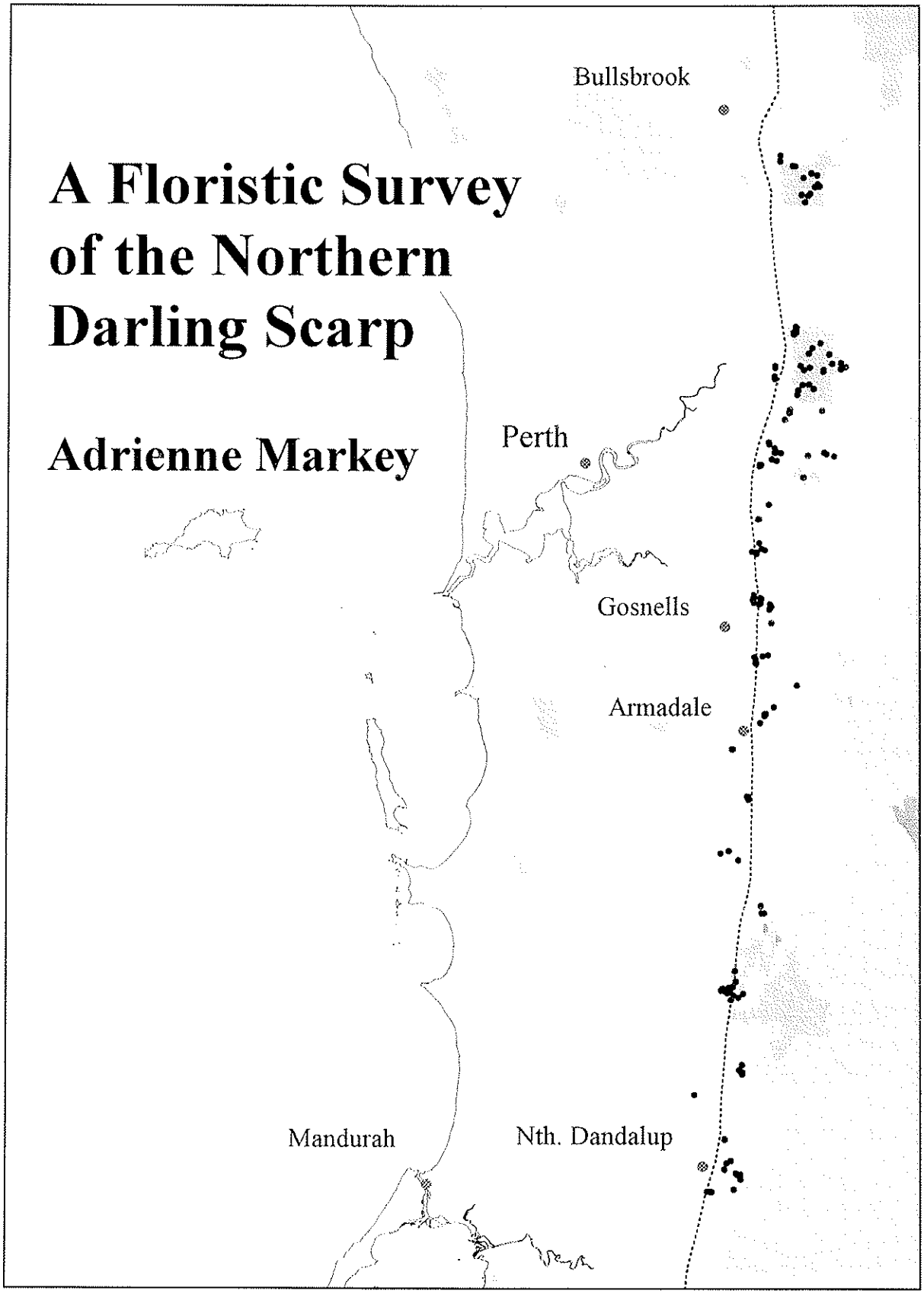
A Floristic Survey of the Northern Darling Scarp

Adrienne Markey



A report to the Western Australian Department of Conservation and Land Management, the Western Australian Department of Environmental Protection and the Western Australian Conservation Council for the Australian Heritage Commission.

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by

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Abstract

A floristic survey was undertaken of the remnant bushland along the northern Darling Scarp, in area between Bullsbrook and North Dandalup. A total of one hundred and twenty quadrats were surveyed in this area and data from an additional thirty quadrats provided by the Department of Environmental Protection and the Friends of Ellis Brook Valley. The final data set from one hundred and fifty sites was used to define the major types of floristic communities.

A total of 728 taxa (species, subspecies and varieties) of vascular plants was recorded from within or adjacent to the 150 quadrats, of which 651 were native taxa and 77 were introduced species. Two species of Declared Rare Flora (DRF) and 24 priority taxa were found in the 150 quadrats. Two taxa were recommended for changes in their priority status to listing as Declared Rare Flora. Nineteen taxa appeared to be endemic to the Darling Scarp between Bullsbrook and North Dandalup. in a region spanning from the Ridge Hill Shelf to the slopes of the scarp face and western margin of the Darling Plateau. A further 12 taxa endemic to both the northern and southern Darling Scarp and eleven near-endemic taxa were recorded in this survey. A total of twenty four species appeared to reach their southern range end within the study area, with four species occurring as unusual populations disjunct from their northern ranges in the Irwin Botanical Province.

The floristic analysis discerned eleven floristic community types, of which one community type was further resolved into three subunits. Topographic position and aspects of soil texture were found to be most closely associated with particular community types. There was a marked division between the three community types restricted to the upland plateau and the remaining communities on the slopes of the Darling Scarp. A second major division distinguished the woodlands and shrublands on the deeper soils on the slopes and foothills of the Darling Scarp (4 types, three subtypes) from the communities occurring on poorly drained, shallow sands over an impermeable hardpan (claypan or granite). This latter group included the shrublands on the granite outcrops of the Darling Scarp (2 types) and woodlands on the gravelly clays of the Ridge Hill Shelf (2 types).

Considering the distribution of these floristic communities over the profile of the Darling Scarp, several unique floristic communities were found to be restricted to Scarp face and / or foothills and were not encountered on either the valley slopes or uplands of the adjacent western margin of the Darling Plateau. Conversely, floristic communities found on the slopes of the valley systems on the western margin of the Darling Plateau were also found on the face of the Darling Scarp, which was attributed to similarities between these areas in their underlying geology and hydrology.

The floristic communities were found not to be correlated with the vegetation structure, nor was an association found between the species composition of the dominant stratum and the understorey, Therefore, the entire floristic community was found to be largely dependent on the floristic composition of the shrub, herb and sedge layers.

Of the thirteen community types and subtypes, one community type was completely unreserved, this being the Talbot Road Woodlands on Ridge Hill Shelf. Two community types of the Darling Scarp were represented within only one National Park and a further three community types were represented in only two National Parks. Reservation status based on numerical representation within National Parks and Nature Reserves was found to be misleading since the majority of these secure reserves were found to be clustered in the north-eastern section of the Perth Metropolitan Region. A further three community types well represented in this northern cluster of reserves were infrequently reserved or completely unreserved in the southern half of the study area This was attributable to extensive clearing of the lower slopes and foothills of the Darling Scarp south of the Perth Metropolitan Region, and the occurrence of only two secure reserves within this region Therefore, any vegetation remnants along the Darling Scarp south of Byford are considered to be of high conservation value.

Recommendations

This study of the floristic communities found on the Northern Darling Scarp between Bullsbrook and North Dandalup has generated the following recommendations for their conservation.

1: The two species, *Lasiopetalum pterocarpum* and *Conospermum undulatum*, are proposed for an upgrading from Priority status to gazettal as Declared Rare Flora.

2: Urgent action must be taken to slow or halt the progress of invasive weeds, most notably *Watsonia meriana* into the floristic communities the Northern Darling Scarp. 75 % of Reserves surveyed on the Darling Scarp were observed to have some degree infestation by *Watsonia meriana*. Areas which are under significant threat and requiring urgent attention are:

a) Serpentine National Park
b) Kalamunda National Park
c) John Forrest National Park and adjacent Greenmount Hill National Park
d) the Helena Valley and adjacent Gooseberry Hill Regional Open Space

3: As a consequence of extensive clearing of the Ridge Hill Shelf communities along the length of the northern Darling Scarp, all vegetation remnants are of high conservation value. From the results of this study, specific recommendations are that:

a) The Gooseberry Hill Regional Open Space contains significant remnants of Ridge Hill Shelf floristic communities, including *Themeda triandrus* under an *Eucalyptus rudis* woodland and a stand of *Conospermum undulatum*. Whilst this area will be incorporated into a National Park, it requires careful management to remove the threat from weeds and disturbance.

b) Bushmead Reserve (WAPC Lot #0) contains the only known example of *Eucalyptus wandoo* woodland of community type 1a known to occur on the Ridge Hill Shelf, therefore requires secure protection as an NPNCA vested reserve within the framework of the Darling Range Regional Park.

c) The *Eucalyptus rudis / Melaleuca rhaphiophylla* riverine community adjacent to the Serpentine Falls National Park under requires urgent management to prevent both the extinction of this community type and of *Lasiopetalum pterocarpum*.

d) To encompass and protect the Talbot Road woodlands, Swan Locations 11764 and 11313 and Reserve #23 953 are amalgamated into a single A-class Nature Reserve with vesting in the NPNCA.

4: All remnants of the northern Darling Scarp between Armadale and North Dandalup have high conservation value since there has been extensive clearing of this section, especially of the middle-lower slopes. Therefore, it is recommended that:

a) North Dandalup C-class Reserve #21 038 and the surrounding area of State Forest be amalgamated into a National Park vested in the NPNCA.

b) Goldmine Hill Reserve #21 041 be declared an A-class Nature Reserve vested in the NPNCA.

c) Byford Regional Open Space be managed as a Nature Reserve or Conservation Reserve.

5: Considering the high conservation and scenic value of the Ellis Brook Valley and adjacent lands, it is recommended that:

a) The area is declared as a National Park or Conservation Park within the network of the Darling Range Regional Park.

b) Areas affected by quarrying and access roads are adequately rehabilitated.

c) The impact of present quarrying on the flora of the region is reviewed.

d) Recreational activities are managed to minimise the spread of dieback.

6: A extension of this survey of floristic communities into the southern Darling Scarp is required since it appears that most of the Darling Scarp south of the Perth Metropolitan Region has been cleared and an reserve system does not exist to protect these remnants.

Introduction

1.1 Location

Located in the southwest of Western Australia, the Darling Scarp is a major geological feature that forms the western margin of the Darling Plateau and the eastern boundary of the Swan Coastal Plain. This north - south trending, linear escarpment extends from Bullsbrook to south of Dardanup, and is a narrow region of between one and three kilometres in width which encompasses the transition from coastal sandplain to jarrah forest on the Darling Range. For the purposes of this study, the Darling Scarp was defined as the region from the foothills at the base of the Scarp to within 5 km inland from the face of the escarpment.

The northern half of the Darling Scarp was the subject of this flora survey (Figure 1-1). Approximately 100 km of the Scarp was sampled along a transect commencing at Walyunga National Park, 40 km north of Perth, and extending 70 km southwards to finish at North Dandalup. This region effectively encompassed the area of Darling Scarp from Bullsbrook and Serpentine which is within the Perth Metropolitan Region (PMR) and an area under consideration for the Darling Range Regional Park (Department of Urban Planning 1993, Ministry for Planning 1995). The remaining 20 km of Scarp between Serpentine and North Dandalup lies outside the bounds of the PMR.

1.2 Climate

The Darling Scarp lies within the region of southwest Western Australia that experiences a dry mediterranean climate. Rainfall is seasonal, with most of the annual precipitation falling during the winter, followed by a warm, summer drought lasting five to six months (Gentilli 1989) (Table 1-1). In comparison to the adjacent coastal plain, which experiences an average of between 800 – 900 mm, annual rainfall is considerably higher on the Darling Scarp as a result of the orographic effect with the abrupt increase in altitude. The annual average rainfall commences from 800 to 1100 mm at the foothills and increases to over 1200 mm on the uplands, with peaks of over 1300 mm in locations 10 - 12 km east of the Darling Scarp. Rainfall steadily declines across the Darling Plateau in an easterly direction from these locations (Havel 1975b, Beard 1981; Gentilli 1989). There is an additional rainfall gradient in a north - south direction which is attributable to the prevailing south westerly fronts. Consequently, rainfall declines from 1200 to 1300mm per annum at Dwellingup, to between 700 to 900 mm per annum along the Scarp north of Bullsbrook. (Gentilli 1989).

Table 1-1 Annual average daily temperatures, annual rainfall and rain days for selected stations within the study area. Data from Bureau of Meteorology (1989).

Location	Mean max temp (C°)	Mean min temp (C°)	Rainfall (mm)	Rain days
Bullsbrook	24.0	12.2	692	109
Midland (Perth)	25.4	10.9	737	98
Kalamunda	22.2	11.9	1005	not available
Serpentine	22.1	10.5	1219	124
Dwellingup	21.7	9.7	1275	132

Gentilli (1989) describes the thermal regime of the region as mild, but very hot temperatures (>30°C) can be experienced during the summer and daily maximum temperatures tend to increase with a decrease in latitude (Table 1-1). Mild - moderate south westerly winds predominate during winter which is replaced by a diurnal pattern in the summer wind regime. High pressure systems generate desiccating north easterly winds cross the Scarp overnight and in the morning, with an apparent increase in wind velocity down the Scarp face (Mitchell 1979). These are usually replaced in the afternoon by a strong south westerly sea breeze that is generally of sufficient force to nullify the prevailing easterlies (Gentilli 1989).

The summer conditions of drought, strong winds and high temperatures, in conjunction with steep topography, produce a fire prone environment that lasts from November to April on the Darling Scarp (Robley 1983). This is compounded by the presence of flammable vegetation and litter. Summer thunderstorm activity in the summer can ignite wildfires (Gentilli 1989). However, the majority of fires on the Darling Scarp are of human origin, either as prescribed burns, acts of arson or by accident (Robley 1983). Rapid expansion of the Perth metropolitan region into the Darling Scarp has been associated with an profound increase in the incidence of wild fires (Robley 1983), which tend to cause considerable damage to the vegetation on the edge of the Plateau (Havel 1989). This has serious and immediate implications for both the conservation of reserves and protection of property.

1.3 Geology and geomorphology

The Darling Scarp is the steep, western margin of the Darling Plateau, created by faulting of the Yilgarn Block and exposing a linear profile of the Plateau extending Bullsbrook to Dardanup in a north - south direction. This major geomorphological unit forms the boundaries of two geomorphological provinces of the Darling System, these being the western margin of the Darling Plateau and the eastern boundary of the Swan Coastal Plain (Churchward and McArthur 1980). To the south, the Darling Scarp coincides with the Whicher Scarp south of Dardanup, which then replaces the Darling Scarp to form the southern boundary of the Swan Coastal Plain. Similarly, the Gingin Scarp replaces the Darling Scarp north of Bullsbrook.

The profile of the Darling Plateau is that of Precambrian granites subsequently overlain with a mantle of Tertiary laterite. This granite bedrock is the western portion of the Yilgarn Block that is predominantly comprised of Archaean metamorphic gneisses, granites and intervening migmatities. Narrow intrusions of dolerite constitute 15% of this bedrock and are frequently encountered along the Darling Scarp (Biggs and Wilde 1980).

The Darling Plateau within the study area is comprised of four geomorphological units as described and mapped by Churchward and McArthur (1980) (Table 1-2). The Dwellingup unit constitutes the lateritic uplands which are distinguished by massive laterite and gravely soils, whilst the Yarragil unit encompasses shallow, poorly drained depressions within this landscape. Drainage is rejuvenated on the western margin of the Darling Plateau and the Darling Scarp is dissected by a number of rivers and streams. Drainage generally follows a northwest alignment (Biggs and Wilde 1980) and the associated valleys and gulleys are significant landforms. Minor valleys on the Scarp have been mapped as the Murray unit. Major valleys constitute the Helena unit, where the laterite has been deeply eroded to form steep banks and expose the Archaean bedrock. Within the study area, this landform is represented by the Avon Valley, the Helena Valley, the Canning River, Wungong Valley and the Serpentine valley. Comparatively minor rivers system included Jane Brook, Bickley Valley, the head of Myara Brook, and the North Dandalup Valley.

The Darling Scarp Unit is the steep, narrow margin of the plateau which rises from an altitude of 75 to 250 m over a distance of 1 to 3 km. Erosion of the profile has displaced the Darling Scarp 1 to 3 km east of the actual fault line, and valley systems extend this erosion face further inland (Biggs and Wilde 1980). As a consequence of this exposure of the Archaean bedrock, the Darling Scarp is a landscape of extensive granite and gneiss outcrops interspersed with dolerite dykes.

The Ridge Hill Shelf or Forrestfield Unit constitutes the foothills of the Darling Scarp which is a between 1.5 - 3 km wide and of low relief at altitudes from 25 to 70 m (Sappal 1983, McArthur and Bettenay 1960). The geology consists of alluvial and colluvial deposits derived from the erosion of the Scarp and Plateau, and shoreline deposits derived from a succession of Quaternary marine incursions (Biggs and Wilde 1980; McArthur and Bettenay 1960). Remnants of the Cardup Group of Proterozoic shales, sandstone and siltstone are exposed in some regions along the base of the Darling Scarp from Gosnells to Serpentine (Biggs and Wilde 1980).

Table 1-2 Topographical position of the major geomorphic units on the Darling Scarp, as defined by Churchward and McArthur (1980).

Geomorphological Province	Geomorphic Unit	Topographic location
Darling Plateau	Dwellingup Unit	upland
	Yarragil Unit	winter wet depressions on plateau
	Helena Unit	major valley
	Murray Unit	minor valley
	Darling Scarp	scarp face
Swan Coastal Plain	Forrestfield Unit / Ridge Hill Shelf (McArthur and Bettenay 1960)	foothills at base of Darling Scarp (piedmont zone)

1.4 Soils

Associated with the underlying geology, the soils of the Darling Scarp can be regionalised according to their topographic location. On the plateau, lateritic soil profile of the uplands typically consists of a lateritic duricrust and associated sandy loams or sandy and gravelly yellow earths. Valley slopes tend to be more gravelly and shallow depressions tend to acquire colluvium, which results in deeper sandy duplex soils or yellow earths (McArthur 1991, Clifton 1973). This lateritic mantle overlies a deep, highly leached pallid zone grading from red to yellow - orange kaolinised clays. This pigmentation the result of accumulated iron and oxides and progresses to white with depth. The pallid zone may continue for up to 50 m before the underlying Archaean bedrock is encountered (McArthur 1991).

The soils encountered on the slopes of the Darling Scarp and the valleys on the western margin of the plateau are directly related to the exposure of this lateritic profile. Lateritic scree and pallid zone clays predominate on the upper slopes but the predominant soils are shallow red and yellow earths between exposed granite outcrops and loose boulders. These are relatively younger soils derived from the erosion of the underlying granite, gneiss and dolerite. Colluvial deposits influence this soil profile on the lower scarp and valley slopes. The greatest deposition of colluvial and alluvial material occurs on regions of lowest relief, these being wide valley floors and the Darling Scarp foothills (McArthur 1991, Clifton 1973). Therefore, the soils Ridge Hill Shelf consist of colluvial deposits, received from the Darling Scarp, alternating with the laterised sand deposits, derived from past marine incursions (McArthur 1991, McArthur and Bettenay 1960). The resulting soils encountered on the foothills range from the well drained gravelly yellow - brown sands on ridges, to gravelly clay sands over poorly draining clay and silt lenses where the laterite has been stripped (McArthur 1991; Jordan 1986a, 1986b). Fluviatile deposits of clayey sandy silt occur where rivers have interrupted the Ridge Hill Shelf. As noted by previous authors (Keighery and Trudgen 1992; Gibson *et al.* 1994) there is no consistency between authors for the precise boundaries and geological terms for Ridge Hill Shelf unit of McArthur and Bettenay (1960) as mapped on the 1:50 000 Environmental Geology Series (Gozzard 1986; Smurthwaite 1986; Jordan 1986a, 1986b).

1.5 Vegetation

Since the physical environment determines the vegetation community, the Darling Scarp also forms a biogeographical boundary that delineates the vegetation of the Swan Coastal Plain from that of the Northern Jarrah Forest Bioregion (Thackway and Creswell 1995). These regions lies within Darling District of the floristically rich South West Botanical Province of Beard (1981, 1990). Marchant *et al.* 1987 lists 2057 species (2200 taxa) as occurring in the Perth region, in an area covering the Swan Coastal Plain from Geraldton to Bunbury, and the western portion of the Darling Range. From this document, Bell and Heddle (1989) estimate that this region of the Darling Scarp and Range has at least 784 species, most commonly from the Proteaceae (70), Papilionaceae (68) and Myrtaceae (63).

Patterns in the vegetation structure and floristic associations have long been attributed to the influences of the environment, which is evident at environmental extremes presented by the Darling Scarp. Descriptive work on the vegetation communities of the Darling Scarp and associated regions has proceeded since early in the century as part of the larger undertaking of mapping the vegetation of southwestern Australia (Diels 1906, Gardner 1942, Speck 1958: see Beard (1981) and Havel (1979)). The first detailed studies of

vegetation associations on the Darling Scarp and Plateau were made by Williams (1932; 1945), who mapped the co-occurrence of the dominant tree species and associated understorey with the underlying geology. Three broad associations were recognised; the *Eucalyptus wandoo* - *E. calophylla* association on granites and epidiorite, the *E. marginata* association on lateritic uplands, and the *E. rudis* association on the valley floor. Although detailed, these descriptive studies were limited to two small areas. Speck (1958, in Havel 1975a) adopted a structural approach to describe and map the communities of the Darling - Irwin Botanical Districts and documented the strong patterning of vegetation, soils and topography. Smith (1974) and Beard (1979a, 1979b) both produced 1:250 000 scale phytogeographic maps of southwest Western Australia, which mapped the dominant vegetation structural units and incorporated information on the underlying soils and climate. From this work, Beard (1979a, 1979b) did not distinguish the Darling Scarp as a unique unit but primarily as *Eucalyptus wandoo* and *Eucalyptus calophylla* woodlands within the Darling Botanical District. These formations form the western margin of the Dale Botanical Subdistrict whilst the eastern margin of the Drummond Botanical Subdistrict is delineated by the woodlands of the Ridge Hill Shelf (Beard 1979a, 1979b).These regions of Beard (1980) were used as the basis of the current biogeographic regionalisation (IBRA) of the region for the planning of a national conservation reservation system (Thackway and Cresswell 1995).

The use of structure alone to define vegetation units was considered by Heddle *et al.* (1980) to be insufficient for producing a map of the vegetation of the Darling System for assessing the adequacy of reserves for conserving biodiversity. For this purpose, Heddle *et al.* (1980) produced a classification of the vegetation communities of the Darling system which were mapped at a scale of 1:250 000. These vegetation complexes were an amalgamation of both the structural units of Smith (1974), the geomorphological units of Churchward and McArthur (1980), annual rainfall and the site - vegetation types of Havel (1968, 1975a, 1975b). Rather than the use of structure to define vegetation communities, Havel (1975a, 1975b) employed ordination and classification analysis of quadrat based floristic data to resolve site - vegetation types from continuum of vegetation in the Northern Jarrah Forest. Rather than canopy, the floristic composition of the understorey was the best indicator of the community. Only a quarter of the species surveyed were used in the floristic analysis, these having met strict criteria for selection as indicator species diagnostic of the site- vegetation type. This indirect gradient analysis resolved 20 site vegetation types which were a demonstrated to be a good predictors of the environment. Patterns of vegetation were found to be determined by topographic position in the landscape and edaphic features such as the gravel content of soil profile, soil texture (moisture) and fertility (Havel 1975a; Bell & Heddle 1989). Heddle *et al.* (1980) extrapolated these site - types to cover the entire Darling System and found it necessary to define an additional site - vegetation type G to characterise the shrublands of granite outcrops and the surrounding woodlands. Consequently, this site vegetation type has been incorporated into the definition of the Darling Scarp Complex, which is a unique entity among the 66 complexes mapped by Heddle *et al.* (1980) for the Darling Region. If the adjacent Ridge Hill Shelf, associated valleys and adjacent margin of the Jarrah Forest are included within five kilometres of the Darling Scarp, an additional nine vegetation complexes abut onto the margin of the Darling Scarp Complex . However, the predominant vegetation complexes of Heddle *et al.* (1980) which constitute the Darling Scarp are the Darling Scarp complex, the Forrestfield complex and the Helena complex in the valleys on the western margin of the Darling Plateau.

There are some concerns with the use of this classification to define the floristic communities and assess their reservation status. The first problem is that the site - vegetation types were constructed from a small proportion of the flora, with the significant omission of 75% of the species surveyed, notably annuals and infrequently occurring species (Havel 1989). At the scale of 1:250 000, the vegetation complexes are too broad and obscure local patterns in vegetation communities. The best example of this the Darling Scarp Complex, which remains uniform over its entire area and any possible changes associated with the rainfall gradients, geology or topography are not resolved on the map, and are only discussed as general trends (Heddle *et al.* 1980). Detailed floristic surveys on the eastern side of the Swan Coastal Plain have addressed the floristic diversity of these remnant woodlands on the Ridge Hill Shelf (Keighery and Trudgen 1992, Keighery and Keighery 1993, Gibson *et al.* 1994; B. Keighery, unpublished data). Similar data are not available for the Darling Scarp.

1.6 Purpose of study

Because of its close proximity to the Perth Metropolitan Region, the northern Darling Scarp has been under considerable pressure for development since the first settlement of the region in the 1830's. The woodlands and associated rich soils of the lower slopes and foothills of the Darling Scarp and adjacent eastern side of the Swan Coastal Plain were highly desirable for agriculture. The legacy of this history of agriculture has been that 8% of the original Forrestfield vegetation complex (Heddle *et al.* 1980) within the Perth Metropolitan Region remains intact (Dixon *et al.* 1994), and >98% of the eastern side of the Swan Coastal Plain has been cleared from along the length of the Darling Scarp (Keighery and Trudgen 1992). Within the Perth Metropolitan Region, agriculture was not feasible on the steep, rocky terrain of the slopes of the Darling Scarp. Consequently, comparatively more of the vegetation has remained intact than that on the foothills. However, this still only amounts to 45% of the original Darling Scarp vegetation complex which remains intact within the Perth Metropolitan Region (Dixon *et al.* 1994). Although estimates are not available, considerably more of the Darling Scarp has been cleared outside of the Perth region where the slopes have been more accessible to grazing. In addition to agriculture, current land use of the northern Darling Scarp includes extractive industries (clay, granite, sand, gravel, mineral sands) and residential development from the eastern expansion of the Perth Metropolitan Region. Close proximity to urbanisation is associated with disturbance, weed invasion and frequent fires. The current demand for recreational activities on the Darling Scarp is high.

The objectives for a conservation reserve system for the Darling Scarp is to encompass the biological diversity and the associated landforms and soils. Within the Perth Metropolitan Region, urban planning has set aside an extensive reserve system which encompasses much of the remnant vegetation on public lands. This network of Regional Open Spaces and National Parks is currently being established as the Darling Range Regional Park (Department of Urban Planning 1993, Ministry for Planning 1995). Outside of the Perth Metropolitan Region, remnants of the Darling Scarp are reserved in National Parks and State Forest. The total area of the original Darling Scarp vegetation complex of Heddle *et al.* (1980) within the conservation reserve system (National Parks, Nature Reserves and Conservation Reserves) has been estimated from 1.5% (Havel 1989) to 3.8% (Department of Conservation and Land Management 1994). This amounts to less than 5% of the original area of the Darling Scarp occurring on protected land. Therefore, the current conservation status of plant communities of the Darling Scarp is in urgent need of detailed assessment. Heddle *et al.* (1980) provides the most current information available on the Darling Scarp vegetation communities, which is considered too broad to allow the detailed level of assessment required. The purpose of the present study was to identify major floristic community types within the northern region of the Darling Scarp between Bullsbrook and North Dandalup, based on floristic composition of permanently located quadrats, and to determine the representation of these floristic community types within the current reserves system.

Methods

2.1 Field Survey

One hundred and twenty 10m x 10m quadrats were established systematically in public land over the Darling Scarp. In a north - south direction, this extended along 120 km of from Walyunga National Park to North Dandalup (Figure 1-1). These plots were established along a topographical sequence that ran from the upland plateau, on the western edge of the Darling Plateau, down to lowest slopes and foothills along the profile of the Scarp in a repeated sequence the length of the study area.

Potential sites were identified from aerial photographs (Department of Land Administration Panairama Series, 1996) and Department of Conservation and Land Management (CALM) topographical maps. Prior to sampling, the suitability of these potential locations was assessed from a vehicle and foot survey. Quadrats were placed in locations judged to be representative of the vegetation community, geology and topography observed in each area. There was a bias to select sites that were relatively weed - free, had not been burnt in at least the past 3 - 4 years and were in general good condition.

Sixteen of the 120 plots were rescores of existing quadrats that had been placed by previous surveys. Fourteen plots had previously been located in John Forrest National Park (Department of Conservation and Land Management 1991), and a further two plots in Serpentine National Park had been established by as part of a floristic survey by the Department of Environmental Protection (1996). The remaining 104 quadrats were set up over the period between September to November 1996, and all 120 rescored from November - December. In order to follow the flowering season, progress began at Walyunga National Park and progressed southwards. Almost all the quadrats were visited twice, except the two which had been burnt as part of spring fire control measures.

Quadrats were permanently marked at the corners with galvanised steel fence droppers, and a GPS recorded the position. Altitude was later retrieved from CALM topographic maps. The presence of all vascular plant species were noted within each quadrat, and specimens collected for further identification in the Western Australian Herbarium when the field identification was uncertain. Information was also collected for a number of environmental parameters from each site. Visual estimates were made of leaf litter depth and cover, bare ground cover, exposed rock cover and rock type, soil colour, texture and depth, slope, aspect, and topographical position. A subjective assessment was made on the vegetation condition, based on the criteria and scale from Keighery (1994). The vegetation structure and cover was assessed using categories from Muir (1977). For later analysis, a bulked soil sample was obtained from 24 samples of the A horizon within the quadrat. The information on soil chemistry was not available for this report since these were undergoing analysis at the time of writing. Consultation with the geology maps were not informative since most of the sites fell within a narrow geological region delineated as Archaean granite and gneisses. Only major dolerite and quartz dykes featured on these maps, whilst a large number of smaller features were observed in the landscape. Therefore, visual assessment of the soils and underlying geology and topography was used to locate and describe sites. Geology maps were of some use in discerning Ridge Hill Shelf sites from Scarp slopes, but were found to be of insufficient detail in some instances.

2.2 Additional sites

Data from an additional thirty plots were included in the community analysis. Three of these were supplied by the Friends of Ellis Brook Valley (Inc) (FOEB), and the remaining 27 were from the Department of Environmental Protection (DEP) (1996). Almost all of these sites had been established on public lands, except a number of these DEP sites had been established on private land with the permission of the land owners. The FOEB sites were established at Ellis Brook Valley Reserve between June and August 1996, and rescored in late spring of the same year. Of the DEP sites, the Lambert Lane sites were scored in August 1991, and the condition of the vegetation condition reassessed in 1994. Other DEP sites were established between 1995 and 1996, at Red Hill, Talbot Road Reserve, Ellis Brook Valley Reserve and Page Road.

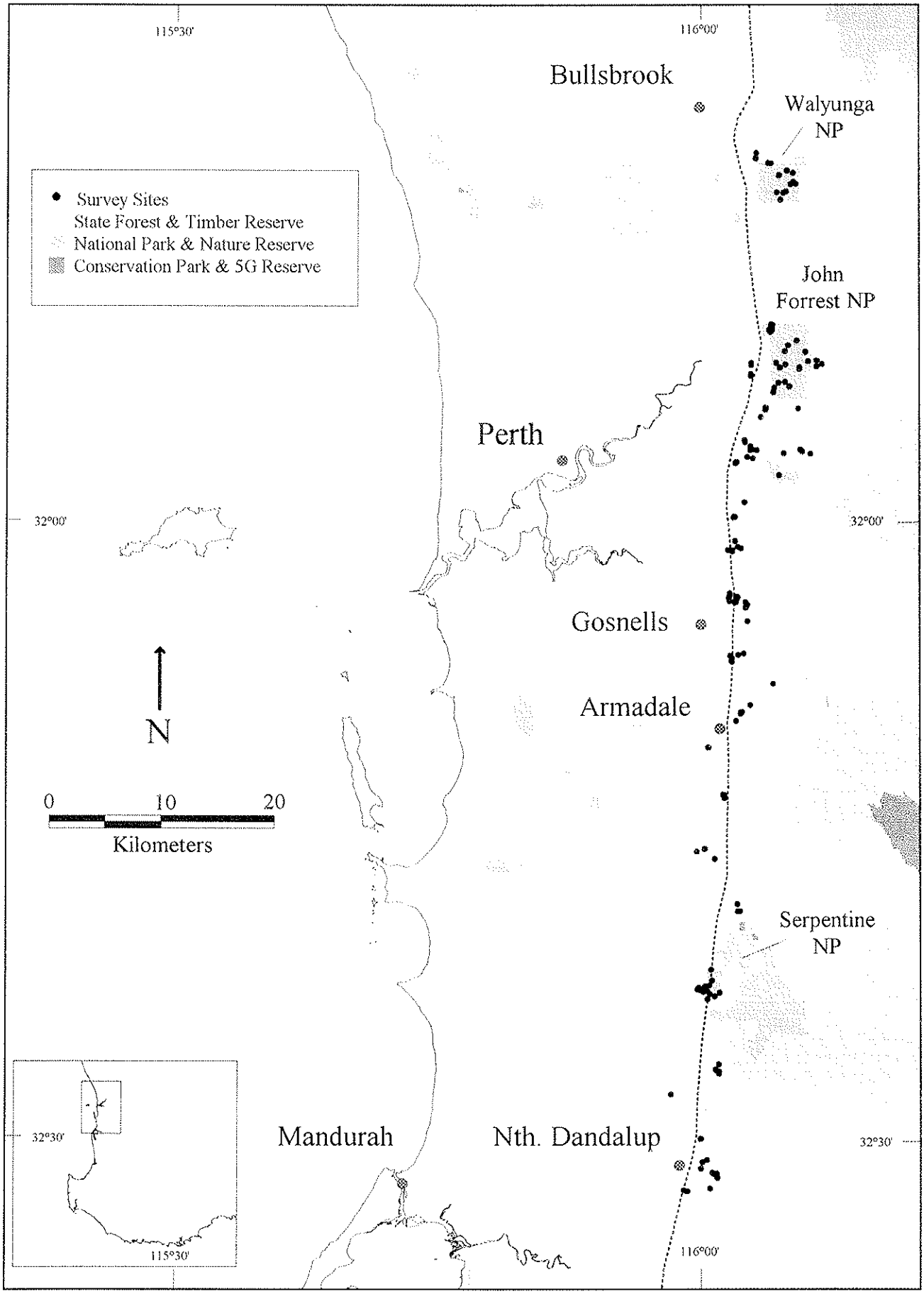


Figure 1-1. Location of the 150 survey sites within the Darling Scarp Floristic Survey Area: The broken line delineates the boundary of the Swan Coastal Plain and Darling Plateau (Beard 1980). CALM managed lands are shaded.

The data obtained from the DEP and FOEB were from a selection sites located on the lateritic and clayey soils of the Ridge Hill Shelf at several localities in the PMR. This included sites on the quartzite ridges and adjacent Ridge Hill Shelf at Ellis Brook Valley on the Darling Scarp. It was decided to include these sites in the analysis to help elucidate the relationship between floristic communities on the foothills sites and the adjacent Scarp communities. Because only a few sites specifically were selected to explore this relationship, results should be considered preliminary and specific to the study area.

2.3 *Floristic Classification*

The presence / absence data obtained from the survey sites was subjected to multivariate analysis in order to discern floristic communities within the study area. Floristic community types and species groups were based on similarity in species composition which was derived from the classification analysis of this combined data set. The Czekanowski coefficient was used to generate similarity matrixes and unweighted pair - group arithmetic averaging (UPGMA) was used as the hierarchal, agglomerative fusion method (Sneath and Snokal 1973). Using inverse analysis, species were classified into groups using the TWOSTEP algorithm (Austin and Belbin 1982) and fused using UPGMA. Estimates of climatic parameters were derived from the BIOCLIM model (Busby 1985) and the Kruskal - Wallis test was employed as a non-parametric statistical method to explore differences in a number of environmental variables for the different community types

Specimens collected were identified at the Western Australian Herbarium (PERTH), where selected voucher specimens will be lodged. Species nomenclature follows Green (1985) and current usage at the Western Australian Herbarium.

Results and Discussion

Flora

A total of 728 taxa (species, subspecies and varieties) were recorded from within the study area along the Northern Darling Scarp (Appendix 1, 7 & 8). This data set was complied from the 120 sites established in this survey, opportunistic collections during field work and data from the thirty additional sites provided by the Department of Environmental Protection (1996) and Friends of Ellis Brook Valley (Inc.). Of this total, 651 were native taxa and 77 were weeds. Ninety-two families were represented in this sample, the most numerous being the Proteaceae (61 taxa), Papilionaceae (53 native and 12 weed taxa), Myrtaceae (45 taxa), Orchidaceae (44 native and 1 weed taxa), Cyperaceae (43 native and 1 weed taxa), Poaceae (22 native and 19 weed taxa), Asteraceae (29 native and 8 weed taxa) and Mimosaceae (23 taxa). These are among the common families of the Western Australian flora (Hopper *et al.* 1996) and for the Northern Jarrah Forest in the Perth Region (Bell and Heddle 1989). The most common genera were *Acacia* (23 taxa) *Stylidium* (23), *Hakea* (16), *Lomandra* (14), *Hibbertia* (13), and *Thysanotus* (13). Although fourteen taxa were recorded for *Drosera*, this is an underestimate since the majority of pygmy droseras were sterile, hence could not be identified to species level. Again, these genera are typically common in the flora of Western Australia (Hopper *et al.* 1996) and in the adjacent Jarrah Forest (Bell and Heddle 1989).

Weed taxa were conspicuous components of the flora represented predominantly in the Poaceae (19 taxa), Papilionaceae (12), Iridaceae (10) and Asteraceae (8). Within the 150 survey sites, the most common weed taxa were generally the small, herbaceous annuals or perennial cryptophytes *Briza maxima* (99 sites), *Aira caryophyllea* (91 sites), *Romulea rosea* (85 sites), *Hypochaeris glabra* (89 sites), *Briza minor* (67 sites), *Ursinia anthemoides* (59 sites), *Vulpia bromoides* (54 sites) and *Anagallis arvensis* (49 sites). The sampling procedure of purposefully setting quadrats in relatively weed - free sites underestimated the extent of weed invasion in these communities. However, a quantitative assessment of weed invasion was beyond the scope of this study.

3.1 Rare and Priority taxa located in the quadrat survey

The objectives of this survey were specifically were to address identify rare plant communities rather than individual taxa, therefore the location of rare taxa was more by chance than design. However, one species of Declared Rare Flora (DRF) and 22 priority taxa were found during the course of this Darling Scarp survey (Table 3-1). One species of DRF and two priority taxa were located in the additional sites established by the Department of Environmental Protection (1996) and the Friends of Ellis Brook Valley (Table 3-2). Details of the rediscovery of the presumed extinct taxon *Tetraria australiensis* has been documented in Gibson *et. al.* (1994). The distributions of these taxa are shown in Appendix 2

At this stage, it is uncertain as to whether a number of the populations located in this survey are new populations since there were previous collections (some over 20 years old) from the general vicinity, as recorded by the Western Australian Herbarium. In comparison to other regions in the state, there appears to be a good collection of DRF and priority taxa for the Darling Scarp. This is attributed to this region being an easily accessed / amenable location for the both scientific community and a number of diligent community groups. A detailed cross checking of more accurate records will determine if the findings of this survey in fact are new populations as opposed to rediscoveries of previously located populations. An additional thirty nine taxa have been listed as occurring on the Darling Scarp that were not found in this survey (Department of Conservation and Land Management 1996).

Table 3-1: Declared Rare and Priority Flora located within 120 sites surveyed on the Darling Scarp. Conservation status current as of 12/10/1996. Relocated populations have a previous record from the general locality in the PERTH. New populations have no previous record in PERTH.

Taxon	Status	Number of new populations	Number of relocated populations
Acacia horridula	3		2
Acacia oncinophylla subsp. *oncinophylla*	3	2	2
Acacia oncinophylla subsp. *patulifolia*	2	1	3
Anthocercis gracilis	DRF		2
Astroloma foliosum	2		2
Boronia tenuis	4	1	2
Calothamnus rupestris	4		2
Conospermum undulatum	4	1	
Darwinia pimelioides	3	2	
Dryandra praemorsa var. *praemorsa*	3		1
Eucalyptus marginata subsp. *elegantella*	2		1
Grevillea pimeleoides	4		1
Hakea myrtoides	3	2	2
Lambertia multiflora var. *darlingensis*	3		3
Lasiopetalum bracteatum	4		
Lasiopetalum pterocarpum MS.	2	1	
Microtis media subsp. *quadrata*	4	1	
Nemcia acuta	3	2	
Senecio leucoglossus	4		1
Synaphea acutiloba	3	2	4
Synaphea pinnata	3	1	
Templetonia drummondii	4	1	
Thysanotus fastigiatus	3	1	

Table 3-2. Declared Rare and Priority Flora located in the 30 additional quadrats or adjacent areas. Conservation status current as of 12/10/1996.

Taxon	Status
Calothamnus graniticus subsp. *leptophyllus*	4
Halgania corymbosa	3
Tetraria australiensis	DRF

3.1.1 Taxa subject to recommendations for gazettal as Declared Rare Flora

As a consequence of this survey, some concern was raised as to the conservation status of two taxa. Additional discussion with Les Robson (Department of Conservation and Land Management) and Carol Wilkins (the University of Western Australia) supported the decision to propose the gazettal of these species to that of Declared Rare Flora. These species are discussed as follows:

Lasiopetalum pterocarpum.
One plant was located at Serpentine National Park on the south bank of the river near a walk trail. Its identity was confirmed by Carol Wilkins (who is revising genera of the Sterculiaceae) and it became evident that this was a new population separate from the first population of five plants had been located on the north bank. This increased the number of plants known to six. At the time of writing, an intensive survey for this species was being conducted by L. Robson (Department of Conservation and Land Management), who has confirmed that a new population exists on the south bank, but still less than ten plants are known in existence. This species appears to be restricted to the riparian community fringing the creek at the base of Serpentine Falls, which is presently succumbing to an invasion of aggressive weeds. Additionally, this area is currently experiences high recreational use (and abuse) and there is some concern that this may increase the risk of harm to this population. This taxon meets all the criteria for gazettal as Declared Rare Flora.

