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Flora and vegetation of banded iron formations of the Yilgarn Craton: Cashmere Downs Range

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ABSTRACT

A quadrat based study of the flora and plant communities of the banded ironstone range of Cashmere Downs, found 144 taxa, with 142 native and two weeds. Two priority taxa and five taxa with significant range extensions (>100km) were found. Fifty one quadrats were established to cover the major geographical, geomorphological and floristic variation across the range. Data from 49 of these quadrats were used to define five community types, with two subtypes in two communities. Differences in communities were strongly correlated with underlying geology and soil fertility. None of the plant communities found on the banded ironstone ranges on Cashmere Downs are represented in secure conservation reserves.

INTRODUCTION

Cashmere Downs is a pastoral lease located on the northern side of Lake Barlee, approximately 100km south of Sandstone, and 550 km northeast of Perth, in the central Goldfields region of Western Australia. The range on Cashmere Downs is located in central region of the Yilgarn Craton on the Youanmi Terrane (Cassidy *et al.* 2006). It is characterized by strike ridges and subrounded hills, with prominent ridges of banded-iron formations and chert (Chen 2004). There is currently no accepted topographic name for these features and here will be referred to as the Cashmere Downs Range. The whole area has previously undergone exploration for base metals and is currently being explored for iron ore.

The Cashmere Downs Range belongs to the northern section of the Mount Elvire greenstone belt which is structurally composed of several synclines resulting from several deformation events. The range is composed of ultramafic rocks (generally referred to as greenstones), mainly tremolite-chlorite (-talc) schists, intercalated with metamorphosed mafic rocks and banded iron formations (Stewart *et al.* 1983, Chen 2004). Mafic refers to igneous rocks or minerals of high magnesium-iron content (Eggleton 2001). Metagabbro is the dominant mafic rock in the Cashmere Downs area and is commonly found exposed on the flanks of banded ironstone and chert ridges (Chen 2004).

The range on Cashmere Downs is the result of several folds and consequently can be divided into 2 main areas. The first area, at the western side of the range, runs approximately north-south with a more complex geology of banded ironstone ridges. Mafic and ultramafic rocks are prevalent amongst banded iron formations. The second area to the east runs in a north-east south-west line. The ridges are predominantly banded iron formations, at a higher elevations and have fewer exposed outcrops of mafic and ultramafic rock.

The climate of the region is semi-desert Mediterranean with mild wet winter and hot dry summers (Beard 1990). Mean annual rainfall at Cashmere Downs Station is 252.9 mm, with moderate seasonal variation over the 83 years of record (1919–2002: decile 1, 128.5 mm; decile 9, 426.9 mm). The highest maximum temperatures occur during summer, with January as the hottest month (mean maximum temperature 36 °C and mean 6.2 days above 40 °C). Winters are mild with lowest mean maximum temperature recorded for July of 17.5 °C. Temperatures occasionally fall below 0 °C in winter (a mean 0.9 days below 0 °C), with a mean minimum of 5.9°C in July.

The Cashmere Downs Range is located in the east of the Murchison bioregion, but has only been mapped at a very broad scale. Beard (1976) mapped the Murchison region at 1:1,000,000 and mapped the range as mulga and *Acacia quadrimarginea* scrubland. A regional survey of the Youanmi-Leonora region, where the range is located, reported a general cover of *Acacia* scrub with scattered shrubs of *Senna* spp. and *Ptilotus obovatus* and herbaceous plants such as *Cheilanthes* sp. (Milewski & Dell, 1992) on the upland areas. Payne *et al.* (1998) mapped the range as part of the Brooking land system, defined as ridges, hillslopes, stony plains of banded ironstone, dominated by the stony ironstone mulga shrublands vegetation class (*Acacia aneura* tall shrublands).

To date, there have been no targeted surveys of the Cashmere Downs Range and the only descriptions have been part of a broader condition or mapping survey (Beard

1976; Payne *et al.* 1998). Previous vegetation surveys of other Banded Iron Formation ranges have shown the presence of rare and endemic taxa and floristic communities that are unique to and often restricted to the range (Gibson and Lyons 1998a, 1998b, 2001a, 2001b; Gibson 2004a, 2004b; Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c). The aim of the present study was to undertake a detailed floristic survey of the Cashmere Downs and to identify and describe the flora and plant communities that occur on these ironstone ranges. This paper is one of a continuing series examining the flora and vegetation of banded iron formation ranges in the Yilgarn (Markey and Dillon 2008a, 2008b; Meissner & Caruso 2008a, 2008b, 2008c).

