo* Woodland	-	-	I	M	-
L	Clayey Drainage Lines	-	M	I	M	M
M	Sandy Drainage Lines	-	M	-	M	-
X	*Allocasuarina campestris* Heath	-	-	M	-	-

[#] Codes after Martinick and Associates (1988)

Landform Codes

PS	Peron Slopes
LDU	Lesueur Dissected Uplands
GDU	Gairdner Dissected Uplands
BU	Banovich Uplands
BPR	Bitter Pool Rises

Abundance Codes

A	Abundant
I	Important
M	Minor
*	mainly as a complex

Lesueur Area, this particular type of drainage line vegetation only occurs in the Bitter Pool Rises. The eastern part of the drainage patterns in the Lesueur Area are slightly incised. Narrow bands of *Melaleuca rhaphiophylla* and also Marri occur along these eroded slopes.

4.4 DETAILED VEGETATION MAPPING

Vegetation on the Lesueur Dissected Uplands, Gairdner Dissected Uplands, Bitter Pool Rises and Banovich Uplands landforms has been mapped in some detail at the scale of 1:10 000 (Griffin 1982, Martinick and Associates 1988). Initial mapping (Griffin 1982) was based on aerial photographic interpretation. However, since a number of authors (e.g. Hopkins and Hnatiuk 1981) highlighted the very considerable disparity between vegetation units defined on physiognomy and on floristics, the vegetation map was subsequently modified to take into account the results of detailed floristic studies (Martinick and Associates 1988).

Fourteen major units were identified. An additional 24 subunits were also recognised. Broadly speaking these units reflect landform and geological characteristics. Beard (1979) had earlier recognized that the vegetation of the Cockleshell Gully Formation (mainly woodlands and heath with scattered trees) was clearly different from that on the Lesueur Sandstone (heath and scrub heath).

Even at the scale of 1:10 000, mapping of the detail recognisable on the ground was difficult. Often it was not possible to draw meaningful boundaries; the vegetation types occurred in such a fine-scale mosaic that mapping could only indicate the presence of a complex of vegetation types. Some 28 complexes were recognised in the area by Martinick and Associates (1988).

Figure 4.1 is a sample of the vegetation map produced by Martinick and Associates (1988). This illustrates some of the heterogeneity of the vegetation: the 5.5 square kilometre area shown contains 13 of the major units of vegetation, as well as 12 subunits and five complexes. The complexity shown on the map is a reflection of the extremely fine mosaic of the soil (and geological substrate) in the Lesueur Area generally. Included in the figure are segments of the three main landforms on which the vegetation was mapped in detail. Even a quick examination reveals that the landforms have quite different assemblages of vegetation.

Table 4.1 provides an analysis of the relative abundance of the major vegetation units in each landform. However, Martinick and Associates (1988) recognised that many of the major units were extremely variable; this Table, therefore, is only indicative.

Sand Heaths and Lateritic Heaths are abundant on the Peron Slopes, Lesueur Dissected Uplands, and the Banovich Uplands. Sandstone Heath occurs predominantly on the Gairdner Dissected Uplands and to a lesser extent on the Lesueur Dissected Uplands. Gravel Heath is present to a minor degree on all units except for the Peron Slopes. Although *Ecdeiocolea* Heath is present on both the Gairdner Dissected Uplands and the Bitter Pool Rises, it appears to be more abundant in the latter area. *Hakea erinacea* Heath, *Melaleuca platycalyx* Heath and *Petrophile seminuda* Heath occur in complexes, with and without *Calothamnus quadrifidus* Heath, principally in the Gairdner Dissected Uplands and the Bitter Pool Rises. *Eucalyptus wandoo* Woodlands are common in the Gairdner Dissected Uplands, the landform on which most stands are found. Drainage line units are mainly found in the Gairdner Dissected Uplands and the Bitter Pool Rises. Clayey drainage units are mostly confined to both of these landforms whereas sandy units are more common in the Lesueur Dissected Uplands, and the Banovich Uplands. *Allocasuarina campestris* Heath is found as a minor component of the vegetation of the Gairdner Dissected Uplands.