Conospermum undulatum:
Previous surveys of this taxon have found it be locally abundant within a restricted geographical range in the eastern suburbs of Perth (Kelly *et al.* 1993). In this region its distribution has become fragmented by clearing and subsequent housing development. In this survey, one population was located growing on sand over laterite in the foothills at Gooseberry Hill / Maida Vale. This unvested reserve is currently in the ownership of the WAPC and has been proposed for inclusion in the Darling Range Regional Park (MFP 1995). The area is currently being invaded by *Ehrharta calycina* and *Gladiolus caryophyllaceus* and requires management. The extent of development in the Maida Vale region appears to have fragmented and removed a previously more widespread distribution of *C. undulatum*, and an examination of the herbarium records all suggest that this species certainly requires reappraisal of its priority status (currently listed as priority 4). Discussion with L. Robson confirms that *Conospermum undulatum* deserves consideration for gazettal as Declared Rare Flora

3.2 Endemic taxa of the Darling Scarp

Marchant *et al.* (1987) notes that 43 of the 2057 species of vascular plants recorded in the Perth region (between Gingin and Boyanup) are endemic. Of the 728 taxa recorded in this survey, 31 taxa appear to be endemic to the Darling Scarp in the region between Gingin and Harvey, which defines the geographical range of the Darling Scarp and covers the same region as covered by Marchant *et al.* (1987) (Table 3-3). Therefore, it appears that the majority of endemic taxa with the Perth Region occur on the Darling Scarp, in the region encompassing the foothills, scarp slopes and western margin of the Darling Scarp.

Herbarium records were used to verify the range of species distributions. Nineteen taxa are endemic to region of Darling Scarp between Bullsbrook and North Dandalup, within which the following taxa are widespread: *Billardiera drummondiana* var. *collina*, *Conostylis setosa*, *Grevillea synapheae* subsp. *synapheae*, *Hakea cristata*, *Hibbertia* aff.. *glomerata*, *Lomandra* aff. *micrantha* and *Pimelea imbricata* subsp. *piligera*. The remaining 12 taxa appear to be further geographically restricted within this region, occurring as small, disjunct populations. *Anthocercis gracilis*, *Grevillea pimelioides*, *Lasiopetalum bracteatum* and *Senecio leucoglossus* are solely restricted to the valleys of the adjacent western margin of the Darling Range which dissect the face of the Darling Scarp. Eleven taxa are near endemics, being primarily restricted to the Darling Scarp but with unusual, disjunct populations in outlying regions. In most instances, these outlying populations either occur on the Pinjarra Plain, on the eastern side of the Swan Coastal Plain, or on granite outcrops within the Darling Plateau (Table 3-3).

Whilst not yet recognised as distinct varieties, a number of taxa were found to have variations unique to the Darling Scarp within the study area and were therefore included in this section. These taxa are:

Hibbertia aff. *glomerata* has been described in Marchant *et al.* (1987) as a variant of *Hibbertia glomerata* which requires further taxonomic work. Material collected in this survey belonged to this variant which is distinguished by fasciculate stamens.

From Lesmurdie - Gosnells on the Darling Scarp, there is a variant of *Trymalium ledifolium* var. *rosmarinifolium* which is distinguished by a dense indumentum of silver - yellow, simple hairs on the adaxial leaf surface. Outside of this central Scarp region, but still within the Darling Scarp and western Margin of the Darling Plateau, *Trymalium ledifolium* var. *rosmarinifolium* specimens had a glabrous adaxial leaf surface typical of this variety.

A variant of *Trachymene coerulea* subsp. *coerulea*, a lanceolate-leaved variant of *Bossiaea eriocarpa* and a six –flowered variant of *Darwinia citriodora* all occur within the study area (G. Keighery per comm).

Beyond the immediate limits of the Darling Scarp, three species were recorded in this survey that are endemic to both the Darling and Whicher Scarps. *Eucalyptus marginata* subsp. *elegantella* and *Lambertia multiflora* var. *darlingensis* are restricted to the foothills of these regions whilst *Agonis grandiflora* occurs on slopes relatively higher on the escarpment. There are considerably more near endemic taxa derived from regions north of the Darling Scarp, reaching their southern limits within the study area. Nine species have their northern limits around Mogumber and New Norcia (Table 3-3), which are approximately 50 km north of Gingin. However, these are still relatively geographically restricted to this region and can be considered as near endemics (Table 3-3).

Table 3-3: List of taxa endemic or near-endemic to the Darling Scarp that were recorded in the present survey. Endemic taxa are defined by their occurrence within ± 5km of the Scarp Face and includes the Ridge Hill Shelf and western margin of the Darling Plateau. Distributions were confirmed from records on the Western Australian Herbarium database, from G. Keighery (per comm) and from B. Keighery (per comm).

Endemic taxa geographically restricted to Darling Scarp between Bullsbrook and North Dandalup

Acacia horridula
Anthocercis gracilis
Astroloma foliosum
Billardiera drummondiana var. *collina*
Billardiera parviflora var. *guttata*
Conospermum undulatum *
Conostylis setosa
Darwinia pimelioides
Grevillea pimelioides
Grevillea synapheae subsp. *synapheae*
Hakea cristata
Halgania corymbosa
Hibbertia aff *glomerata*
Lasiopetalum bracteatum
Lasiopetalum pterocarpum
Lomandra aff micrantha
Pimelea imbricata subsp. *piligera*
Pithocarpa corymbulosa
Senecio leucoglossus

* restricted only to Ridge Hill Shelf sands

Endemic taxa of Darling Scarp from Gingin to Harvey

Acacia drewiana
Acacia oncinophylla subsp. *patulifolia*
Bossiaea eriocarpa (lanceolate leaved variant)
Conostylis aculeata subsp. *preissii*
Conostylis setigera subsp *setigera*
Darwinia citriodora (6 flowered variant)
Dillwynia sp A. FPR
Tetraria australiensis *
Thysanotus fastigiatus
Trachymene coerulea (scarp variant)
Trymalium ledifolium var *rosmarinifolium*
Verticordia acerosa var *acerosa*

* restricted only to Ridge Hill Shelf sands

Endemic taxa on slopes and foothills of Darling Scarp and Whicher Scarp

Agonis grandiflora
Eucalyptus marginata subsp. *elegantella*
Lambertia multiflora var *darlingensis*

Near endemics with outlying, disjunct populations.

Andersonia aristata
Beaufortia macrostemon
Beaufortia purpurea
Boronia tenuis
Calothamnus rupestris
Eucalyptus laeliae
Grevillea bipinnatifida
Kennedia stirlingii
Synaphea pinnata
Thomasia macrocarpa
Synaphea acutiloba

Near endemic taxa ranging between Mogumber / New Norcia / Wannamal and Northern Darling Scarp.

Acacia oncinophylla subsp. *oncinophylla*
Conospermum huegelii
Grevillea endlicheriana
Hakea myrtoides
Hibbertia lasiopus
Microcorys longifolia
Nemcia acuta
Petrophile biloba
Thomasia grandiflora

Northern species with southern limit on Darling Scarp (North of Three Springs/Mt Lesueur)

Acacia incrassata
Actinostrobus acuminatus (disjunction)
Allocasuarina microstachya (disjunction)
Boronia ovata
Boronia ramosa subsp. *ramosa*
Calectasia grandiflora (disjunction)
Calothamnus torulosus
Conostylis androstemma
Conothamnus trinervis (disjunction)
Diplopeltis huegelii var lehmanii
Dryandra armata
Hakea incrassata
Melaleuca radula
Thomasia glutinosa
Xanthorrhoea acanthostachya

Another fifteen taxa have their southern limits on the Darling Scarp and extend further north well into the Irwin Botanical Province of Beard (1980). Some of these taxa, namely *Xanthorrhoea acanthostachya*, *Calothamnus torulosus* and *Diplopeltis huegelii* var. *lehmanii* are a common and distinctive part of the flora of the Darling Scarp. Four other taxa in this group, *Actinostrobus acuminatus*, *Allocasuarina microstachya*, *Calectasia grandiflora* and *Conothamnus trinervis* are considered to be taxa characteristic of the northern sandplains, yet these have unusual, disjunct populations within the Perth Metropolitan Region, on both the Darling Scarp and the eastern side of the Swan Coastal Plain (Table 3-3).

Additional work and collections from the Darling Scarp at Gosnells (Keighery and Trudgen 1992, A.S. George, per comm, B. Lepschi, per comm, H. Bowler, per comm, and per. obs.) continually emphasise the importance of the Ridge Hill Shelf and the quartzite / laterite ridges on the Darling Scarp slopes at of Ellis Brook and Bickley Valley as the source of disjunct populations of species usually found in the Irwin Botanical Province. It is not certain if this reflects a natural disjunction of these distributions, since extensive clearing of the Swan Coastal Plain and Ridge Hill Shelf may have removed any intervening populations.

The second major region with which the Darling Scarp has floristic affinities is with the northern and north-eastern margin of the Darling Plateau (Table 3-4). This has been attributed to historically more arid conditions which supported a more extensive distribution of semi - arid taxa across the Darling Plateau. Relatively mesic conditions had resulted in a contraction of this distribution to both the margins of the Darling Plateau and to granite outcrops within its interior (Beard 1981). These regions are geologically similar in that Archaean granite bedrock has been exposed following tectonic uplift and erosion of the lateritic mantle. Fifteen taxa with such a distribution were collected during this survey (Table 3-4).

Table 3-4. Taxa found on the Darling Scarp which also occur along the northern and eastern boundaries of the Darling Plateau.

Allocasuarina huegeliana	*Acacia barbinervis* subsp. *barbinervis*
Dryandra praemorsa var. *praemorsa*	*Darwinia thymoides*
Eucalyptus lane-poolei	*Dryandra fraseri* var. *fraseri*
Hakea erinacea	*Eucalyptus accedens*
Hakea petiolaris	*Gahnia aristata* (disjunct)
Lomandra spartea	*Haemodorum simulans* (disjunct)
Templetonia drummondiana	*Beyeria lechenaultii*
Verticordia acerosa var *preissii*	

Vegetation

Generally, only material than could be taken to species or subspecific level was included in the analysis. There were some exceptions where specimens were resolved to an amalgamated "species complex". Amalgamated complexes was employed when either there were conflicting taxonomic characters, usually within groups requiring revision (eg *Hibbertia ovata - H. commutata*, *Tetratheca setigera - T. hirsuta* and species of *Leucopogon*) or only sterile material was available for closely related taxa (eg *Vulpia*) (see Appendix 2). Material from the genus *Lepidosperma* was divided into "morpho-species" units since the taxonomy is presently under review and taxonomic keys have yet to become available. Since only the overall morphology (and not a detailed examination of floral characters) was used to distinguish specimens, these unit only serve as approximations of species.

Using this procedure, a total of 689 taxa from 150 sites were entered into a preliminary analysis. Initial runs of the classification procedure resolved four sites that both highly dissimilar from one another and quite distinct from all other site groups at a high level in the classification. Since no further information could be resolved from these outliers, these were omitted from the final analysis. This resulted in 673 taxa from the remaining 146 sites being used in the final classification analysis. 159 taxa were represented only once in the data set. These singletons were removed from further analysis since previous studies have demonstrated that these are not informative and therefore have little effect on the community classification (Clifford & Stephenson 1975, Gibson *et al.* 1994). After the removal of singletons, the species richness varied from between 20 and 90 species per site ($100m^2$).

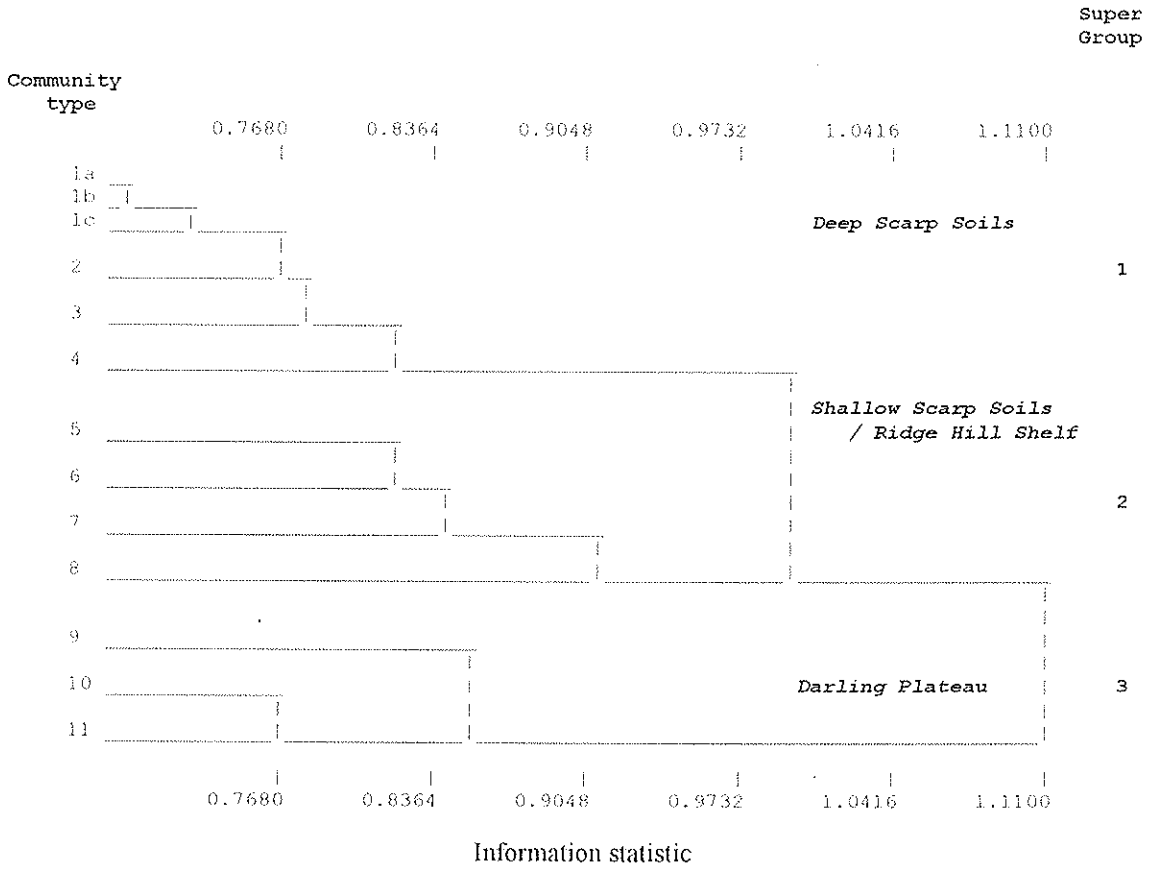
Classification analysis was employed to resolve discrete floristic units from the continuum of vegetation observed on the Darling Scarp. The resulting dendrogram (Figure 4-1) was split at two levels, resolving the sites into three groups (' super groups') and, at a lower level, eleven groups ('community units') which was deemed to best reflect the patterns of association seen in the field. Whilst this procedure introduces a subjective decision into the analysis for resolving the floristic communities, this decision is based on extensive field observations and emphases the supportive function of classification analysis to verify these findings (Kent and Coker 1992; Clifford and Stephenson 1975). Similarly, species groups derived from the inverse analysis were split at the 23 group level and further subdivided into subgroups where appropriate. This was achieved by using both the two-way table (Appendix 3) and the dendrogram from the species classification.

The density of the sampling was considered to be sufficient to resolve the 146 sites into a number of floristic groups that have been referred to in the text as 'floristic community types'. Within the study area, these community types occurred repeatedly within the study area on the Darling Scarp, and were strongly associated with topography and substrate.

4.1 Three group level classification

At a high level in the analysis, there was a separation of the sites into three distinct floristic groups that could be defined primarily by topographic location and secondarily by soil type (Figure 4-1). The first major division was Super group 3 which consisted of the upland Darling Plateau sites dominated by Jarrah forest and floristically dissimilar to the woodlands and heath downslope on the Darling Scarp. Within this latter group there was a second major division between the floristic community types which appeared to be based more on substrate. Super group 1 encompassed the woodlands and shrublands on the relatively deeper soils (loams and clayey loams) on the Darling Scarp slopes. Floristic community types in this group spanned from the lateritic breakaways at the upper reaches of the scarp slopes, to the poorly drained, clay - loam soils low in the landscape and on the intervening moderately shallow clay - loams over granites. Super group 2 incorporated the vegetation types on generally poorly drained shallow, sandy soils over an relatively impermeable hardpan (claypan or granite). This included the shrublands on the skeletal soils of granite outcrops on the Darling Scarp and woodlands on the gravelly - clay soils of the Ridge Hill Shelf.

Figure 4-1. Dendrogram of the three super groups and the 11 community types defined from floristic presence / absence data.



4.2 Eleven group classification

Eleven community types and 23 species groups were defined from the classification (Figure 4-1, Appendix 3). Floristic Community type 1 was further subdivided further into three distinct subunits (1a, 1b, 1c), based from an examination of the two-way site groups / species table (Appendix 3). Based on their site association, 23 species groups were resolved from the species classification (Appendix 3). These were also divided into sub-groupings, since it was evident that environmental gradients were being expressed within these groupings that were of interest and assisted in resolving the floristic community types. Whilst the patterns observed in the two-way table opens avenue for further exploration, this were considered beyond the scope of this report. Distribution maps for each of the eleven floristic community types (and subtypes) are illustrated in Appendix 4. Community descriptions are summarised in Appendix 5 and particular community types are illustrated in Appendix 6.

4.2.1 Site classification

SUPER GROUP 1 -Woodlands and shrublands on scarp and valley slopes

Floristic Community Type 1 – Darling Scarp *Eucalyptus wandoo* woodlands

***Community Type 1a* - Upper slope *Eucalyptus wandoo* woodlands**
This community type was characteristic of the upper slopes of the Darling Scarp where the laterite mantle had given way to gravelly scree slopes and relatively deep, clayey loam soils (Figure 4-1, Appendices 3, 4 & 6). It was found across the entire length of survey area and consisted of *E. wandoo* to *E. wandoo* - *E. calophylla* woodland over a low heath or dwarf scrub understorey and rich herb layer. In the northern sites at Walyunga National Park, *E. accedens* was present either as the solitary tree species or in admixtures with *E. wandoo*. The average species richness was 66.9 ± 8.9 taxa / plot, which was within the middle range relative to the other community types. Whilst this community type occurred typically at the higher altitudes (208.5 ± 45.8m asl) (Figure 4-2), there was once occurrence on Ridge Hill Shelf at 90m asl. This was at the Bushmead Reserve (Lot #0, WAPC) in Helena Valley, on a lateritic ridge which was elevated well above the surrounds.

The common species that characterised community type 1a included species groups B1 and B2, and A1 to a lesser extent, all of which were consistently present. Group I was relatively faithful to this community type and group M was useful in resolving this subgroup within community type 1 (Appendix 3).

***Floristic Community Type 1b* - *Eucalyptus wandoo* – *Eucalyptus calophylla* woodlands on poorly-drained clay flats**
This community type consisted of *E. wandoo* - *E. calophylla* woodland on winter wet, loamy clay flats adjacent to a drainage feature. This variety of features included the creek flats on a valley floor, wet clays around granites, poorly drained clays and clay loams on scarp mid-upper slopes and the lower scarp slopes bordering on Ridge Hill Shelf. The slope was generally flat - slight (Figure 4-3, Appendix 6), which would account in part for the poor drainage. This community type was typically shrub poor and herb rich, with the typical shrub taxa consisting of *Hakea lissocarpha*, *Baeckea camphorosmae* and *Hypocalymma angustifolium* (Appendix 5). The ubiquitous species groups B1 and B2, and B3 to a lesser extent, were associated with this community type, however groups E and F were characteristic of and faithful to this community type. These groups consisted of infrequently occurring small herbs, herbaceous annuals and shrubs that were indicative of poorly draining, heavy soils. Such taxa included the small shrubs *Hakea myrtoides*, and herbaceous taxa such as *Juncus capitatus*, *Schoenus sculptus*, *Anigozanthos bicolour* subsp. *bicolor*, *Haemodorum simplex*, *Tribonanthes longipetala*, and *Laxmannia sessilis* (Appendix 3 and 5). The species richness for this community was 69.1 ± 5.2 taxa / plot.

Whilst this community type was encountered relatively frequently in the northern region of the survey area, it was not encountered between Armadale and North Dandalup (Appendix 4). This was attributed to loss of this community type as a consequence of a long history of grazing and more recent residential development on the foothills and lower-mid slopes of the Darling Scarp.

***Floristic Community Type 1c* - Northern granite shrublands and woodlands**
Community type 1c consisted of and *Hakea erinacea* / *Calothamnus quadrifidus* shrublands and open *E. wandoo* - *E. calophylla* woodlands on moderately deep, loamy soils over granite, often with some exposed granite, quartzite or dolerite (Appendix 6). It only occurred in the northern regions of the survey area (Appendix 4) and was located predominantly, but not exclusively, on the Darling Scarp mid-slopes. Only on one occasion was this community type located within a major valley away from the Scarp Face (Table 4-1). Tree canopy species were not constant within this community type, which was more typically dominated by the tall shrubs, *Hakea erinacea* and *Calothamnus quadrifidus*. Typical taxa of this community type included those from species groups B1, B2 and notably B3, which contained the lithic-associated taxa such as *Borya sphaerocephala*, *Actinotus leucocephalus*, and *Synaphea acutiloba*. This community type was characterised by the granite - associated species groups G, which consisted of small annual herbs and small perennials such as *Darwinia pimelioides*, and M (orchids) and some infrequent occurrences in O (Appendix 3). The average species richness was 69.9 ± 8.3 taxa / plot. There were some typical weed taxa, such as *Gladiolus caryophyllaceous* and *Ursinia anthemoides* (Appendix 5).

Figure 4-2: Whisker plot of altitude (m) for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).

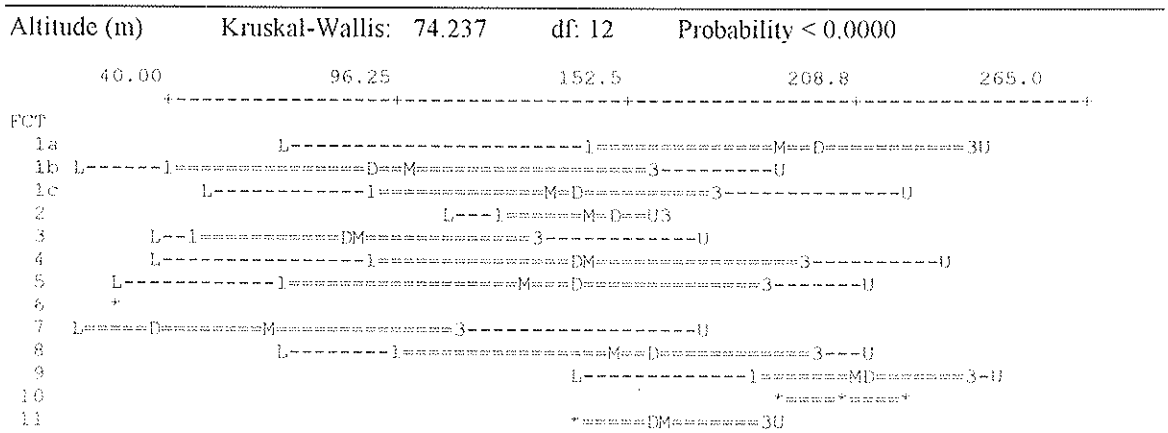
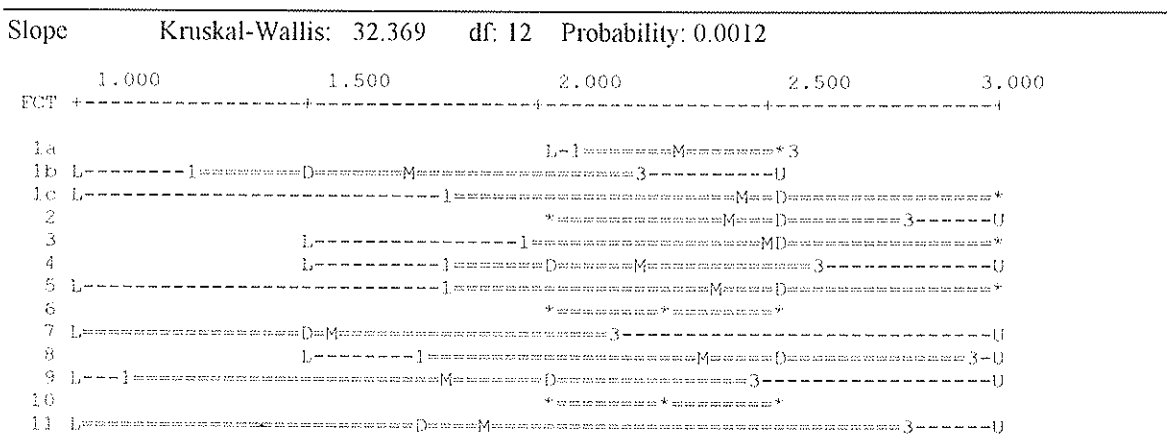


Figure 4-3: Whisker plot of slope (1 = < 5°, 2 = 5-20°, 3 = > 20°) for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).



Floristic Community Type 2 - Southern granite shrublands and woodlands

This community type consisted of granite shrublands that were restricted to the southern region of the survey area (Appendices 4 and 5). These were considered to be analogous to the northern shrublands of Community Type 1c. This association was restricted to the granites on the western face of the Darling Scarp, predominantly on the mid-upper slopes. Common species which characterised this community type included *Melaleuca radula*, *Grevillea endlicheriana*, *Allocasuarina huegeliana* and *Grevillea bipinnatifida* (Appendix 3 and 5). There was a notable absence of representation in species group A, and in species group B3, which was a group consistently occurring in the other granite - associated community types (Appendix 3). This accounted for the paucity of taxa in Community Type 2 with a comparatively low average species richness of 53.8 $\pm$ 1.9 taxa / plot. Most of the taxa in Community type 2 were from species groups B1 and B2, and less frequent but distinctive components were derived from groups F and C.

This community type was located at two disjunct locations along the Darling Scarp. The was a small stand at Byford which was a remnant of what may have more extensive stand of granite heath had it not been cleared for quarrying, grazing and residential development. The next occurrence was at Serpentine National Park, and the extensive clearing of the Scarp between Byford and Serpentine may have removed intervening stands of Community type 2.

The extensive and prominent granite outcrops at Serpentine National Park supported a good cover of this community, and accounted for most of the diversity of vegetation structure which was found in this community type (Appendix 5). There was no predominant overstorey, where the structure graded from heath to woodland. *Allocasuarina huegeliana* low woodland would occur on the upper surfaces of fractured granite outcrops, and continued to occur as isolated individuals over the landscape beyond these woodlands. *Eucalyptus calophylla* appeared on the deeper, loamy soils on the slopes, and *Eucalyptus wandoo* coincided with dolerite-derived clay soils between the outcrops of granite.

The high incidence of small, herbaceous annuals weeds in the herb layer was attributed to the close proximity to pastures. Otherwise, these sites were found to be in excellent to very good condition.

Table 4-1: Comparison of topographic position with the associated community types for the eleven floristic community types along the profile of the Darling Scarp. (* = minor drainage line on face of the Scarp).

	Community type												
Position	**1a**	**1b**	**1c**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Upland (plateau)	2		1				1				11		
Scarp upper slope	4	1	4	4	3	7	3			4	7	1	
Scarp mid slope		2	6	1	2	4	6			3			1
Scarp lower slope		1	1		1	2	4		1	1			
Ridge Hill Shelf	1	1				2	1	4	10				
Valley upper slope	2					2	1			2	1	1	
Valley mid slope	1		1		1	1			2	2			1
Steep lower valley slope					6	1							
Valley floor		3											
Creek line					1								1
Scarp drainage line*		1			4	1	1						1

Floristic Community Type 3 - Woodlands on steep, loamy Scarp and valley slopes.

This community type consisted of *Eucalyptus calophylla* woodland on the steep slopes of the Darling Scarp and within the major valleys on the western margin of the Darling Plateau. This community type was a large group (18 sites) which ranged over the entire length of the survey area. The soils were typically deep loams and associated with a drainage feature in the landscape, whether this was either a major valley system or drainage and soil lens around a granite outcrop (Appendix 6). Within this community type, *E. calophylla* was consistently a good indicator of the edaphic conditions associated with this community type was the predominant canopy species in this group, co-occurring with *E. wandoo* or *E. laeliae* when these species were present. However, these eucalypts did not define the vegetation community. This was influenced by the shrub and herb understorey which was generally composed of species which also were common in other community types. This includes *Trymalium floribundum*, *Phyllanthus calycinus, Hakea lissocarpha, Cheilanthes austrotenuifolia* and *Caesia micrantha* (Appendix 5). Overall, Community type 3 was distinguished by an absence of taxa across most of the species groups (Appendix 3). This included a lack of the small herbs such as *Homalosciadium homalocarpum*, *Vulpia myuros*, *Centrolepis aristata* and *Centrolepis drummondiana* from group B1. Whilst lacking common

herbs, the understorey harboured a good number of native grass taxa and *Desmocladus aspera*. There was limited representation in species group A, a moderate level constancy in group B1 and B2, but characteristic representation in the smaller, infrequent species group C and D that are associated with loamy river terraces (Appendix 3 and 5). Consequently, the species richness was moderately poor, with an average of 52.6 ± 10.1 taxa / plot.

Floristic Community Type 4 – Woodlands on steep colluvial slopes of Scarp face and upper valleys

This community type consisted of woodlands and low forests on moderately steep slopes, predominantly on the mid-upper slopes of the Darling Scarp face but also occurring in the valleys and Ridge Hill Shelf. This community type was distributed from the central to southern region along the Darling Scarp (Appendix 4). The soils were usually red earths and clay loams, often of a gravelly nature. The proximity of these sites to granites outcrops and the presence of colluvial quartzite / laterite (Table 4-1) had a profound influence on the species richness and floristic composition. This was clearly evident in sites on steep valley slopes that were distinguished from community type 3 by this greater diversity of understorey shrubs (Appendices 3 and 5). Vegetation typically associated with granites was found occurring within these low woodlands, with representation in the species groups M and O. These were additional to the typical and common taxa from species groups A1, A2, B1 and B2, namely *Hypocalymma angustifolium*, *Hibbertia hypericoides*, *Baeckea camphorosmae*, *Melaleuca* aff. *scabra* and *Isopogon asper*. Taxa from groups A1 and V which were typically associated with the upland jarrah forests were also conspicuous in this community type. This includes *Bossiaea ornata* and *Labichea punctata*. Although not distinguished for the analysis, *Eucalyptus marginata* subsp. *elegantella* occurred in a number of these sites. The average species richness was 75.65 ± 10.93 taxa / plot, which was the highest recorded for the eleven community types.

The dominant stratum was not restricted to any particular species, but varied from *Eucalyptus lane-poolei*, *Eucalyptus calophylla*, *Eucalyptus laeliae*, *Eucalyptus wandoo* and *Eucalyptus marginata*. There were two instances where *E. lane-poolei* did occur in this community type. At Ellis Brook Valley, there was an unusual occurrence of *E. lane-poolei* comparatively high in the landscape. The similarity of this site to the other woodlands in the group was attributed to the understorey that was associated with sandy colluvium on comparatively steep slopes. The second site was at Serpentine National Park, at the boundary of the lower Darling Scarp slopes and Ridge Hill Shelf (Appendix 6). This and adjacent sites further upslope were distinguished by *Xanthorrhoea acanthostachya*, and *Dryandra armata*, *Lambertia multiflorus* var *darlingensis* and *Pithocarpa pulchella* (Appendix 3). These taxa from species group O also occur in Community types 5 and 7, on Scarp slopes and Ridge Hill Shelf sites. This suggests there is some affinity between these sites at Serpentine and community types in super group 2, but the overall similarity lies with community type 4.

SUPER GROUP 2 - Ridge Hill Shelf woodlands and Granite shrublands

Community Type 5 – Central granite shrublands

This community type was a heterogeneous assemblage of shrublands and heath on loamy soils derived from granite or occasionally Ridge Hill Shelf soils. The analysis distinguished this as a centrally located heath community that ranged from John Forest National Park to Ellis Brook Valley (Appendix 4). Rather than consisting of granite outcrops, the exposed rock was highly fragmented and the soils were typically a combination of shallow sands with colluvial lateritic gravels and / or conspicuous quartzite fragments. This was particularly obvious at Crystal Brook Reserve and Ellis Brook Valley where there were prominent quartzite ridges in the landscape (Appendix 6). The average species richness was 64.9 ± 8.7 taxa / plot. This heath community typically consisted of the taller shrubs *Xanthorrhoea acanthostachya* and *Allocasuarina humilis* over smaller proteaceous and myrtaceous shrubs, namely *Melaleuca* aff. *scabra*, *Baeckea camphorosmae* and, too a lesser extent, the proteaceous shrubs *Dryandra armata*, *Hakea incrassata* and *Hakea undulata* (Appendices 3 & 5).

There was good representation in the species group B1, with characteristic representation in species groups B3, O, and Q. This included the shrubs previously mentioned and common granite-associated

herbs and shrubs such as *Levenhookia stipitata*, *Laxmannia squarrosa* and *Stylidium repens*. The absence of specific taxa in group B2 suggests that these sites were relatively dry sites with poor soils (Appendix 3).

There was some suggestion from patterns in species groups P, O, R, S and T that there was some dissimilarity between particular Ellis Brook sites and the other sites within this community type. Notably, the taxa in species group P and O which were restricted to these Ellis Brook sites in community type 5 were also faithful to community type 7, namely *Kingia australis, Borya scirpoidea, Schoenus subflavus, Schoenus discifer* and *Stylidium piliferum*. Therefore, whilst these sites were most similar in this analysis to the other granite heaths constituting this community type, there were some affinities with community type 7. However, there were greater overall shared taxa between community types 6 to 8 which overwhelmed this (Appendix 3).

Community Type 6 – Talbot Road *Eucalyptus calophylla – Eucalyptus wandoo* woodlands and heaths

A small group of sites restricted to the Talbot Road Bushland formed a distinct community type of *E. wandoo - E. calophylla* low woodland and lateritic heath on the well drained, gravelly-sandy soils of the Ridge Hill Shelf (Appendices 3 and 4). This separation from the other communities occurred at a reasonably high level in the classification (Figure 4-1). This dissimilarity was evident in the two-way table (Appendix 3), where the Talbot Road sites were poorly represented or conspicuously absent from the majority of common species groups. There was better representation in species group B1 and in the smaller species groups E, N, O, and to a lesser extent, Q and S, which indicated. that this group was being distinguished by taxa not frequently occurring in the area surveyed. With an average species richness of 57.0 $\pm$ 12.5 taxa / plot, these sites were still moderately species rich. The small number of sites representing this community type inflates the number of common taxa listed in Appendix 5, however common species in community type included a shrub layer of *Xanthorrhoea preissii, Hakea trifurcata, Hakea undulata, Beaufortia purpurea* and *Hypocalymma angustifolium* over a rich herb layer.

Community Unit 7 – Woodlands on poorly drained colluvial deposits

This community type was a relatively heterogeneous unit which incorporated two upland sites that lay on the Yarragil Soil Unit in a shallow valley on the western edge of the Darling Plateau (Churchward and McArthur 1980) with the remaining sites predominantly located on the Ridge Hill Shelf (Appendix 4). What appeared to unite this group was the common species in groups A2, B1, W1 and W2. These were associated with the underlying sandy clays or gravelly sands which had been deposits in low lying areas in the landscape. *Eucalyptus calophylla* and *Eucalyptus marginata* were the common dominant species, with occurrences of *Eucalyptus lane-poolei* and in southern Ridge Hill Shelf sites (Appendix 6) and *Eucalyptus patens* on the upland. With a moderately high species richness averaging at 61.3 $\pm$ 8.3 taxa / plot, this site was well represented in the common species groups A2, B1, W1 and W2, and had taxa distributed over a number of more sparse species groups (Appendix 3). As previously discussed, taxa in groups O, and P also occurred in community type 5. However, groups U and V were restricted to community type 7, and to within only a few sites. Therefore, there was some patterning in the two-way table that suggested three major distinctions existed within this community type, but site replication was not available to confirm this. These distinguishing species included *Eucalyptus lane-poolei, Kingia australis, Xanthorrhoea acanthostachya,* and *Dryandra armata* (Appendices 3 and 6)
Along with community types 5 and 6, further analyses with the Swan Coastal Plain dataset is needed to better resolve the relationships of these intermediate land units.

Community Type 8 – Shrublands on upper slope granite outcrops

The second of the two major granite associated heaths and low shrublands constituted community type 8, which was a relatively homogeneous group occurring on the upper slopes of the major valleys and the face of the Darling Scarp. It was widely distributed over the length of the Scarp (Appendix 4) and the patterning of species groups within this community which suggested that topography was affecting the species composition. This community type typically occurred on the shallow lithic soils around massive granite outcrops (Appendix 6). Soils were either loams or clays derived from the upslope pallid zone. Common, dominant shrubs included *Grevillea endlicheriana, Petrophile biloba,. Isopogon dubious,*

Calothamnus quadrifidus, *Darwinia citriodora*, *Hakea erinacea*, *Verticordia huegelii* and *Hibbertia subvaginata* (Appendix 5). *Eucalyptus calophylla* and *Xanthorrhoea preissii* occurred as emergents on the on deeper soils adjacent to the exposed granite and there was a rich herb layer associated with water draining off the granites (Appendices 3 & 5). This distinctive community was defined by the common species group B3, and the rarer groups Q, R, and S. There was a notable absence of representation in of sites groups B1 and B2 which distinguished this community type. These granite heaths were species rich, with an average species richness of 61.8 ± 10.0 taxa / plot.

SUPER GROUP 3 – Woodlands of the lateritic uplands

Community type 9 – Upland Jarrah Forest

This community type consisted of typical Northern Jarrah forest and woodland on the lateritic upper slopes and Darling Plateau and was widely distributed across the study area (Appendix 4 and 6). The soils were typically gravelly loams on the flat uplands or steeper slopes at the lateritic breakaway. The canopy was almost invariably dominated by *Eucalyptus marginata*, although some *Eucalyptus accedens* - *E. wandoo* woodlands sampled in John Forrest National Park are also included in this community type. Examination of the two-way table indicated that these sites were comparatively dissimilar to the *Eucalyptus marginata* dominated vegetation and appeared transitional between this community and community type 1a. This illustrated the importance of the understorey defining the vegetation community (Appendix 3).

This community type was well represented in species groups A2, B1, W1 and W2. The latter two groups were considered indicative of community type 9, with high fidelity and constancy of species such as *Acacia barbinervis*, *Hovea chorizemifolia*, *Adenanthos barbiger*, and *Isopogon sphaerocephala*. There was poor representation in species groups other than these four. However, this community type was typically diverse, with a high average species richness of 68.7 ± 12.3 taxa / plot.

Community type 10 – Upland *Eucalyptus calophylla* woodland

This floristic group was comprised from only two sites which were both structurally and floristically dissimilar. The grouping of these sites from the classification was based on both an absence of taxa across all species groups and both of these sites being species poor (Appendix 3). The average species richness was 25.5 ± 5.5 taxa / plot, and part of this paucity of taxa was attributed to leaf litter or sedges occluding a lower herb layer. Structurally, both sites were *Eucalyptus calophylla* woodland on the deep loams on upland valley slopes.

Community Type 11 – Upland *Eucalyptus calophylla-Eucalyptus marginata* woodland

This community type was essentially an intermediate between the previous two communities, consisting of *Eucalyptus calophylla* - *Eucalyptus marginata* low woodland or forest on the loams and clay loam soils on the upper valley slopes. This was a heterogeneous community which was species poor (average species richness of 45.5 ± 10.8 taxa / plot), with moderate representation in species groups A2, B1, B2 and W1 (Appendix 3).

The community classification techniques used in this analysis are sensitive to species richness, with species poor sites often forming somewhat heterogenous small groups. Further sampling will be needed to fully resolve the relationships of quadrats in community types 10 and 11.

4.2.2 Sites omitted from analysis

In a preliminary analyses, four sites were so visibly distant from the other groupings on the dendrogram, that it was decided to exclude these from further community analyses. These sites are discussed as follows:

* As part of a flora survey of the John Forest National Park (Department of Conservation and Land Management 1991), a site was surveyed that had been previously located on the herbaceous community covering an exposed granite outcrop. This was the single example of a moss and lichen sward surveyed, which was lacking in vascular taxa and therefore proved to be highly dissimilar to all other granite sites surveyed. Whilst non-vascular plant communities are important aspects of the biota on granite outcrops, these were considered not appropriate for the purposes of this survey.

* One site had been established along a creek-line as part of a transect of the Scarp face at Red Hill (John Forrest National Park). The vegetation consisted of *Eucalyptus calophylla* woodland over a tall shrub layer of *Viminaria juncea, Calothamnus quadrifidus* and *Darwinia citriodora*. Both this dense shrub layer and a sedge layer appeared to prevent the establishment of a rich herbaceous layer. Therefore, the site was species poor and this may partially account for its omission from the classification.

* A sites was located in upper slope wandoo woodland in State Forest at Jarrahdale. The vegetation consisted of *Eucalyptus wandoo* woodland over an understorey of *Nemcia plicata, Kunzea micrantha, Sollya heterophylla* and *Hakea lissocarpha*. With a sparse herb layer, this site was species poor (40 taxa) relative to other apparently homologous *Eucalyptus wandoo* woodland sites. At present it is not possible to place this site within any of the other community types defined. Further sampling south may elucidate the relationship of this site to other communities on the Scarp. Either this was an unusual site or it is from a community that has yet to be adequately sampled. It is suggested that further sampling along the southern Scarp may resolve this.

* The final site was located at Serpentine National Park, in remnant vegetation along the banks of the Serpentine river at the base of the valley (Figure 5-1). This site proved to be quite distinct from the other creek line-associated vegetation sites established in this survey. The site was dominated by *Eucalyptus rudis* / *Eucalyptus calophylla* low forest over sedges / rushes. Like most other rivers on the western margin of the Darling Plateau, a pipehead dam had been established on the river upstream from the site. The site was distinct from community type 3, which may be partially attributable to the inclusion of the sedge stratum. Other similar stands of *E. rudis* / *Melaleuca rhaphiophylla* on valley flats (deeper alluvial soils) could not be established in this survey since they were found to be in too poor condition to sample, as a result a combination of weed invasion (*Watsonia meriana*), grazing and frequent fires.

4.2.3 Species groups

Twenty three species groups were derived from their site-associations in the classification analysis. Of these, species groups A, B and W were further subdivided, based on information from the two-way table, to produce a total of thirty species groups and subgroups (Appendix 3). The ubiquitous species group B1 consisted of taxa that were common to all community types and well represented within each floristic community. Therefore, community types were defined more by a lack of representation within this group than be species presence.

A number of species groupings were found to clearly indicate the underlying environmental conditions. Species group A2 was associated with woodland communities on the lateritic soils of the Ridge Hill Shelf, scarp mid-upper scarp slopes and Darling Plateau. Species group W was virtually exclusive to the upland Jarrah forest sites, with some limited representation on the laterites of the Ridge Hill Shelf.