METHODS

The methodology employed in this survey follows the standard procedure used in previous vegetation surveys of other ironstone and greenstone ranges in Western Australia (Gibson and Lyons 1998a, 1998b, 2001a, 2001b; Gibson 2004a, 2004b; Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a,b,c). Fifty one 20 x 20 m quadrats were established on the crests, slopes and foot slopes of the range on Cashmere Downs in August and September 2006 (Figure 1). Quadrats were established to cover the broader geographical and geomorphological variation on banded iron formations and adjacent geologies found in the study area. The quadrats were

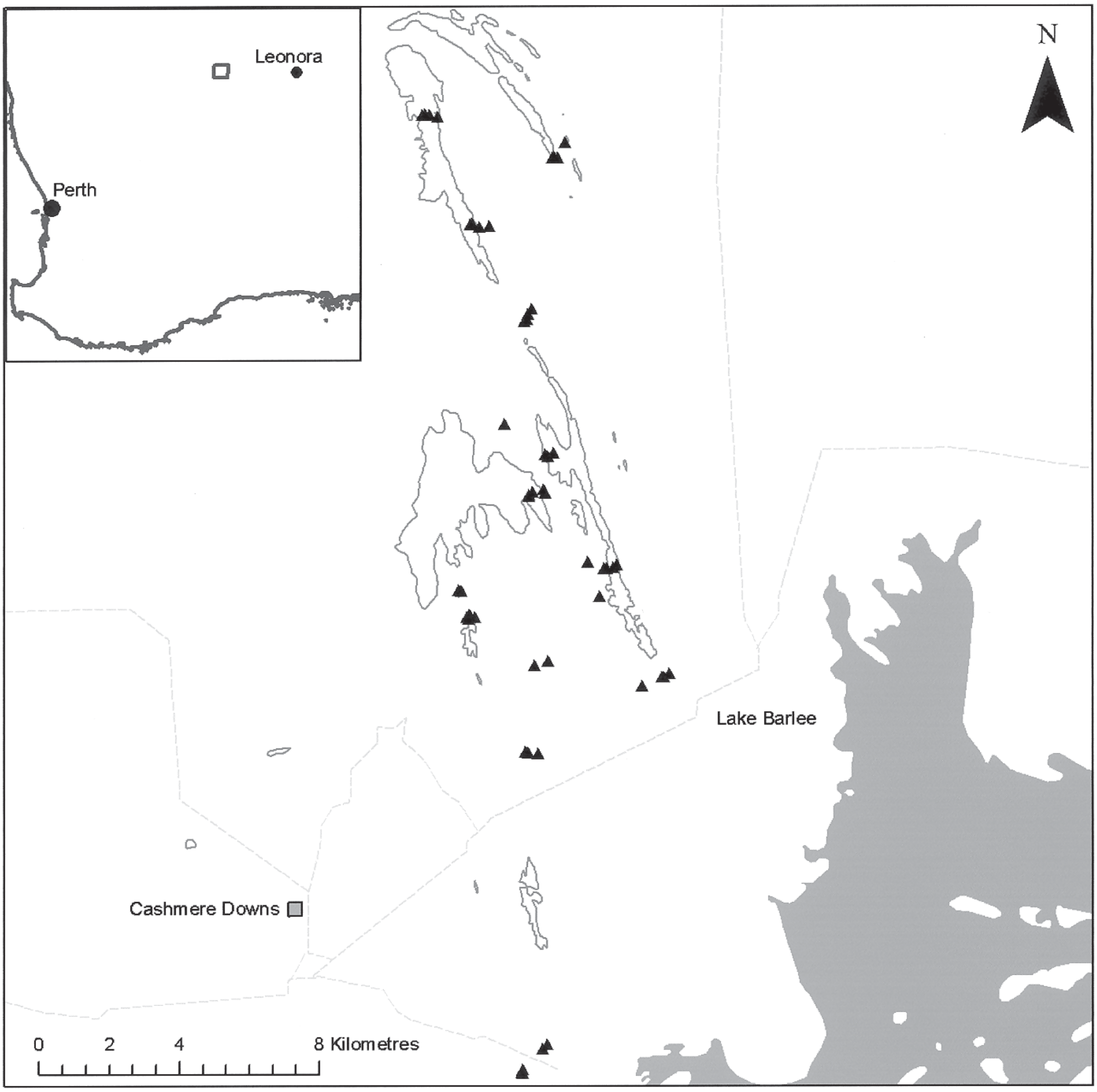

Figure 1. Location of the study area, approximately 100km south of Sandstone, on the Cashmere Downs pastoral lease. Fifty one quadrats (▲) were established on the ranges of Cashmere Downs. The 480m contour is shown.