The area that has been mapped in detail contains a number of vegetation units of special interest. Small areas of heath dominated by *Dryandra* aff. *patens* (E.A. Griffin 1507) occur within major unit B, lateritic heath (rarely within D, gravel heath) in the northern part of the area. The dominant species, *Dryandra* aff. *patens*, is undescribed and occurs patchily throughout its limited range in the district. It is poorly represented in conservation reserves.

Particularly fine stands of *Eucalyptus wandoo* with *Trymalium floribundum* as an understorey dominant occur on steep slopes of some V-shaped valleys with highly oxidised carbonaceous sedimentary rocks outcropping to the north-north-east of Mount Lesueur.

The *Calothamnus quadrifidus* heath (unit J) on the Bitter Pool rises landform differs from that occurring elsewhere, although this has not been documented in detail. On this landform, the *Calothamnus* heath is associated with the poorly-drained, heavy soils with sink holes and gilgais.

Where the heath dominated by *Ecdeiocolea monostachya* (unit E) occurs on the Bitter Pool Rises landform, it too is associated with heavy soil substrates. These contrast markedly with those found on the Gairdner Dissected Uplands landform, where the substrates are comparatively more sandy. Elsewhere in

Table 4.2

Relationship between floristic groups and landforms, geological units and erosional modifications in lateritic heath uplands (Data from Griffin and Hopkins unpubl.).

Group No*	Code+	Landform Unit	Geological Unit	Erosional Modification
I	B1.1	LDU	LS	H
II	B1.2	PS,LDU	LS	
III	B1.42	BU	CGF	
IV	B1.3	BU	YF	
V	B1.41	LDU,GDU,BU	LS,CGF	M
VI		PS,LDU	LS	
VII	B2.2	GDU	CGF	
VIII		?BU	YF	M
IX		?BU	YF	
X	C1	GDU	CGF	V
XI	B2.1	BPS	CGF	M

* Group No. from Griffin and Hopkins (unpublished) - see Figure 4.3.

\+ Code from Martinick and Associates (1988)

Landform Unit (this Publication)

PS	Peron Slopes
LDU	Lesueur Dissected Uplands
GDU	Gairdner Dissected Uplands
BU	Banovich Uplands
BPR	Bitter Pool Rises

Geological Unit (Lowry 1974)

LS	Lesueur Sandstone
CSG	Cockleshell Gully Formation
YF	Yarragadee Formation

Erosional Modification

V	Very Highly Stripped
H	Highly Modified
M	Moderately Modified

south western Australia, *Ecdeiocolea* heath typically occurs on yellow, sandy soils.

Drainage line vegetation (units L and M) is an important feature of the area mapped in comparison with areas to the west. Sandy substrates support particularly fine stands of *Melaleuca preissiana*, while the broad, clayey flats have *Melaleuca hamulosa* and some associated open sedgelands. The prominence of the *Melaleuca* units is largely a reflection of the diverse drainage pattern in the area east of the Lesueur and Peron faults.

4.5 DETAILED FLORISTIC STUDIES

Since 1979 over 400 permanent quadrats have been established in the eastern portion of the Lesueur Area and as far as Mt Benia and the Brand Highway for the purposes of detailed study of soil/plant relationships. Data from these quadrats have been analysed to provide an objective framework for the small scale vegetation map of Martinick and Associates (1988). Subsets of the data have also been examined (see Hopkins and Griffin 1984; Griffin and Hopkins 1985a).