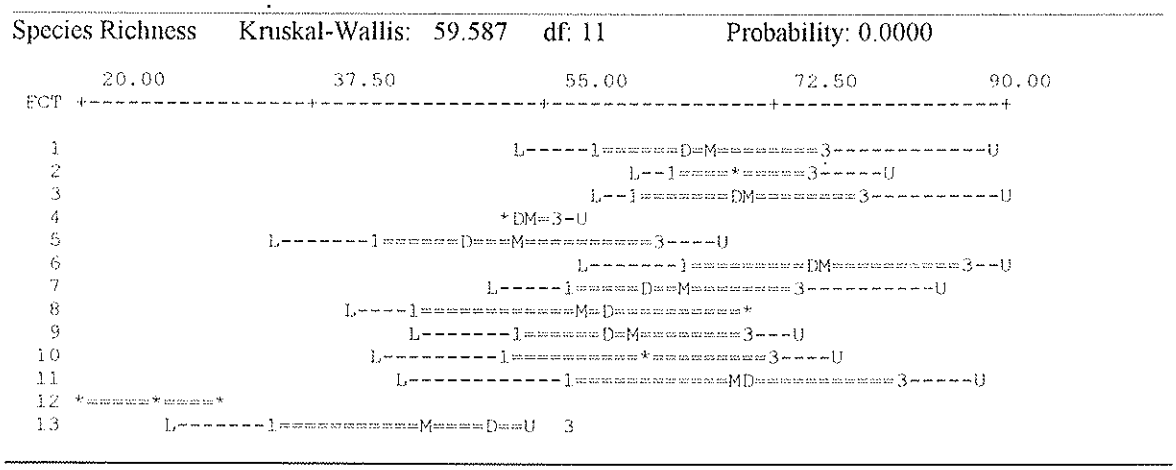
There were species groups characteristic of the exposed granites. Species groups B3, R and S were characteristic all granite shrubland communities and the associated wet, shallow soils of these habitats. These groups included both perennial shrubs and herbaceous annuals. Species groups P, O, Q and U were associated with both the shrublands on quartzite ridges (community type 5) and the adjacent Ridge Hill Shelf receiving colluvium from these slopes.

Species groups B2 and F were associated with the wandoo and marri woodlands on the deeper clays and loams of the scarp and valley slopes, whilst species groups D and C were more characteristic of deep loamy soils on steep slopes. Species group I was associated with the wandoo woodlands of the upper slope.

4.2.4 Species diversity

The communities were diverse, with the average species richness ranging from 45.5 to 75.7 species / plot. These figures are slightly underestimated since these were derived from the analysis after omission of singletons but this does not appear to change the overall picture of species rich sites. Community type 10 was notable for its paucity of species, which defined this small group (Figure 4-4).

Figure 4-4: Whisker plot of species richness for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).



4.2.5 Singletons

Although singletons were omitted from the classification analysis, the distribution of singletons across the sites was still informative. Fifty five percent of the 146 survey sites had singletons, with the majority of these sites (79%) possessing either one or two singletons (Figure 4-5). The exception to this was the occurrence of high numbers of singletons (≥5) in five particular sites. Four of these five sites were from the Ridge Hill Shelf sites of community type 7 and the remaining site was from the Talbot Road woodlands (community type 6). Singletons are unique taxa that may be naturally infrequent. However, their disproportionate occurrence in the Ridge Hill Shelf sites indicates that extensive clearing on this landform has fragmented these communities into unique remnants of a previously more extensive land system. This community type was therefore undersampled in this analysis, despite the effort made to include as many sites as possible that were located on the gravelly sandy clays of the Ridge Hill Shelf. A similar pattern of the distribution of singletons was found on the Swan Coastal Plain where the singletons were concentrated on the Ridge Hill Shelf and Pinjarra Plain systems which have both been heavily cleared. (Gibson *et al.* 1994).

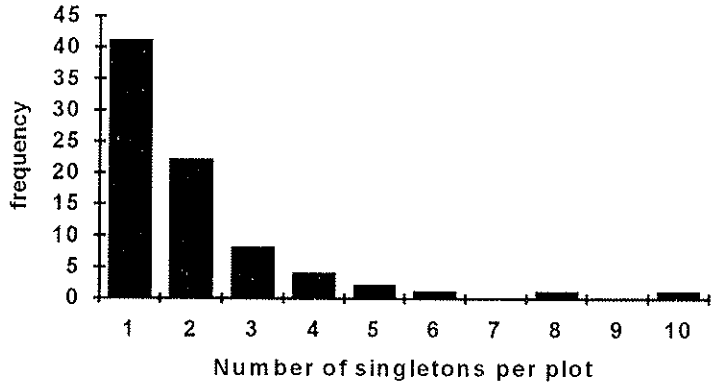


Figure 4-5: Frequency histogram of the occurrence of singletons within a quadrat.

4.2.6 Vegetation condition

Vegetation condition was recorded on a condition scale (Keighery 1994) that was based on a subjective assessment of the level of weed invasion, the presence of disease, fire frequency and logging history. All groups were observed to be in generally good condition, which is expected since the quadrats were deliberately placed in the best available locations. Given this limitation, there was a significant difference in vegetation condition found between community types (Figure 4-6). The vegetation condition tended to be in excellent to near pristine condition in community types 4, 5 and 8, which were the floristically rich woodlands and shrublands on the scarp slopes. In community types 1a, 1b, and 6 the condition ranged from very good to excellent. It appears that the granites tended to be more resistant to disturbance than the woodlands on clays.

Some information on the distribution of weeds within the floristic communities can be obtained from the two-way table (Appendix 3), which may have some bearing on the condition index observed in the field. The relatively higher condition index observed in community type 1b may be associated with the a number of weedy taxa in species group F. Likewise, an assemblage of weedy taxa in species group C were primarily represented in community types 2 and 3. Weedy taxa in species groups B1 were ubiquitous to most community types, whilst those in B2 were more commonly associated with the vegetation on the woodlands of the scarp and valley slopes (community types 1a, 1b, 1c, 2, 3, and 4)

Figure 4-6: Whisker plot of vegetation condition class (1 near pristine to 5 poor) for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).

Vegetation condition class Kruskal-Wallis: 35.658 df: 12 Probability: 0.0004

```
  near pristine             excellent             very good              good
     1.000               1.750           2.500            3.250            4.000
FCT  +-----------------+-----------------+-----------------+-----------------+

  1a                         L-1===========M====D=====*
  1b                         L----1=======DM========3-U
  1c             L--1========D======M==============3--------------U
   2             L----1======D=======M=============3--U
   3 L------------1==========D=========M====================3----------------U
   4 L----1===========MD==========3-------------------U
   5 L-----1============M====D======3-----------------U
   6                         L---1========*=======3---U
   7 L--------------1============M=D==========3-------U
   8 L---1=======D==M==========3----------U
   9 L----------------1======D======M==============3--------------U
  10 *=======================*========================*
  11 L---------1===================M======D===========U 3
```

4.2.7 Vegetation structure

The canopy species were conspicuous elements which dominated the structure of the vegetation communities surveyed on the Darling Scarp. Prior to the analysis, it was expected that these would have some association with particular communities. It was observed that low granite heath and shrublands occurred on the shallow soils of the scarp face. An open woodland of *Eucalyptus calophylla* and *E. wandoo* occurred on deeper soils. *E. wandoo* was found to be a good indicator of dolerite dykes and associated rich red clays and *E. calophylla* was associated with the deep loams and soil lenses around granites. Apart from one very unusual exception, *Eucalyptus lane-poolei* was restricted to the colluvial soils of the Ridge Hill Shelf. *Eucalyptus marginata* was typically found on the laterites of the plateau and the Ridge Hill Shelf, and low woodlands of *Allocasuarina huegeliana* were restricted to granite outcrops.

The dominant tree species not only were segregated by topography, but also along a north-south gradient. *Eucalyptus accedens* was restricted to the lateritic breakaways in the north-east margin of the study area, whilst the *Eucalyptus laeliae* replaced *E. wandoo* as a predominant canopy species in the southern woodlands on the scarp and valley slopes. Notably, the northern occurrences of *E. laeliae* were restricted to the Helena Valley. Although *Eucalyptus haematoxylon* is known to occur south of Keysbrook (Marchant *et al.* 1987), it was not encountered in this survey despite active searching in these locations. These observations on the distribution of the major canopy species have been well documented by previous workers (Williams 1932; Beard 1979a, 1979b, 1981; Heddle *et al.* 1980; Clifton 1973).

Table 4-2: The association of the dominant canopy species with floristic community type

Canopy species	Species group	Community types
Eucalyptus calophylla	B1	1a, 1b, 1c, 2, 3, 4, 5,6, 7, 8, 9, 10, 11
Eucalyptus laeliae	C	3, 4
Eucalyptus lane-poolei	P	4, 5, 7
Eucalyptus wandoo	B2	1a, 1b, 1c, 2, 3, 4, 5, 6, 9, 11
Eucalyptus marginata	W	4, 9,10,11

On closer inspection, there was no clear association found between the tree species and a particular floristic community (Table 4-2, Appendix 3). No single species of *Eucalyptus* was found to predominate within the community types. *Eucalyptus calophylla* was found to be the most widespread species among the sites, and was represented in all thirteen community types and subtypes. Often *E. calophylla* would co-occur with. *E. wandoo* or with *E. laeliae* (Appendix 3). *E. wandoo* was the second most common tree species which occurred in most of the floristic communities. Whilst *E. laeliae* was restricted to community types 3 and 4, it was neither a typical nor distinguishing species for these communities. Therefore, the replacement of *E. wandoo* by *E. laeliae* in the southern sites of these community types was not associated with any profound change in the overall floristic composition. In terms of floristic composition, *Allocasuarina huegeliana* woodlands were indistinguishable from the surrounding granite heath (community type 2). As previously observed, *Eucalyptus marginata* was associated with communities on both the Darling Plateau and the Ridge Hill Shelf, but its presence was not essential to define these communities. This was most evident in community types 4 and 9, where both *E. marginata* and *E. wandoo* were represented but were almost never observed to co-occur in the field. Although *E. marginata* was not consistently identified to subspecies level, *E. marginata* subsp. *elegantella* appeared to be the predominant subspecies on Ridge Hill Shelf and lower scarp slopes.

A variety of vegetation structures were found within each community type that had no clear correlation with the floristic community (Appendix 3). It is concluded that the community type is driven by the floristic composition of the understorey and the dominant tree species are not suitable predictors of the floristic community.

4.3 Environmental Correlates

4.3.1 Topographic position

The eleven community types identified along the Darling Scarp were to be strongly associated with both topographic position and the underlying geology. As a consequence of the steep gradient, there was a rapid transition from an upland plateau to an exposed, eroded surface with associated drainage, culminating at the base as a depositional landscape. This topographic sequence was similar for both the western face of the Darling Scarp and the slopes of the adjacent major valleys incised in the western margin of the Darling Plateau. This resulted in a reasonably diverse array of landforms within the limited dimensions of the Darling Scarp survey area.

Two measures were used to estimate topographic position along the profile of the Darling Scarp. Altitude was an objective measure of elevation whilst the category of Topographic Position was a subjective estimate which noted the location within the profile of the Darling Scarp and, where relevant, its proximity to a drainage feature (Table 4-1). Both measures demonstrated that the vegetation communities of the Darling Scarp were arranged along a topographic sequence (Figure 4-2, Table 4-1).

The range of altitudes in which the sites was located encompassed the full range of altitudes found along the profile of the Darling Scarp. Following this altitudinal sequence down the Scarp profile, Community types 9, and 10 were generally restricted to the higher altitudes corresponding with the uplands of the Darling Plateau and upper slopes of the Scarp (Figure 4-2, Table 4-1). Community type 11 tended to occur at comparatively lower altitudes and on the corresponding mid-regions of the scarp and valley slopes, with some co-occurrence with drainage features. The slopes associated with these regions ranged widely but community types 9 and 11 tended to occur on flat - gentle slopes whilst community type 10 was associated with moderately steep slopes (Figure 4-3).

The distribution of Community type 1a was also skewed to the higher altitudes or the upper-mid scarp and valley slopes, with some outlying occurrences further down the scarp profile. These were typically moderately steep slopes. Community types 8, 1c, 1b, 3, 4 and 5 had comparatively wide range of altitudes, with type 8 mostly occurring in the mid-upper altitudes, types 1c, 4 and 5 on the mid altitudes and type 1b and 3 tending to occur on the lower altitudes. Similarly, when considering topographic location and slope, Community Types 8 and 1c were primarily located on moderately steep, mid-upper scarp slopes and community types 1b and 5 tended to occur on the mid-lower scarp slopes. Whilst community type 5 occurred on the moderately steep slopes of this region, community type 1b occupied the flat-gentle slopes at the same altitude. Community type 3 occurred on both the mid- and upper scarp face and valley slopes, on slopes that tended from moderately steep to steep. Otherwise, most of these communities were more frequently encountered on the scarp face.

Community type 2 was restricted to a narrow range in the middle altitudes, which corresponded with the flat to gently undulating upper slopes of the scarp face. Community type 7 was skewed to the lower altitudes, with most of this community type being located on the gentle-flat terrain on Ridge Hill Shelf at the base of the Scarp. Community type 6 was only found at an altitude of 40m on the Ridge Hill Shelf on terrain that was moderately steep.

The greatest extent of clearing and urban development has occurred on the flat-gentle slopes along the base and mid-lower slopes of the Darling Scarp. Based on topographic position alone, the community types that would be most affected by this activity would be community types 1b, 5, 2, 7 and 6.

There was a tendency for the granite - associated heaths (community types 1c, 2, 5 and 8) and the woodlands of community types 3 and 4 to be associated with the steepest terrain. Community types 1b and 9 were associated with the flattest terrain. This relationship was statistically significant (Figure 4-3).

It was postulated that the vegetation within the valleys may actually be similar to the face of the Darling Scarp, since both surfaces represent an eroded margin of the plateau with exposed granites and younger soils. Because these regions were considered to be continuous with the face of the Darling Scarp, the valley slopes within 5 km east of the Darling Scarp were included in this survey. It was also considered that the valley slopes may experience a different environmental regime and therefore harbour unique vegetation communities distinct from the face of the Darling Scarp. Valley - associated vegetation has been described as the Helena Complex by Havel (1975b), and has been mapped as separate unit which dissects the

Darling Scarp and Plateau (Heddle *et al.* 1980). Forty one of the 146 sites analysed were located within valleys, with community type 3 being the most common community type found at these sites. However, no community type was found to be restricted exclusively to the valley slopes. Particular community types were exclusive or nearly exclusive to of the face of the Darling Scarp. These were granite-associated shrublands and woodlands (community types 1c, 2, 4 and 5), and woodlands on the Ridge Hill Shelf (community types 6 and 7).

Particular floristic communities were associated with the drainage features of the Darling Scarp. The only community type located on the poorly drained, flat valley floors was the wandoo woodland of community type 1b. Likewise, Community type 3 was a riparian vegetation community that predominated on both the drainage lines on the scarp face and the steep lower slopes and river terraces in the major valleys. Conversely, although these community types were characteristic of these drainage features, they also were distributed over the face of the Darling Scarp. This can be attributed to similar edaphic conditions and moisture regimes occurring on the face of the Darling Scarp face. This is on a much smaller scale than that found along valleys and creek lines which would account for the a patchy distribution of this community type observed on the scarp face.

4.3.2 Aspect

Aspect was of interest since it may have some bearing on the microclimate which would have some effect on the vegetation community (Table 4-3). Therefore, a southern aspect would be associated with a comparatively more shaded and wetter microclimate than an exposed north-westerly aspect. This may have been the case for community type 11, which did occur on the south-facing slopes in half of its occurrences. However, this is not conclusive since only a few sites represented this community type. Community types 7 and 9 tended to have no aspect, which corresponded to their occurrence on predominantly flat terrain. There was no clear trend for community types 1c, 3 and 6 which may be related to their occurrences in valleys or on the Ridge Hill Shelf where aspect may be of little consequence. Community type 1b experienced a predominantly northern aspect, but this may also be insignificant since it was on flat to gently undulating terrain.

Table 4-3: Frequency of aspect, as observed for each site, occurring within the 13 floristic community types and subtypes

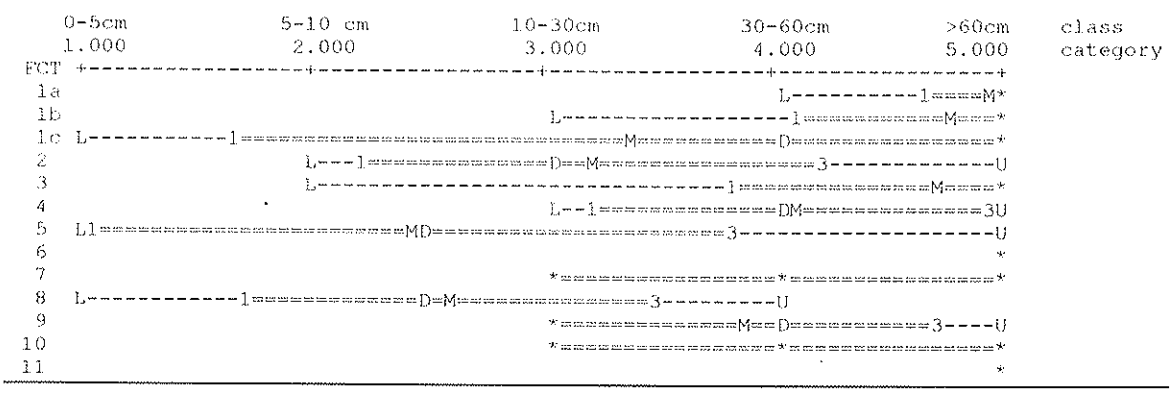
	Floristic Community Type												
Aspect	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
None		1					1		6		6		2
N	1	1	1			2		1	1	1	2		
NNE		1				1	2			2			
NE			4		3	1	5						
ENE						1					1		
E		1							1				
ESE			1										
SE	1		2		1	1	1	1	1		2		1
SSE											1		
S	1	1	1	1	2		4	1		1	1		1
SSW					1				1				
SW			1		1	3				1	2		
WSW						2						1	
W	1		1	2	4	5	1		3	2	2		
WNW	1		2	1	1	1	1						
NW	5	2			4	2	1	1		1	1		
NNW		2		1	1	1	1			4	1	1	

The only instances where aspect may have had some association with community type was with the woodlands (communities types 1a and 4) and granite - associated shrublands and heath (community types 2, 5 and 8) of the moderately steep slopes of the scarp face. These had a predominantly west to north-western aspect which corresponded to their occurrence on the exposed and eroded surfaces of the Darling Scarp. Therefore, this trend may be more closely associated with underlying geology than microclimate.

4.3.3 Soils

Soil Depth (Depth to rock) was derived from an visual estimate gauged in the field. An analysis of these results found good correlations of soil with floristic community type, with statistically significant differences between groups (Figure 4-7). It was confirmed that the granite - associated shrublands of community types 8 and 5 were established on the shallowest soils. The analysis showed that these soils tended to be shallower those of the other granite - associated shrublands of community types 1c and 2 (Figure 4-7). The soils of community types 5 and 8 were predominantly grey to yellow sandy clays, whilst the deeper soils of community types 1c and 2 tended to be loamy red earths of a sandy clay texture (Tables 4-4 and 4-5). It is concluded that community types 5 and 8 tended to occur at higher topographic positions, where the skeletal soils are influenced by the yellow - white clays of the pallid zone. The deeper loamy red earths associated with community types 1c and 2 reflect the influence of dolerite in the granite matrix and therefore appear to support woodlands in addition to granite shrublands and heath.

Figure 4-7: Whisker plot of soil Depth class (1 = 0-5 cm (skeletal); 2 = 5 -10 cm (shallow), 3: 10-30 cm (moderate); 4 = 30-60 cm (mod-deep); 5 = > 60 cm (deep)) for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard .Deviation, M = mean, D = Median, 3 = Mean + 1 Standard .Deviation, U = upper limit, * = more than one symbol at print position).



Of the other floristic communities, the deepest soils (>60cm) tended to be associated with community types 1a, 1b, 3, 6 and 11. Whilst community type 11 possessed dark brown clay loams, the soils of the former three communities were primarily loamy red earths. There was a distinct influence from the upland lateritic mantle found in the gravelly and / or sandy orange clays of the upper slope wandoo woodland (Community type 1a). The woodlands of community types 1b and 3 had less gravel and were typically sandy orange-red clays or clay loams, with a greater incidence of loamy soils in community type 3. There was no clear pattern of soil colour for the Talbot Road woodlands (community type 6), but these appeared to consist of gravelly sands with varying degrees of loam and clay.

To generalise for the remaining sites: the uplands site of community types 9 had the typical orange-brown gravelly loams typical of the Dwellingup landforms of Churchward and McArthur (1980). In community type 11, these tended to be brown clay loams. The gravelly clay texture of the soils of community types 4

and 7 suggested the deposits of colluvium derived from the upper slopes (Table 4-4), whilst their coloration suggested the presence of loamy sands or loamy yellow or red earths (Table 4-5).

Table 4-4: Soil texture tables indicating frequency of soil texture , as observed for each site, occurring within the 13 community types and subtypes.

	Floristic Community Type												
Soil texture	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
clay		1			2								
clayey loam	2	1	2	1	6	4	2				1	1	1
sandy clay	2	3	4	1		3	5		3	4	1		
sand clay loam			2			3							1
gravelly clay	2				1	1	1		3				
gravelly clay loam	1	2	1	1	1	3	1		2	1	3		1
gravelly sand clay		2	1			1	1		1	1			
loam					6	1						1	1
sandy loam			2	1	2	2	3		1	4			
loamy sand	1						1	1		2			
gravelly loam	2			1		2			1		11		
gravelly sand loam			1					3	1				
gravelly sand							3		1		3		

Table 4-5. Soil colour tables indicating frequency of soil colour ,as observed for each site, occurring within the 14 community types and subtypes.

	Floristic Community Type												
Soil colour	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
grey							1	1		3			1
grey - brown			1	1		4	5		5	2	1		
yellow							2		3	2			
brown-yellow		2					5	1		2	1		
brown	5	3	8	2	12	6	1	1	2	2	8	2	3
brown-orange	2			1	1		1			1	7		
orange	2					1	1		2		2		
orange-red		1	1										
red		2	3	1	1	1		1	1				
brown-red	1	1			4	8	1						

4.3.4 Geology

Rock was present at the soil surface in all but seventeen of the survey sites analysed (exceptions being those in community types 6 and 10) (Figure 4-8, Table 4-6). This surface rock ranged in size from 0.5 –2 cm as lateritic gravel, to large, loose granite boulders of width exceeding one metre and granite outcrops with dimensions exceeding those of the quadrat. Four general categories of rock was observed in the study area; with the most predominant rock type being granite (granites, gneisses and migmatites) and, secondarily, gravelly laterite with smaller occurrence of quartzite and dolerite. Prominent intrusions of quartzite were occasionally found in the granites, but the most frequently encountered rock intrusion was dolerite. The dolerite was most often found as a linear dyke of fragmented boulders which were readily eroded to rich red earths.

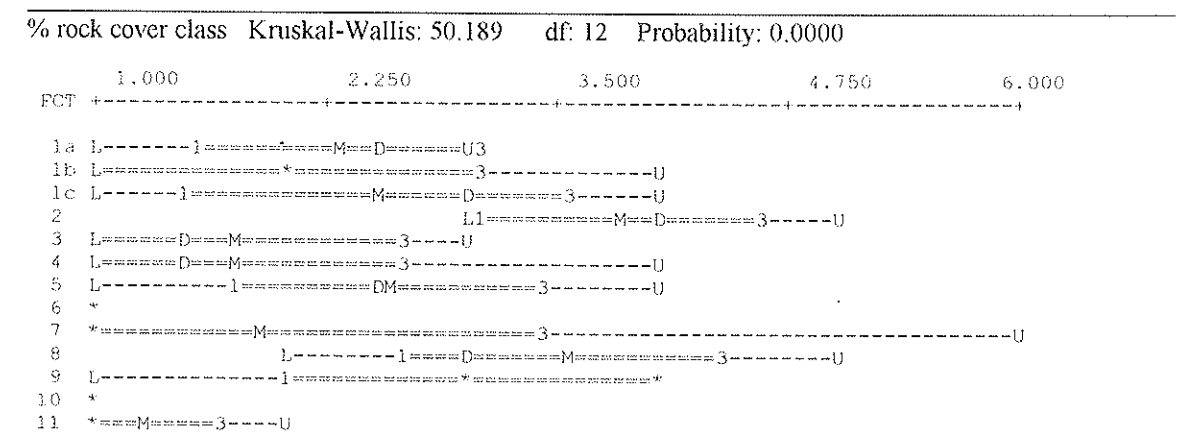
Exposed granite was characteristic of the heaths and shrublands of community types 1c, 2, and 8. In the two latter communities, there was a significantly high cover (50-70%) of this exposed granite over the quadrat area. In the other granite associated heath and woodland community (type 1c), there was a moderate cover of exposed rock (Figure 4-8). Dolerite was most commonly associated with community type 3, but the coverage of this and granite tended to be below 10% of the quadrat area.

Laterites were predominant in community types 9, 7 and 1a. Whilst this rock type was derived from the Darling Plateau for types 1a and 9, most of the laterites in community type 7 were derived from the Ridge Hill Shelf (Jacob 1986). At levels of 30-40% , the cover of this gravelly laterite was comparatively high in community type 9.

TABLE 4-6: Frequency of surface rock type, as coded from site observations, occurring within the 13 community types and subtypes. Laterite = lateritic gravels and massive laterites; LT/GN/QZ =combination of laterite, granites and quartzite; granite = granites, migmatites and gneiss; DO/LT/QZ = dolerite in combination with laterite and quartz.

	Floristic Community Type												
Surface rock	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
laterite	6	1	2		1	2	2		7		18	1	
laterite & granite			1		1	2	2						
LT/GN/QZ						1							
laterite & quartz		1							1				
quartz							4		1				
granite & quartz							3						
granite	1	4	9	4	8	11	4			12			1
dolerite & granite		1			1	1	1						
dolerite & quartz							1						
DO/LT/QZ						1							
dolerite & laterite	2					1							
dolerite	1	1	1	1	5								
no rock seen		1			2	1		4	4		1	1	3

Figure 4-8: Whisker plot of % surface rock class (rock % cover class codes: 1 = <2% ; 2 = 2-10%; 3 = 10-30%; 4 = 30-50%; 5 = 50-70%; 6 = >70%) for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).

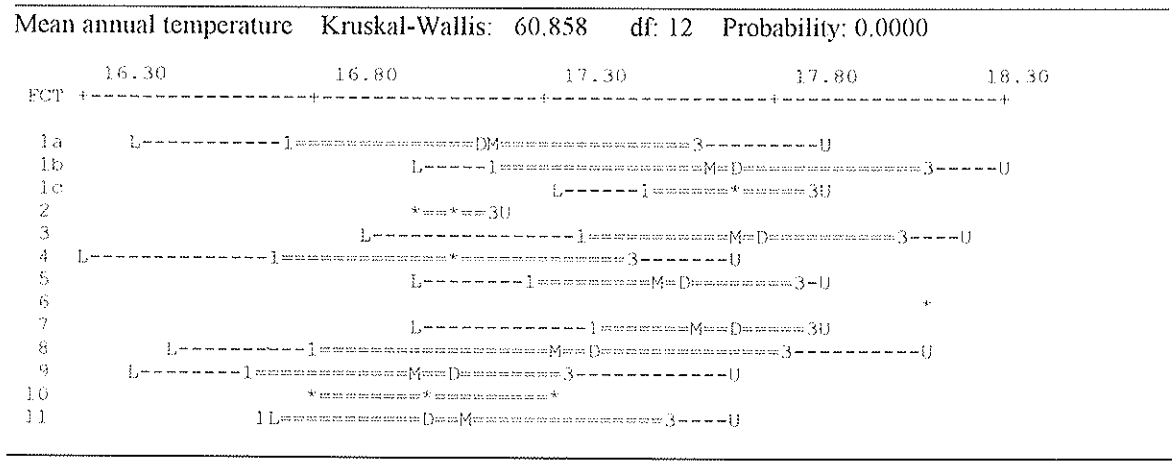


Community types 4 and 7 tended to have a mixed array of rock types within the quadrats (Table 4-6), indicating the colluvium nature of the scarp slopes. Whilst fragments of quartzite were found in this colluvium, it was a common rock type associated with the granite shrublands of community type 5. A large proportion of these sites were located along the prominent quartzite ridges at Ellis Brook Valley. Since quartzite is exceedingly resistant to weathering, these ridges were outstanding features in the landscape of the Darling Scarp. No other quartzite ridges of the same magnitude as those at Ellis Brook Valley were encountered elsewhere along the Darling Scarp.

4.3.5 Climatic variables

The general pattern for average temperatures across the Scarp is for these to decrease in an easterly direction across the Darling Scarp and Plateau and to decrease with an increase in latitude. To summarise these trends, there are two temperature gradients which operate in a north-south and east-west direction (Gentilli 1989, Seddon 1972). The most comprehensive set a climatic variables that were available for this report were estimates derived from the BIOCLIM model (Busby 1985). Since these were generated from latitude, longitude and altitude, the estimates of climate are auto-correlated with patterns in topographic position observed for the floristic communities.

Figure 4-9: Whisker plot of mean annual air temperature estimates for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).

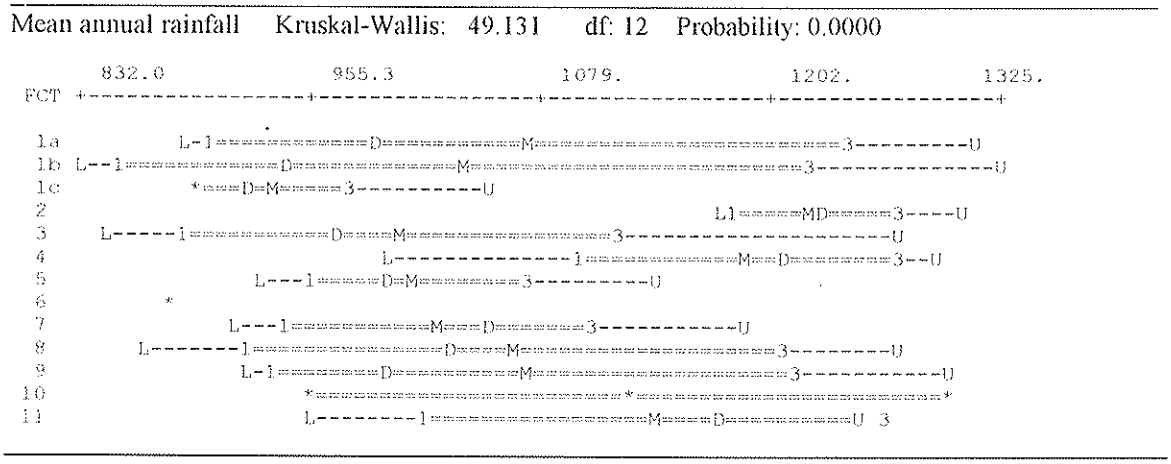


There was a significant difference in average annual temperature between the floristic communities. The trend for higher annual temperatures was evident in community types 1b, 1c, 3, 5, 6 and 7. This is associated with these community types being located on predominantly lower altitudes on the western slopes of the Darling Scarp and / or in northern sites. The association of an comparatively lower annual rainfall in these sites was also a function of topographic position (Figure 4-9). Communities that had a distinctly southern distribution, namely community types 2 and 4, experienced both lower annual temperatures and higher annual rainfall. Likewise, the upland sites also experienced lower temperatures and higher rainfall which was associated with an eastern distribution at the higher altitudes (Figures 4-9 & 4-10). The wide range of temperatures experienced in community types 1a and 8 reflect the wide distribution of these floristic communities across a range of latitudes.

The effect of topography on climate has been noted by Gentilli (1989) to be very strong. Whilst temperature and rainfall is intricately associated with topographic location, it is difficult to separate climate alone as a causal factor driving the distribution of the plant communities on the Darling Scarp. Soils, the underlying geology and drainage are also intricately associated with topographic position. It appears that soil moisture is of more relevance than rainfall regime to the vegetation. For example, it was observed that herbaceous annuals were found in abundance both at the at the base of the Scarp and around

granites. Whilst these regions received the lowest rainfall, they were habitats that received and held both considerable drainage and heavy, clay soils. Likewise, both BIOCLIM estimates and weather stations can not record the subtle variations in temperature on the actual surface of the Darling Scarp, where it is of most relevance to the plant communities. Temperatures on exposed granites outcrops will greatly exceed those experienced in adjacent valleys or shaded woodlands. What can be concluded is that a complex set of interrelated environmental variables are determining the distribution and composition of the vegetation communities on the Darling Scarp, among these being topographic position, microclimate, soils and underlying geology.

Figure 4-10: Whisker plot of mean annual rainfall estimates for each of the eleven floristic community types (FCT) found on the Darling Scarp. Non parametric analysis of the differences in the group means. (Key to symbols: L = lower limit, 1 = Mean - 1 Standard Deviation, M = mean, D = Median, 3 = Mean + 1 Standard Deviation, U = upper limit, * = more than one symbol at print position).



4.4 *Similarity between the communities of the Ridge Hill Shelf and the Scarp*

Vegetation on the Ridge Hill Shelf has been shown to be floristically distinct from other vegetation types on the Swan Coastal Plain survey (Gibson *et al.* 1994), this survey was the first opportunity to critically assess the similarity between vegetation of the Ridge Hill Shelf and the Scarp. Keighery and Trudgen (1992) and Keighery and Keighery (1993) suggested that the understorey of the woodland associations on the eastern side of the Swan Coastal Plain were similar structurally and floristically to the understorey of analogous woodlands on the Darling Scarp. Keighery and Keighery (1993) also noted the floristic similarities between woodlands on the Ridge Hill Shelf with those on the Darling Plateau, with between 20-25% of taxa in these Ridge Hill Shelf communities also occurring on the Darling Plateau. Similarly, this study found many species characteristic of Darling Scarp and Plateau also occurred on the Ridge Hill Shelf. These occurrences are expected since the Ridge Hill Shelf is both part of a catena originating upslope on the Plateau and possesses similar lateritic gravels. Despite this sharing of common taxa, the results from the analysis clearly demonstrated that the vegetation of the Ridge Hill Shelf and of the Scarp are sufficiently different to be considered as a distinct vegetation types. Likewise, despite the occurrence of shared taxa, this present study found the vegetation communities of the Darling Plateau to be distinct from the vegetation on the Scarp slopes and foothills. These distinctions may become more pronounced when singletons are considered, since singletons predominantly were found in the Ridge Hill Shelf communities yet were omitted from the analysis. Therefore, this omission of singletons may have enhanced the similarity of the Ridge Hill Shelf with the Darling Scarp communities. Keighery and Keighery (1993) note that, in addition to large component of the taxa of these Ridge Hill Shelf communities being shared with the Darling Scarp, there also is a large number of taxa shared with Swan Coastal Plain. Further classification analyses which include sites from the Swan Coastal Plain may elaborate on the floristic similarity of the Ridge Hill Shelf to adjacent regions.

Reservation Status of Darling Scarp Communities

5.1 Vegetation communities not in classification

5.1.1 The riverine community in the valley floors and lower Darling Scarp slopes

In the process of surveying the Darling Scarp, it was observed that a suite of community types had been severely impacted upon since settlement of the region. These floristic communities occurred on the rich alluvial soils which have been deposited on both the foothills of the Darling Scarp and in the valley floors which dissect the Darling Scarp. The conversion of these lands to pasture has subsequently removed the understorey associated with these *Eucalyptus rudis* and *Eucalyptus rudis / Melaleuca rhaphiophylla* woodlands. Therefore, whilst extensive stands of *Eucalyptus rudis* woodlands line the river banks in Walyunga National Park, Bickley Valley, Wungong Gorge and Serpentine Valley, these all have been degraded following a long history of grazing. Similar degradation was observed in these *Eucalyptus rudis / Melaleuca rhaphiophylla* woodlands on the lower slopes of the Darling Scarp at Kelmscott (Lloyd Hughes Reserve) and Armadale Settlers Common. In the narrower valleys, *Eucalyptus rudis / Melaleuca rhaphiophylla* woodlands were found to fringe the banks of the Churchman and Piesse Brooks but the riverine understorey was in the process of being invaded by *Watsonia meriana*. Quadrats in these areas were subsequently placed upslope of the weed affected areas and into the vegetation community types 3 and 4.

There were two locations of *Eucalyptus rudis* woodland found in this survey where were there was understorey in a reasonable condition. The first site was at Serpentine National Park, under a small stand of *Eucalyptus rudis / Melaleuca rhaphiophylla* woodland adjacent to the river (Figure 5-1). This small stand had escaped the degradation that was widespread downstream from this site. Although sampled, it was omitted from the classification analyses since it proved to be highly dissimilar to the other sites. Ironically, no other locations could be found to replicate this site but descriptions of remnant vegetation from along banks of the Canning river and Churchmans Brook (Reserve M75; System 6 Report. Department of Environmental Protection 1983) include a suite of understorey taxa that were also found at the base of Serpentine Falls. This includes *Acacia saligna*, *Baumea* spp., *Juncus* spp., *Cyperus vaginalis* and *Lobelia alata*. These sites were also found to be in urgent need of reservation and rehabilitation (Department of Environmental Protection 1983). Further survey work by Keighery and Trudgen (1992) found that all of the *Eucalyptus rudis / Melaleuca rhaphiophylla* woodlands that they encountered on the eastern side of the Swan Coastal were in a degraded condition.

The second site was at Gooseberry Hill Regional Open Space, where an extensive cover of *Themeda triandrus* grassland was found under an open woodland of *Eucalyptus rudis* (Figure 5-2). This was located on the poorly drained, clays on the border of the Darling Scarp and the Ridge Hill Shelf. Other small occurrences of this community have only been observed at the base of the Scarp at Lesmurdie and Mundijong (G. Keighery, per comm). Additionally, degraded roadside remnants of *Themeda triandrus* grasslands under *Eucalyptus wandoo* woodland have been documented between Gingin and Dardanup (Gibson *et al.* 1994). This confirms that this is a restricted community type confined to the heavy soils of the Ridge Hill Shelf / Pinjarra Plain which has been adversely affected by agriculture. Since 92% of this land has been cleared in the Perth Metropolitan Region (Dixon *et al.* 1994), it is concluded that most stands of this community type have been converted to pasture. The community at Gooseberry Hill presently stands on WAPC land and will be incorporated into the proposed 'Helena Valley National Park as part of the Darling Range Regional Park (Ministry for Planning 1995). It is currently unreserved and there is evidence of unrestricted horse riding and livestock encroaching onto the area. Particular attention must directed to conserve this and the other communities on the Ridge Hill Shelf that will eventually be incorporated into this park.

The results of the classification analysis clearly demonstrated that the canopy tree species were not associated with the community type. Therefore there could be a number of different community types associated with the *Eucalyptus rudis* woodlands observed in this survey. This will remain speculative since there is no understorey to confirm this, but it is suggested that vegetation communities have become extinct in the survey area as a consequence of grazing in the valley floors and foothills of the Darling Scarp.

Figure 5-1: Remnant *Eucalyptus rudis* / *Melaleuca rhaphiophylla* woodland adjacent to the Serpentine river, at the base of Serpentine Falls.

Figure 5-2: *Eucalyptus rudis* woodland over *Themeda triandrus* at Gooseberry Hill Regional Open Space. *Tribonanthes longipetala* and *Philydrella pygmaea* are conspicuous components of the herbaceous understorey (foreground) and are indicative of the poorly drained wet clays from this area of Ridge Hill Shelf.

5.1.2 *Perched swamps on western margin of the Darling Plateau*

Melaleuca preissiana woodlands on perched winter wet depressions were observed on the lateritic uplands. Although encountered on three occasions, this community was only sampled once from a site that had been previously established in John Forrest National (Department of Conservation and Land Management 1991) and therefore was not adequately replicated to be resolved as a distinct community type. This lack of sampling was based on the assumption that these perched swamps are community more representative of the Northern Jarrah Forest (Darling Range) than of the Darling Scarp (Havel 1975b). In hindsight, these perched swamps on the western edge of the plateau are fragile communities that require further attention. These perched swamps are particularly susceptible to mechanical disturbance, weeds and fire. The adverse impact of 4WD tracks, hot fires and trampling by horses was apparent in two of the three perched swamps observed during the course of this survey.

5.1.3 *Wandoo woodland community requiring further sampling*

A site was located in upper slope wandoo woodland on the upper Darling Scarp slopes at Jarrahdale which was found to be highly dissimilar to the other sites in the analysis. It was observed to be an extensive stand but was located once only at the southern end of the survey area and it is not known if it represents an actual community type. Not enough is known of the floristic communities in the southern Darling Scarp to ascertain if this unusual Wandoo woodland at Jarrahdale is repeated south of this present survey area.

5.2 Reservation status of the eleven floristic community types

When considering the representation of the remaining community types within the reservation system along the Darling Scarp, it must be noted that reservations within the Perth Metropolitan Region were generally greater in area and of more secure reservation status than lands outside of this region. This can be attributed to the historical establishment of regional reservations as part of the planning the Perth Metropolitan Region (Department of Urban Planning 1993). It can also be attributed to the fact that the steep, rocky slopes of the Darling Scarp are most pronounced within the Perth Metropolitan Region, which has precluded them from the agricultural development which has cleared much of the adjacent eastern side of Swan Coastal Plain (Keighery and Trudgen 1992). Therefore, the most intact geomorphological features of the Darling Scarp are the granite shrublands and the woodlands on the steep slopes. These areas are reserved in the central cluster of National Parks in the Perth Metropolitan Region, these being John Forrest National Park, Greenmount Hill National Park, Gooseberry Hill National Park, Kalamunda National Park, and Lesmurdie Falls National Park. There is some concern that these reserves are both small (Table 5-1) and frequently disturbed, therefore requiring intensive management to be viable (Havel 1989).