strategically placed in vegetation across the range in a toposequence, from crests and slopes of exposed bedrock and scree, to footlsope and plains composed of colluvial deposits. Each quadrat was permanently marked with four steel fence droppers and their positions determined using a GPS unit. All vascular plants within the quadrat are recorded and collected for later identification at the Western Australian Herbarium.

Data on topographical position, disturbance, abundance, size and shape of coarse fragments on surface, the abundance of rock outcrops (defined as the cover of exposed bedrock), cover of leaf litter and bare ground were recorded following McDonald *et al.* (1990). Additionally, growth form, height and cover were recorded for dominant taxa in each strata (tallest, mid- and lower). The quantitative data were used to describe the plant communities following McDonald *et al.* (1990).

Soil Analysis

Twenty soil samples were collected from the upper 10 cm of the soil profile within each quadrat. The soil was bulked and the 2 mm fraction extracted using the Mehlich No. 3 procedure (Mehlich 1984). The extracted samples were analysed for B, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S and Zn using an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). The extracted samples were then analysed using Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). This procedure is an effective and cost efficient alternative to traditional methods for evaluating soil fertility and has been calibrated for Western Australian soils (Walton and Allen 2004). pH was measured in 0.01M CaCl2 at soil to solution ratio of 1:5. Effective cation exchange capacity (eCEC) was calculated from the sum of exchangeable Ca, Mg, Na and K (Rengasamy & Churchman 1999). Exchangeable Ca, Mg, Na and K were obtained by multiplying the values of Ca, Mg, Na and K obtained from ICP-AES by a standard constant. Organic carbon was measured on soil ground to less than 0.15 mm using Metson's colorimetric modification of the Walkley and Black method 6A1 (Metson 1956; Walkley 1947). It involved wet oxidation by a dichromate-sulfuric acid mixture, which produced enough heat to induce oxidation of the organic carbon (Rayment and Higgenson 1992). Total Nitrogen was measured using the Kjeldahl method 7A2 (Rayment and Higgenson 1992). The nitrogen was measured by automated colorimetry by the nitroprusside/dichloro-S-triazine modification (Blakemore *et al.* 1987) of the Berthelot indophenol reaction reviewed by Searle (1984). Electrical conductivity (EC) was based on a 1:5 soil/deionised water extract and measured by a conductivity meter at 25° C (Rayment and Higgenson 1992).

Multivariate Analysis

Quadrats were classified on the basis of similarity in species composition on perennial species only and excluding singletons. This was to facilitate comparison with other analyses of banded ironstone ranges and to allow these comparisons not to be confounded by temporal variations in annuals numbers (Gibson & Lyons 1998 a, b, 2001a,b; Gibson 2004a,b; Markey and Dillon 2008a,b; Meissner and Caruso 2008a,b,c). The quadrat and species classifications were undertaken using the Bray - Curtis coefficient followed by Flexible UPGMA (Unweighted pair-group mean average; β = -0.1; Belbin 1989) clustering. The Bray – Curtis coefficient is commonly used in ecological studies especially in presence/ absence datasets (Belbin 1989; Clarke *et al.* 2006) while Flexible UPGMA is an effective method of recovering true group structure (Belbin & McDonald 1993). PATN uses a beta value of -0.1 in Flexible UPGMA to dilate and counteract the known underestimation of larger association values (Belbin 1989; Belbin *et al.* 1992). Indicator species and species assemblages characterising each community were determined following Dufréne and Legendre (1997) using INDVAL routine in PC-ORD (McCune and Mefford 1999). Quadrats were ordinated using SSH (semi-strong hybrid multidimensional scaling), a non parametric approach and not based upon the assumptions of linearity, or presume any underlying model of species response gradients. Correlations of environmental variables were determined using PCC (Principal Component Correlation) routine and significance determined by MCAO (Monte Carlo Attributes in Ordination) routine in PATN (Belbin 1989). PCC uses multiple linear regressions of variables in the three dimensional ordination space (Belbin 1989). Statistical relationships between quadrat groups were tested using Kruskal-Wallis non parametric analysis of variance (Siegel 1956), followed by Dunn's Multiple comparison test (Zar 1999).