When detailed floristic analyses involve several distinct vegetation types, soil and landform have usually been identified as the major factors in discriminating between vegetation types (e.g. Hnatiuk and Hopkins 1981; Bell and Loneragan 1985; Martinick and

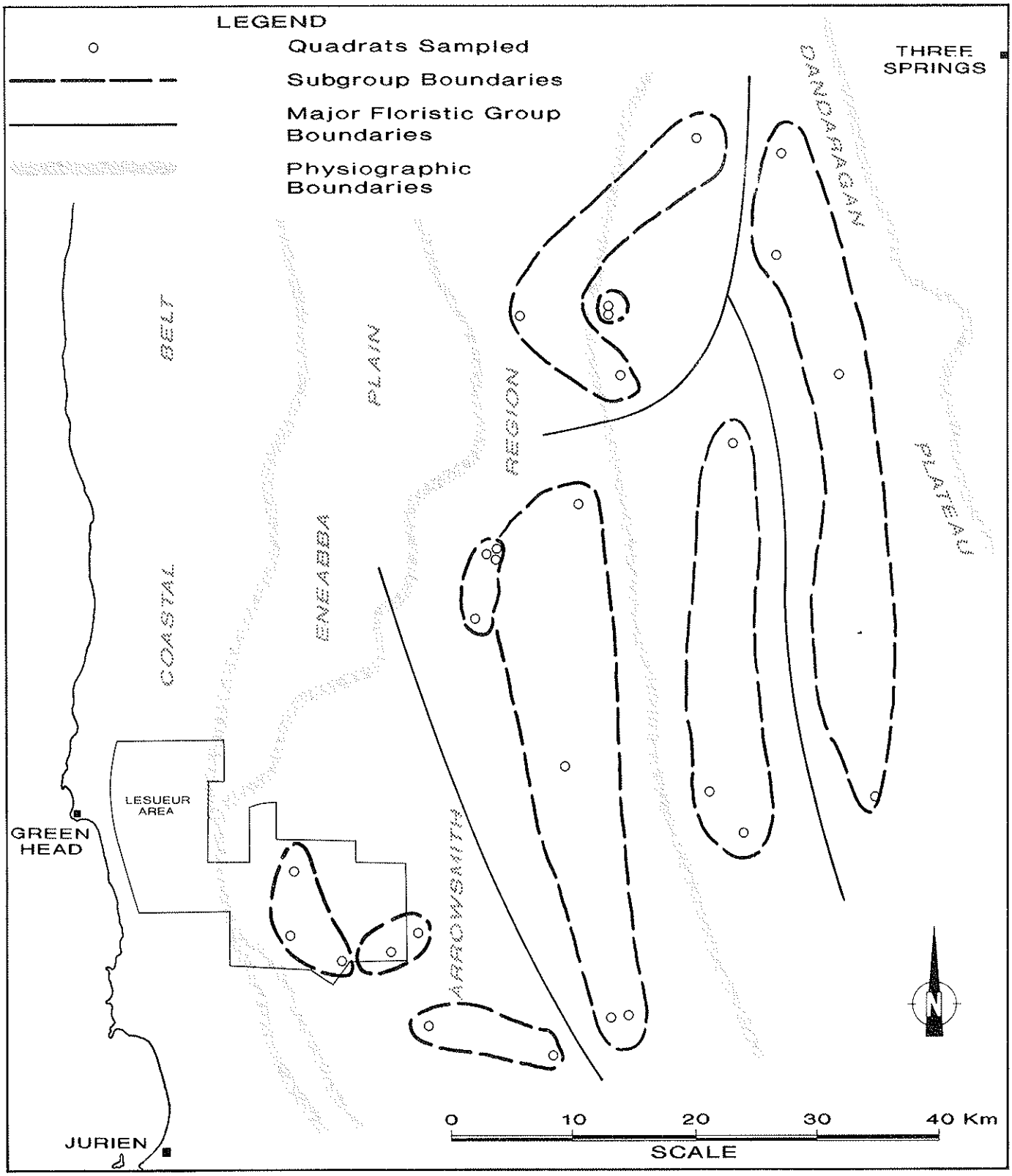


Figure 4.2

Regional variation in floristic composition of lateritic uplands in the Jurien-Eneabba area (from Griffin *et al.* 1983) shown on base map of physiographic regions (Playford *et al.* 1976).

Table 4.3

Diversity measures for selected vegetation types and subtypes in the proposed Lesueur National Park.