Table 5-1: National Parks and Nature Reserves Vested in the NPNCA within the Darling Scarp Study Area

Name	Area (ha)
Gooseberry Hill NP *	33
Greenmount Hill NP	58
John Forrest NP	2676
Kalamunda NP *	375
Serpentine NP	4360
North Dandalup Nature Reserve # 40 476	31

* Regions proposed by the Ministry for Planning to be incorporated into the 'Helena Valley' National Park and vested in the NPNCA (Ministry for Planning 1995)

The trend for a reduced slope of the escarpment north and south of Perth has lead to substantial clearing for grazing and little of the understorey remains in these regions. Coincidentally, there is also a marked decline in the number of secure reserves in these regions. A substantial proportion of the Darling Scarp has been cleared in the northern Perth Metropolitan Region, in areas between John Forrest National Park and Walyunga National Park, and north of Walyunga National Park. The Darling Scarp in the southern Perth Metropolitan Region has also fared poorly, with most of the lower scarp slopes having been cleared for agriculture and urban development south of Kelmscott. Substantial clearing has occurred at all levels on the Darling Scarp south of Byford, with the exception of the Serpentine National Park. Therefore, whilst it has been estimated that 55% of the Darling Scarp within the Perth Metropolitan Region has been cleared since settlement (Dixon *et al.* 1994), this figure probably underestimates the extent of clearing beyond these limits. In the survey area outside of the Perth Metropolitan Region, the clearing of the Darling Scarp has been so substantial that <2% of the foothills remain (Keighery and Trudgen 1992) and a similar figure is expected for the lower-mid slopes. State forest accounts for most of the conservation estate which reserves the remnant vegetation of the Darling Scarp outside of the Perth Metropolitan Region. It has been estimated that only 3.8% of the Darling Scarp in Darling Region has been reserved in CALM estate (Department of Conservation and Land Management 1994), and the only secure reserve of Ridge Hill Shelf in the survey area is a small section at the base of Serpentine National Park.

Five general categories of land tenure covered the regions in which both the sites established in this survey and the additional sites were located (Table 5-2). Only the first category was considered to be secure, the this being National Parks and Nature Reserves which are CALM estate vested in the NPNCA. These lands are protected by legislation and have been reserved for the primary purpose of conservation (*Conservation and Land Management Act* 1984). It must be noted that the timing of this survey has coincided with the release of the final proposal for the Darling Range Regional Park (Department of Urban Planning 1993, Ministry for Planning 1995). A considerable proportion of the surveyed lands are either vested in local government or owned by the Western Australian Planning Commission (WAPC) and are awaiting revesting in Department of Conservation and Land Management or a local authority for eventual incorporation into the proposed Darling Range Regional Park. This will be a significant conservation estate encompassing most of the Darling Scarp remaining on public lands. Whilst number of these areas are not within CALM estate, they have been zoned for Parks and Recreation under the Metropolitan Region Scheme to meet the additional demands for public access and development. Although the proposed management of these lands will be coordinated between the relevant land holders and government agencies, these will not be afforded the same degree of statutory protection afforded to National Parks and Nature Reserves.

Table 5-2: Current land tenure and reservation status of floristic community types occurring on the Northern Darling Scarp. Numbers refer to the frequency of occurrence of a community the within a land tenure class. Tenure classes have been listed in descending order of security for conservation purposes. Only NPNCA-vested lands are considered as secure reserves. NPNCA = National Parks and Nature Reserves; WAWA = Water Corporation; WAPC = Western Australian Planning Commission; DOLA = Department of Land Administration; LG= Local Government; VCL = Vacant Crown Land.

	Floristic community type												
Land tenure class	1a	1b	1c	2	3	4	5	6	7	8	9	10	11
NPNCA	1	2	2	1	4	3	3		2	4	4	1	1
State Forest	2	1				2			1	2	2		1
WAWA					1					1	1		1
WAPC	3	2	2	1	4	2	2		1	2	3		
DOLA					1	2							
LG	1	1			1	2	1	1			2	1	1
VCL								1	1				
Private Land									2				

Gibson *et al.* (1994) considered a community well reserved if it occurred in two widely separated National Parks and / or Nature Reserves, poorly reserved if it was known from only one National Park or Nature Reserve, and unreserved if it occurred outside of NPNCA vested estate. This assessment was only based on community occurrence in a reserve not on the extent of the community in the reserve. This assignment of reservation status has not been use because it can overestimate the reservation status of a community type. This potential for misinterpretation arises from the fact that although several National Parks occur in the survey area, these generally tend to be clustered in the northern half of the Darling Scarp and are either small in area or greatly fragmented by development and roadways. An additional problem is that the survey methodology identified community types by their point occurrence along the Darling Scarp. Whilst this indicates their distribution, it yields little information on the area covered by a particular community type. To do this would require intensive sampling which was beyond the scope of this project. For the purposes of this report, the representation of a particular community type within the reservation system is described based solely on the number of reserves in which it was encountered.

5.2.1 Unreserved community types

Of the 13 community types and subtypes which were resolved by the floristic analysis, community type 6 was found to be totally unreserved within the study area (Table 5-2). These were the Talbot Road woodlands which were represented at only one location on the Ridge Hill Shelf, on a small block of land that is a remnant of what had been more extensive community. Variable tenure of this land has resulted in two sites being located on land vested in the Shire of Swan (Reserve #23 953), and the other two sites occurring on adjacent vacant crown land (Swan Locations 11764 and 11314). Neither of these tenures constitute a secure reservation and restriction of these sites to a single unit of land leaves them vulnerable to disturbance. It must be stated that This area has not been included in the Darling Range Regional Park but there is an urgent need to protect this community in a secure reserve. It is proposed that that these lots are amalgamated into a single A class reserve and afforded legislative protection with vesting in the NPNCA. It is recognised that both the Shire of Swan and local community groups, namely the Friends of Talbot Road Reserve and Woodbridge-Blackadder Creek Catchment Group, are actively involved in the management of Reserve #23 953, and the region is currently the subject of an Interim Recovery Plan by the Western Australian Threatened Species and Communities Unit of CALM (V. English, per comm) However, vesting in the NPNCA will ensure the long-term protection of the Talbot Road woodlands beyond changes in local government. The past recognition of this community as poorly reserved and vulnerable by Gibson *et al.* (1994) is supported by the findings of this survey.

5.2.2 Community types occurring predominantly on unreserved lands

Two of the characteristic Darling Scarp community types were reserved within only one secure reserve, these being upper slope wandoo woodlands and the southern granite heaths (community types 1a and 2) (Table 5-2). Only one example of community type 1a was located in a National Park, this being in Walyunga National Park at the extreme north of the survey area. Otherwise, two sites were reserved in State Forest, and three locations on WAPC land which have been proposed for the Darling Range Regional Park. At present, one of these sites is located at Helena Valley adjacent to the Bushmead Rifle Range, on an ex-MRD gravel reserve recently vested (1st July 1997) in the WAPC. This is the only example of this community type on the Ridge Hill Shelf (as mapped by Gozzard, 1986) and therefore the conservation value of this reserve is considerably high. Its value has been recognised with its inclusion into the Darling Range Regional Park (Ministry for Planning 1995). The only examples of these upper slope woodlands south of Kelmscott were small stands fringing the margins of State Forest and farmland. Therefore, the lack of reservation of this community type south of the Perth Metropolitan Region may be a combination of extensive clearing and its possible natural replacement by *E. wandoo - E. laeliae* woodlands and their associated communities (community type 4) on the more southern upper slopes of the scarp face.

The southern granite heathlands (community type 2) are restricted to two locations on the Darling Scarp, and only one of these regions presently has secure reservation status. Between Byford and Serpentine there is an expanse of 15 km of predominantly cleared scarp face and it is speculated that this community type may have had a wider distribution within this expanse of escarpment but this has been subsequently lost. Whilst only Serpentine National Park has secure reservation status, the Byford Regional Open Space has been proposed to be included in the Darling Range Regional Park and has been purchased by the Ministry for Planning for this purpose (N. Robinson, per comm).

Whilst there was one upland location of woodlands on poorly drained deposits (community type 7) in John Forrest National Park, this community type was predominantly restricted to the Ridge Hill Shelf. Within this geomorphic unit, only one stand was located within secure reservation at Serpentine National Park, in a location truncated by farmland from a previously more extensive distribution. Otherwise, this community type remained as fragmented stands on unreserved land. The most northern stand of this community type was found in the Gooseberry Hill Regional Open Space. This small but significant remnant of Ridge Hill Shelf is currently owned by the WAPC and is marked for inclusion in the proposed 'Helena Valley' National Park as part of the Darling Range Regional Park. Outside of the Perth Metropolitan Region, the only remnant was located on the edge of state forest at North Dandalup and it was obvious that this was part of a more extensive distribution at the base of the Darling Scarp that had been mostly converted to pasture. Dieback appears to have already affected this community, with a number of the jarrah trees (*Eucalyptus marginata* subsp. *elegantella*) displaying symptoms of infection. The origin of this outbreak is attributed to the gravel excavation pits located upslope of this stand.

5.2.3 Communities predominantly reserved in northern National Parks

Floristic community types 1b, 3 and 4 were found to be well represented in the northern cluster of National Parks in the Perth Metropolitan Region, however they were either infrequently reserved or completely unreserved in the southern range of their distributions. Compounding this lack of reservation south of Armadale was the loss of the community from the extensive clearing on the Darling Scarp. This was the case for wandoo woodland on the poorly drained, heavy soils of the scarp and valley slopes (community type 1b). This community was not located between Armadale and North Dandalup, coinciding with regions where most of the lower Darling Scarp slopes and Ridge Hill Shelf had been cleared. A small stand was located at North Dandalup on the lower slopes of State Forest. Most of the surrounding region along Hines road and at the base of Whittaker Road appears to have supported similar wandoo woodland which, prior to clearing, would have covered this region of the Darling Scarp from the middle - lower slopes. In the northern end of the Darling Scarp, there is secure reservation of this community type in the two larger National Parks. It is represented as a small area in a local government reserve in a the Ellis Brook Valley and a small reserve in the Gooseberry Hill Regional Open Space. Both locations are planned for incorporation into the Darling Range Regional Park, with the latter site being included in the proposed 'Helena Valley" National Park.

The riparian vegetation on the steep valley slopes of the Darling Scarp and similar vegetation on the scarp face (community type 3) was reserved in four national parks, three of these being in the Perth metropolitan region. The remaining occurrences were on land owned by the WAPC for incorporation into the Darling Range Regional Park. One of these sites is destined to be amalgamated into the Greenmount Hill National Park and the other sites, which characterise the vegetation in the Helena Valley, will be included in the proposed 'Helena Valley' National Park. South of Byford, this community type was restricted to the major valleys along the Serpentine and North Dandalup rivers. It was represented only within one National Park on the southern limit of the Perth Metropolitan Region and in small (61 ha) unvested C-class reserve at North Dandalup (North Dandalup Reserve #21 038). It is estimated that this community type had a more widespread distribution along the North Dandalup River, but recent aerial photographs indicate that the steep banks and granite outcrops associated with this community type have been flooded above the North Dandalup Dam. Therefore, this community was restricted to approximately 1km of riverbank immediately below the dam wall There was no opportunity to determine if this community type occurred on the scarp face south of Byford since most the land appeared to have been cleared.

Community type 4 included the woodlands on the eroded surface of the Darling Scarp and associated valleys in the southern half of the study area, between Kalamunda and North Dandalup. Clearing between Kelmscott and North Dandalup appears to have restricted this previously widespread vegetation community to three national parks and to two WAPC reserves in the Perth metropolitan region. South of the Metropolitan Region, this community type was located as limited stand on the edge of State forest and on two DOLA unvested reserves. Therefore, not only has the range of this community type been severely restricted by clearing, but remnants outside of the Perth region are currently unreserved. The most extensive stands of Community type 4 were located in Serpentine National Park. To a lesser extent, stands lined the valley in the North Dandalup Reserve (#21 038), but this was restricted to the valley upper slopes downstream from the North Dandalup Dam. More of this community type appears to have been lost since the lower half of the valley has been cleared for pasture and the section above the dam flooded. A small stand (<30 ha) was located at Goldmine Hill (Reserve #21 041), but this A class reserve is presently unvested. This small strip of scarp face extending down from State Forest appears to be remnant of a

previously widespread woodland predominating on the upper scarp slopes in this region of the Darling Scarp. This is supported by the occurrence of this community type on private land west of Gobby Road and as remnant vegetation bordering Whittaker and Del Park Roads, and is suggested by the canopy remaining on the cleared land between these roads.

5.2.4 Geographically restricted granite shrublands

The northern granite shrublands and heath (community type 1c) appeared to be restricted to the northern half of the study area. Within this limited distribution, this community was represented in the two larger national parks, a third, smaller national park and a WAPC reserve. The proposed 'Helena Valley' National Park (Ministry for Planning 1995) would reserve significant stands of this community type. Whilst not receiving the same level of protection, the incorporation of Crystal Brook and Bickley Valley (M80) into the Darling Range Regional Park would also reserve the southern most stands of this community type.

The granite heaths and shrublands of Community type 5 were geographically restricted to a central portion of the Darling Scarp in the Perth Metropolitan Region. Whilst located in three national parks, all of these stands were of comparatively small area. The most extensive stands of this community type were located on WAPC land at Ellis Brook Valley and the adjacent Crystal Brook Valley (Reserve M80), notably on the exposed quartzite ridges of Ellis Brook Valley which are currently unreserved. The incorporation of these lands to the Darling Range Regional Park would be a significant addition to the conservation estate. However, these regions are under considerable pressure from quarrying and further intensive development for recreational purposes. There is some concern that the adjacent quarrying has already had an adverse impact on the adjacent community, with exotic shrubs from the rehabilitation efforts invading into the adjacent reserve (G. Keighery, per comm). *Phytophthora cinnamomi* is also proving to be a serious threat to these heaths (H. Bowler, per comm), and needs urgent consideration when catering to public demand for recreational access to these reserves.

5.2.5 Community types occurring in widely distributed reserves

The shrubland community restricted to granite outcrops (community type 8) was found across the study area, with representation in four, widely separated reserves vested in the NPNCA. Additionally, four of the five stands located in this survey occur on conservation estate that will eventually be incorporated into the Darling Range Regional Park. The exception to this is the southernmost stand at North Dandalup, which is within State Forest and just outside the periphery of North Dandalup Reserve (#21 038). It must be noted that this community type is restricted to skeletal soils around exposed granite outcrops, which are not extensive geological features along the Darling Scarp. Therefore, whilst this community type is widely distributed, the area occupied by this community type is comparatively small.

The three upland community types 9 and 10 and 11 were located in four national parks along the length of the survey area. These were essentially a sample of the western margin of the Darling Plateau forest and it is likely that at least community type 9 is repeated in the Northern Jarrah Forest and beyond the eastern limit of the survey area. Further sampling is required to ascertain if community types 10 and 11 are actually restricted to the western margin of the Darling Plateau.

5.2.6 Significant reserves not currently vested in NPNCA

Five areas of public land not currently vested as secure reserves are considered to be of significance for conserving floristic communities of the northern Darling Scarp. Gooseberry Hill Regional Open Space and the adjacent Bushmead Reserve are small but significant reserves that contain remnants of Ridge Hill Shelf communities that have been mostly lost to clearing. This region was recently a gravel reserve vested in the MRD, but recently has been purchased by the WAPC for inclusion into the proposed Darling Range Regional Park for the purposes of Parks and Recreation (N. Robinson, per comm). There is the potential for some of this region to be incorporated into the proposed "Helena Valley" National Park with vesting in the NPNCA (Ministry for Planning 1995). However, the boundaries of this proposed National Park have currently not been defined at this early stage of planning (N. Robinson, per comm). Whilst land within Ellis Brook Valley has also been proposed for inclusion in the Darling Range Regional Park, it will not be vested in the NPNCA. The present tenure status the Ellis Brook Valley is either in the City of Gosnells or the WAPC and it appears that future park management will be the responsibility of the local government.

Ellis Brook Valley was found to encompass an entire profile of the Darling Scarp from the plateau to the Ridge Hill Shelf, with distinct floristic communities associated with the prominent quartzite ridges. A number of disjunct populations of typically northern species are found on these ridges. Based on the results from this survey, the conservation value of the Ellis Brook Valley and adjacent lands warrant vesting in the NPNCA as a National Park or Conservation Park within the network of the Darling Range Regional Park.

It was evident from this study that extensive clearing of land south of Armadale had restricted a number of community types to small fragments of the Darling Scarp. The Byford Regional Open Space is currently vested in the WAPC for future inclusion in the Darling Range Regional Park and the adjacent private land is in the process of being purchased for addition to this reserve. This area reserves a remnant of the Darling Scarp in the southern PMR that has escaped clearing, therefore it is recommended that this land is managed primarily for conservation purposes. It is recommended that some protection is granted to this area with vesting in the NPNCA as a National Park or as a Conservation Reserve. Recreational activities can be accommodated for in the adjacent Wungong Valley, where grazing and clearing has greatly reduced its conservation value.

Whilst Byford Regional Open Space and Serpentine National Park have been incorporated into the Darling Range Regional Park, notable areas of land south of Serpentine have yet to be vested in a managing authority. This area surrounding the North Dandalup Dam consists of a C-class reserve vested in DOLA and adjacent portions of the Myara and Whittaker State Forests. It is proposed that this North Dandalup Reserve # 21 038 and adjacent State Forest be amalgamated into a NPNCA vested National Park to protect the diverse array of community types that were located in this region. (Table 5-3). In addition to the conservation value of this area, the existing recreational facilities presently cater for the high public demand. Whilst the Water Corporation maintains these public facilities, more management of the reserve is required for conservation purposes. There is urgent need rehabilitate the gravel excavations in the north-western region of this area, which are in such a poor condition that they have become a dumping ground for rubbish. Dieback was observed in the Jarrah forest on the upper slopes and this present outbreak of *Phytophthora cinnamomi* needs to be controlled before it spreads downslope into the valleys and onto the scarp face.

It appears that private land west of the Myara State Forest surrounding Gobby road has an extensive stand of *Eucalyptus laeliae* woodlands (community type 4) on the upper slopes of the Darling Scarp. This land could not be sampled in this survey but appears to be in excellent condition. Its significance as a conservation reserve is that it provides a continuous link between the Darling Plateau and Darling Scarp in a region on the Darling Scarp where most of the upper slope woodlands have been cleared or grazed. Therefore, in agreement with the System 6 recommendations for this land (Reserve M89), it is proposed that procedures are initiated to secure this as an A class reserve vested in the NPNCA.

Table 5.3; Reserves unvested in the NPNCA found to be of conservation significance from this survey of the northern Darling Scarp

Reserve	Community types	Present tenure	Rare flora
Byford Regional Open Space *	2	WAPC	
Ellis Brook Valley *	1b,3,4,5,8,9,11	WAPC/LC	1 DRF and 8 Priority taxa
Gooseberry Hill Regional Open Space * and Bushmead Reserve (Lot 0, WAPC)	1b, 7	WAPC	
North Dandalup Reserve #21 038 and adjacent State Forest (Myara and Whittaker)	1a,1b,3,4,5,7,8,9,11	DOLA / CALM	1 DRF and 2 Priority taxa

* Regions proposed by the Ministry for Planning to be incorporated into the Darling Range Regional Park (Ministry for Planning 1995).

5.2.7 Weed invasion in reserves on the northern Darling Scarp

It must be noted that this survey found that a secure reservation status of a community was not necessarily adequate to ensure its conservation. The close proximity of the northern Darling Scarp to urban development produces particular problems for management, where frequent fires, mechanical disturbance and extensive trails all contribute to the cycle of weed invasion. *Watsonia meriana* was observed to be the most invasive weed species that is currently threatening most of the areas surveyed, where an estimated 75% of public lands that were visited during this survey had some degree of infestation. Extensive infestations were observed in the riparian communities of Walyunga National Park, John Forrest National Park Churchmans Brook, Kalamunda National Park, the Helena Valley, and Serpentine National Park. Similar outbreaks were also noted on the valley and scarp slopes in Lesmurdie Falls National Park, Greenmount Hill National Park, John Forrest National Park, Serpentine National Park, Ellis Brook Valley, Byford Regional Open Space, Gooseberry Hill Regional Open Space, and Bickley Valley. *Watsonia meriana* was found to be such an aggressive weed of poorly drained loam and clay soils that it would eventually displace the entire native understorey. In sections of Serpentine National Park, sections of entire valley sides had an understorey dominated by *Watsonia meriana* to the exclusion of the native understorey

Efforts to eradicate *Watsonia meriana* and restore the original floristic community have been initiated by local community groups in Ellis Brook Valley and Churchmans Brook. However, there appears to be insufficient resources and/or inadequate management to address the extensive invasions occurring in the majority of National Parks, water catchments and Regional Open Spaces visited during the course of this survey. Compounding this task of weed eradication is the continual reinvasion from adjacent private properties and the role of frequent fires in promoting weed establishment. However, for the future integrity of a number of Darling Scarp floristic communities, *Watsonia meriana* must be adequately managed.

5.3 Conclusion

This survey has resolving a greater number of floristic communities and produced a considerably more detailed description of the vegetation on the northern Darling Scarp than previously available. Generally, stands of excellent - near pristine condition could be found for most of the community types in these bushland remnants. The exception to this was found in the riverine vegetation communities and *Eucalyptus rudis* woodlands on the Ridge Hill Shelf, where most stands were observed to be in a degraded state and few were of sufficient condition to sample. It is encouraging that the high conservation value of remnant Darling Scarp bushland in the Perth Metropolitan Region has been recognised by planning authorities (Ministry for Planning 1995). Most of these remnants on public land have proposed for incorporation into the Darling Range Regional Park where many reserves will eventually be vested in the NPNCA and managed by the Department of Conservation and Land Management (Department of Urban Planning 1993, Ministry for Planning 1995). Outside of the Perth Metropolitan Region, considerably less of the original Darling Scarp vegetation exists and a network of reserves equivalent to the Darling Range Regional Park is lacking. Therefore, it is recommended that future work on the Darling Scarp be directed to these areas.

Whilst this survey produced a detailed description of vegetation communities, it does not give an estimate of the area covered by a particular vegetation community. Whilst this is desired for the purposes of vegetation mapping and the planning of reserves, it requires considerably more effort and expense. What has been achieved is the identification of at least ten vegetation community types within a region previously described by Heddle *et al.* (1980) as essentially the Forrestfield and Darling Scarp vegetation complexes. This has implications for the planning of reserves to represent the biodiversity of the northern Darling Scarp.

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Appendix 1

Flora list for the Darling Scarp compiled from 150 sites and opportunistic records.

Nomenclature follows Green (1985) and current usage at PERTH (ms indicates a manuscript name, * indicates an introduced species)

Adiantaceae
- Cheilanthes austrotenuifolia
- Cheilanthes sieberi subsp. sieberi

Amaranthaceae
- Ptilotus declinatus
- Ptilotus drummondii var. drummondii
- Ptilotus manglesii
- Ptilotus stirlingii

Anthericaceae
- Agrostocrinum scabrum
- Borya constricta
- Borya scirpoidea
- Borya sphaerocephala
- Caesia micrantha
- Caesia occidentalis
- Chamaescilla corymbosa var. corymbosa
- Chamaescilla corymbosa var. latifolia
- Dichopogon capillipes
- Dichopogon preissii
- Laxmannia grandiflora
- Laxmannia ramosa
- Laxmannia sessiliflora
- Laxmannia squarrosa
- Sowerbaea laxiflora
- Thysanotus aff. tenellus.
- Thysanotus arbuscula
- Thysanotus arenarius
- Thysanotus asper
- Thysanotus dichotomus
- Thysanotus fastigiatus
- Thysanotus manglesianus
- Thysanotus multiflorus
- Thysanotus patersonii
- Thysanotus sparteus
- Thysanotus tenellus
- Thysanotus thyrsoideus
- Thysanotus triandrus
- Tricoryne aff. humilis
- Tricoryne elatior
- Tricoryne humilis

Apiaceae
- Actinotus leucocephalus
- Daucus glochidiatus
- Eryngium pinnatifidum subsp. pinnatifidum ms
- Homalosciadium homalocarpum
- Hydrocotyle alata
- Hydrocotyle callicarpa

Apiaceae (cont.)
- Hydrocotyle diantha
- Hydrocotyle pilifera
- Pentapeltis peltigera
- Platysace compressa
- Platysace juncea
- Trachymene coerulea
- Trachymene pilosa
- Xanthosia atkinsoniana
- Xanthosia candida
- Xanthosia ciliata
- Xanthosia huegelii
- Xanthosia pusilla

Asparagaceae
- * Asparagus asparagoides

Aspleniaceae
- Pleurosorus rutifolius

Asteraceae
- * Arctotheca calendula
- Asteridea athrixioides
- Asteridea pulverulenta
- Brachyscome ciliaris
- Brachyscome iberidifolia
- * Conyza albida
- Craspedia variabilis
- * Crepis foetida
- Hyalosperma cotula
- Hyalosperma demissum
- * Hypochaeris glabra
- Lagenifera huegelii
- Lawrencella rosea
- Millotia myosotidifolia
- Millotia tenuifolia
- Olearia elaeophila
- Olearia paucidentata
- Ozothamnus cordatus
- Pithocarpa corymbulosa
- Pithocarpa pulchella
- Podolepis gracilis
- Podolepis lessonii
- Podotheca angustifolia
- Pterochaeta paniculata
- Quinetia urvillei
- Rhodanthe citrina
- Rhodanthe corymbosa
- Rhodanthe manglesii
- * Senecio diaschides

Asteraceae (cont.)
Senecio leucoglossus
Siloxerus humifusus
Siloxerus multiflorus
* Sonchus oleraceus
Trichocline spathulata
* Tolpis barbata
Waitzia suaveolens
* Ursinia anthemoides

Boraginaceae
* Echium plantagineum
Halgania corymbosa

Caesalpiniaceae
Labichea punctata
Labichea lanceolata subsp. lanceolata

Campanulaceae
* Wahlenbergia capensis
Wahlenbergia preissii

Caryophyllaceae
* Cerastium glomeratum
* Moenchia erecta
* Petrorhagia velutina

Casuarinaceae
Allocasuarina fraseriana
Allocasuarina huegeliana
Allocasuarina humilis
Allocasuarina microstachya

Centrolepidaceae
Aphelia brizula
Aphelia cyperoides
Centrolepis alepyroides
Centrolepis aristata
Centrolepis cephaloformis
Centrolepis drummondiana
Centrolepis humillima
Centrolepis inconspicua

Colchicaceae
Burchardia congesta
Burchardia multiflora
Wurmbea dioica

Convolvulaceae
Convolvulus remotus

Crassulaceae
Crassula colorata
Crassula exserta
Crassula pedicellosa

Cupressaceae
Actinostrobus acuminatus

Cyperaceae
Baumea juncea
Baumea rubiginosa
Baumea vaginalis
Chorizandra enodis
Cyathochaeta avenacea
* Cyperus tenellus
Gahnia aristata
Isolepis cyperoides
Isolepis marginata
Isolepis nodosa
Lepidosperma tetraquetrum
Lepidosperma tuberculatum
Lepidosperma sp. type A
Lepidosperma sp. type B (aff. squamatum)
Lepidosperma sp. type C
Lepidosperma sp. type D
Lepidosperma sp. type E
Lepidosperma sp. type F
Lepidosperma sp. type G
Lepidosperma sp. type H
Lepidosperma sp. type I
Lepidosperma sp. type J
Lepidosperma sp. type K
Lepidosperma sp. type M
Lepidosperma sp. type N
Mesomelaena graciliceps
Mesomelaena pseudostygia
Mesomelaena stygia
Mesomelaena tetragona
Schoenus bifidus
Schoenus brevisetis
Schoenus clandestinus
Schoenus discifer
Schoenus grammatophyllus
Schoenus humilis
Schoenus nanus
Schoenus odontocarpus
Schoenus sculptus
Schoenus subbarbatus
Schoenus subflavus
Schoenus unispiculatus
Tetraria australiensis
Tetraria capillaris
Tetraria octandra

Dasypogonaceae
Lomandra aff. micrantha
Acanthocarpus preissii
Calectasia cyanea
Calectasia grandiflora
Chamaexeros serra
Dasypogon bromeliifolius
Kingia australis
Lomandra brittanii
Lomandra caespitosa
Lomandra hermaphrodita
Lomandra integra
Lomandra micrantha
Lomandra nigricans

Dasypogonaceae
Lomandra odora
Lomandra preissii
Lomandra purpurea
Lomandra sericea
Lomandra sonderi
Lomandra spartea
Lomandra suaveolens

Dennstaedtiaceae
Pteridium esculentum

Dilleniaceae
Hibbertia aff. glomerata
Hibbertia acerosa
Hibbertia amplexicaulis
Hibbertia aurea
Hibbertia commutata
Hibbertia huegelii
Hibbertia hypericoides
Hibbertia lasiopus
Hibbertia mylnei
Hibbertia ovata
Hibbertia rhadinopoda
Hibbertia subvaginata
Hibbertia spicata subsp. spicata

Dioscoreaceae
Dioscorea hastifolia

Droseraceae
Drosera bulbosa
Drosera erythrorhiza
Drosera gigantea
Drosera glanduligera
Drosera heterophylla
Drosera macrantha
Drosera neesii
Drosera paleacea
Drosera pallida
Drosera stolonifera
Drosera rosulata
Drosera menziesii subsp. menziesii
Drosera menziesii subsp. penicillaris
Drosera miniata

Epacridaceae
Leucopogon aff. gracillimus
Andersonia aristata
Andersonia heterophylla
Andersonia lehmanniana
Astroloma ciliatum
Astroloma foliosum
Astroloma glaucescens
Astroloma pallidum
Astroloma stomarrhena
Leucopogon capitellatus
Leucopogon gracillimus
Leucopogon polymorphus
Leucopogon propinquus

Epacridaceae
Leucopogon pulchellus
Leucopogon sprengelioides
Leucopogon verticillatus
Lysinema ciliatum
Styphelia tenuiflora

Euphorbiaceae
Beyeria lechenaultii
* Euphorbia peplus
Phyllanthus calycinus
Poranthera microphylla
Stachystemon vermicularis

Fumariaceae
* Fumaria capreolata

Gentianaceae
* Centaurium erythraea
* Cicendia filiformis

Geraniaceae
Pelargonium littorale subsp. littorale

Goodeniaceae
Dampiera alata
Dampiera linearis
Goodenia aff micrantha
Goodenia caerulea
Goodenia fasciculata
Goodenia micrantha
Lechenaultia biloba
Lechenaultia floribunda
Scaevola calliptera
Scaevola canescens
Scaevola glandulifera
Scaevola pilosa
Scaevola platyphylla
Scaevola repens
Velleia trinervis

Haemodoraceae
Anigozanthos bicolor subsp. bicolor
Anigozanthos humilis
Anigozanthos manglesii
Conostylis aculeata subsp. preissii
Conostylis androstemma
Conostylis aurea
Conostylis caricina
Conostylis juncea
Conostylis setigera subsp. setigera
Conostylis setosa
Haemodorum discolor
Haemodorum laxum
Haemodorum paniculatum
Haemodorum simplex
Haemodorum simulans
Haemodorum spicatum
Tribonanthes brachypetala
Tribonanthes longipetala

Haloragaceae
Gonocarpus cordiger
Gonocarpus nodulosus
Gonocarpus pithyoides
Glischrocaryon aureum var. aureum

Hypoxidaceae
Hypoxis glabella
Hypoxis occidentalis

Iridaceae
* Freesia aff. leichtlinii FPR
* Babiana disticha
* Gladiolus caryophyllaceus
* Gladiolus undulatus
* Hesperantha falcata
* Homeria flaccida
* Ixia maculata
Orthrosanthus laxus var. laxus
Patersonia aff pygmaea
Patersonia babianoides
Patersonia juncea
Patersonia occidentalis
Patersonia pygmaea
Patersonia rudis subsp. rudis
Patersonia umbrosa var. xanthina
* Romulea rosea
* Sparaxis bulbifera
* Watsonia meriana

Juncaceae
* Juncus bufonius
Juncus caespiticius
* Juncus capitatus
Luzula meridionalis

Juncaginaceae
Triglochin centrocarpum

Lamiaceae
Hemiandra pungens
Hemigenia incana
Hemigenia sericea
Microcorys longifolia

Lauraceae
Cassytha flava
Cassytha glabella
Cassytha micrantha
Cassytha pomiformis
Cassytha racemosa

Linaceae
* Linum trigynum

Lobeliaceae
Isotoma hypocrateriformis
Lobelia alata
Lobelia gibbosa
Lobelia heterophylla

Lobeliaceae (cont.)
Lobelia rhombifolia
Lobelia rhytidosperma
Lobelia tenuior
* Monopsis debilis

Loganiaceae
Logania campanulata
Phyllangium paradoxum

Loranthaceae
Nuytsia floribunda

Lycopodiaceae
Phylloglossum drummondii

Mimosaceae
Acacia alata var. alata
Acacia barbinervis
Acacia dentifera
Acacia drewiana
Acacia ericifolia
Acacia extensa
Acacia horridula
Acacia incrassata
Acacia lasiocarpa
Acacia lateriticola
Acacia nervosa
Acacia obovata
Acacia oncinophylla subsp. oncinophylla
Acacia oncinophylla subsp. patulifolia
Acacia pulchella var. glaberrima
Acacia pulchella var. pulchella
Acacia restiacea
Acacia saligna
Acacia sessilis
Acacia stenoptera
Acacia teretifolia
Acacia urophylla
Acacia willdenowiana

Myrtaceae
Astartea aff. fascicularis
Agonis grandiflora
Agonis linearifolia
Baeckea camphorosmae
Beaufortia macrostemon
Beaufortia purpurea
Calothamnus graniticus subsp. leptophyllus
Calothamnus lateralis
Calothamnus quadrifidus
Calothamnus rupestris
Calothamnus sanguineus
Calothamnus torulosus
Calytrix acutifolia
Calytrix aurea
Calytrix glutinosa
Calytrix variabilis
Conothamnus trinervis
Darwinia citriodora

Myrtaceae (cont.)
Darwinia pimelioides
Darwinia thymoides
Eremaea pauciflora
Eucalyptus accedens
Eucalyptus calophylla
Eucalyptus laeliae
Eucalyptus lane-poolei
Eucalyptus marginata subsp. marginata
Eucalyptus marginata subsp. elegantella
Eucalyptus patens
Eucalyptus rudis
Eucalyptus wandoo
Hypocalymma angustifolium
Hypocalymma robustum
Kunzea micrantha
Leptospermum erubescens
Melaleuca aff. scabra
Melaleuca preissiana
Melaleuca radula
Melaleuca rhaphiophylla
Verticordia acerosa var. preissii
Verticordia acerosa var. acerosa

Verticordia densiflora
Verticordia huegelii
Verticordia insignis
Verticordia pennigera
Verticordia plumosa var. plumosa

Olacaceae
Olax benthamiana

Orchidaceae
Caladenia flava
Caladenia footeana ms
Caladenia gemmata
Caladenia longicauda subsp. longicauda ms
Caladenia macrostylis
Caladenia marginata
Caladenia reptans
Caladenia sericea
Cyanicula deformis ms
Cyanicula gemmata ms
Cyanicula sericea ms
Diuris aff. corymbosa
Diuris brumalis
Diuris corymbosa
Diuris laxiflora
Diuris longifolia
Diuris porrifolia
Elythranthera brunonis
Elythranthera emarginata
Eriochilus dilatatus subsp. multiflorus ms
Eriochilus helonomos ms
Eriochilus palladous ms
Leporella fimbriata
Lyperanthus nigricans
Lyperanthus serratus

Orchidaceae (cont.)
Microtis media subsp. media
Microtis media subsp. quadrata
* Monadenia bracteata
Prasophyllum drummondii
Prasophyllum gracile
Prasophyllum parvifolium
Pterostylis aff. nana
Pterostylis barbata
Pterostylis recurva
Pterostylis sanguinea
Pterostylis vittata
Thelymitra aff. macrophyllum
Thelymitra aff. pauciflora
Thelymitra antennifera
Thelymitra benthamiana
Thelymitra campanulata
Thelymitra canaliculata
Thelymitra crinita
Thelymitra flexuosa
Thelymitra macrophylla

Orobanchaceae
* Orobanche minor

Oxalidaceae
* Oxalis glabra
Oxalis perennans

Papilionaceae
Bossiaea eriocarpa
Bossiaea ornata
Bossiaea sp. Waroona
Brachysema celsianum
Chorizema dicksonii
Daviesia angulata
Daviesia cordata
Daviesia decipiens
Daviesia decurrens
Daviesia horrida
Daviesia longifolia
Daviesia nudiflora
Daviesia polyphylla
Daviesia preissii
Daviesia rhombifolia
Dillwynia cinerascens
Dillwynia sp. A
Gastrolobium bilobum
Gastrolobium spinosum
Gastrolobium villosum
Gompholobium knightianum
Gompholobium marginatum
Gompholobium ovatum
Gompholobium polymorphum
Gompholobium preissii
Gompholobium shuttleworthii
Hardenbergia comptoniana
Hovea chorizemifolia
Hovea pungens
Hovea trisperma var. grandiflora

Papilionaceae (cont.)
Hovea trisperma var. trisperma
Isotropis cuneifolia
Jacksonia alata
Jacksonia condensata
Jacksonia restioides
Jacksonia sternbergiana
Kennedia carinata
Kennedia coccinea
Kennedia prostrata
Kennedia stirlingii
* Lotus angustissimus
* Lotus suaveolens
Mirbelia spinosa
Nemcia acuta
Nemcia capitata
Nemcia dilatata
Nemcia plicata
Nemcia reticulata
Nemcia spathulata
* Ornithopus compressus
Pultenaea ericifolia
Sphaerolobium linophyllum
Sphaerolobium medium
Templetonia biloba
Templetonia drummondii
* Trifolium angustifolium
* Trifolium arvense
* Trifolium campestre
* Trifolium cernuum
* Trifolium dubium
* Trifolium ligusticum
* Trifolium repens
* Trifolium scabrum
* Trifolium subterraneum
Viminaria juncea

Philydraceae
Philydrella pygmaea

Phormiaceae
Stypandra glauca
Dianella revoluta var. divaricata

Pittosporaceae
Billardiera bicolor var. bicolor
Billardiera candida
Billardiera coeruleo-punctata
Billardiera drummondiana var. collina
Billardiera parviflora var. guttata
Billardiera variifolia
Pronaya fraseri var. fraseri
Sollya heterophylla

Poaceae
Agrostis avenacea
Agrostis plebeia
* Aira caryophyllea
* Aira cupaniana
Amphipogon amphipogonoides

Poaceae (cont.)
Amphipogon debilis
Amphipogon laguroides
Amphipogon strictus
Amphipogon turbinatus
Austrostipa campylachne
Austrostipa compressa
Austrostipa elegantissima
* Avellinia michelii
* Avena barbata
* Avena fatua
* Brachypodium distachyon
* Briza maxima
* Briza minor
* Bromus diandrus
* Bromus hordeaceus
Dichelachne crinita
* Ehrharta calycina
* Ehrharta longiflora
* Gastridium phleoides
Hemarthria uncinata
* Lolium perenne
* Lolium rigidum
Microlaena stipoides
Neurachne alopecuroidea
Notodanthonia acerosa
Notodanthonia caespitosa
Notodanthonia setacea
Notodanthonia pilosa
* Paspalum dilatatum
* Pentaschistis airoides
Poa drummondiana
Poa homomalla
Tetrarrhena laevis
Themeda triandra
* Vulpia bromoides
* Vulpia myuros

Polygalaceae
Comesperma calymega
Comesperma ciliatum
Comesperma virgatum

Polygonaceae
Muehlenbeckia adpressa
* Polygonum aviculare

Portulacaceae
Calandrinia corrigioloides
Calandrinia granulifera

Primulaceae
* Anagallis arvensis

Proteaceae
Adenanthos barbiger
Banksia grandis
Banksia littoralis
Conospermum huegelii
Conospermum stoechadis

Proteaceae (cont.)
Conospermum undulatum
Dryandra armata
Dryandra bipinnatifida
Dryandra fraseri var. fraseri
Dryandra kippistiana
Dryandra lindleyana var. lindleyana
Dryandra praemorsa var. praemorsa
Dryandra sessilis
Grevillea bipinnatifida
Grevillea diversifolia subsp. diversifolia
Grevillea endlicheriana
Grevillea manglesii subsp. manglesii
Grevillea pilulifera
Grevillea pimeleoides
Grevillea quercifolia
Grevillea synapheae
Grevillea wilsonii
Hakea amplexicaulis
Hakea auriculata
Hakea ceratophylla
Hakea conchifolia
Hakea cristata
Hakea cyclocarpa
Hakea erinacea
Hakea incrassata
Hakea lissocarpha
Hakea myrtoides
Hakea petiolaris
Hakea prostrata
Hakea ruscifolia
Hakea stenocarpa
Hakea trifurcata
Hakea undulata
Isopogon asper
Isopogon divergens
Isopogon dubius
Isopogon sphaerocephalus
Lambertia multiflora var. darlingensis
Persoonia angustiflora
Persoonia elliptica
Petrophile biloba
Petrophile linearis
Petrophile macrostachya
Petrophile seminuda
Petrophile squamata
Petrophile striata
Stirlingia latifolia
Stirlingia simplex
Synaphea acutiloba
Synaphea aff. gracillima
Synaphea aff. petiolaris
Synaphea gracillima
Synaphea gracillima x acutiloba
Synaphea petiolaris
Synaphea pinnata
Synaphea spinulosa subsp. spinulosa

Ranunculaceae
Clematis pubescens

Restionaceae
Alexgeorgea nitens
Anarthria gracilis
Anarthria humilis
Desmocladus aspera ms
Harperia lateriflora
Hypolaena exsulca
Lepidobolus preissianus
Lepyrodia drummondiana
Lepyrodia glauca
Loxocarya cinerea
Loxocarya fasciculata
Lyginia barbata
Restio sinuosus ms

Rhamnaceae
Cryptandra arbutiflora
Cryptandra micrantha ms
Cryptandra nutans
Cryptandra pungens
Cryptandra scoparia var. scoparia
Stenanthemum emarginatum
Trymalium angustifolium
Trymalium floribundum subsp. floribundum
Trymalium ledifolium var. rosmarinifolium

Rosaceae
* Rubus aff. selmeri

Rubiaceae
* Galium aparine
* Galium divaricatum
* Galium murale
Opercularia apiciflora
Opercularia echinocephala
Opercularia hispidula
Opercularia vaginata

Rutaceae
Boronia cymosa
Boronia fastigiata subsp. fastigiata ms
Boronia ovata
Boronia ramosa subsp. ramosa
Boronia tenuis
Eriostemon spicatus

Santalaceae
Leptomeria cunninghamii
Santalum acuminatum

Sapindaceae
Dodonaea ceratocarpa
Diplopeltis huegelii var. lehmanii ms

Scrophulariaceae
* Bartsia trixago
* Kickxia elatine subsp. elatine
* Parentucellia latifolia
* Parentucellia viscosa

Selaginellaceae
Selaginella gracillima

Solanaceae
Anthocercis gracilis
* Solanum linnaeanum
* Solanum nigrum

Stackhousiaceae
Guichenotia sarotes subsp. sarotes ms
Stackhousia monogyna
Tripterococcus brunonis

Sterculiaceae
Lasiopetalum bracteatum
Lasiopetalum pterocarpum ms
Rulingia cygnorum
Thomasia foliosa
Thomasia glutinosa
Thomasia grandiflora
Thomasia macrocarpa