Nomenclature generally follows Paczkowska and Chapman (2000).

RESULTS

Flora

A total of 144 taxa were recorded from the Cashmere Downs Range, with 142 native taxa and 2 weed species, *Pentaschistis airoides* subsp. *airoides* and *Cucumis myriocarpus* (Appendix). Annual species comprised approximately 20% of the taxa (41 taxa). The best represented families were Poaceae (15 taxa), Chenopodiaceae (12), Mimosaceae (10), Asteraceae (11), Myoporaceae (9). The most common genera were *Acacia* (10 taxa), *Eremophila* (9) and *Ptilotus* (7).

Rare and Priority Flora

Two priority species were recorded from the Cashmere Downs Range. Priority taxa are threatened flora that are protected under the Wildlife Conservation Act. They are considered to be poorly known, potentially rare or threatened (Atkins 2008).

- *Phyllanthus baeckeoides* (Euphorbiaceae) is a priority one species, recorded from two quadrats in this survey on ironstone substrate. It is a dioecious shrub to 1.5 m with small white flowers recorded as growing on laterite and ironstone outcrops from around Laverton, Weld Range and with the nearest population at Windemarra station, 115km NW of Cashmere Downs.

- *Hemigenia exilis* (Lamiaceae) is a Priority 4 shrub to 2 m with pale blue flowers. It was an opportunistic collection, found growing on laterised ironstone. The nearest population is 100 km to the east.

Flora of Taxonomic Interest

A single species of taxonomic interest was recorded during the survey of Cashmere Downs Range. *Portulaca* aff. *oleracea* (R. Meissner & B. Bayliss 963) is a succulent annual morphologically similar to *Portulaca oleracea* apart from the seeds which have low rounded tubercules in more or less concentric rows and a shiny surface as opposed to tuberculate seed not arranged in concentric rows and with a dull surface (Jessop 1981). This taxon has also been collected from Robinson Range, 200km north of Meekatharra.

Range Extensions

Four taxa, including *Hemigenia exilis*, had significant range extensions (>100 km from previously known collections).

- *Senecio pinnatifolius* var. *pinnatifolius* is a perennial shrub to 1m with bright yellow, daisy flowers. The nearest population is approximately 300km to the west. It was collected on a disturbed exploration track on the crest of the range. The variants of *Senecio pinnatifolius* intergrade and further collections are required to elucidate the status of inland forms (Radford *et al.* 2004).
- *Grevillea haplantha* subsp. *haplantha* is a Proteaceous shrub to 3m commonly found growing in red loamy soils. In this survey, it was found growing on the sandy loam soils derived from ultramafic rocks. This collection extended the range by 100km north.
- *Cheilanthes brownii* is a perennial fern with densely woolly fronds found growing in the cracks of rocky outcrops on the range. Eight collections were made from rocky sites across the range. Subsequently, an additional collection was made at the nearby Mount Forrest – Mount Richardson Range , 30 km to the east. Both collections extend the eastern range by 300 km.

Vegetation Communities

A total of 134 taxa were recorded from the 51 quadrats, with 93 perennial taxa. Two quadrats were excluded from the final analysis as they were outliers. Both sites were located close to Lake Barlee, occurred on a mixed geology of mafic and banded iron and some evidence of disturbance by goats. In addition, a high number of singletons and annuals were recorded for both sites. Preliminary analysis showed no difference on community classification when annual species and singletons were removed. The final analysis removed all annuals and singletons to be consistent with previous work (Gibson and Lyons 1998a, 1998b, 2001a, 2001b; Gibson 2004a, 2004b; Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c).

Five community types were determined from the analysis, based upon ecological sound groupings (Figure 2). Community 5, found on sites with ultramafic geology, were clearly different from the remaining communities (Figure 2). The remaining communities are divided into communities found on sites with mixed geology (Communities 1 and 2) and the communities growing mainly on banded ironstone (Communities 3 and 4), on the eastern area of the range (Figure 1).