Vegetation Type	No.of Quads.	-Beta (a)*	Homo. (b)*
All sites[1]	226	9.19	0.17
Laterite - all[2]	142	3.57	0.59
Laterite - GI[2]	18	1.33	1.10
Laterite - GII[2]	29	1.52	1.24
Sand - all[1]	48	4.69	0.47
Sand - A2.1[1]	14	2.34	0.40
Sandstone - all[1]	20	2.88	0.43
Sandstone - C2[1]	7	1.51	0.57
Gravel - all[1]	48	4.63	0.48
Gravel - D5[1]	25	3.55	0.41
Wandoo[1]	12	3.73	0.19

Original data from: [1]Martiniek and Associates (1988); and [2]Griffin and Hopkins (unpublished).

(a)* Beta (between stand) Diversity (Whittaker 1972)

(b)* Homotoneity (a statistic measuring homogeneity. For Homotoneous vegetation this value should equal about 1.0; Westhoff and van der Maarel 1973)

Associates 1988; Froend 1987). Few studies have investigated floristic variation within a single vegetation type, especially within this region. Beard (1976) commented on the variation in the floristic composition of *Banksia* woodlands on his Bassendean System. Two recent unpublished, detailed studies have confirmed Beard's impressions (J.Dodd pers. comm.; Griffin *et al.* in litt.). The latter showed that the *Banksia* woodlands of the eastern part of the Lesueur Area were significantly different from near sites sampled on the Hill River and in the Badgingarra National Park. More detailed study is required to understand what factors are responsible for this variation and at what scale regional variation can be identified.

The only vegetation type where such regional variation has been investigated in any detail is Lateritic Heath growing on uplands (Griffin *et al.* 1983). This study, between Jurien and Three Springs, demonstrated a clear regional basis underlying the variation in its floristic composition (Figure 4.2). These authors believed that water stress (as measured by potential evapotranspiration) might be the factor responsible. However, there was a clear recognition of the potential role of landform and substrate differences in controlling plant species distribution patterns at the regional level. Recent observations of distribution patterns of *Dryandra* (Griffin unpublished) have highlighted a correlation with geological factors.