Stylidiaceae
Levenhookia pusilla
Levenhookia stipitata
Stylidium affine
Stylidium amoenum
Stylidium breviscapum
Stylidium brunonianum
Stylidium bulbiferum
Stylidium calcaratum
Stylidium caricifolium
Stylidium carnosum
Stylidium ciliatum
Stylidium dichotomum
Stylidium diuroides
Stylidium ecorne

Stylidiaceae (cont.)
Stylidium emarginatum
Stylidium hispidum
Stylidium junceum
Stylidium lineatum
Stylidium perpusillum
Stylidium petiolare
Stylidium piliferum
Stylidium pubigerum
Stylidium pycnostachyum
Stylidium repens
Stylidium schoenoides

Thymelaeaceae
Pimelea argentea
Pimelea brevistyla subsp. brevistyla
Pimelea ciliata
Pimelea imbricata var. piligera
Pimelea preissii
Pimelea suaveolens subsp. suaveolens

Tremandraceae
Tetratheca hirsuta
Tetratheca nuda
Tetratheca setigera

Violaceae
Hybanthus floribundus

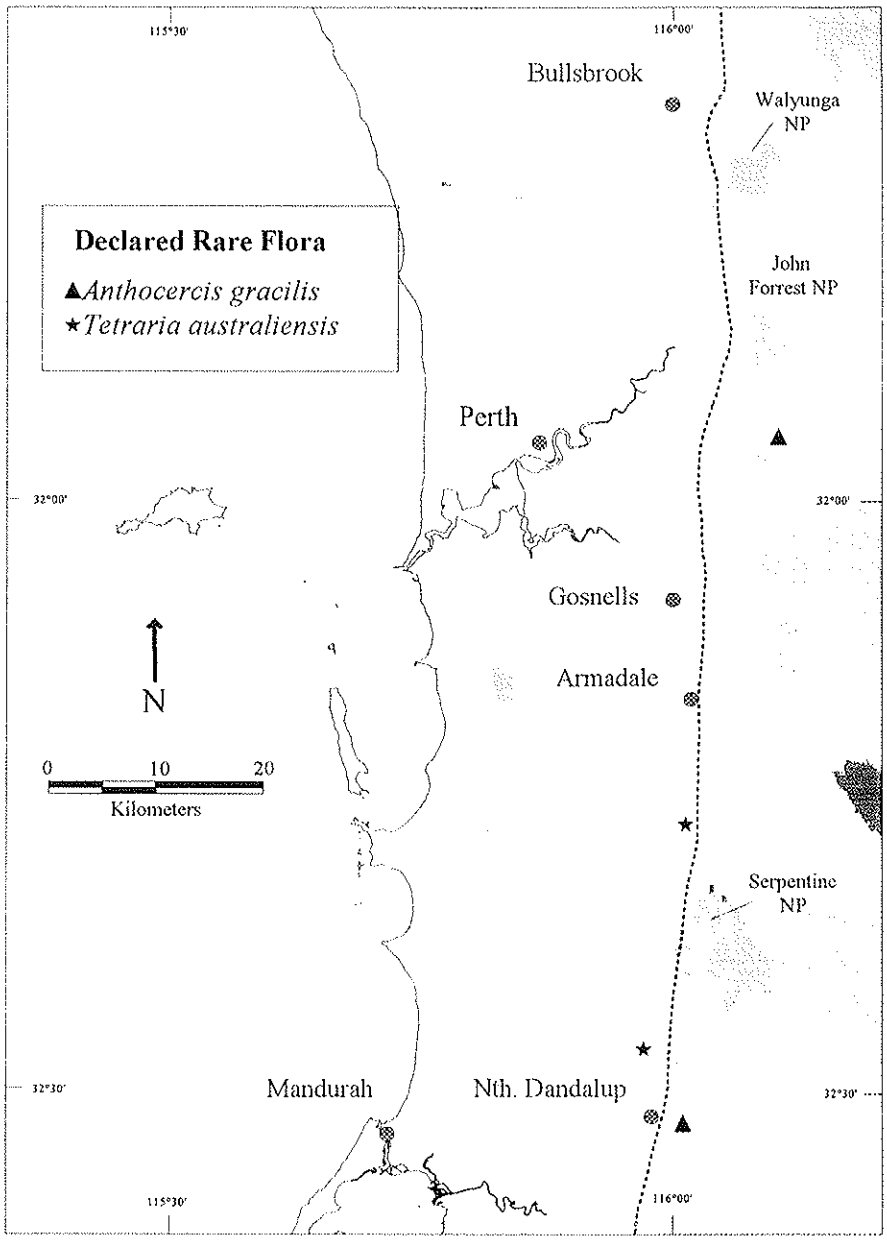
Xanthorrhoeaceae
Xanthorrhoea acanthostachya
Xanthorrhoea gracilis
Xanthorrhoea preissii

Zamiaceae
Macrozamia riedlei

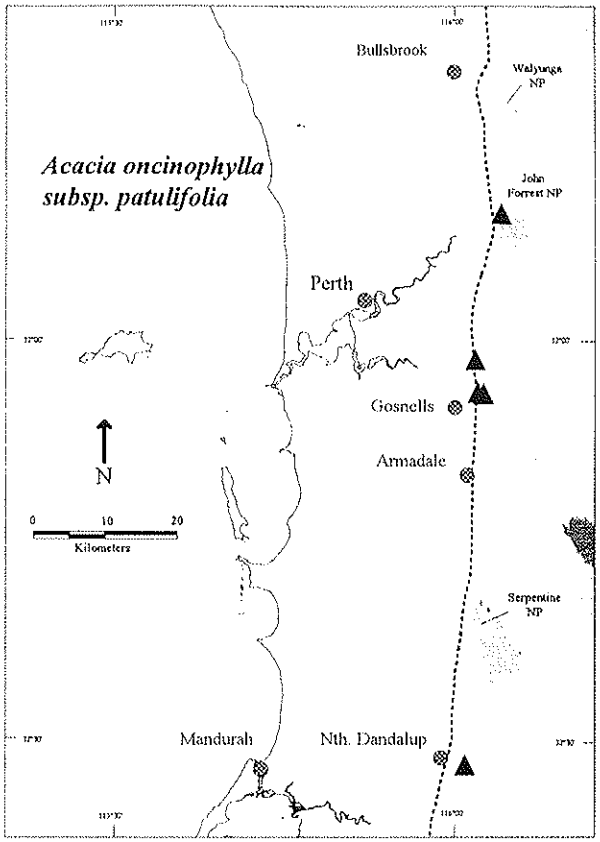
Appendix 2

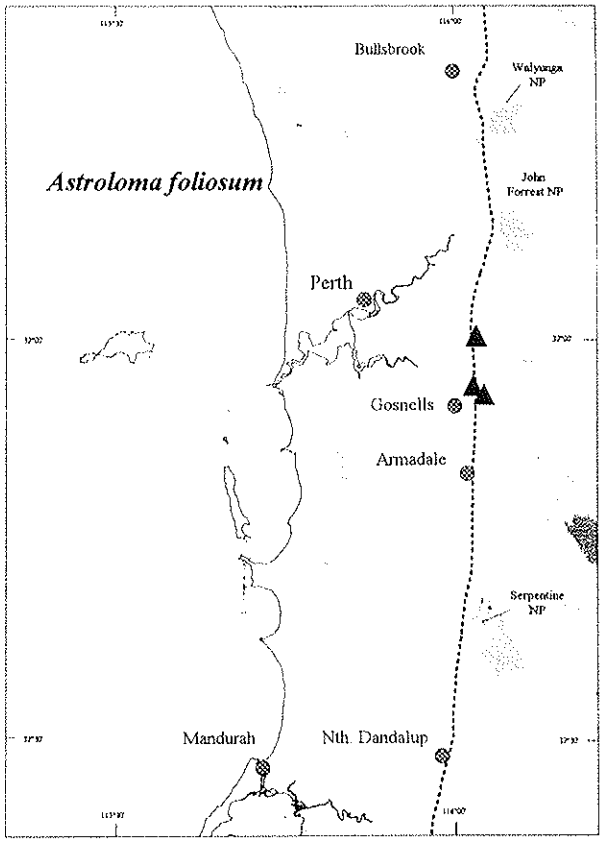
Distribution maps of Declared Rare Flora and Priority Taxa located within the study area on the northern Darling Scarp.

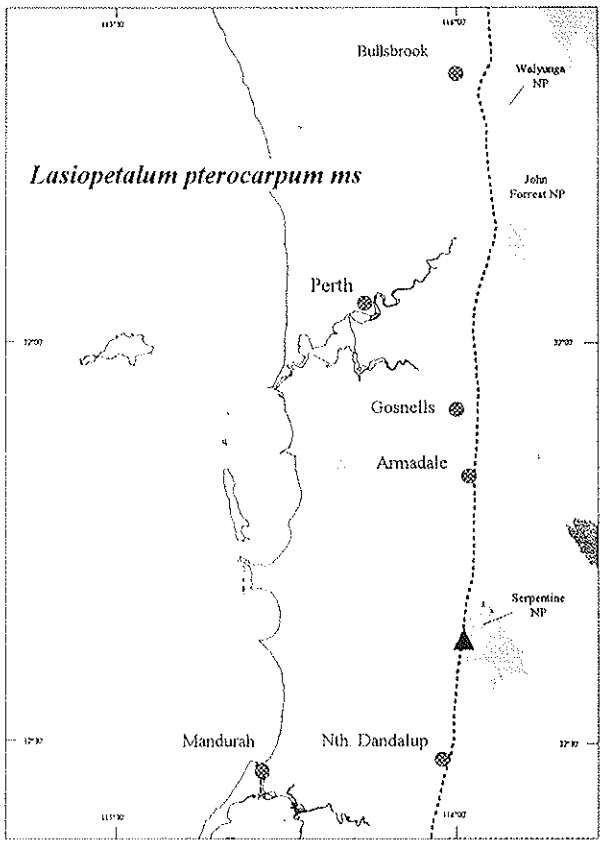
Occurrences of taxa recorded from the total 150 quadrats. Both new and potentially relocated populations are included in the figures.



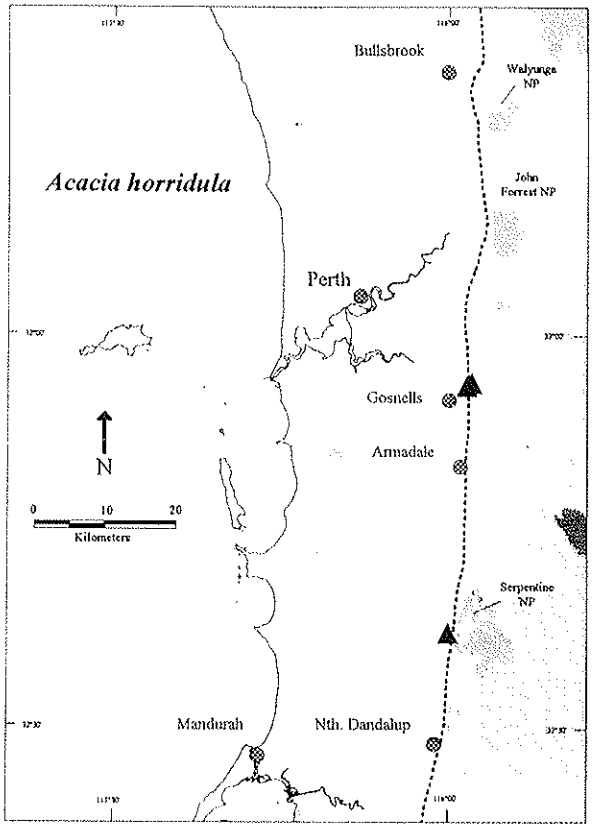
Appendix 2-1: Distribution map for the two taxa of Declared Rare Flora located within the 150 quadrats on the northern Darling Scarp.

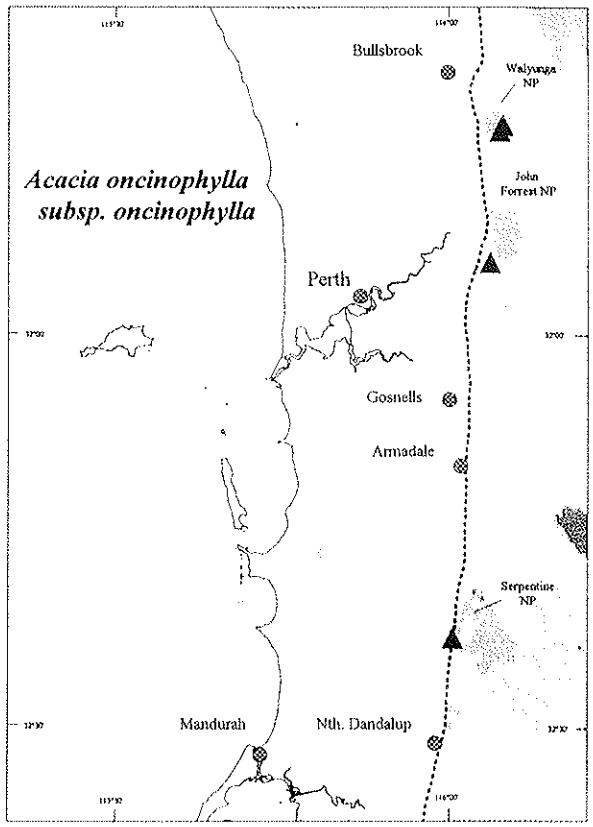


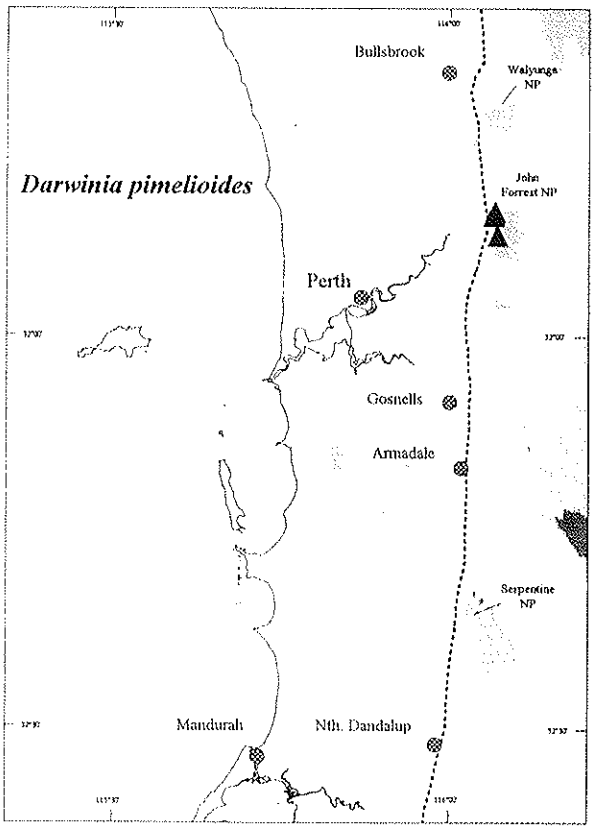


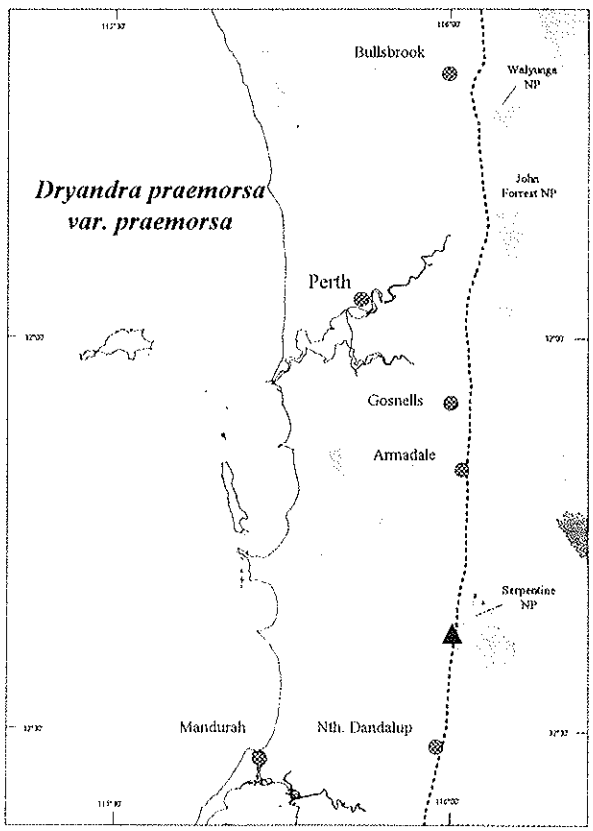


Appendix 2-2: Distribution maps of three of the four Priority Two taxa located within the 150 quadrats on the northern Darling Scarp. *Eucalyptus marginata* subsp. *elegantella* is not included since a definite identification was not made for some of the sites

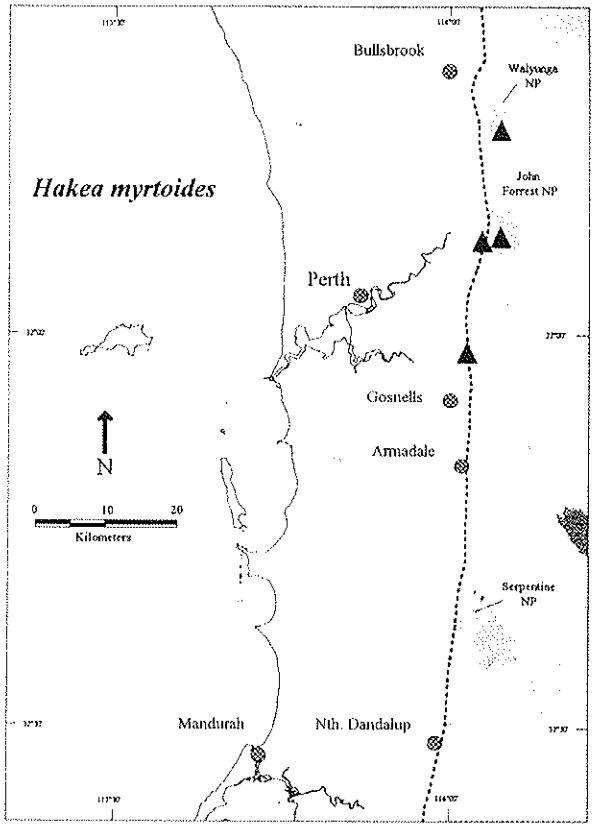


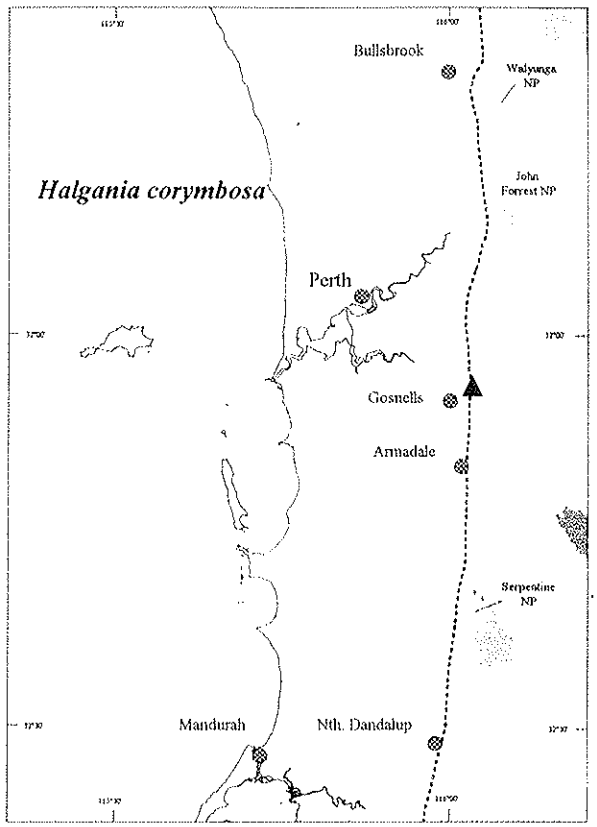


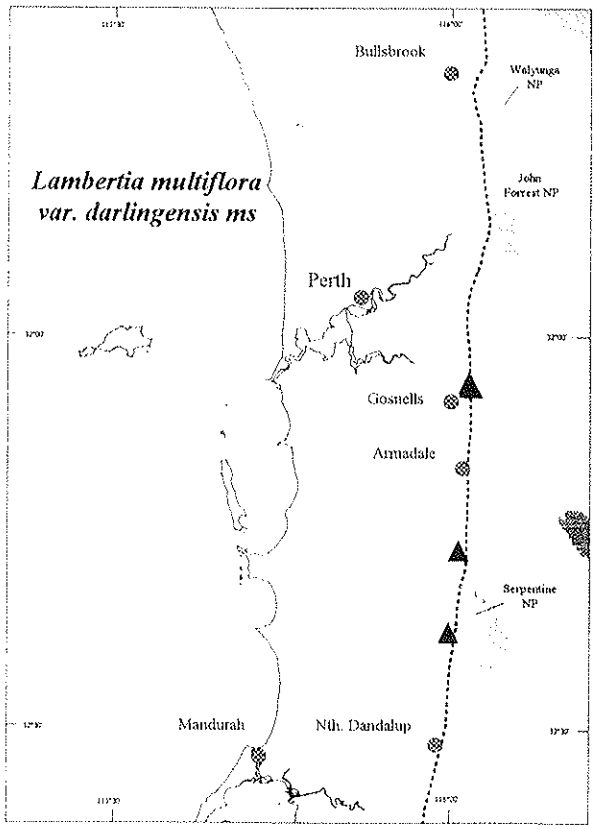


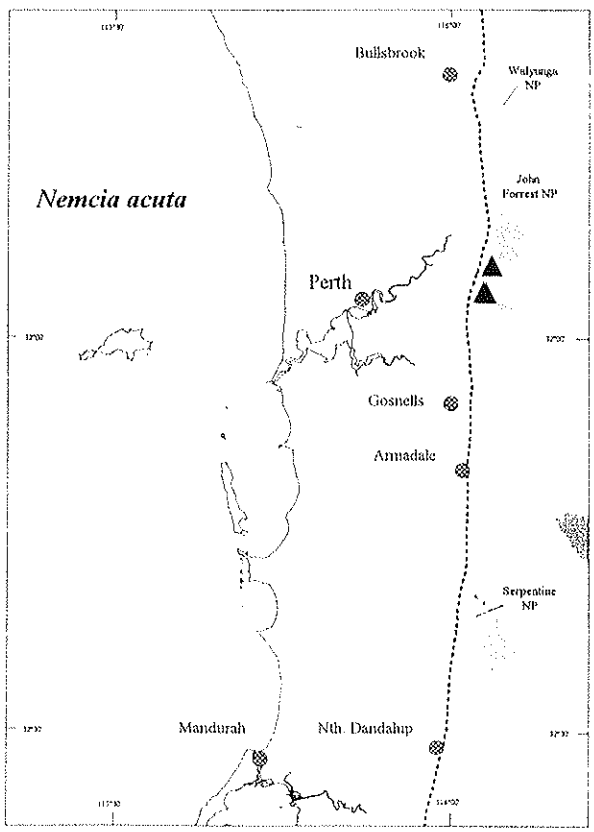


Appendix 2-3: Distribution maps of the eleven Priority Three taxa located within the 150 quadrats on the northern Darling Scarp

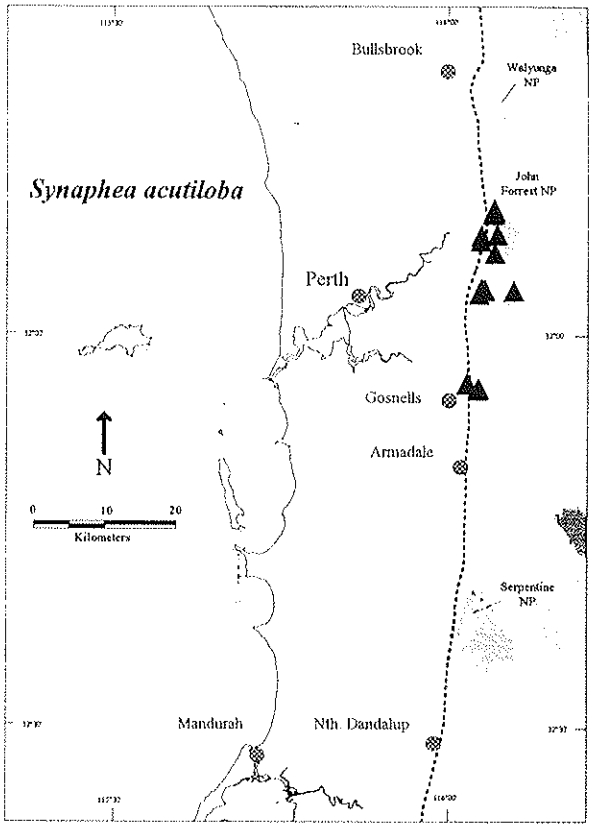


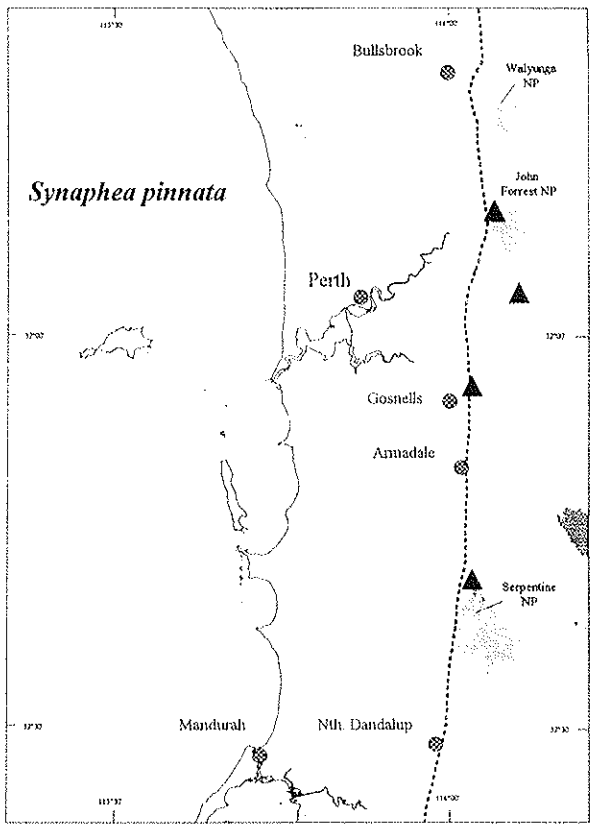


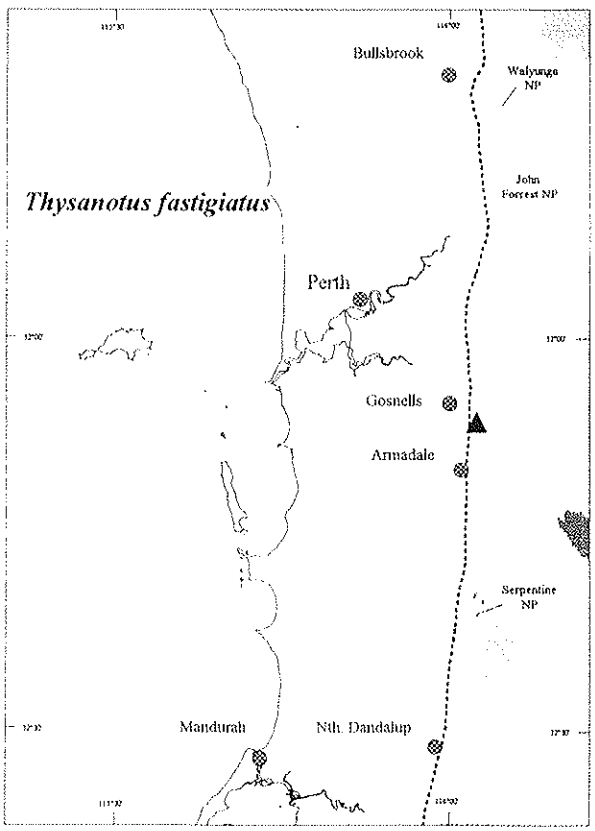




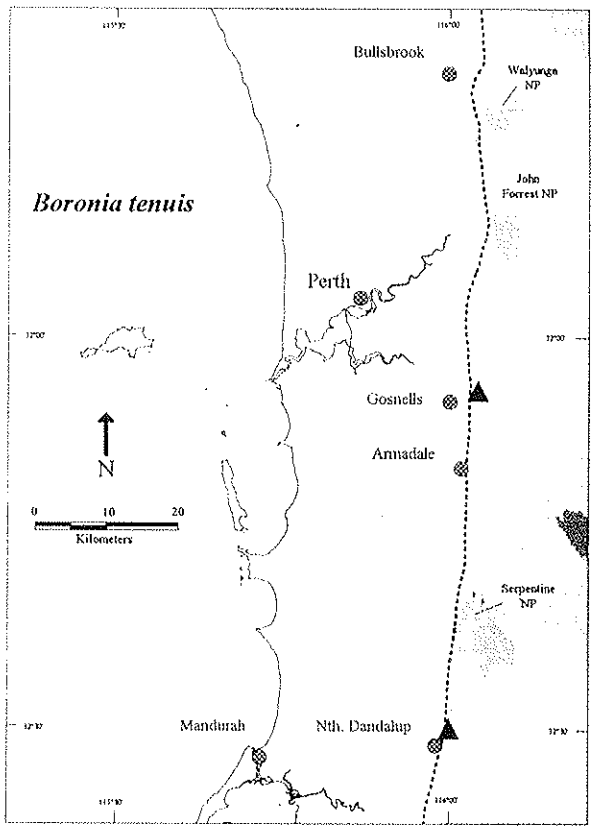
Appendix 2-3:cont.. Distribution maps of the eleven Priority Three taxa located within the 150 quadrats on the northern Darling Scarp.

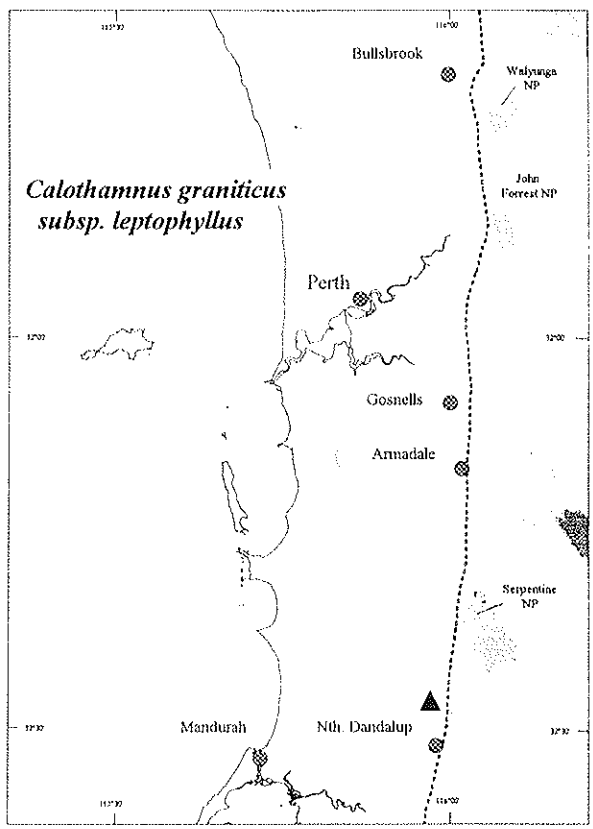


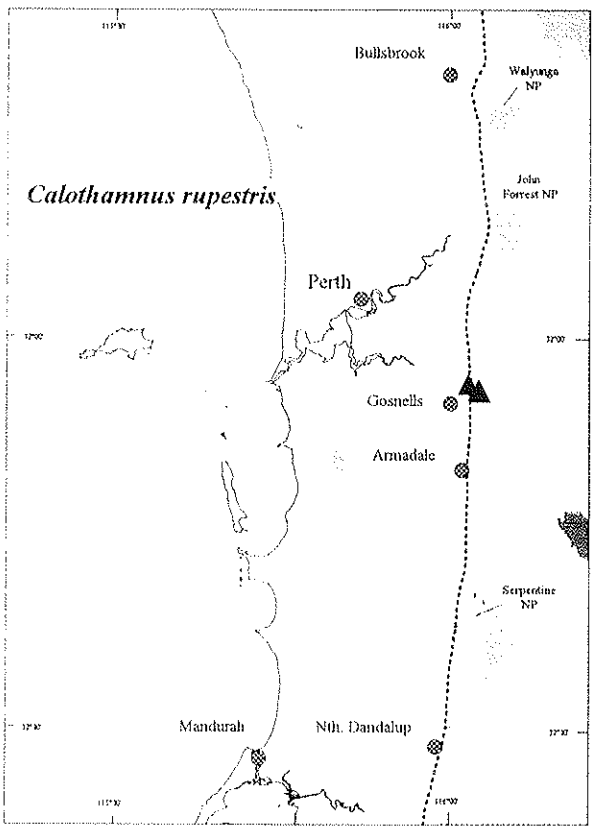


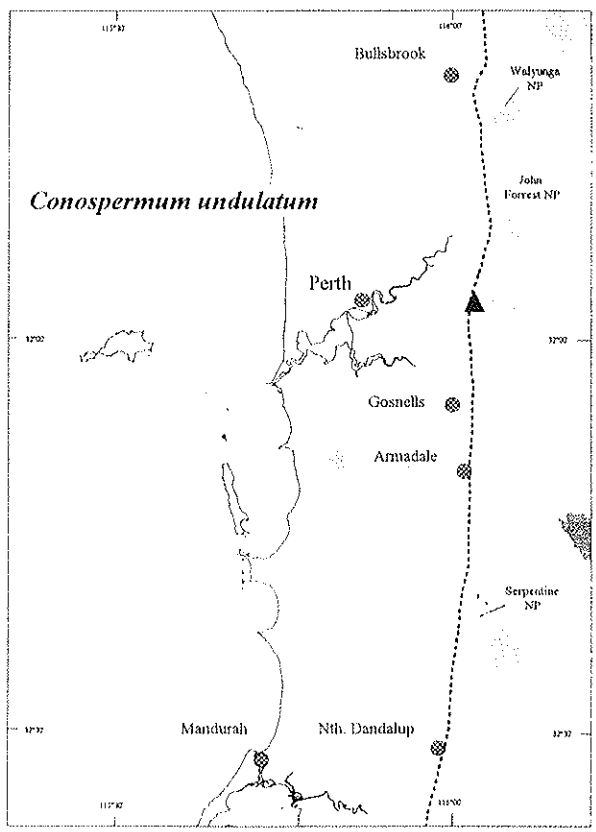


Appendix 2-3:cont.. Distribution maps of the eleven Priority Three taxa located within the 150 quadrats on the northern Darling Scarp.

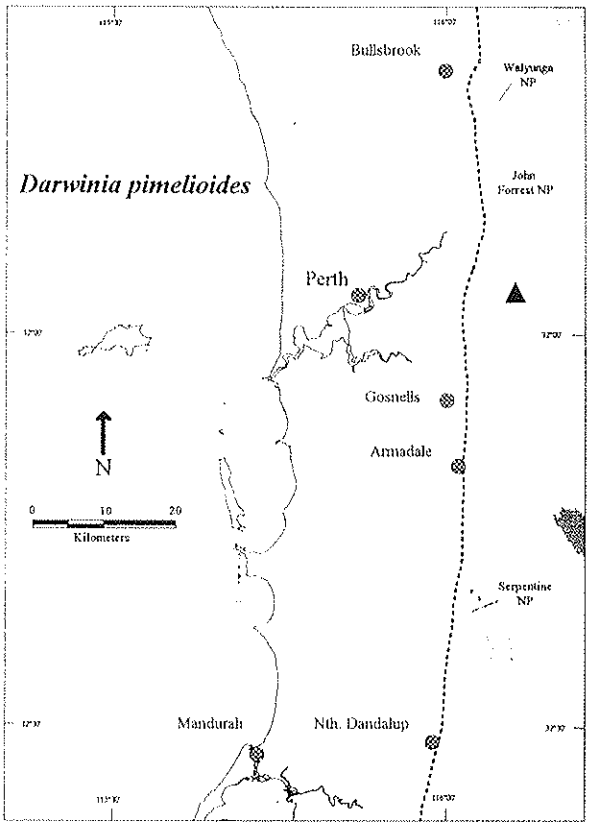


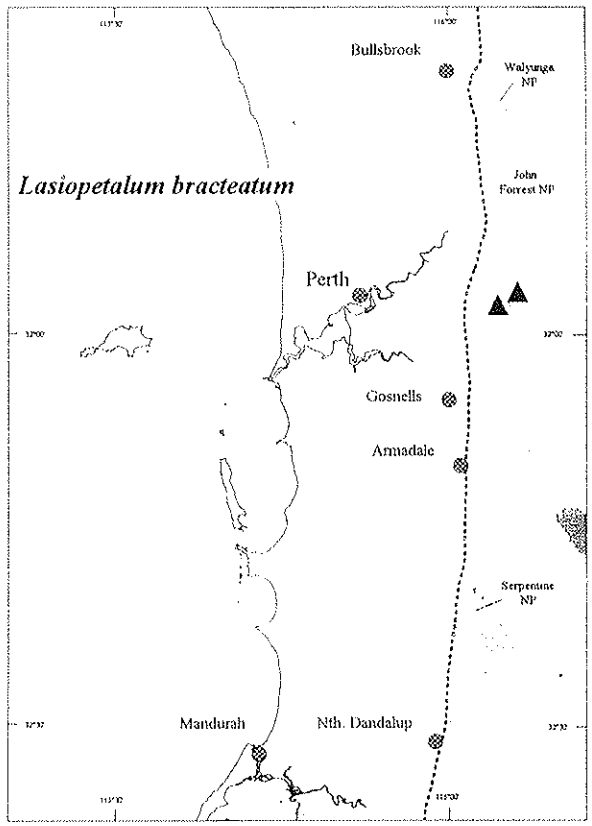


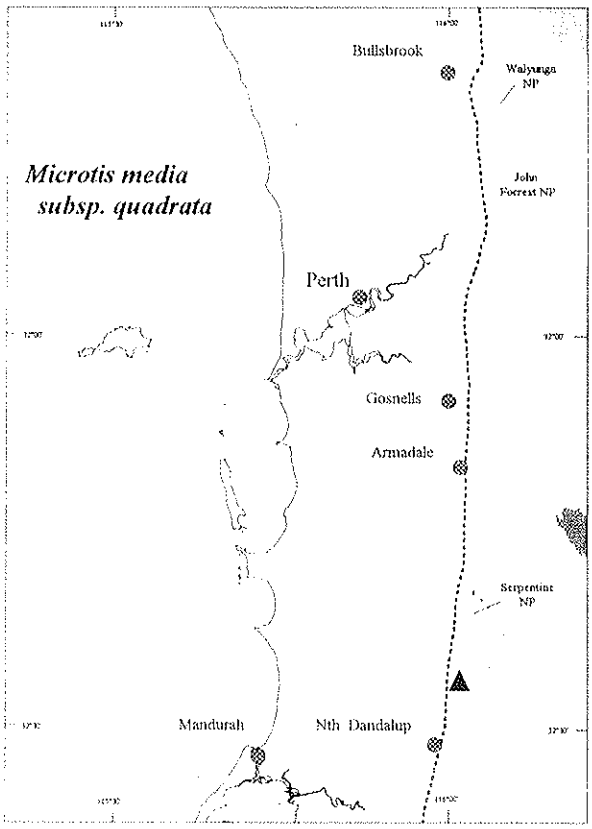


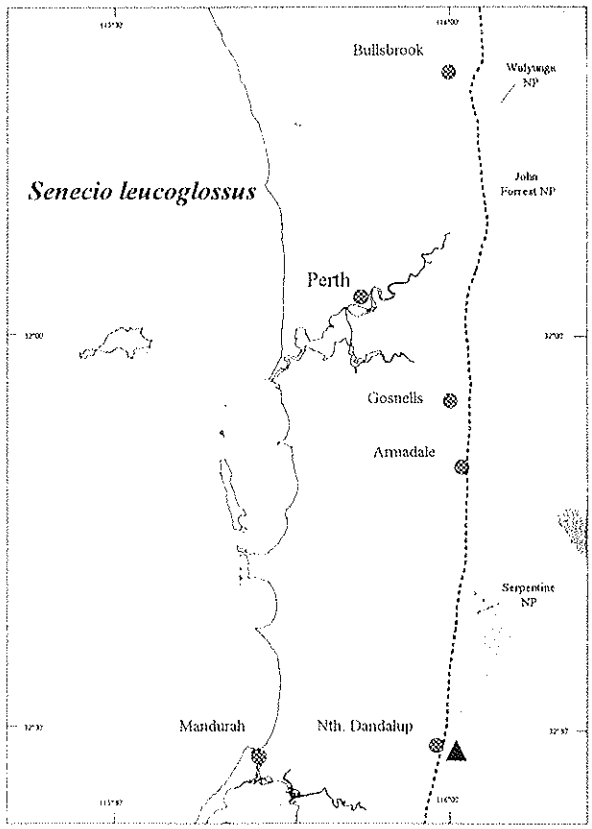


Appendix 2-4: Distribution maps of the nine Priority Four taxa located within the 150 quadrats on the northern Darling Scarp.

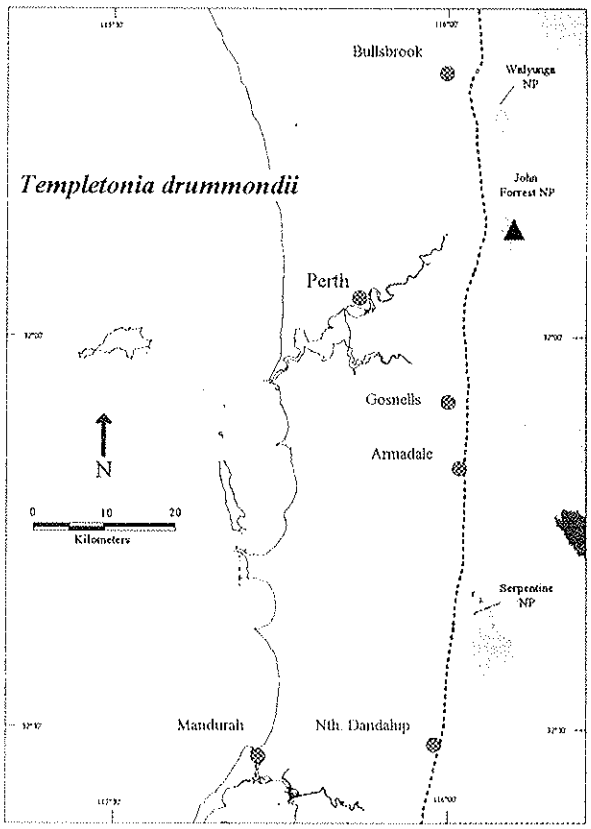








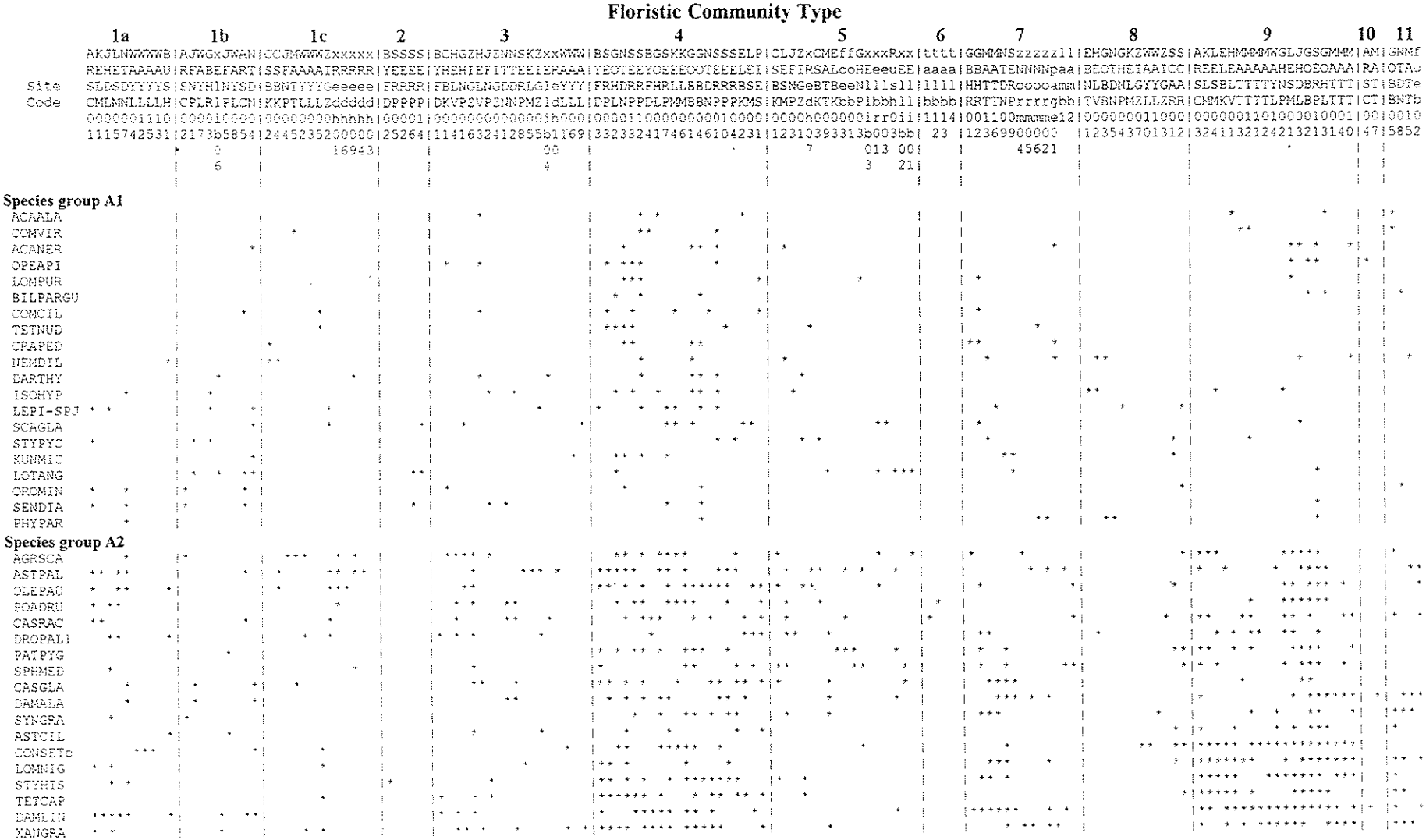
Appendix 2-4:cont.. Distribution maps of the nine Priority Four taxa located within the 150 quadrats on the northern Darling Scarp

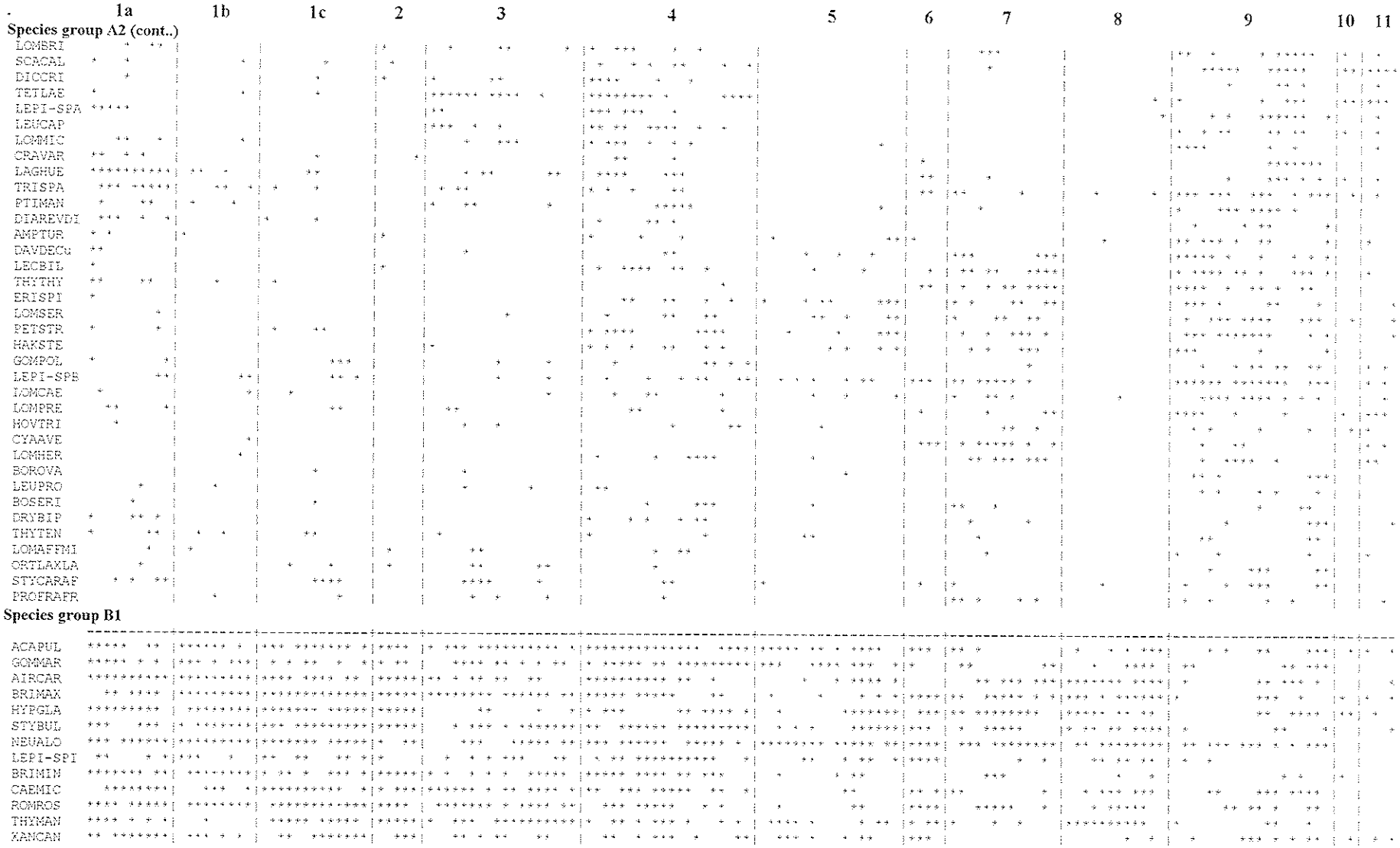


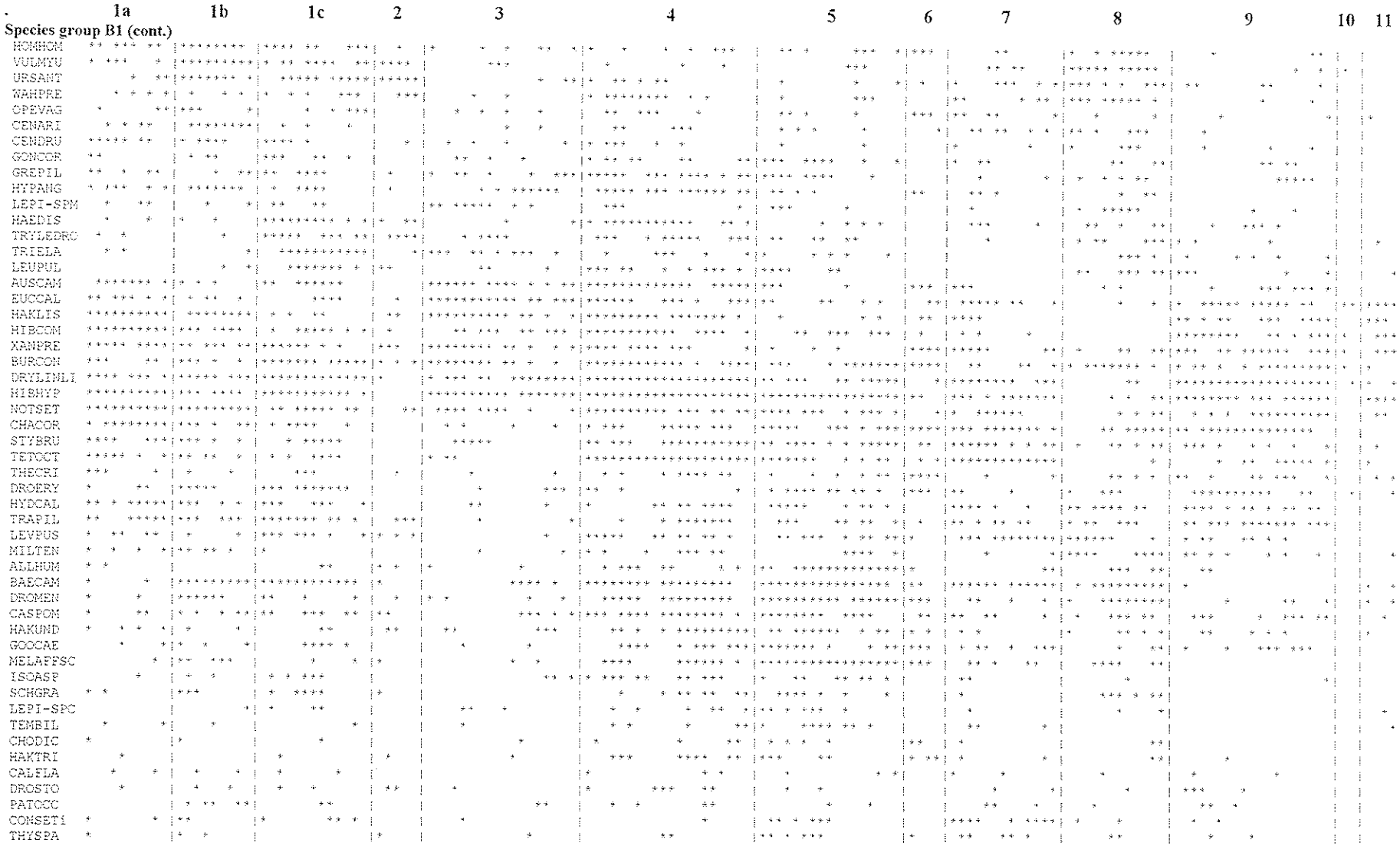
Appendix 2-4: cont.. Distribution maps of the nine Priority Four taxa located within the 150 quadrats on the northern Darling Scarp.

Appendix 3 – Two way table of species classification

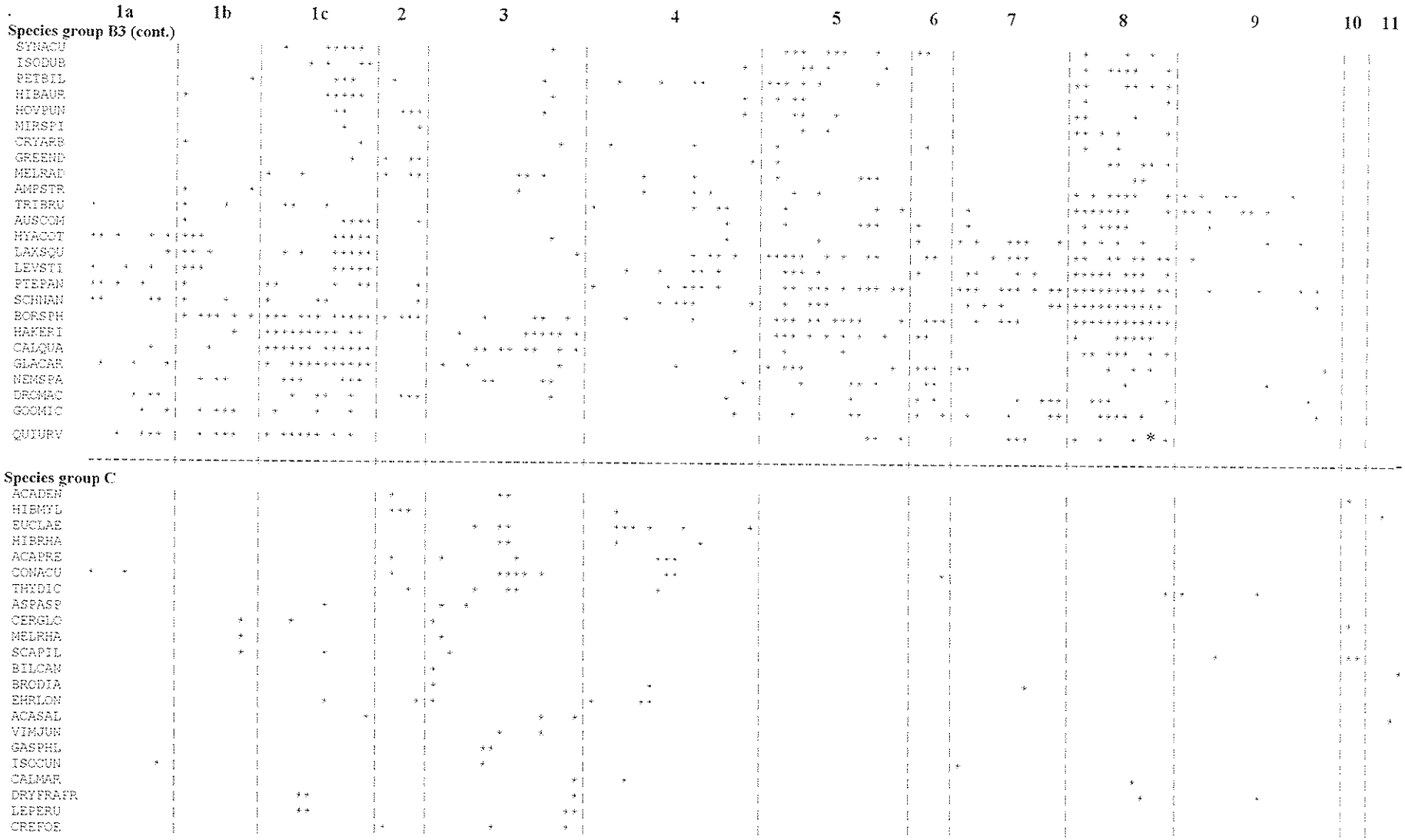
Species classification of 689 taxa from 146 sites on the northern Darling Scarp. Taxa are collated into 28 species groups and subgroups. Sites are clustered into their respective community type or subtype.

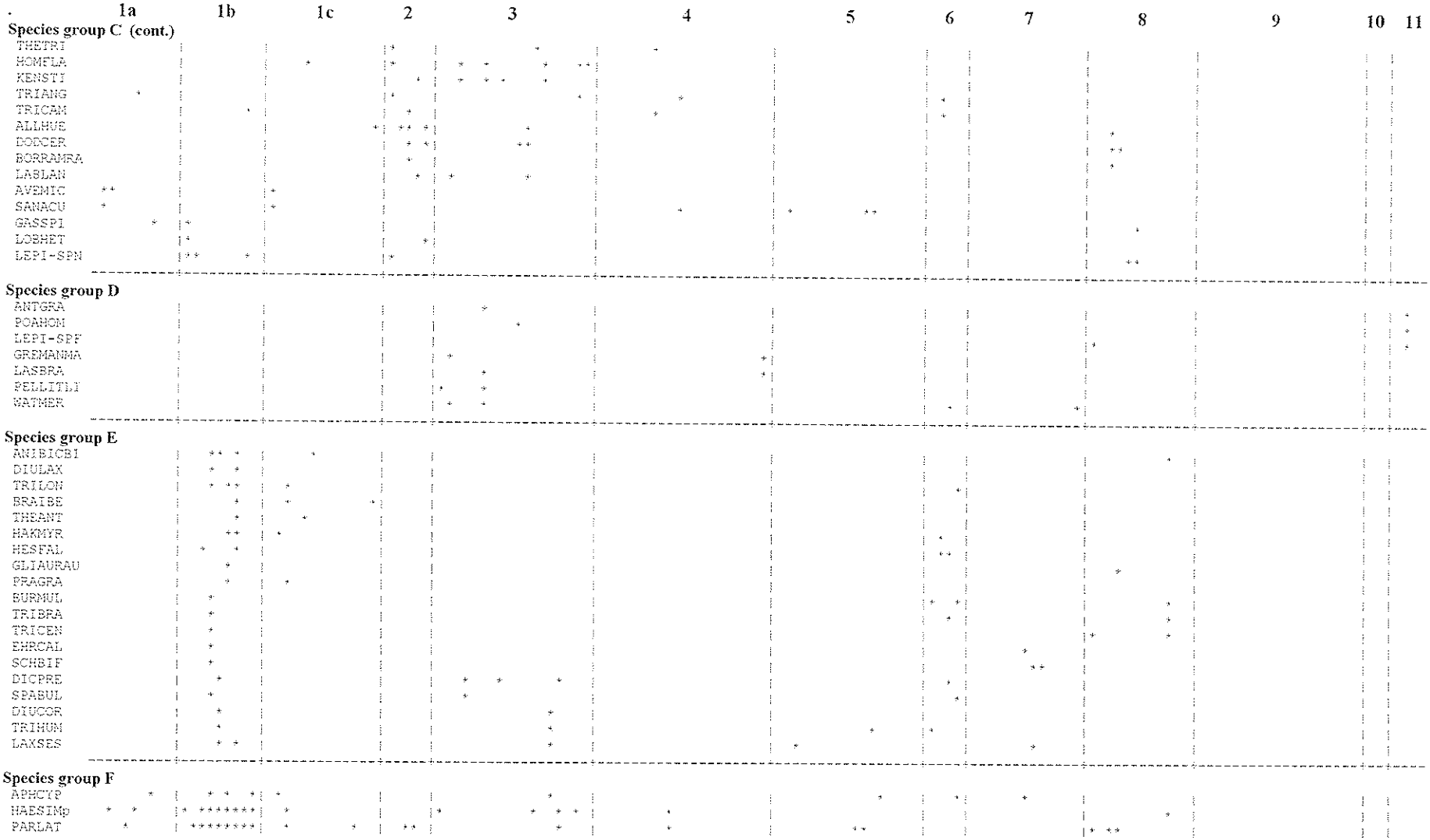

Floristic Community Type
1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Site
Code
Species group A1
ACAALA
COMVIR
ACANER
OPEAPI
LOMPUR
BILPARGU
COMCIL
TETNUD
CRAPED
NEMDIL
DARTHY
ISOHYP
LEPI-SPJ
SCAGLA
STYPYC
KUNMIC
LOTANG
OROMIN
SENDIA
PHYPAR
Species group A2
AGRSCA
ASTPAL
OLEPAU
POADRU
CASPAC
DROPAL1
PATPYG
SPHMED
CASGLA
DAMALA
SYNPA
ASTCIL
CONSETo
LOMNIG
STYHIS
TETCAP
DAMLIN
XANGRA

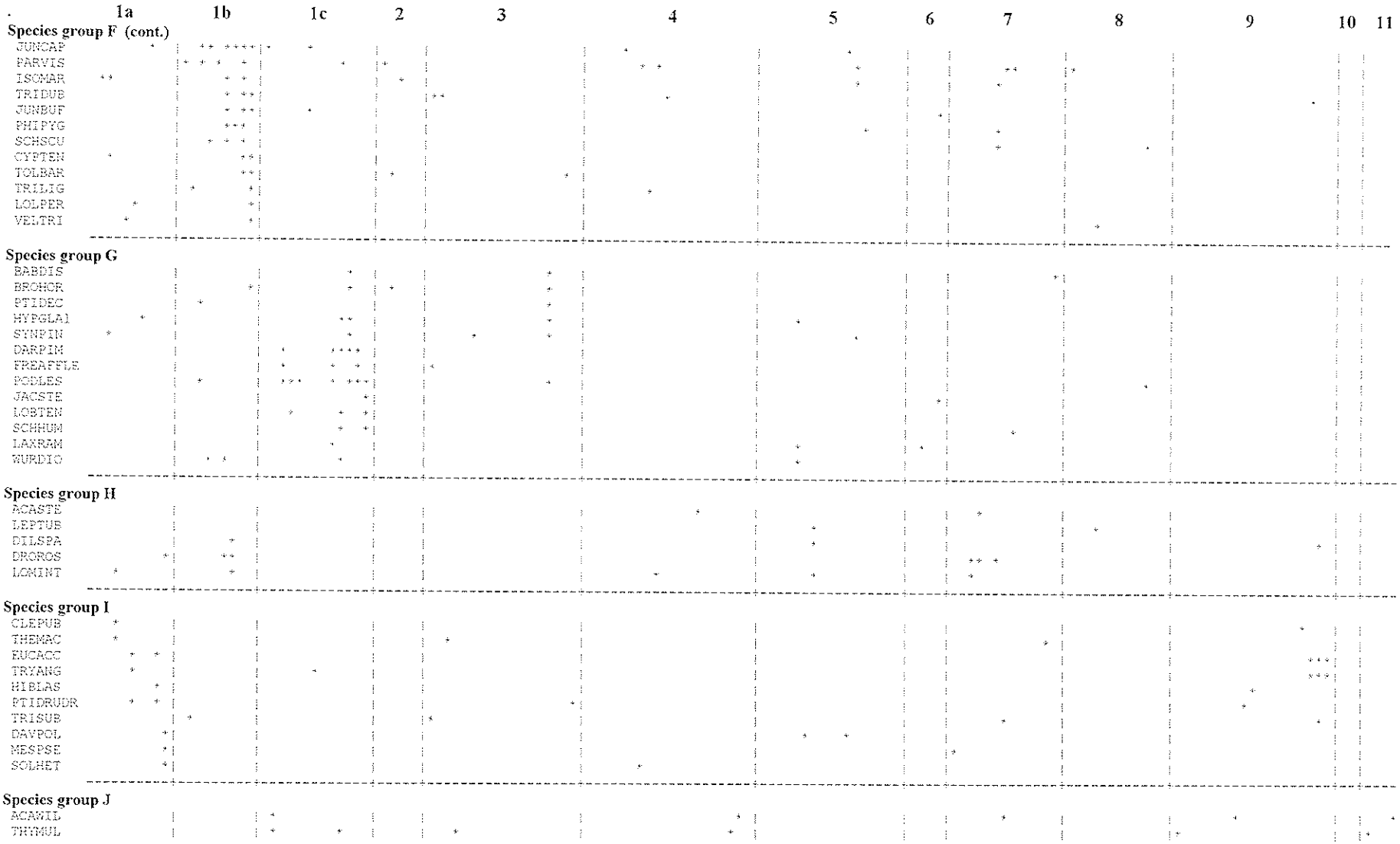

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group A2 (cont..)
LOMBRI
SCACAL
DICCRI
TETLAE
LEPI-SPA
LEUCAP
LOMMIC
CRAVAR
LAGHUE
TRISPA
PTIMAN
DIAREVDI
AMPTUR
DAVDECu
LECBIL
THYTHY
ERISPI
LOMSER
PETSTR
HAKSTE
GOMPOL
LEPI-SPB
LOMCAE
LOMPRE
HOVTRI
CYAAVE
LOMHER
BOROVA
LEUPRO
BOSERI
DRYBIP
THYTEN
LOMAFFMI
ORTLAXLA
STYCARAP
PROFRAFR
Species group B1
ACAPUL
GOMMAR
AIRCAR
BRIMAX
HYPGLA
STYBUL
NEUALO
LEPI-SPI
BRIMIN
CAEMIC
ROMROS
THYMAN
XANCAN

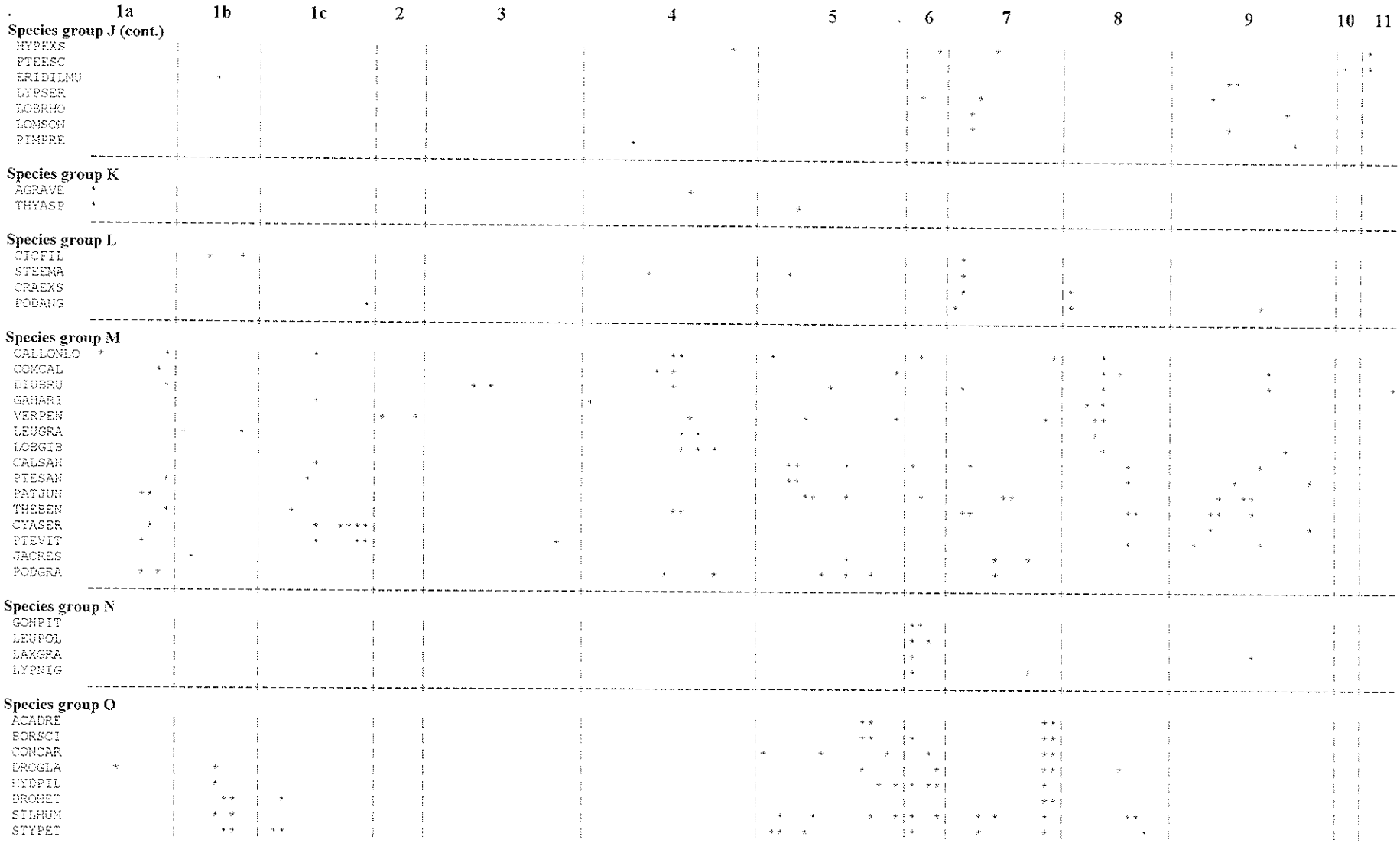

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group B1 (cont.)
HOMHOM
VULMYU
URSANT
WAHPRE
OPEVAG
CENARI
CENDRU
GONCOR
GREPIL
HYPANG
LEPI-SPM
HAEDIS
TRYLEDRO
TRIELA
LEUPUL
AUSCAM
EUCCAL
HAKLIS
HIBCON
XANPRE
BURCON
DRYLINLI
HIBHYP
NOTSET
CHACOR
STYBRU
TETOCT
THECRI
DROERY
HYDCAL
TRAPIL
LEVPUS
MILTEN
ALLHUM
BASCAM
DROMEN
CASPOM
HAKUND
GOOCAE
MELAPPSC
ISOASP
SCHGRA
LEPI-SPC
TEMBIL
CHODIC
HAKTRI
CALFLA
DROSTO
PATOCC
CONSET1
THYSPA

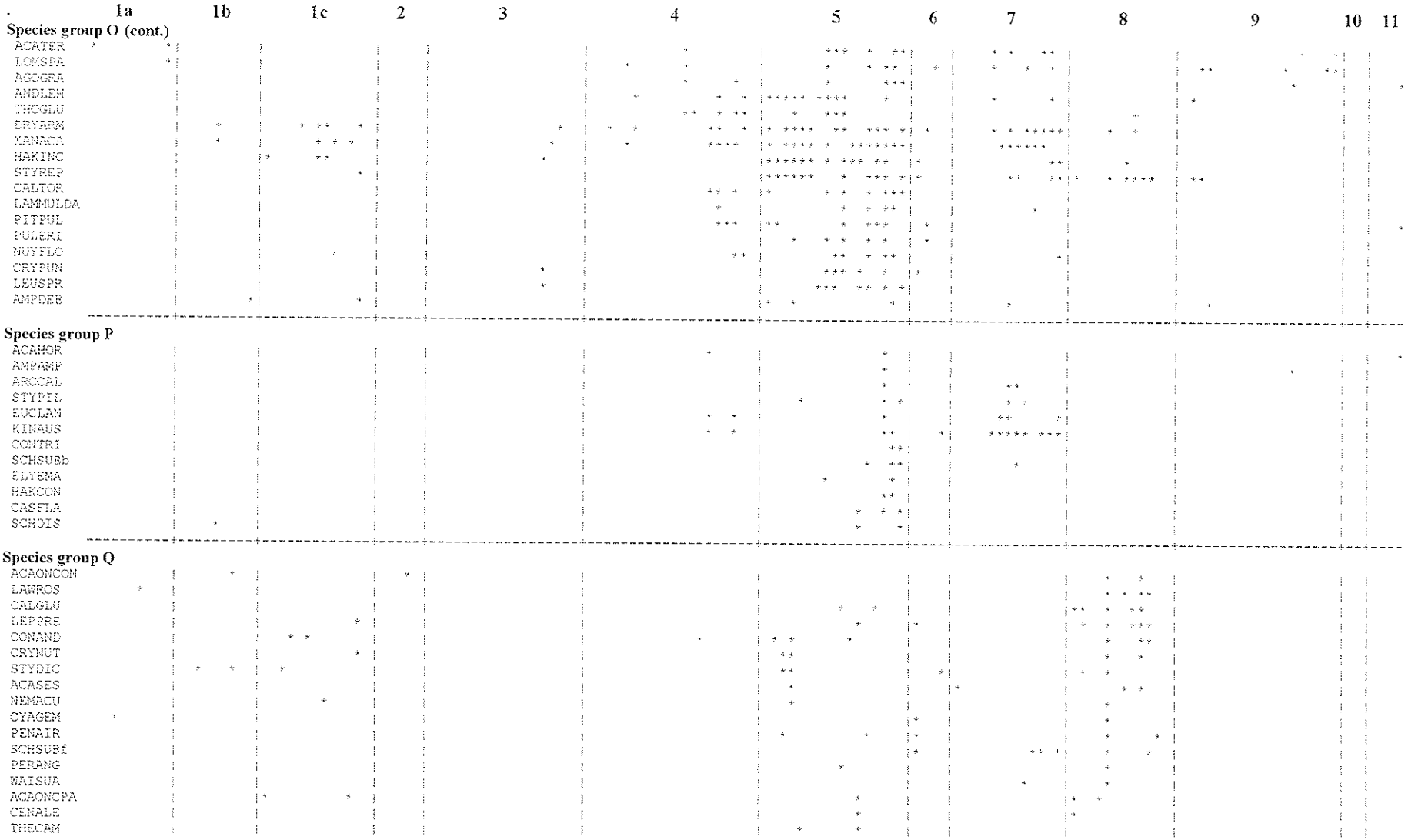

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group B1 (cont.)
HAELAX
MESTET
XANHUS
LOXFAS
Species group B2
STYCAL
ANAARV
CENERY
DESASP
GALDIV
DAUGLO
EUCWAN
BARTRI
BRADIS
LINTRI
AVEBAR
DICCAP
PHYCAL
MACRIE
MICSTI
OXAPER
THOFOL
AUSELE
LEPI-SPG
DARCIT
HEMINC
STYGLA
DAVHOR
SONCLE
STAMON
GREBIP
HIBSPISP
ERYPINPI
HYPOCC
SCHUNI
NEMCAP
SOWLAX
PORMIC
MONBRA
TRICER
CHEAUS
DIOHAS
TRYFLO
DIPHUELE
HAKCRI
RHOCOR
Species group B3
ACTLEU
PIMIMBPI
HIBSUB

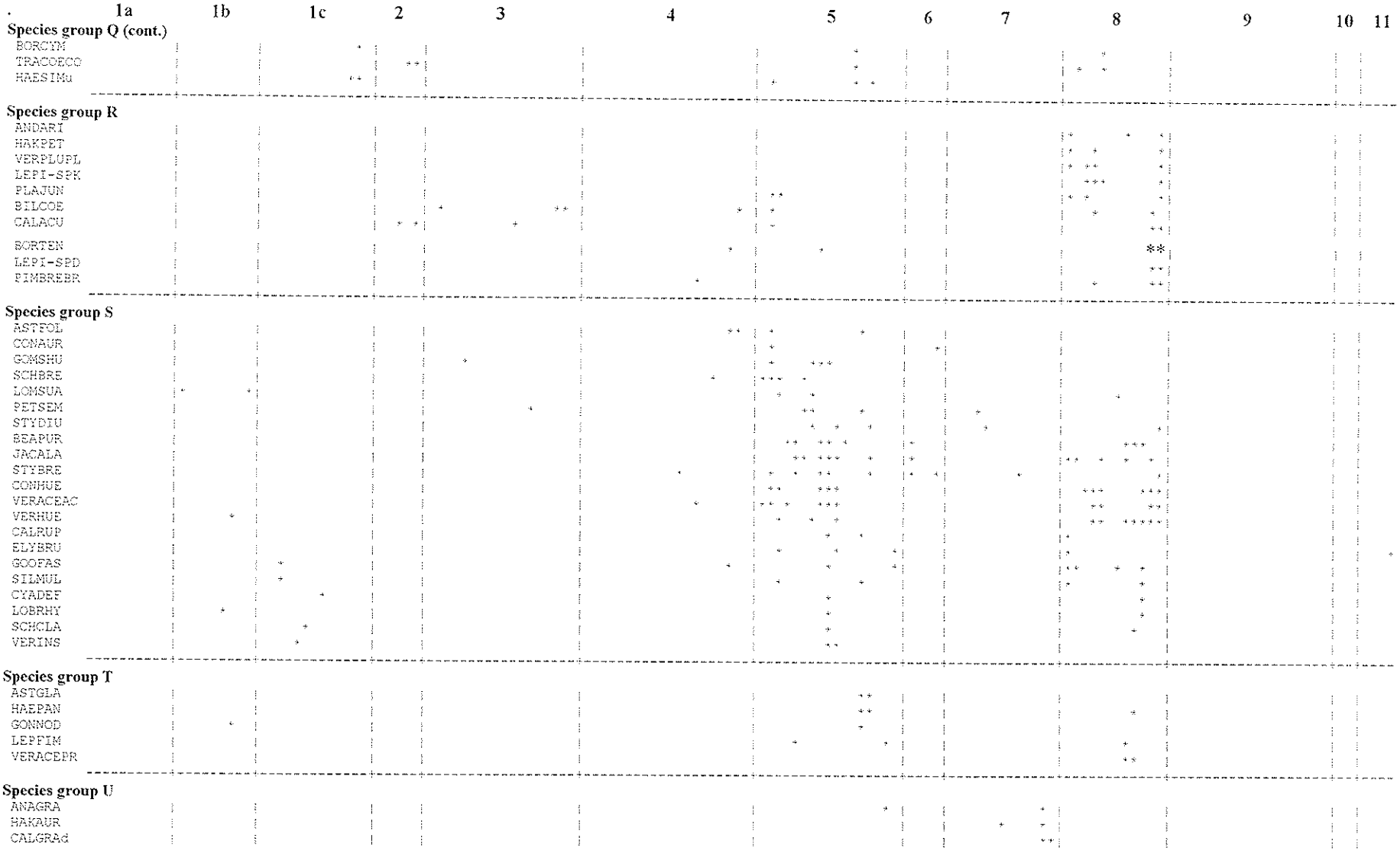

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group B3 (cont.)
SYNACU
ISODUB
PETBIL
HIBAUR
HOVPUN
MIRSPI
CRYARB
GRESND
MELRAD
AMPSTR
TRIBRU
AUSCOM
MYACOT
LAXSQU
LEVSTI
PTEPAN
SCHNAN
BORSPH
HAKERI
CALQUA
GLACAR
NEMSPA
DRONAC
GOOMIC
QUIURV
Species group C
ACADEN
HIBMYL
EUCLAE
HIBRHA
ACAPRE
CONACU
THYDIC
ASPASP
CERGLO
MELRHA
SCAPIL
BILCAN
BRODIA
EHRLON
ACASAL
VIMJUN
GASPHL
ISOCUN
CALMAR
DRYFRAFR
LEPERU
CREFOE

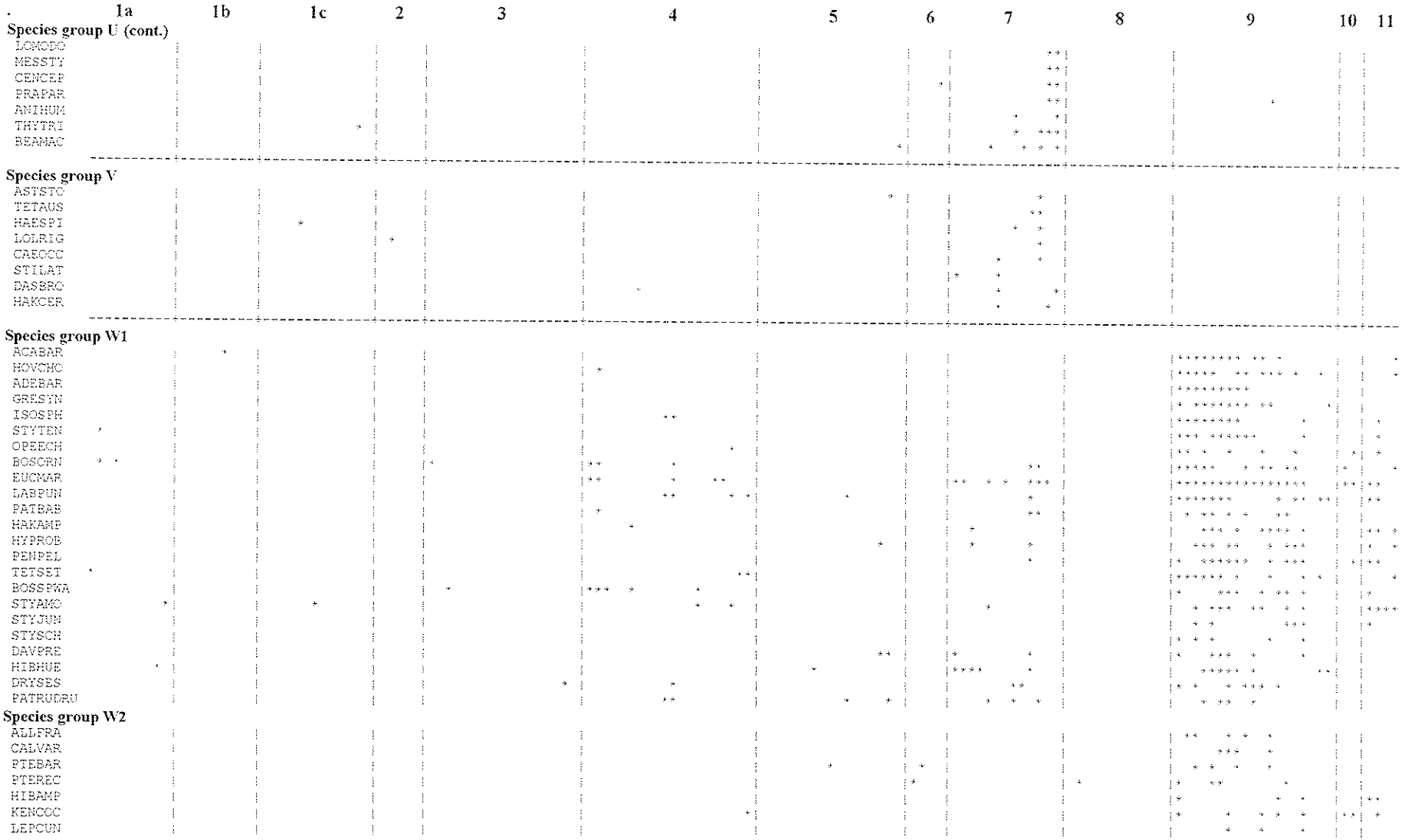

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group C (cont.)
THETRI
HOMFLA
KENSTI
TRIANG
TRICAM
ALLHUE
DODCER
BORRAMRA
LABLAN
AVEMIC
SANACU
GASSPI
LOBHET
LEPI-SPN
Species group D
ANTGRA
POAHOM
LEPI-SPF
GREMANMA
LASBRA
PELLITLI
WATMER
Species group E
ANIBICBI
DIULAX
TRILON
BRAIBE
THEANT
HAKMYR
HESFAL
GLIAURAU
PRAGRA
BURMUL
TRIBRA
TRICEN
EHRCAL
SCHBIF
DICPRE
SPABUL
DIUCOR
TRIHUM
LAXSES
Species group F
APHCYP
HAESIMp
PARLAT