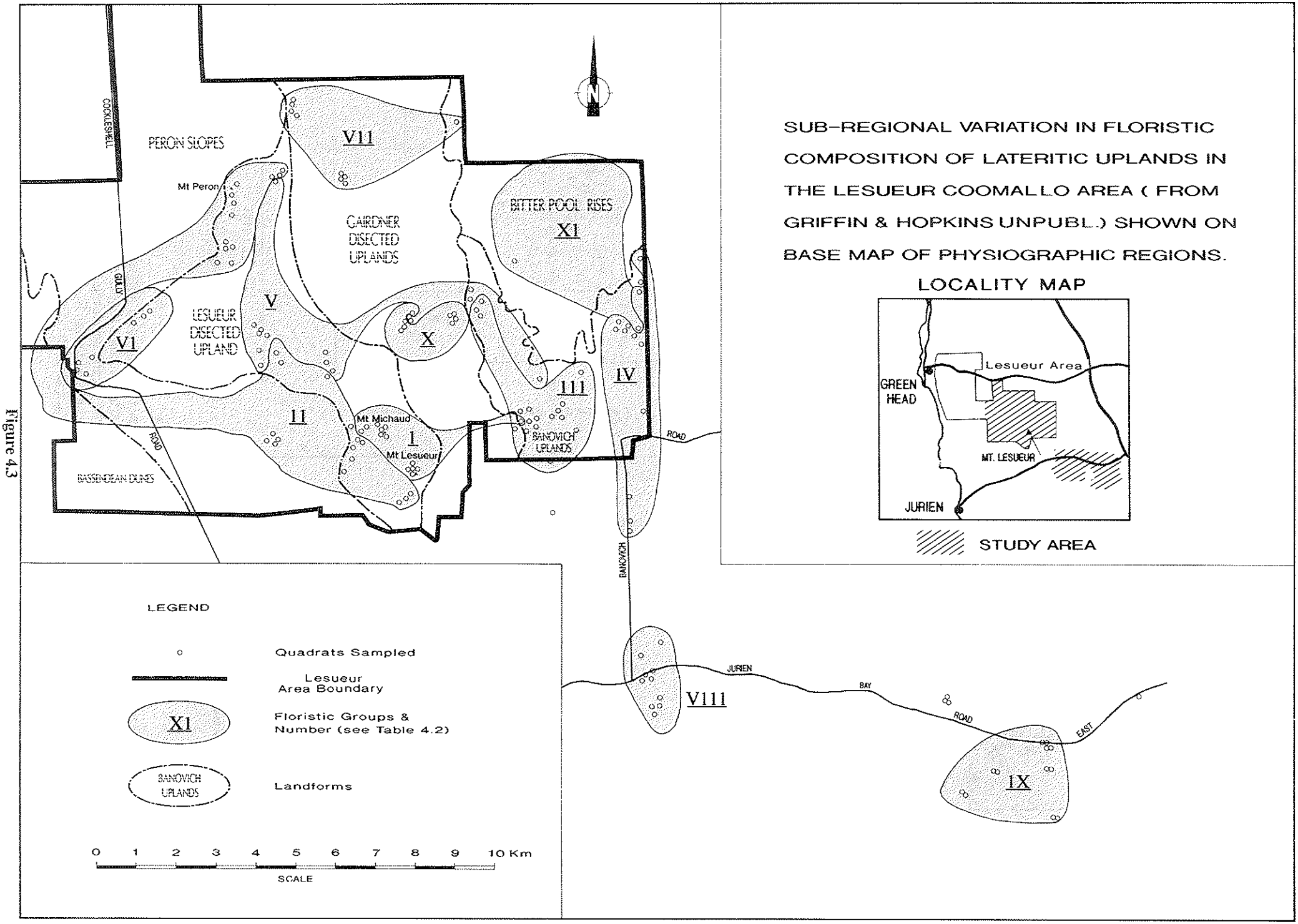


Figure 4.3 Sub-regional variation in floristic composition of lateritic uplands in the Lesueur - Coomallo area

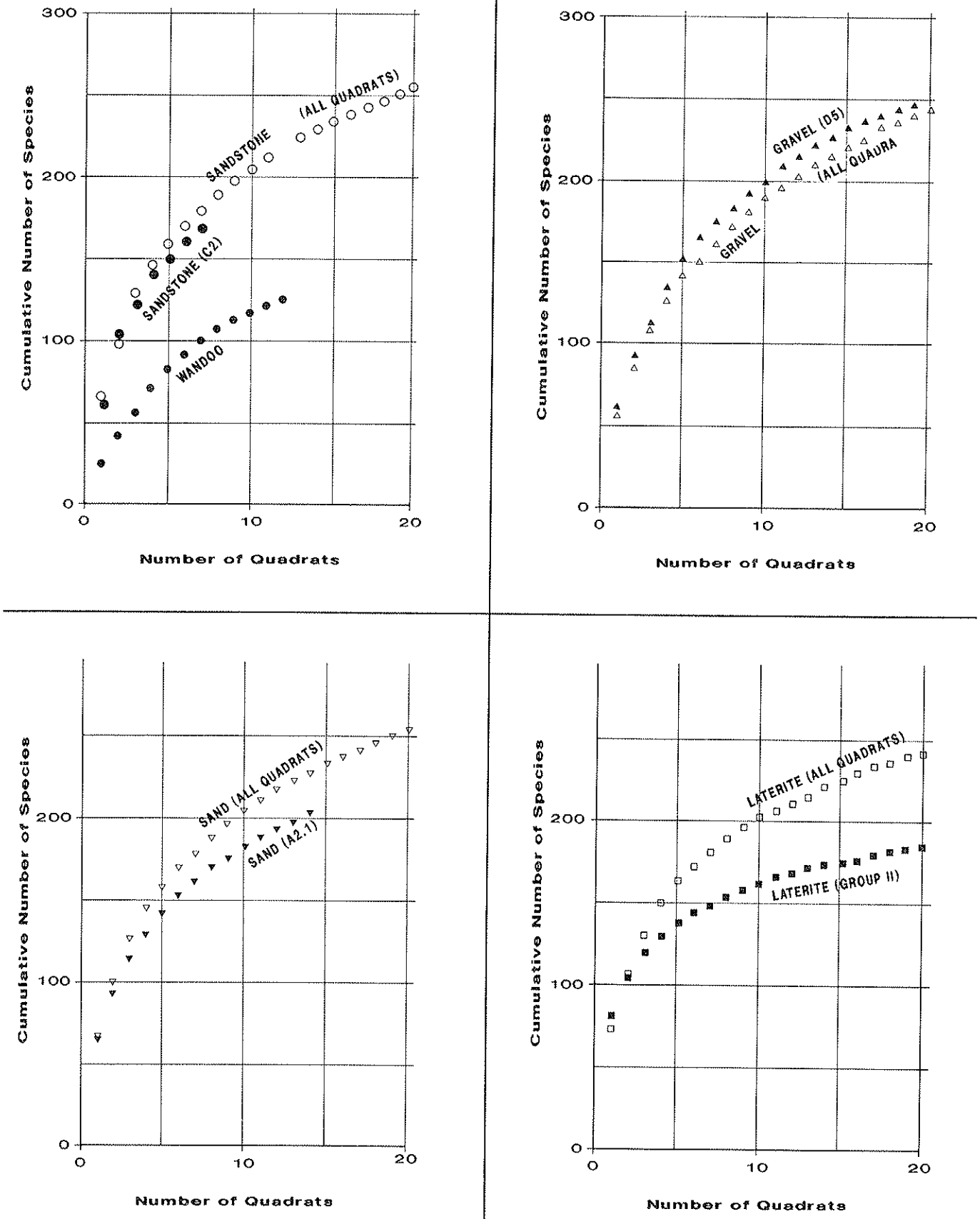


Figure 4.4

Species diversity of vegetation types. Curves indicate how the number of different species encountered increases as the number of quadrats sampled increases. Curves which flatten out quickly, indicate data sets which are more homogenous. Each data point is the mean cumulative number of species of 20 combinations of randomly selected quadrats: [Data on laterite sets from Griffin and Hopkins (unpublished), remainder from Martinick and Associates (1988)].

Detailed sampling of Lateritic Heath in the Lesueur Area and areas as far east as the Brand Highway was carried out to investigate the role of geology on soil formation and vegetation patterns at a finer scale. Figure 4.3 illustrates the results of this study: 11 groups of sites, 10 heath on laterite and one on sandstone, were recognised using multivariate ordination and classification programs as detailed in Martinick and Associates (1988).

There was an exact correspondence between eight of the 11 groups in this study and eight recognised by Martinick and Associates (1988; cf. Table 4.2). All three new groups recognised herein were not sampled by Martinick and Associates (1988). The pattern of distribution of the 11 groups is best explained in terms of geological substrate and erosional modification. As an example, differences in substrate make it possible to distinguish between Group II (laterite on sandstone), Group VII (laterite on siltstone) and Group XI (laterite on claystone) (Table 4.2).

Several stages of the erosional processes involved in stripping laterite are represented. A sequence of Group II, Group V, Group I and Group X reflects the relatively unmodified upland on the one hand (Group II), to bare sandstone from which the laterite has been completely stripped (Group X), on the other.

The significance of this study is that distinct types of Lateritic Heath on uplands can be identified and related reasonably well to the landforms in the Lesueur Area.

It is not yet possible to establish whether other vegetation types vary in similar ways. The distribution patterns of certain species suggest that this could be the case.

Comparing diversity measures is another way of establishing how likely this is. Table 4.3 and Figure 4.4 demonstrate that all of the major vegetation types examined in this way are at least as heterogeneous as laterite heath. More or less homogenous subtypes of lateritic vegetation were able to be established after detailed analyses. But the analyses by Martinick and Associates (1988) have not defined homogenous subtypes of the other major vegetation types. This disparity suggests that basic subtypes of most vegetation types could be identified if more detailed analyses and studies were undertaken.

It is important therefore to appreciate that although the map produced by Martinick and Associates (1988) (e.g. Figure 4.1) is complex, it is actually a simplification of an obviously more complex vegetation.