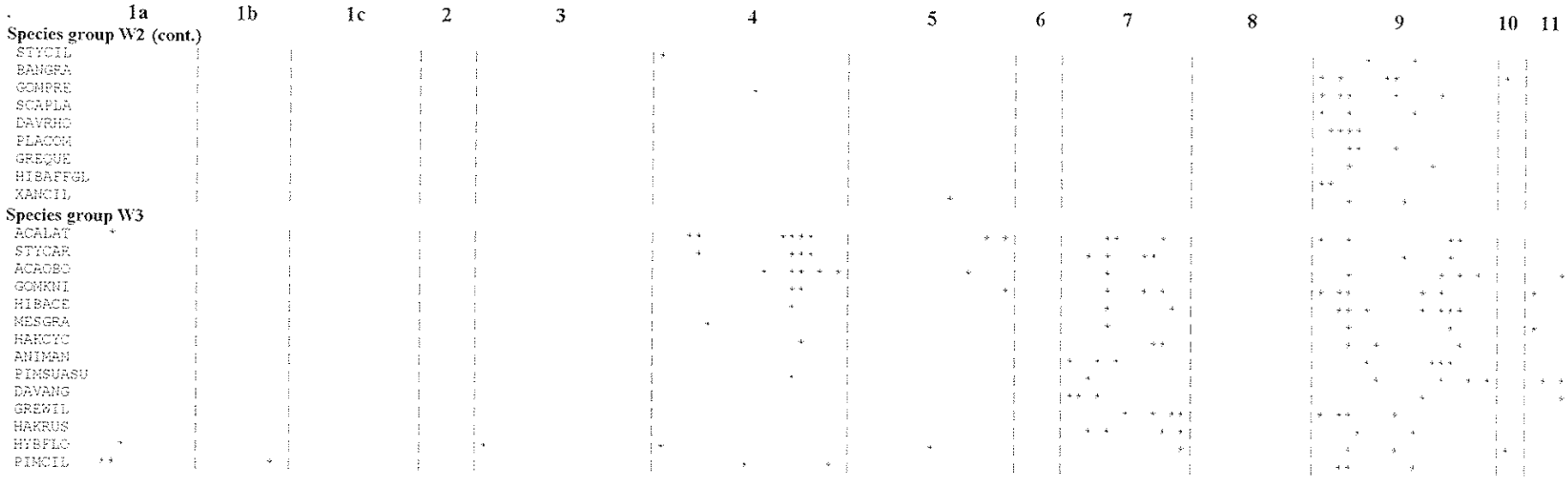

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group F (cont.)
JUNCAP
PARVIS
ISOMAR
TRIDUB
JUNBUF
PHIPYG
SCHSCU
CYPTEN
TOLBAR
TRILIG
LOLPER
VELTRI
Species group G
BABDIS
BROHOR
PTIDEC
HYPGLA1
SYNPIN
DARPIM
FREAFFLE
PODLES
JACSTE
LOBTEN
SCHHUM
LAXRAM
WURDIO
Species group H
ACASTE
LEPTUB
DILSPA
DROROS
LOMINT
Species group I
CLEPUB
THEMAC
EUCACC
TRYANG
HIBLAS
PTIDRUDR
TRISUB
DAVPOL
MESPSE
SOLHET
Species group J
ACAMID
THYMUL


1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group J (cont.)
HYPEXS
PTEESC
ERIDILMU
LYPSER
LOBRHO
LOMSON
PIMPRE
Species group K
AGRAVE
THYASP
Species group L
CICFIL
STEEMA
CRAEXS
PODANG
Species group M
CALLONLO
COMCAL
DIUBRU
GAHARI
VERPEN
LEUGRA
LOBGIB
CALSAN
PTESAN
PATJUN
THEBEN
CYASER
PTEVIT
JACRES
PODGRA
Species group N
GONPIT
LEUPOL
LAXGRA
LYPNIG
Species group O
ACADRE
BORSCI
CONCAR
DROGLA
HYDFIL
DROHET
SILNUM
STYPET


1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group O (cont.)
ACATER
LOMSPA
AGOGRA
ANDLEH
THOGLU
DRYARM
XANACA
HAKINC
STYREP
CALTOR
LAMMULDA
PITPUL
PULERI
NUYFLO
CRYPUN
LEUSPR
AMPDEB
Species group P
ACAHOR
AMPAMP
ARCCAL
STYPIL
EUCLAN
KINAUS
CONTRI
SCHSUBb
ELYEMA
HAKCON
CASFLA
SCHDIS
Species group Q
ACAONCON
LAWROS
CALGLU
LEPPRE
CONAND
CRYNUT
STYDIC
ACASES
NEMACU
CYAGEM
PENAIR
SCHSUBi
PERANG
WAISUA
ACAONCPA
CENALE
THECAM


1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group Q (cont.)
BORCYM
TRACOECO
HAESIMu
Species group R
ANDARI
HAKPET
VERPLUPL
LEPI-SPK
PLAJUN
BILCOE
CALACU
BORTEN
LEPI-SPD
PIMBREBR
Species group S
ASTFOL
CONAUR
GOMSHU
SCHBRE
LOMSUA
PETSEM
STYDIU
BEAPUR
JACALA
STYBRE
CONHUE
VERACEAC
VERHUE
CALRUP
ELYBRU
GOOPAS
SILMUL
CYADEF
LOBRHY
SCHCLA
VERINS
Species group T
ASTGLA
HAEPAN
GONNOD
LEPFIM
VERACEPR
Species group U
ANAGRA
HAKAUR
CALGRAc

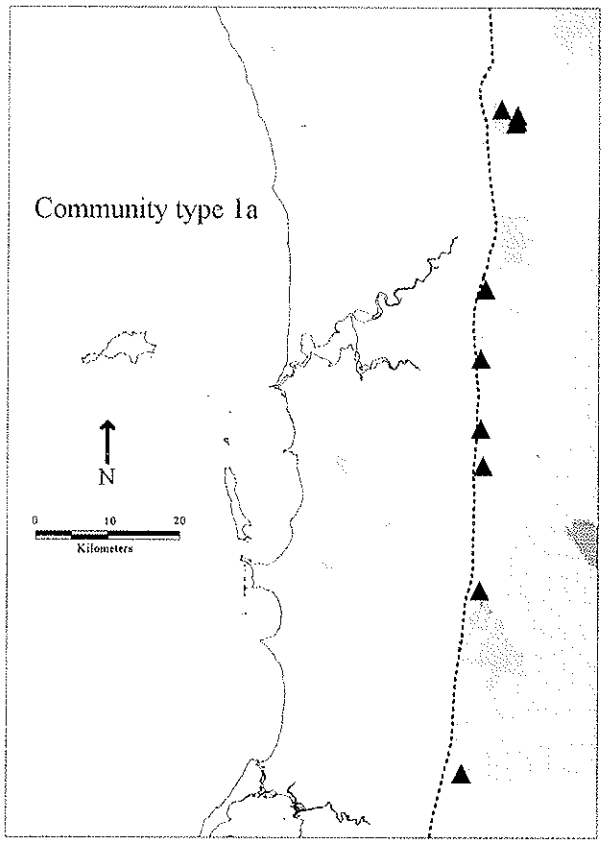

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group U (cont.)
LOMODO
MESSTY
CENCEP
PRAPAR
ANTHUM
THYTRI
BEAMAC
Species group V
ASTSTO
TETAUS
HAESPI
LOLRIG
CAEOCC
STILAT
DASBRO
HAKCER
Species group W1
ACABAR
HOVCHO
ADEBAR
GRESYN
ISOSPH
STYTEN
OPEECH
BOSCRN
EUCMAR
LABPUN
PATBAB
HAKAMP
HYPROB
PENPEL
TETSET
BOSSPWA
STYAMO
STYJUN
STYSCH
DAVPRE
HIBHUE
DRYSES
PATRUDRU
Species group W2
ALLFRA
CALVAR
PTEBAR
PTEREC
HIBAMP
KENCOC
LEPCUN

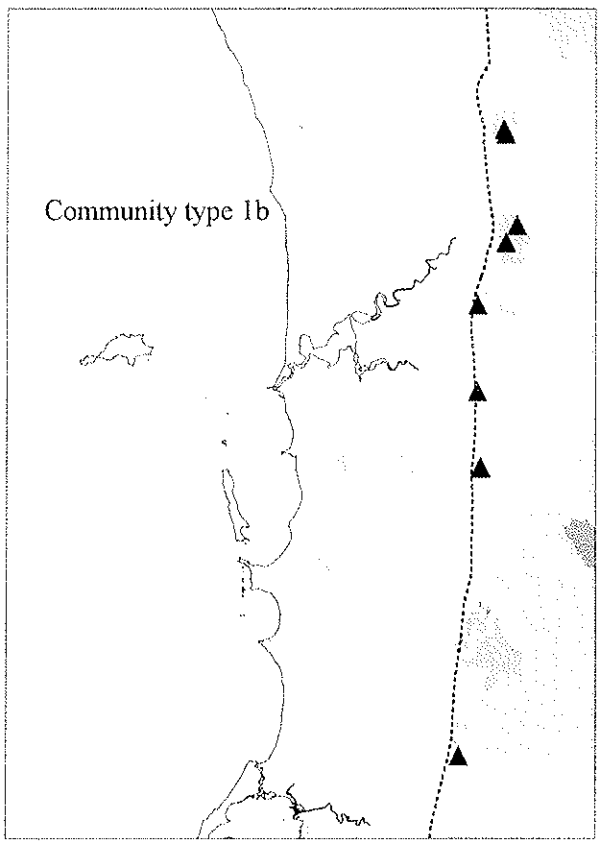

1a
1b
1c
2
3
4
5
6
7
8
9
10
11
Species group W2 (cont.)
STYCIL
BANGRA
GOMPRE
SCAPLA
DAVRHO
PLACOM
GREQUE
HIBAFFGL
XANCIL
Species group W3
ACALAT
STYCAR
ACAOBO
GOMKNI
HIBACE
MESGRA
HARCYC
ANIMAN
PIMSUASU
DAVANG
GREVIL
HAKRUS
HYBFLO
PIMCIL

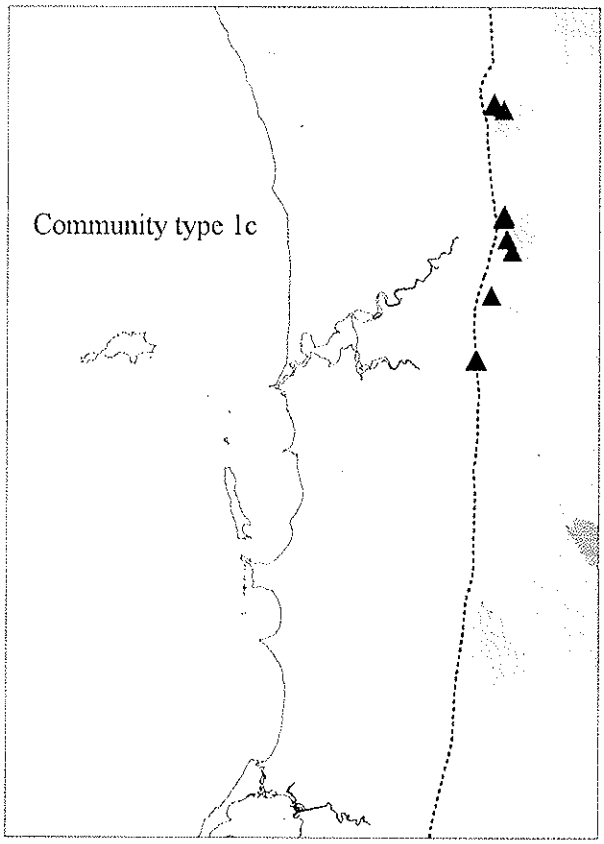
Appendix 4

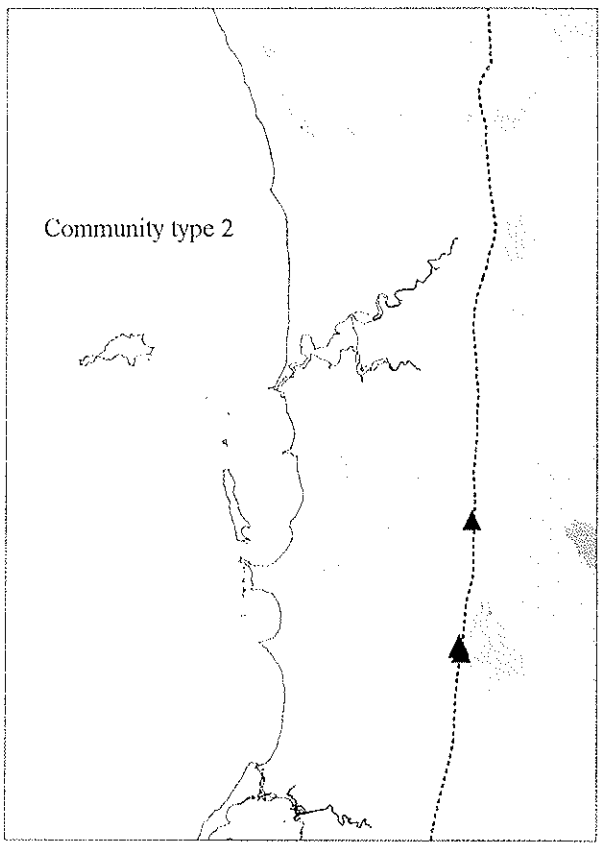
Distribution maps of the thirteen floristic community types and subtypes identified on the northern Darling Scarp.

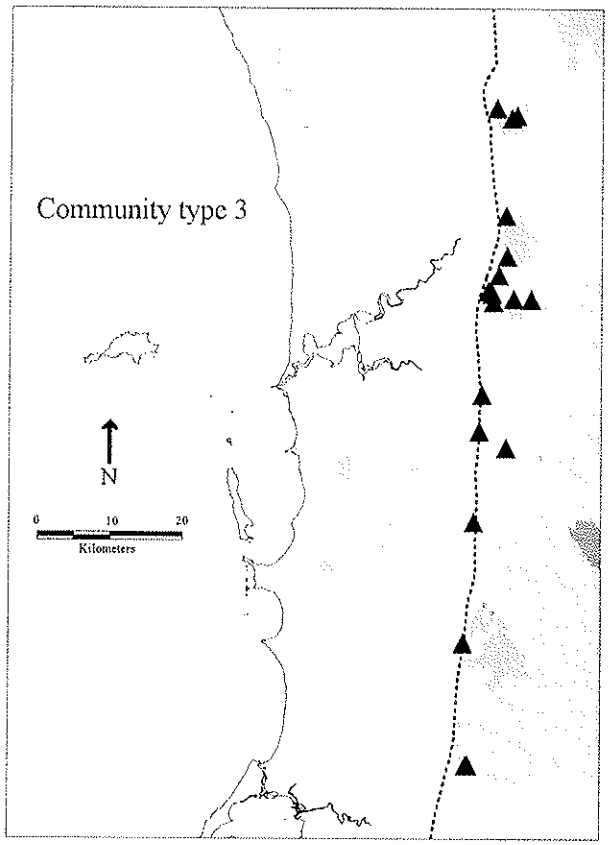
From the classification of floristic data from 146 sites located within the study area on the northern Darling Scarp

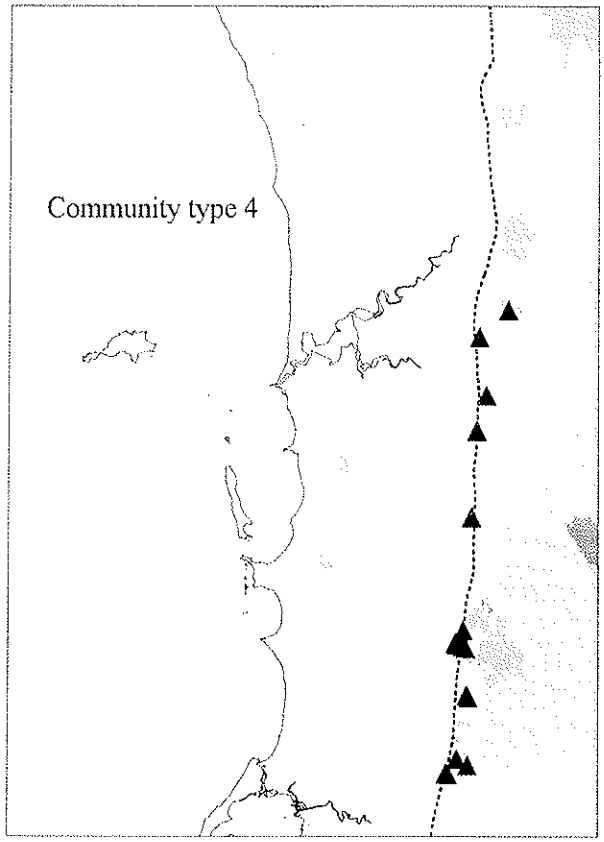

Community type 1a
N
0
10
20
Kilometers

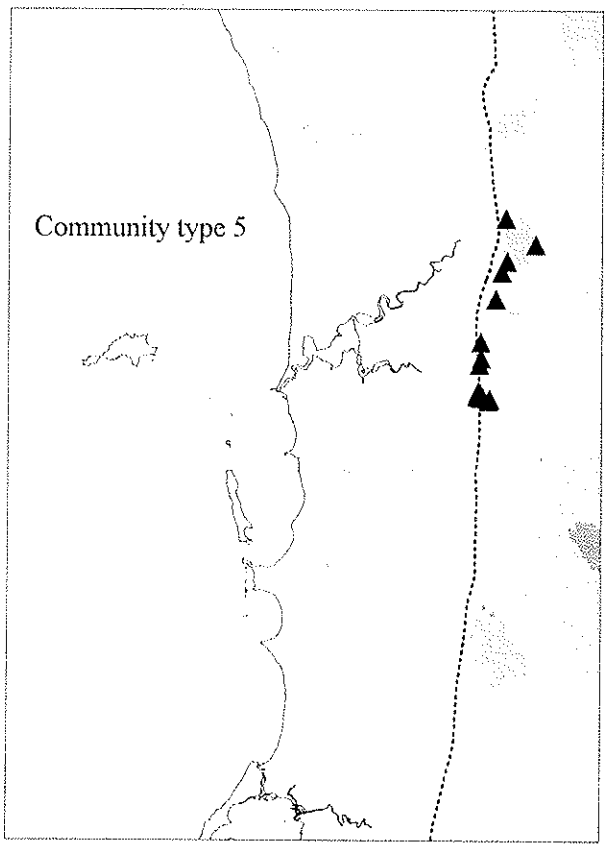

Community type 1b

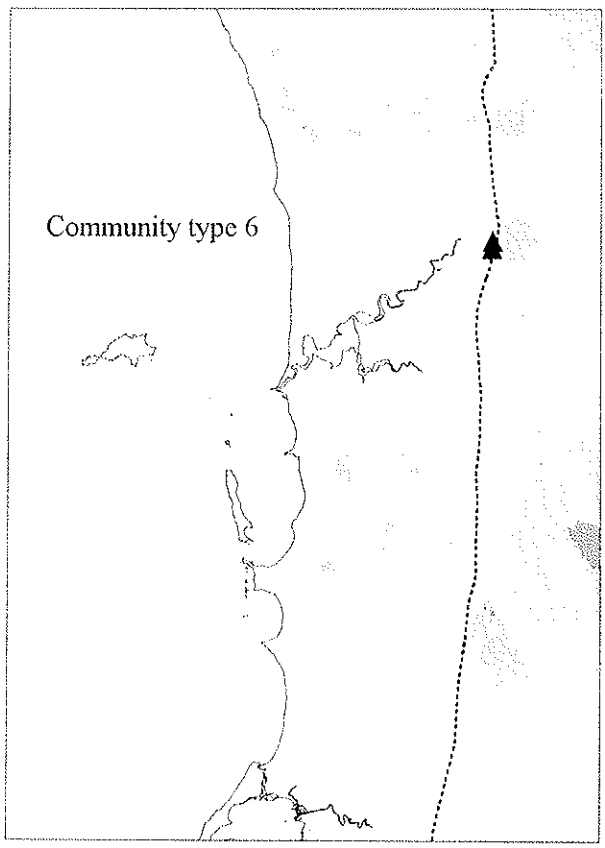

Community type 1c

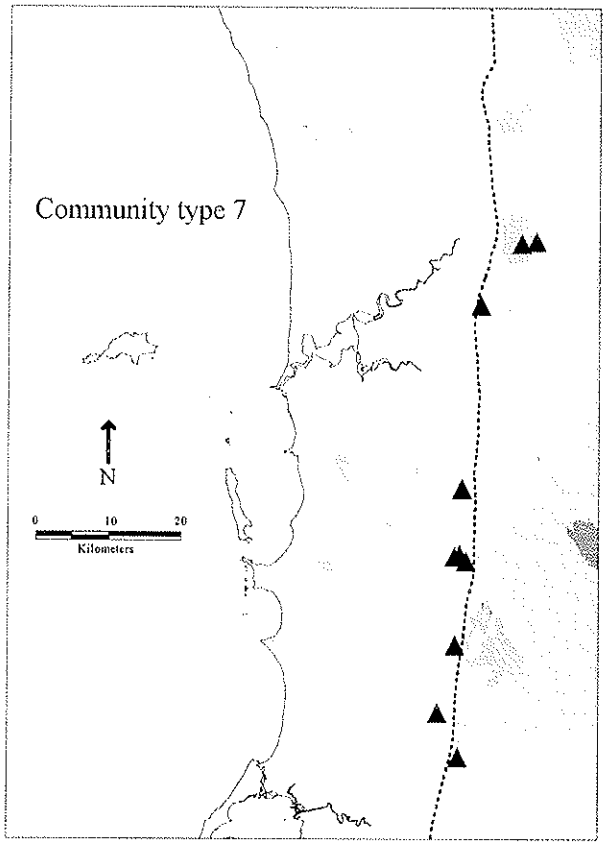

Community type 2

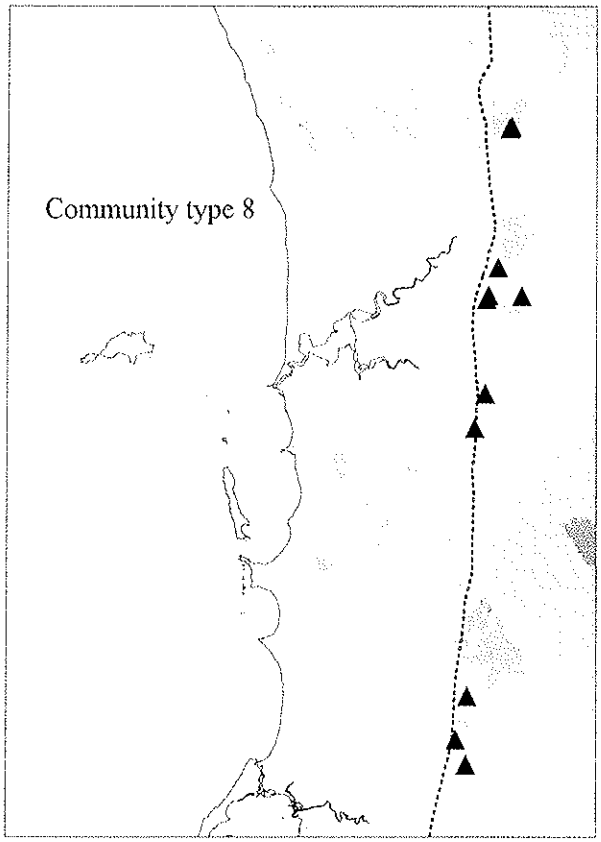

Community type 3
N
0
10
20
Kilometers

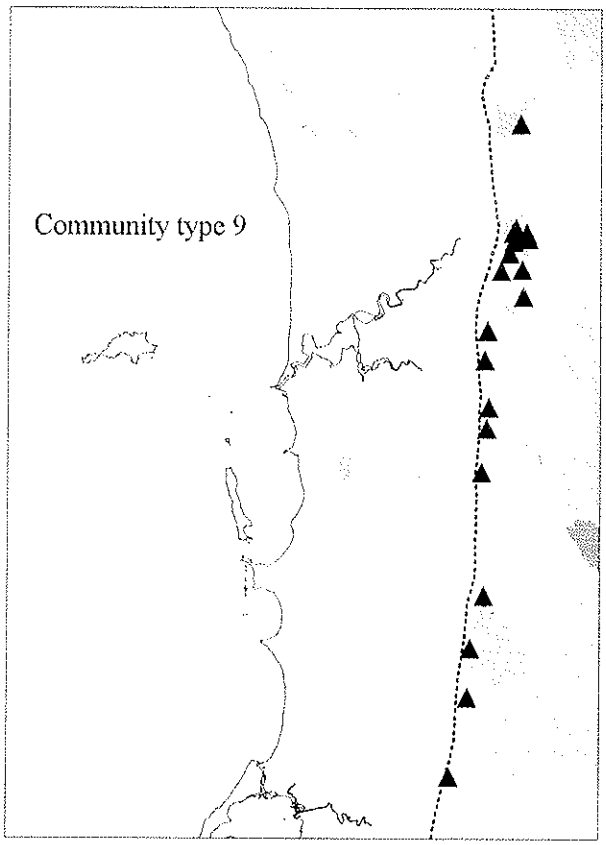

Community type 4

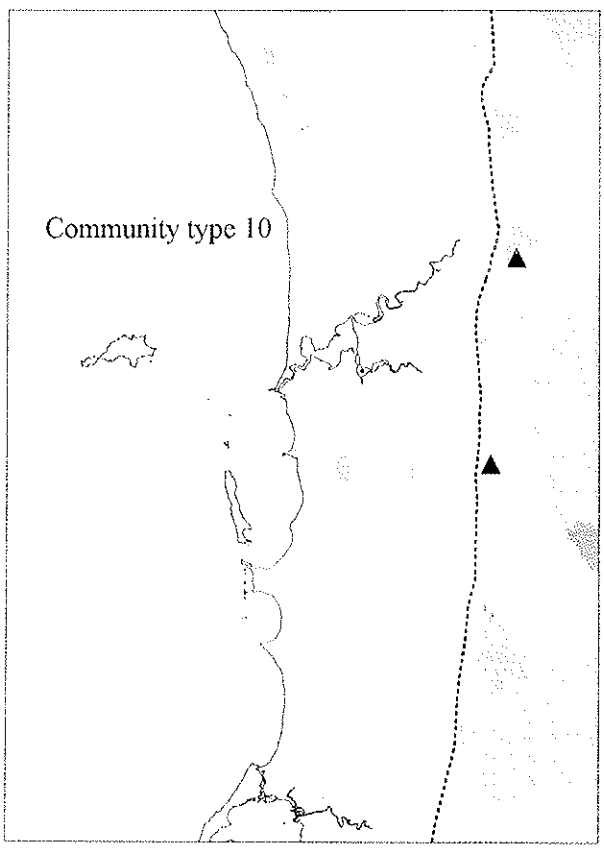

Community type 5

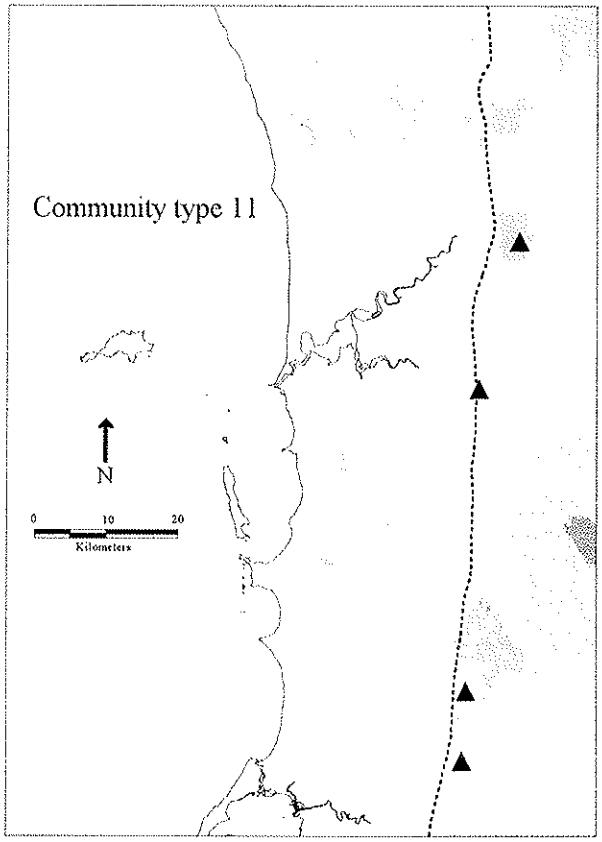

Community type 6


Community type 7
N
0
10
20
Kilometers


Community type 8


Community type 9


Community type 10


Community type 11
N
0
10
20
Kilometers

Appendix 5 – Community descriptions

Typical Taxa are those that occurred in 75% or more of the quadrats of a particular community type.

Common Taxa are those that occurred in between 50% to 75% of quadrats. Introduced taxa are marked with an asterix.

Structural Units follow Muir (1977) and indicate the range of structural vegetation types observed in these communities

Mean species richness refers to the average number of taxa within a plot (100 m^2), after the omission of singletons

Topographic units are from categories recorded in the field survey and the number of sites are in parentheses.

Community Type 1a

Upper slope *Eucalyptus wandoo* woodlands

Community description: Upper slope *Eucalyptus wandoo* woodland over low heath / dwarf scrub on mid-upper Scarp face and valley slopes. *E. accedens* occurs in northern sites.

Reservation status: Known from one secure reserve (National Park), Known occurrences in other reserves : State Forest (2); Western Australia Planning Commission reserve (3); Local Government vested reserve (1)

Mean species richness: **66.9 ± 8.9**

Typical Taxa

Trees
Eucalyptus wandoo

Shrubs
Acacia pulchella
Dryandra lindleyana var. *lindleyana*
Hakea lissocarpha
Hibbertia commutata
Hibbertia hypericoides
Phyllanthus calycinus
Xanthorrhoea preissii

Herbs
**Anagallis arvensis*
Caesia micrantha
Chamaescilla corymbosa
Daucus glochidiatus
Dichopogon capillipes
Hydrocotyle callicarpa
**Hypochaeris glabra*
Lagenifera huegelii
**Romulea rosea*
Trichocline spathulatum
Xanthosia candida

Grasses
**Aira caryophyllea*
Austrostipa campylachne
**Briza minor*
Neurachne alopecuroidea
Notodanthonia setacea

Sedges
Desmocladus asper

Other Common Taxa

Trees
Eucalyptus calophylla

Shrubs
Dianella revoluta var. *divaricata*
Grevillea pilulifera
Hypocalymma angustifolium
Macrozamia riedlei

Herbs
**Centaurium erythraea*
Centrolepis drummondiana
Dampiera linearis
Gompholobium marginatum
Homalosciadium homalocarpum
Stylidium brunonianum
Stylidium bulbiferum
Thysanotus manglesianus / patersonii
Trachymene pilosa

Grasses
**Briza maxima*
Microlaena stipoides
**Vulpia myuros*

Sedges
Lepidosperma sp. A
Tetraria octandra

Structural Units
low woodland A
open low woodland A
open woodland
woodland

Topographic Position
Ridge Hill Shelf (1)
Scarp upper slope (4)
Upland (2)
Valley mid slope (1)
Valley upper slope (2)

Community Type 1b

***Eucalyptus wandoo – Eucalyptus calophylla* woodlands on poorly-drained clay flats**

Community description: *Eucalyptus wandoo- Eucalyptus calophylla* woodland on winter wet, deep loamy clays on creek flats and adjacent to granites and/or dolerite.

Reservation status: Known from two secure reserves (National Parks), Known occurrences in other reserves : State Forest (1); Western Australia Planning Commission reserve (2); Local Government vested reserve (1)

Mean species richness: 69.1 ± 5.2

Typical Taxa

Trees
Eucalyptus calophylla
Eucalyptus wandoo

Shrubs
Acacia pulchella
Baeckea camphorosmae
Dryandra lindleyana var. *lindleyana*
Gompholobium marginatum
Hakea lissocarpha
Hibbertia commutata
Hibbertia hypericoides
Hypocalymma angustifolium
Xanthorrhoea preissii

Herbs
Centrolepis aristata
Homalosciadium homalocarpum
**Hypochaeris glabra*
**Romulea rosea*
Stylidium bulbiferum
**Ursinia anthemoides*

Grasses
**Aira caryophyllea*
**Briza maxima*
**Briza minor*
Neurachne alopecuroidea
**Vulpia myuros*

Other Common Taxa

Trees

Shrubs
Melaleuca aff *scabra*

Herbs
**Bartsia trixago*
Borya sphaerocephala
Burchardia congesta
Cassytha pomiformis
**Centaurium erythraea*
Centrolepis drummondiana
Chamaescilla corymbosa
Drosera erythrorhiza
Drosera menziesii
Hydrocotyle callicarpa
Hypoxis occidentalis
**Juncus capitatus*
Millotia tenuiflora
Patersonia occidentalis
Stylidium brunonianum
Trachymene pilosa
Xanthosia candida

Sedges
Desmocladus asper
Tetraria octandra

Structural Units
low scrub B over low heath C
open low woodland A
woodland

Topographic Position
Scarp lower slope (1)
Scarp face drainage line (1)
Scarp mid slope (2)
Valley floor (3)
Scarp upper slope (1)
Valley mid slope (1)
Ridge Hill Shelf (1)

Community Type 1c

Northern granite shrublands and woodlands

Community description: Northern Darling Scarp and valley slope *Hakea erinacea* / *Calothamnus quadrifidus* shrublands and open *Eucalyptus wandoo- Eucalyptus calophylla* woodlands on the deeper clay-loams over granite.

Reservation status: Known from two secure reserves (National Parks), Known occurrences in other reserves : Western Australia Planning Commission reserve (2)

Mean species richness: 69.9 ± 8.3

Typical Taxa

Trees

Shrubs
Acacia pulchella
Baeckea camphorosmae
Calothamnus quadrifidus
Dryandra lindleyana var. *lindleyana*
Hakea erinacea
Hibbertia hypericoides
Trymalium ledifolium var rosmarinifolium

Herbs
Borya sphaerocephala
Burchardia congesta
Caesia micrantha
Drosera erythrorhiza
**Gladiolus caryophyllaceus*
Haemodorum discolour
**Hypochaeris glabra*
**Romulea rosea*
Stylidium bulbiferum
Thysanotus manglesianus
Trachymene pilosa
Tricoryne elatior
**Ursinia anthemoides*

Grasses
**Aira caryophyllea*
**Briza maxima*
Neurachne alopecuroidea

Sedges
Desmocladus asper

Other Common Taxa

Trees

Shrubs
Hibbertia commutata
Leucopogon pulchellus
Xanthosia preissii

Herbs
Actinotus leucocephalus
Cassytha pomiformis
Cheilanthes austrotenuifolia
Homalosciadium homalocarpum
Hydrocotyle callicarpa
Levenhookia pusilla
Podolepis lessonii
Quinetia urvillei
Xanthosia candida

Grasses
Austrostipa campylachne
**Briza minor*
Notodanthonia setacea
**Vulpia myuros*

Sedges
Lepidosperma sp. I

Structural Units
heath A
heath B
low scrub A
low woodland A
low woodland B
open low scrub B
open low woodland A
open scrub over heath B
open woodland

Topographic Position
Scarp upper slope (4)
Scarp mid slope (6)
Scarp lower slope (1)
Upland (1)
Valley mid slope (1)

Community Type 2

Southern granite shrublands and woodlands

Community description: Southern Darling Scarp and valley slope shrublands and wandoo / marri woodlands. *Melaleuca radula / Grevillea endlicheriana* shrublands and open *Eucalyptus wandoo-Eucalyptus calophylla* on the deeper clay-loams over granite. Similar to community type 1c, but restricted to scarp face south of Perth.

Reservation status: Known from one secure reserve (National Park), Known occurrences in other reserves : Western Australia Planning Commission reserve (2)

Mean species richness: **53.8 ± 1.9**

Typical Taxa

Trees

Shrubs
Acacia pulchella
Trymalium ledifolium var rosmarinifolium
Grevillea bipinnatifida

Herbs
**Anagallis arvensis*
**Bartsia trixago*
Borya sphaerocephala
Caesia micrantha
**Centaurium erythraea*
Cheilanthes austrotenuifolia
Daucus glochidiatus
**Galium divaricatum*
**Hypochaeris glabra*
**Romulea rosea*
Sonchus oleraceus
Stylidium bulbiferum
Thysanotus manglesianus
**Ursinia anthemoides*

Grasses
**Aira caryophyllea*
**Briza minor*
**Briza maxima*
**Vulpia myuros*

Sedges
Desmocladus asper
Lepidosperma sp. G

Other Common Taxa

Trees

Shrubs
Allocasuarina huegeliana
Cryptandra arbutiflora
Gompholobium marginatum
Grevillea endlicheriana
Hibbertia spicata subsp. *spicata*
Hibbertia mylnei
Hovea pungens
Melaleuca radula
Xanthorrhoea preissii

Herbs
Burchardia congesta
Dioscorea hastifolia
Drosera macrantha
Haemodorum discolour
Levenhookia pusilla
**Linum trigynum*
Trachymene pilosa
Wahlenbergia preissii
Xanthosia candida

Grasses
Neurachne alopecuroidea

Sedges

Structural Units
dense low heath C
low woodland B
low scrub B over low heath C
open low woodland B over low heath C
woodland

Topographic Position
Scarp mid slope (1)
Scarp upper slope (4)

Community Type 3

***Eucalyptus calophylla* woodland on steep, loamy Darling Scarp and valley slopes.**

Community description: *Eucalyptus calophylla* woodlands over deep loams on the steep slopes of the Darling Scarp and within major valleys on western margin of Darling Plateau, often as riparian vegetation in association with a drainage feature.

Reservation status: Known from four secure reserves (National Park), Known occurrences in other reserves : Water Corporation Catchment (1); Western Australia Planning Commission reserve (4), Department of Land Administration (unvested) (1); Local Government reserve (1)

Mean species richness **52.6 ± 10.1**

Typical Taxa

Trees
Eucalyptus calophylla

Shrubs
Acacia pulchella
Dryandra lindleyana var. *lindleyana*
Hakea lissocarpha
Hibbertia hypericoides
Phyllanthus calycinus

Herbs
Cheilanthes austrotenuifolia
Caesia micrantha
**Romulea rosea*
Thysanotus manglesianus

Grasses
**Briza maxima*
Austrostipa campylachne

Sedges
Desmocladus asper

Other Common Taxa

Trees

Shrubs
Daviesia horrida
Gompholobium marginatum
Hibbertia commutata
Macrozamia riedlei
Thomasia foliosa
Trymalium floribundum
Xanthorrhoea preissii

Herbs
**Anagallis arvensis*
Burchardia congesta
**Centaurium erythraea*
Dichopogon capillipes
Oxalis perennans
Stackhousia monogyna
Stylidium bulbiferum
Stypandra glauca
Tricoryne elatior

Grasses
**Aira caryophyllea*
Austrostipa elegantissima
**Briza minor*
Microlaena stipoides
Neurachne alopecuroidea
Notodanthonia setacea
Tetrarrhena laevis

Sedges
Lepidosperma sp. M

Structural Units
heath B
low forest A
low woodland A
low woodland A over thicket
open low woodland A
open low woodland B
open scrub over low heath C
woodland

Topographic Position
Creek-line (1)
Scarp drainage line (4)
Scarp lower slope (1)
Scarp mid slope (2)
Scarp upper slope (3)
Steep lower valley slope (6)
Valley midslope (1)

Community Type 4

Woodlands on steep colluvial slopes of Scarp face and upper valleys

Community description: Woodlands on the steep slopes of the Darling Scarp and within major valleys on western margin of Darling Plateau. No predominant eucalypt species. Occurring on clay loams with exposed granite and colluvial deposits.

Reservation status: Known from three secure reserves (National Parks), Known occurrences in other reserves : State Forest (2); Western Australia Planning Commission reserve (2), Department of Land Administration (unvested) (2); Local Government reserve (2)

Mean species richness 75.7 ± 10.9

Typical Taxa

Trees

Shrubs
Acacia pulchella
Baeckea camphorosmae
Dryandra lindleyana var. *lindleyana*
Hakea lissocarpha
Hibbertia commutata
Hibbertia hypericoides
Hypocalymma angustifolium

Herbs
Burchardia congesta
Cassytha pomiformis
Haemodorum discolour
Stylidium brunonianum

Grasses
Austrostipa campylachne
Notodanthonia setacea

Sedges
Tetraria octandra

Other Common Taxa

Trees
Eucalyptus calophylla

Shrubs
Astroloma pallidum
Dampiera linearis
Gompholobium marginatum
Grevillea pilulifera
Hakea undulata
Isopogon aspera
Lepidosperma sp 1
Leucopogon capitellatus
Leucopogon pulchellus
Macrozamia riedlei
Melaleuca aff *scabra*
Olearia paucidentata
Phyllanthus calycinus
Stylidium hispidum
Tetraria capillaris

Shrubs (cont..)
Trymalium ledifolium var rosmarinifolium
Xanthorrhoea gracilis
Xanthorrhoea preissii

Herbs
Caesia micrantha
Cassytha glabella
Chamaescilla corymbosa
Drosera menziesii
Goodenia caerulea
Haemodorum laxum
Levenhookia pusilla
**Romulea rosea*
Thysanotus manglesianus
Wahlenbergia preissii
Xanthosia huegelii

Grasses
**Briza minor*
Neurachne alopecuroidea
Tetrarrhena laevis

Sedges
Mesomelaena tetragona

Structural Units
low forest A
low woodland A
open low woodland A
open low woodland B
open woodland
woodland

Topographic Position
Ridge Hill Shelf (2)
Scarp drainage line (1)
Scarp lower slope (2)
Scarp mid slope (4)
Scarp upper slope (7)
Steep lower valley slope (1)
Valley mid slope (1)
Valley upper slope (2)

Community Type 5

Central granite shrublands

Community description: Shrublands and heath on deeper loams and red earths on fragmented granite/quartzite. Located in central region east of Perth.

Reservation status: Known from three secure reserves (National Parks), Known occurrences in other reserves : Western Australia Planning Commission reserve (2), Local Government reserve (1)

Mean species richness 64.9 ± 8.7

Typical Taxa

Trees

Shrubs
Allocasuarina humilis
Baeckea camphorosmae
Hibbertia hypericoides
Melaleuca aff *scabra*
Xanthorrhoea acanthostachya

Herbs
Drosera menziesii
Stylidium brunonianum

Grasses
Neurachne alopecuroidea

Sedges
Tetraria octandra

Other Common Taxa

Trees

Shrubs
Acacia pulchella
Andersonia lehmanniana
Dryandra armata
Dryandra lindleyana var. *lindleyana*
Gompholobium marginatum
Grevillea pilulifera
Hakea incrassata
Hakea undulata

Herbs
Borya sphaerocephala
Burchardia congesta
Cassytha pomiformis
Chamaescilla corymbosa
Drosera erythrorhiza
Gonocarpus cordiger
Goodenia caerulea
Hydrocotyle callicarpa
Laxmannia squarrosa
Levenhookia pusilla
Pterochaeta paniculata
Stylidium bulbiferum
Stylidium repens

Grasses
Notodanthonia setacea

Sedges
Mesomelaena tetragona
Tetraria octandra

Structural Units
heath B
low heath C
low scrub A
low scrub B
open low scrub A
open low scrub B
open low woodland A
open scrub over low scrub A

Topographic Position
Scarp lower slope (4)
Scarp mid slope (6)
Scarp upper slope (3)
Ridge Hill Shelf (1)
Upland (1)
Valley upper slope (1)
Scarp drainage line (1)

Community Type 6

Talbot Road *Eucalyptus calophylla – Eucalyptus wandoo* woodlands and heaths

Community description: *Eucalyptus calophylla – Eucalyptus wandoo* low woodlands and lateritic heath on well drained, sandy gravels of Ridge Hill Shelf.

Reservation status: Not known from secure reserve. Known from one reserve of mixed tenure: vested in part by Local Government and part Vacant Crown Land.

Mean species richness 57.0 ± 12.5

Typical Taxa

Trees

Shrubs
Xanthorrhoea preissii

Herbs
Burchardia congesta
Chamaescilla corymbosa
**Romulea rosea*
Thelymitra crinita

Grasses
**Briza maxima*
Neurachne alopecuroidea

Sedges
Lepidosperma sp. I

Other Common Taxa

Trees
Eucalyptus calophylla
Eucalyptus wandoo

Shrubs
Acacia pulchella
Baeckea camphorosmae
Chorizema dicksonii
Hakea erinacea
Hakea lissocarpha
Hakea trifurcata
Hakea undulata
Hibbertia hypericoides
Hypocalymma angustifolium
Leucopogon polymorphus
Melaleuca aff *scabra*
Nemcia capitatum
Nemcia spathulatum
Pimelea imbricata piligera
Synaphea acutiloba

Herbs
Borya sphaerocephala
Burchardia multiflora
Caesia micrantha
Cassytha pomiformis
Drosera erythrorhiza
Drosera macrantha
Drosera menziesii
**Gladiolus caryophyllaceus*
Gonocarpus pithyoides
Goodenia caerulea
Goodenia micrantha
**Hesperantha falcata*
Homalosciadium homalocarpum
Hydrocotyle pilifera
**Hypochaeris glabra*
Hypoxis occidentalis
Lagenifera huegelii
Laxmannia squarrosa
Opercularia vaginatum
Siloxerus humifusus
Stylidium brunonianum
Stylidium bulbiferum
Thysanotus manglesianus
Thysanotus thyrsoideus
Trichocline spathulatum
Xanthosia candida

Grasses
Austrostipa campylachne

Sedges
Cyathochaeta avenacea
Desmocladus asper
Lepidosperma sp. B
Loxocarya fasciculata
Mesomelaena tetragona
Schoenus unispiculatus
Tetraria octandra

Structural Units
heath A
open low woodland A

Topographic Position
Ridge Hill Shelf (4)

Community Type 7

Woodlands on poorly drained colluvial deposits

Community description: *Eucalyptus marginata* and *Eucalyptus calophylla* woodlands on colluvial deposits over clay in poorly drained, low lying areas. Typically located on the Ridge Hill Shelf, with *Eucalyptus lane-poolei* occurring in southern sites.

Reservation status: Known from two secure reserves (National Parks), Known occurrences in other reserves : State Forest (1); Western Australia Planning Commission reserve (1), Vacant Crown Land (1); Private Land (2)

Mean species richness: **61.3 ± 8.3**

Typical Taxa

Trees

Shrubs
Dryandra lindleyana var. *lindleyana*
Hibbertia hypericoides
Baeckea camphorosmae

Herbs
Chamaescilla corymbosa
**Hypochaeris glabra*
Levenhookia pusilla
Stylidium brunonianum

Grasses
Neurachne alopecuroidea

Sedges
Loxocarya fasciculata
Mesomelaena tetragona
Tetraria octandra

Other Common Taxa

Trees
Eucalyptus calophylla
Eucalyptus marginata

Shrubs
Dryandra armata
Xanthorrhoea preissii

Herbs
Conostylis setigera
Dampiera linearis
Goodenia caerulea
Haemodorum laxum
Lechenaultia biloba
Lomandra hermaphrodita
Pterochaeta panniculata
Thysanotus thyrsoideus
Trachymene pilosa
Xanthosia huegelii

Grasses
* *Aira caryophyllea*
* *Briza maxima*
Notodanthonia setacea

Sedges
Cyathochaeta avenacea

Structural Units
forest
low dwarf scrub B
low woodland A
open low woodland A
open woodland over open low woodland A
woodland

Topographic Position
Ridge Hill Shelf (10)
Scarp lower slope (1)
Valley mid slope (2)

Community Type 8

Shrublands on upper slope granite outcrops

Community description: Heaths and low shrublands on shallow lithic soils around massive granite outcrops

Reservation status: Known from four secure reserves (3 National Parks and 1 Nature reserve), Known occurrences in other reserves : State Forest (2); Water Corporation catchment (1); Western Australia Planning Commission reserve (2)

Mean species richness: 61.8 ± 10.0

Typical Taxa

Trees

Shrubs
Baeckea camphorosmae

Herbs
Actinotus leucocephalus
Borya sphaerocephala
Pterochaeta panniculata
Thysanotus manglesianus

Grasses
* *Aira caryophyllea*
* *Briza maxima*
Neurachne alopecuroidea
* *Vulpia myuros*

Sedges
Schoenus nanus

Other Common Taxa

Trees

Shrubs
Acacia pulchella
Calothamnus quadrifidus
Conospermum huegelii
Darwinia citriodora
Hakea erinacea
Hemigenia incana
Hibbertia subvaginata
Isopogon dubious
Leucopogon pulchellus
Melaleuca aff *scabra*
Petrophile biloba
Pimelea imbricata var *piligera*
Trymalium ledifolium var *rosmarinifolium*
Verticordia huegelii

Herbs
Burchardia congesta
Caesia micrantha
Cassytha pomiformis
Centrolepis aristata
Chamaescilla corymbosa
Drosera menziesii
Homalosciadium homalocarpum
Hydrocotyle callicarpa
**Hypochaeris glabra*
Laxmannia squarrosa
Levenhookia pusilla
Levenhookia stipitata
Millotia tenuifolia
**Romulea rosea*
Stylidium brunonianum
Stylidium bulbiferum
Stylidium repens
Stypandra glauca
Trachymene pilosa
Tripterococcus brunonis
**Ursinia anthemoides*
Wahlenbergia preissii

Grasses
Amphipogon striata

Sedges
Lepidosperma sp. I
Lepidosperma sp. M
Schoenus grammatophyllus

Structural Units
heath B
low heath C
low scrub A
open low scrub A over low scrub B
open low woodland B over low scrub B
open scrub

Topographic Position
Scarp lower slope (1)
Scarp mid slope (3)
Scarp upper slope (4)
Valley upper slope (2)
Valley mid slope (2)

Community Type 9

Upland *Eucalyptus marginata* Forest

Community description: *Eucalyptus marginata* forest and woodland on lateritic upper slopes and upland Darling Plateau.

Reservation status: Known from four secure reserves (National Parks), Known occurrences in other reserves : State Forest (2); Water Corporation catchment (1); Western Australia Planning Commission reserve (3), Local Government reserve (2)

Mean species richness 68.7 ± 12.3

Typical Taxa

Trees
Eucalyptus marginata

Shrubs
Dryandra lindleyana var. *lindleyana*
Hibbertia hypericoides

Herbs
Chamaescilla corymbosa
Conostylis setosa
Dampiera linearis
Lomandra nigricans
Stylidium hispidum
Trachymene pilosa

Grasses

Sedges

Other Common Taxa

Trees
Eucalyptus calophylla

Shrubs
Acacia barbinervis
Bossiaea ornata
Daviesia decurrens
Grevillea synapheae
Hakea lissocarpha
Hibbertia commutata
Hovea chorizemifolia
Labichea punctata
Lomandra sericea
Petrophile striata
Phyllanthus calycinus
Styphelia tenuiflora
Xanthorrhoea gracilis
Xanthorrhoea preissii

Herbs
Burchardia congesta
Drosera erythrorhiza
Hydrocotyle callicarpa
Lechenaultia biloba
Lomandra caespitosa
Pentapeltis peltigera
Scaevola calliptera
Tetratheca setigera
Thysanotus thyrsoideus
Trichocline spathulata

Grasses
Neurachne alopecuroidea
Notodanthonia setacea

Sedges
Tetraria capillaris

Structural Units
forest
low forest A
low woodland A
open low woodland A
open woodland
woodland

Topographic Position
Scarp upper slope (7)
Upland (11)
Valley upper slope (1)

Community Type 10

Upland *Eucalyptus calophylla* woodland

Community description: *Eucalyptus calophylla* woodland on deep loams of upland valley slopes. Species poor.

Reservation status: Known from one secure reserve (National Park) and one Local Government reserve

Mean species richness 25.5 ± 5.5

Typical Taxa

Trees
Eucalyptus calophylla
Eucalyptus marginata

Shrubs

Herbs
**Hypochaeris glabra*
Kennedia coccinea
Scaevola calliptera
Sonchus oleraceus

Grasses
Tetrarrhena laevis

Sedges

Other Common Taxa

Trees

Shrubs
Acacia dentifera
Acacia pulchella
Banksia grandis
Bossiaea ornata
Dryandra lindleyana var. *lindleyana*
Hibbertia commutata
Hovea trisperma
Leucopogon capitellatus
Lomandra sericea
Macrozamia riedlei
Phyllanthus calycinus
Pteridium esculentum
Xanthorrhoea preissii

Herbs
Burchardia congesta
**Cerastium glomeratum*
Cheilanthes austrotenuifolia
Dampiera alata
Dampiera linearis
Dichopogon capillipes
Drosera erythrorhiza
Hybanthus floribundus
Lagenifera huegelii
Lomandra brittanii
Lomandra preissii
Opercularia apiciflora
Opercularia echinocephala
Oxalis perennans
Pentapeltis peltigera
Scaevola calliptera
Trichocline spathulatum
Xanthosia candida
Xanthosia huegelii

Grasses
**Briza maxima*
**Briza minor*
Microlaena stipoides
**Vulpia myuros*

Sedges

Structural Units
forest
low woodland A

Topographic Position
Scarp upper slope (1)
Valley upper slope (1)

Community Type 11

Upland *Eucalyptus calophylla-Eucalyptus marginata* woodland

Community description: *Eucalyptus calophylla-Eucalyptus marginata* woodland on upper slope clay – loams. Species poor.

Reservation status: Known from one secure reserve (National Park). Known occurrences in other reserves : State Forest (1); Water Corporation catchment. Local Government reserve (1)

Mean species richness: **45.5 ± 10.8**

Typical Taxa

Trees
Eucalyptus calophylla

Shrubs
Hibbertia hypericoides

Herbs
Scaevola calliptera
Stylidium amoenum

Grasses
Microlaena stipoides

Sedges

Other Common Taxa

Trees
Eucalyptus marginata

Shrubs
Acacia pulchella
Astroloma pallidum
Baeckea camphorosmae
Darwinia citriodora
Dryandra lindleyana var. *lindleyana*
Gompholobium polymorphum
Hakea amplexicaulis
Hakea lissocarpha
Hibbertia amplexicaulis
Hibbertia commutata
Hypocalymma robustum
Labichea punctata
Macrozamia riedlei
Mesomelaena tetragona
Synaphea gracillima
Xanthorrhoea gracilis
Xanthorrhoea preissii

Herbs
Cassytha racemosa
Dampiera alata
Dampiera linearis
Drosera menziesii
Lomandra hermaphrodita
Lomandra nigricans
Lomandra preissii
Pentapeltis peltigera
Stylidium calcaratum
Thelymitra crinita
Xanthosia candida

Grasses
**Briza maxima*
Notodanthonia setacea
Tetrarrhena laevis

Sedges
Cyathochaeta avenacea
Lepidosperma sp. B
Tetraria capillaris

Structural Units
forest
open woodland over low forest A
low woodland A

Topographic Position
Scarp mid slope (1)
Valley mid slope (2)
Creek-line (1)

Appendix 6

Photographs illustrating sites representative of particular floristic community types identified on the northern Darling Scarp.

Appendix 6-1: Community type 1a. Upper slope *Eucalyptus accedens* woodland on lateritic scree slope in Walyunga National Park.

Appendix 6-2: Community type 1b. *Eucalyptus wandoo* open woodland on winter wet clay flats of the lower valley slopes. Site located in Walyunga National Park, adjacent to the Avon river. *Hypocalymma angustifolium* is a conspicuous component (in flower) of the low shrub layer.

Appendix 6-3: Community type 1c. Mid slope granite heath at John Forrest National Park, on a clay spur with exposed granite boulders. *Hakea erinacea* and *Calothamnus quadrifidus* form the dominant shrub layer. An adjacent stand of *Eucalyptus wandoo* coincides with deeper clay soils.

Appendix 6-4: Community type 2. View (looking north - west) of massive granite ridge forming the face of the Darling Scarp at Serpentine National Park. Upper slope granite heath with *Grevillea endlicheriana*, *Melaleuca radula* and *Darwinia citriodora* forming the dominant shrub layer. This community type covers much of the middle and upper slopes of this granite ridge.

Appendix 6-5: Community type 3. *Eucalyptus laeliae* and *Eucalyptus calophylla* woodland over a dense thicket of *Grevillea diversifolia* subsp. *diversifolia* , *Calothamnus quadrifidus* and *Darwinia citriodora*. Riparian vegetation on the steep slopes of the North Dandalup river embankment. Note that massive areas of granite bedrock have been exposed in this steep valley.

Appendix 6-6: Community type 4. A stand of *Eucalyptus lane-poolei – Eucalyptus marginata* subsp. *elegantella* woodland on the colluvial lower slopes and Ridge Hill Shelf of Serpentine National Park. Notable shrub taxa include *Xanthorrhoea acanthostachya*, *Dryandra armata*, and *Lambertia multiflora* var. *darlingensis*.

Appendix 6-7: Community type 5. Granite heath on a quartzite ridge at Ellis brook valley. A fire in 1994 has altered the structure of the vegetation. Dominant taxa are *Xanthorrhoea acanthostachya* and *Allocasuarina humilis* over *Lambertia multiflora var. darlingensis* (flowering), *Hakea conchifolia* and *Melaleuca* aff. *scabra*. This region contains an unusually high number of taxa characteristic of the northern sandplains.

Appendix 6-8: Community type 7. A stand of *Eucalyptus lane-poolei – Eucalyptus marginata* subsp. *elegantella* woodland Shelf at Serpentine National Park. This community typically occurs on poorly draining sands over a claypan, as with this site on the Ridge Hill Shelf. Notable shrub taxa include *Kingia australis, Dasypogon bromelioides and Melaleuca* aff *scabra.*

Appendix 6-9: Community type 8..Heath on mid slope granite outcrop at Greenmount Hill National Park. The Perth Metropolitan Region is visible in distance (facing west). Dominant shrubs include *Grevillea endlicheriana* and *Verticordia acerosa* subsp. *acerosa* (yellow flowers) and *Borya sphaerocephala* forms a dense cover on the shallow soils over the massive granite.

Appendix 6-10: Community type 9. A stand of *Eucalyptus marginata* forest on the lateritic gravels of the Darling Plateau at Kelmscott, with an sub - canopy of *Allocasuarina fraseriana* and *Dryandra sessilis. Isopogon sphaerocephala* (yellow flowered low shrub) is restricted the understorey of this community type. Like most stands of the northern jarrah Forest near the Perth Metropolitan Region, this area has been logged and frequently burnt.

Appendix 7

Floristic data set for the 120 sites surveyed on the Darling Scarp.

The data set (604 taxa x 120 quadrats) is provided in Cornell University Condensed Format. The taxa listed below were amalgamated for the floristic analysis. The species code is derived from the first three letters of the genus and species names with a further two letters from intraspecific rank where applicable, except where otherwise listed below.

Full species list given in Appendix 1, latitude and longitude of sites given in Appendix 8.

Non standard species codes.

CONSETi	*Conostylis setigera*
CONSETo	*Conostylis setosa*
DAVDECi	*Daviesia decipiens*
DAVDECu	*Daviesia decurrens*
HAESIMp	*Haemodorum simplex*
HAESIMu	*Haemodorum simulans*
HYPGLA	*Hypochaeris glabra*
HYPGLAl	*Hypoxis glabella*
LEPI-SPA	*Lepidosperma* sp. A
LEPI-SPB	*Lepidosperma* sp. B (aff *squamatum*)
LEPI-SPC	*Lepidosperma* sp. type C
LEPI-SPD	*Lepidosperma* sp. type D
LEPI-SPE	*Lepidosperma* sp. type E (aff *scabrum*)
LEPI-SPF	*Lepidosperma* sp. type F
LEPI-SPG	*Lepidosperma* sp. type G
LEPI-SPH	*Lepidosperma* sp. type H
LEPI-SPI	*Lepidosperma* sp. type I
LEPI-SPJ	*Lepidosperma* sp. type J
LEPI-SPK	*Lepidosperma* sp. type K
LEPI-SPM	*Lepidosperma* sp. type M
LEPI-SPN	*Lepidosperma* sp. type N

Taxa amalgamated for floristic analysis.
"sp indet." Refers to sterile material that was unable to be resolved to species level.

Acacia alata subsp. *alata*
Acacia alata

Acacia barbinervis subsp. *barbinervis*
Acacia barbinervis

Acacia lasiocarpha sedifolia
Acacia lasiocarpha

Acacia pulchella subsp. *glaberrima*
Acacia pulchella subsp. *pulchella*
Acacia pulchella

Austrostipa sp. indet
Austrostipa campylachne

* *Avena sp. indet*
* *Avena barbata*
* *Avena fatua*

Caladenia flava subsp. *flava*
Caladenia flava

Cassytha racemosa subsp. *racemosa*
Cassytha racemosa

Chamaescilla corymbosa var *latifolia*
Chamaescilla corymbosa var *corymbosa*
Chamaescilla corymbosa

Dianella revoluta
Dianella revoluta var. *divaricata*

Drosera bulbosa
Drosera erythrorhiza

Drosera stolonifera
Drosera stolonifera subsp. *porecta*
Drosera stolonifera subsp. *stolonifera*

Eryngium pinnatifidum
Eryngium pinnatifidum subsp. *pinnatifidum*

Eucalyptus marginata
Eucalyptus marginata subsp. *elegantella*

* *Galium divaricatum*
* *Galium murale*

Goodenia micrantha
Goodenia aff. *micrantha*

Grevillea synapheae subsp. synapheae
Grevillea synapheae

Hibbertia commutata
Hibbertia ovata

Hovea trisperma
Hovea trisperma var. *trisperma*
Hovea trisperma var *grandiflora*

Lambertia multiflora
Lambertia multiflora var *darlingensis*

* *Lotus suaveolens*
* *Lotus suaveolens/ angustissimus*
* *Lotus angustissimus*

Melaleuca scabra
Melaleuca acerosa
Melaleuca trichophylla..
Melaleuca aff *scabra*

Millotia sp indet
Millotia tenuiflora subsp. *tenuiflora*
Millotia tenuiflora

Notodanthonia acerosa
Notodanthonia sp.indet
Notodanthonia setacea

Patersonia umbrosa
Patersonia occidentalis
Patersonia umbrosa/occidentalis complex

Patersonia pygmaea subsp. pygmaea
Patersonia aff. *pygmaea*
Patersonia pygmaea

Philydrella pygmaea
Philydrella pygmaea subsp. *pygmaea*
Philydrella aff. *pygmaea*

Pimelea ciliata
Pimelea ciliata subsp. *ciliata*

Pithocarpa corymbosa
Pithocarpa pulchella

Schoenus odontocarpus
Schoenus sculptus

Tetratheca hirsuta
Tetratheca setigera
Tetratheca setigera/hirsuta complex

Thysanotus manglesianus /patersonii complex
Thysanotus manglesianus
Thysanotus patersonii

Thysanotus aff. *tenellus*
Thysanotus thyrsoideus

Trymalium floribundum subsp. *floribundum*
Trymalium floribundum

Vulpia bromoides
Vulpia myuros

Xanthosia pusilla
Xanthosia huegelii

Northern Darling Scarp dataset

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Scarp data set 120 sites and 604 taxa 15-8-97
(13I6)                                                          5
     1     14     19     26     28     32     38     39     52     58     88     91    110
   111    114    118    122    129    137    140    143    154    163    170    172    183
   187    193    195    205    213    227    229    232    237    241    259    266    276
   278    285    289    293    294    296    298    322    330    335    344    357    358
   374    394    399    406    410    411    414    419    437    445    446    452    465
   478    483    492    493    498    514    515    516    530    540    542    543    548
   554    557    559    560    561    564    569    593    600    602    604
     2     14     22     27     28     37     38     53     54     58     61     79     87
    91    110    114    118    122    137    145    164    170    183    187    195    221
   227    234    237    247    248    250    275    276    278    285    289    293    329
   343    347    352    358    359    362    380    388    399    410    411    418    419
   423    440    446    465    492    493    498    514    515    535    542    559    564
   569    584    593    604
     3      2      8     23     27     37     38     50     52     59     82     83     87
    91    111    118    138    140    153    154    163    168    172    195    197    210
   226    230    244    245    259    264    273    274    276    278    286    306    314
   321    330    336    351    354    368    369    373    374    375    416    428    432
   466    471    487    507    524    532    533    539    540    543    548    555    557
   558    561    569    579    583    602    603    604
     4      3     59     82     87     88     91    117    120    140    154    172    210
   276    291    296    314    322    351    369    375    384    387    415    421    440
   464    483    486    503    504    540    593    604
     5     14     28     39     52     56     58     61     87     88     91     98    110
   111    113    115    117    118    123    124    127    140    152    154    195    212
   213    227    241    250    259    266    276    278    285    293    294    296    304
   310    312    336    347    352    357    371    373    381    391    398    410    411
   419    422    423    427    439    445    478    483    486    494    498    504    514
   515    540    542    562    564    567    571    574    578    593    594    600    603
   604
     6      7     19     28     50     53     55     71     88     93    101    118    140
   154    167    171    172    179    189    190    195    206    213    223    229    234
   236    248    259    262    266    276    278    289    293    294    298    322    329
   336    343    375    379    393    399    407    410    411    414    418    440    467
   478    502    512    514    518    537    542    547    552    557    564    579    584
   594    600    604
     7     14     28     32     39     53     56     69     82     87     88     89     91
    93    115    117    120    140    154    155    170    172    173    176    187    189
   195    199    215    218    241    250    259    264    268    278    282    285    291
   335    346    351    387    421    430    440    471    504    505    539    540    542
   557    574    575    580    582    604
     8     14     28     32     38     39     58     61     79     85     87     88     91
    93    110    115    144    170    173    195    218    227    237    239    247    248
   282    284    296    330    341    343    347    354    357    369    388    390    410
   423    440    478    492    504    508    515    524    551    557    559    565    566
   573    584    590    593    604
     9     14     28     38     39     52     53     58     61     82     83     87     88
    91     93     98    109    110    114    118    140    154    159    172    173    183
   191    193    195    199    210    213    217    218    227    232    241    247    259
   264    276    278    285    291    293    296    300    335    344    351    354    357
   369    373    374    387    394    399    402    410    411    414    428    437    440
   465    507    514    515    519    524    539    540    542    552    557    560    569
   573    579    584    594    602    604
    10     14     28     32     37     38     39     53     55     56     58     61     85
    87     88     91     93    110    111    115    120    128    154    164    170    172
   176    187    189    195    199    213    218    227    232    234    237    247    259
   266    276    278    282    300    330    335    337    343    359    375    387    390
   398    410    411    418    421    423    427    440    478    502    504    508    515
   540    542    551    557    571    584    594    600    602    604
    11     13     27     28     39     48     53     55     70     87     91     93    120
   140    170    172    213    219    223    240    259    268    278    320    335    342
   346    351    387    391    398    411    415    417    419    440    478    504    540
   560    574    575    579    582    596    604
    12     14     27     32     35     41     53     58    107    109    110    118    133
   140    187    192    195    205    223    227    232    234    241    248    258    265
   278    300    329    337    354    388    394    410    411    414    434    449    490
   504    507    514    518    524    531    537    542    559    575    586    598    603
    13     12     14     22     28     39     53     57     58     79     87     88     91
    93    104    110    114    115    120    137    142    170    171    172    176    183
   187    195    218    223    232    237    241    247    248    257    258    278    285
   293    296    312    341    343    357    390    399    407    410    440    465    473
   482    493    504    515    523    564    583    593    594    604
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14 22 28 32 33 52 58 79 110 115 122 163 164
167 183 187 192 195 205 232 234 237 241 257 258 266
276 278 282 285 293 300 302 308 337 343 357 388 410
411 418 426 436 440 446 452 465 490 492 493 496 504
514 528 530 531 537 542 559 560 590 598 603
15 14 21 28 46 52 53 58 79 87 91 93 104
110 114 118 120 170 172 177 183 187 195 213 227 232
236 241 247 248 257 259 260 276 278 282 285 293 294
296 298 300 337 343 346 357 406 407 410 411 414 437
440 465 478 492 496 505 515 523 528 542 557 558 561
564 579 583 604
16 12 22 28 37 40 79 87 91 100 105 112 113
114 141 155 183 187 200 235 257 261 266 283 285 287
290 293 296 303 308 329 340 357 358 359 399 400 422
423 434 446 451 454 465 473 493 501 515 523 531 557
564 569 572 584 591 595 594
17 2 8 10 23 32 35 38 52 54 77 82 91
110 113 114 118 138 140 148 154 163 169 183 191 195
205 210 226 229 230 243 244 245 248 253 256 259 266
272 276 277 278 286 291 293 299 306 321 330 336 351
353 357 370 371 373 374 375 379 383 387 392 416 425
427 429 432 437 445 450 465 483 487 514 524 539 543
560 561 569 601 602 603
18 1 10 14 24 51 53 58 80 91 104 107 109
111 118 122 140 153 155 187 189 195 205 209 227 229
234 235 236 247 248 265 266 278 285 288 293 295 296
313 318 321 329 357 383 394 412 416 449 485 504 512
514 515 516 539 540 542 548 553 558 564 583 598 603
19 14 19 22 24 32 41 58 66 80 87 107 110
133 134 137 140 147 187 191 201 205 227 231 232 237
241 247 248 257 258 265 266 278 288 302 308 329 337
355 357 377 379 388 394 400 410 411 428 446 455 465
472 492 493 508 513 516 534 537 553 559 583 586 598
603
20 14 17 27 29 43 53 58 81 87 93 96 97
98 110 114 118 135 137 139 142 154 160 163 166 168
183 195 205 210 223 232 248 259 277 278 289 293 296
301 336 370 377 393 394 406 411 418 435 454 458 461
465 474 484 488 504 505 510 514 518 542 557 564 579
584 594 604
21 14 53 54 58 81 87 93 110 118 122 124 127
137 140 141 142 148 154 160 163 179 183 189 195 210
223 227 234 236 237 259 265 266 269 276 277 278 293
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583	600	604										
120	17	22	28	32	37	53	54	55	56	58	61	79
87	88	91	93	104	110	114	115	126	137	138	140	172
183	184	187	232	234	235	236	241	247	257	258	266	268
282	283	285	293	294	296	302	326	337	343	346	354	358
370	380	388	409	410	411	434	446	465	478	492	493	514
515	531	534	548	557	559	564	569	575	584	593	594	604
0												

ACAALA	ACABAR	ACADEN	ACAEXT	ACAHOR	ACAINC	ACALAS	ACALAT	ACANER	ACAOBO
ACAONCONA	CAONCPAA	CAPRE	ACAPUL	ACARES	ACASAL	ACASES	ACASTE	ACATER	ACAURO
ACAWIL	ACTLEU	ADEBAR	AGOGRA	AGOLIN	AGRAVE	AGRSCA	AIRCAR	ALENIT	ALLFRA
ALLHUE	ALLHUM	ALLMIC	AMPAMP	AMPDEB	AMPLAG	AMPSTR	AMPTUR	ANAARV	ANDARI
ANDLEH	ANIBICBI	ANIMAN	ANTGRA	APHBRI	APHCYP	ARCCAL	ASPASP	ASTAFFF	AASTCIL
ASTFOL	ASTPAL	AUSCAM	AUSCOM	AUSELE	AVEBAR	AVEMIC	BAECAM	BANGRA	BANLIT
BARTRI	BAUJUN	BAURUB	BAUVAG	BEAMAC	BEAPUR	BEYLEC	BILBICBI	BILCAN	BILCOE
BILDRUCO	BILPARGU	BILVAR	BORCON	BORCYM	BORFAS	FABOROVA	BORRAMRA	BORSPH	BORTEN
BOSERI	BOSORN	BOSSPWA	BRACIL	BRADIS	BRAIBE	BRIMAX	BRIMIN	BRODIA	BROHOR
BURCON	BURMUL	CAEMIC	CAEOCC	CALACU	CALCOR	CALCYA	CALFLA	CALFOO	CALGLU
CALLONLO	CALMAC	CALMAR	CALQUA	CALRUP	CALSAN	CALTOR	CALVAR	CASGLA	CASPOM
CASRAC	CENALE	CENARI	CENDRU	CENERY	CENINC	CERGLO	CHACOR	CHASER	CHEAUS
CHESIESI	CHODIC	CHOENO	CICFIL	CLEPUB	COMCAL	COMCIL	COMVIR	CONACU	CONALB
CONAND	CONAUR	CONCAR	CONHUE	CONJUN	CONREM	CONSETi	CONSETo	CONUND	CORCAL
CRAEXS	CRAPED	CRAVAR	CREFOE	CRYARB	CRYNUT	CRYPUN	CYAAVE	CYADEF	CYAGEM
CYASER	CYPTEN	DAHALA	DAMLIN	DARCIT	DARPIM	DARTHY	DASBRO	DAUGLO	DAVANG
DAVCOR	DAVDECi	DAVDECu	DAVHOR	DAVLON	DAVNUD	DAVPOL	DAVPRE	DAVRHO	DESASP
DIAREVDI	DICCAP	DICCRI	DICPRE	DILSPA	DIOHAS	DIPHUELE	DIUAFFC	ODIUBRU	DIULAX
DIUPOR	DODCER	DROERY	DROGLA	DRONET	DROMAC	DROMEN	DRONEE	DROPALl	DRORoS
DROSTO	DRYARM	DRYBIP	DRYFRAFR	DRYLINLI	DRYPRA	DRYSES	EHRCAL	EHRLON	ELYBRU
ELYEMA	ERIDILMU	ERIHEL	ERIPALL	ERISPI	ERYPINPI	EUCACC	EUCLAE	EUCLAN	EUCMAR
EUCPAT	EUCRUD	EUCWAN	EUPPEP	FREAFFLE	FUMCAP	GAHARI	GALDIV	GASBIL	GASPHL
GASSPI	GASVIL	GLACAR	GLAUND	GLIAURAU	GOMKNI	GOMMAR	GOMOVA	GOMPOL	GOMPRE
GOMSHU	GONCOR	GONNOD	GOOCAE	GOOFAS	GOOMIC	GREBIP	GREDIVDI	GREEND	GREMANMA
GREPIL	GREPIM	GREQUE	GRESYN	GREWIL	GUISARSA	HAEDIS	HAELAX	HAEPAN	HAESIMp
HAESIMu	HAESPI	HAKAMP	HAKCER	HAKCRI	HAKCYC	HAKERI	HAKINC	HAKLIS	HAKMYR
HAKPET	HAKPRO	HAKRUS	HAKSTE	HAKTRI	HAKUND	HARCOM	HEMINC	HEMPUN	HEMUNC
HESFAL	HIBACE	HIBAFFGL	HIBAMP	HIBAUR	HIBCOM	HIBHUE	HIBHYP	HIBLAS	HIBMYL
HIBRHA	HIBSPISP	HIBSUB	HOMFLA	HOMHOM	HOVCHO	HOVPUN	HOVTRI	HYACOT	HYADEM
HYBFLO	HYDALA	HYDCAL	HYPANG	HYPEXS	HYPGLA	HYPGLAi	HYPOCC	HYPROB	ISOASP
ISOCUN	ISODUB	ISOHYP	ISOMAR	ISONOD	ISOSPH	IXIMAC	JACALA	JACRES	JUNBUF

JUNCAE JUNCAP KENCAR KENCOC KENPRO KENSTI KICELAELKINAUS KUNMIC LABLAN
LABPUN LAGHUE LAMMULIALASBRA LASPTE LAWROS LAXGRA LAXSES LAXSQU LECBIL
LEPCUN LEPERU LEPFIM LEPGLA LEPI-SPALEPI-SPBLEPI-SPCLEPI-SPDLEPI-SPELEPI-SPF
LEPI-SPGLEPI-SPHLEPI-SPILEPI-SPJLEPI-SPKLEPI-SPMLEPI-SPNLEPPRE LEPTET LEPTUB
LEUCAP LEUGRA LEUPRO LEUPUL LEUSPR LEUVER LEVPUS LEVSTI LINTRI LOBALA
LOBGIB LOBHET LOBRHO LOBRHY LOBTEN LOLPER LOLRIG LOMAFFMILOMBRI LOMCAE
LOMHER LOMINT LOMMIC LOMNIG LOMPRE LOMPUR LOMSER LOMSON LOMSPA LOMSUA
LOTANG LOXC1N LOXFAS LUZMER LYPSER LYSCIL MACRIE MELAFFSCMELPRE MELRAD
MELRHA MESGRA MESPSE MESTET MICLON MICMEDMEMICMEDQUMICSTI MILTEN MIRSPI
MOEERE MONBRA MONDEB MUEADP NEMACU NEMCAP NEMDIL NEMPLI NEMSPA NEUALO
NOTSET NUYFLO OLABEN OLEPAU OPEAPI OPEECH OPEHIS OPEVAG OROMIN ORTLAXLA
OXAPER PARLAT PARVIS PASDIL PATBAB PATJUN PATOCC PATPYG PATRUDRUPELLITLI
PENAIR PENPEL PERANG PETBIL PETLIN PETSEM PETSTR PETVEL PHIPYG PHYCAL
PHYDRU PHYPAR PIMARG PIMBREBRPIMCIL PIMIMBPIPIMPRE PIMSUASUPITPUL PLACOM
PLAJUN POADRU POAHOM PODANG PODGRA PODLES POLAVI PORMIC PRAGRA PRAPAR
PROFRAFRPTEAFFNAPTEBAR PTEESC PTEPAN PTEREC PTESAN PTEVIT PTIDEC PTIDRUDR
PTIMAN PULERI QUIURV RESSIN RHOCIT RHOCOR RHOMAN ROMROS RUBAFFSERULCYG
RUME-SPASANACU SCACAL SCACAN SCAGLA SCAPIL SCAPLA SCAREP SCHBIF SCHBRE
SCHCLA SCHGRA SCHNAN SCHSCU SCHSUBf SCHUNI SELGRA SENDIA SENLEU SILHUM
SILMUL SOLHET SOLNIG SONOLE SOWLAX SPABUL SPHMED STAMON STEEMA STILAT
STISIM STYAMO STYBRE STYBRU STYBUL STYCAL STYCAR STYCARAFSTYCIL STYDIC
STYDIU STYECO STYGLA STYHIS STYJUN STYLIN STYPER STYPET STYPUB STYPYC
STYREP STYSCH STYTEN SYNACU SYNGRA SYNPIN TEMBIL TEMDRU TETCAP TETLAE
TETNUD TETOCT TETSET THEAFFMATHEAFFPATHEANT THEBEN THECRI THEFLE THEMAC
THETRI THOFOL THOGLU THYASP THYDIC THYFAS THYMAN THYMUL THYSPA THYTEN
THYTHY TOLBAR TRACOECOTRAPIL TRIANG TRIARV TRIB-SP TRIBRA TRIBRU TRIC-SP
TRICAM TRICEN TRICER TRIDUB TRIELA TRILIG TRILON TRISCA TRISPA TRISUB
TRYANG TRYFLO TRYLEDROURSANT VELTRI VERACEACVERACEPRVERHUE VERINS VERPEN
VERPLUPLVIMJUN VULMYU WAHPRE WAISUA WATMER WURDIO XANACA XANATK XANCAN
XANCIL XANGRA XANHUE XANPRE
ARSC01 ARSC02 ARSC03 ARSC04 ARSC05 BUSH01 BYFD01 BYFD02 BYFD03 BYFD04
CHBK01 CSBK01 CSBK02 CSBK03 CSBK04 EBNT01 ELBK01 ELBK02 ELBK03 GBHR01
GBHR02 GBHR03 GHNP01 GHNP02 GHNP03 GHNP04 GOBB01 GOBB02 GOBB03 GOBB04
GOBB05 GOHL01 GOHL02 GOHL03 HELV01 HELV02 HELV03 HELV04 JFNP01 JFNP02
JFNP03 JFNP04 JFNP05 JHDL01 JHDL02 JHDL03 KELM01 KELM02 KELM03 KELM04
KELM05 KELM06 LESM01 LESM02 LESM03 LESM04 LESM05 MATT01 MATT02 MATT03
MATT04 MATT05 MATT07 MATT08 MATT09 MATT10 MATT11 MATT12 MATT13 MATT15
MATT16 NTDN01 NTDN02 NTDN03 NTDN04 NTDN05 NTDN06 NTDN07 NTDN08 NTDN09
PIES01 SCAR01 SCAR02 SERP01 SERP02 SERP03 SERP04 SERP05 SERP06 SERP07
SERP08 SERP09 SERP10 SERP11 SERP12 SERP13 SERP14 SERP15 WAYL01 WAYL02
WAYL03 WAYL04 WAYL05 WAYL06 WAYL07 WAYL08 WAYL09 WAYL10 WAYL11 WAYL12
WAYL13 WAYL14 WAYL15 ZIGZ01 ZIGZ02 ZIGZ03 ZIGZ04 ZIGZ05 ZIGZ06 ZIGZ07

Appendix 8

Location of 120 sites surveyed along the Darling Scarp.

Latitude and longitude in degrees, minutes and seconds.

Plot	Latitude			Longitude		
ARSC01	32	9	11	116	2	15
ARSC02	32	9	16	116	2	11
ARSC03	32	9	37	116	1	55
ARSC04	32	8	51	116	2	43
ARSC05	32	9	11	116	2	11
BUSH01	31	56	0	116	2	25
BYFD01	32	13	20	116	1	15
BYFD02	32	13	12	116	1	15
BYFD03	32	13	12	116	1	12
BYFD04	32	13	10	116	1	10
CHBK01	32	7	48	116	4	1
CSBK01	32	0	54	116	1	53
CSBK02	32	1	21	116	1	43
CSBK03	32	1	25	116	1	44
CSBK04	32	1	20	116	1	27
EBNT01	32	3	52	116	2	29
ELBK01	32	4	48	116	2	34
ELBK02	32	4	4	116	2	29
ELBK03	32	4	8	116	2	28
GBHR01	31	57	6	116	1	55
GBHR02	31	57	9	116	1	54
GBHR03	31	57	5	116	1	59
GHNP01	31	54	54	116	3	22
GHNP02	31	54	33	116	3	36
GHNP03	31	54	30	116	3	37
GHNP04	31	54	26	116	3	38
GOBB01	32	26	30	116	0	46
GOBB02	32	26	27	116	0	44
GOBB03	32	26	34	116	0	56
GOBB04	32	26	39	116	0	54
GOBB05	32	26	13	116	0	55
GOHL01	32	32	19	115	58	55
GOHL02	32	32	22	115	59	6
GOHL03	32	32	22	115	59	10
HELV01	31	56	30	116	5	34
HELV02	31	56	35	116	5	43
HELV03	31	56	41	116	6	10
HELV04	31	56	39	116	4	39
JFNP01	31	51	11	116	5	24
JFNP02	31	53	29	116	4	6
JFNP03	31	53	42	116	4	3
JFNP04	31	52	17	116	4	15
JFNP05	31	52	29	116	4	27
JHDL01	32	18	29	116	1	58
JHDL02	32	18	51	116	2	1
JHDL03	32	18	50	116	2	8
KELM01	32	6	24	116	2	3
KELM02	32	6	21	116	2	22
KELM03	32	6	27	116	1	36
KELM04	32	6	42	116	1	40
KELM05	32	6	33	116	1	41
KELM06	32	6	45	116	1	42
LESM01	31	59	2	116	2	25
LESM02	31	59	44	116	1	48
LESM03	31	59	44	116	1	52
LESM04	32	1	15	116	2	12
LESM05	32	1	11	116	2	2

MATT01	31	53	14	116	4	21
MATT02	31	54	29	116	5	29
MATT03	31	51	44	116	5	53
MATT04	31	51	42	116	4	43
MATT05	31	53	12	116	4	43
MATT07	31	53	24	116	5	0
MATT08	31	52	10	116	6	33
MATT09	31	52	26	116	6	33
MATT10	31	52	22	116	4	46
MATT11	31	52	11	116	6	3
MATT12	31	51	26	116	4	54
MATT13	31	52	30	116	5	33
MATT15	31	52	33	116	5	33
MATT16	31	52	21	116	6	51
NTDN01	32	31	30	116	0	48
NTDN02	32	31	32	116	0	39
NTDN03	32	31	15	115	59	54
NTDN04	32	30	50	116	0	15
NTDN05	32	31	39	116	0	49
NTDN06	32	31	44	116	0	50
NTDN07	32	32	14	116	0	26
NTDN08	32	31	27	116	0	33
NTDN09	32	30	57	116	0	0
PIES01	31	57	43	116	4	24
SCAR01	32	29	49	115	59	55
SCAR02	32	29	48	115	59	53
SERP01	32	22	39	115	59	55
SERP02	32	22	27	116	0	8
SERP03	32	22	28	116	0	7
SERP04	32	22	30	116	0	10
SERP05	32	22	41	116	0	12
SERP06	32	23	4	116	0	16
SERP07	32	22	50	116	0	24
SERP08	32	22	25	116	0	22
SERP09	32	22	36	115	59	42
SERP10	32	22	31	115	59	47
SERP11	32	22	46	116	0	58
SERP12	32	22	57	116	0	41
SERP13	32	21	39	116	0	29
SERP14	32	22	42	116	0	2
SERP15	32	22	11	116	0	32
WAYL01	31	42	21	116	3	5
WAYL02	31	42	20	116	3	5
WAYL03	31	42	5	116	3	7
WAYL04	31	42	34	116	3	47
WAYL05	31	42	35	116	3	57
WAYL06	31	43	10	116	4	24
WAYL07	31	43	59	116	4	17
WAYL08	31	44	21	116	4	29
WAYL09	31	42	57	116	4	51
WAYL10	31	44	2	116	4	40
WAYL11	31	43	57	116	4	48
WAYL12	31	43	37	116	5	3
WAYL13	31	43	29	116	5	14
WAYL14	31	43	35	116	5	20
WAYL15	31	43	3	116	5	11
ZIGZ01	31	56	31	116	3	8
ZIGZ02	31	56	29	116	2	53
ZIGZ03	31	56	31	116	2	45
ZIGZ04	31	56	18	116	2	46
ZIGZ05	31	56	7	116	2	28
ZIGZ06	31	56	54	116	2	53
ZIGZ07	31	56	50	116	2	35