Community 1a – This community consists of seven quadrats found on the lower slopes of mafic and banded ironstone bedrock. It can be described as an open

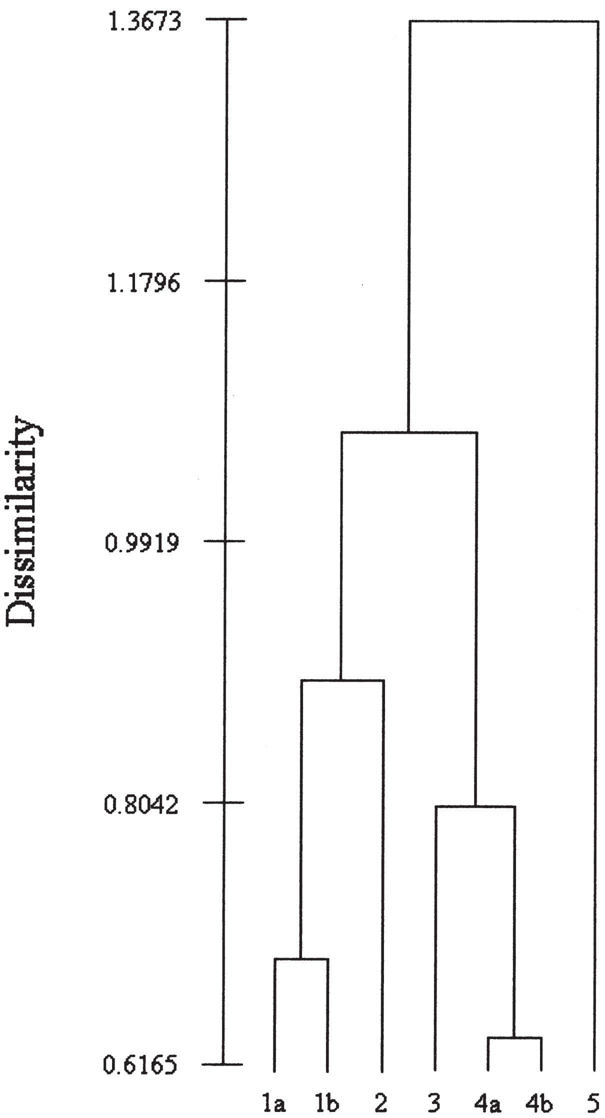

Figure 2. Dendrogram of 7 group level classification of 48 quadrats established at Cashmere Downs. Dissimilarity is based upon the Bray-Curtis index (dilated using β = -0.1).

shrubland to shrublands of dominated by *Acacia aneura*, *Acacia cockertoniana* and *Eucalyptus lucasii* over shrublands of *Scaevola spinescens*, *Acacia exocarpoides*, *Acacia ramulosa* var. *ramulosa*, *Eremophila* spp. (*Eremophila forrestii* subsp. *forrestii*, *Eremophila platycalyx* subsp. *platycalyx*, *Eremophila georgei*), *Dodonaea rigida*, *Senna cardiosperma* over isolated shrubs and grasslands of *Ptilotus schwartzii*, *P. obovatus* var. *obovatus*, *Sida ectogama* and *Eragrostis eriopoda*. The community was characterised by taxa from Species Group B, C and F, and indicator species were *P. obovatus* var. *obovatus*, *A. ramulosa* var. *ramulosa*, *E. eriopoda* and *E. forrestii* var. *forrestii* (Table 1). The community had a mean species richness of 19.3 taxa per quadrat.

Community 1b – The community is found on the midslopes and crests of banded ironstone and mafic bedrock in western part of the range and consists of twelve quadrats. It is described as shrublands of *A. aneura*, *Acacia burkittii*, *Acacia quadrimarginea*, *A. cockertoniana*, *Acacia tetragonophylla* over open shrublands of *Eremophila* spp. (*Eremophila platycalyx* subsp. *platycalyx*, *E. georgei*, *Eremophila latrobei* subsp. *latrobei*), *Senna artemisioides* subsp. *filifolia*, *D. rigida*, *Dodonaea lobulata*, *Drummondita microphylla*, *Acacia exocarpoides*, *Thryptomene decussata* and *Scaevola spinescens* over shrubland and fernland of *Calytrix amethystina*, *Olearia stuartii* and *Cheilanthes sieberi* subsp. *sieberi*. It is characterised by taxa from Species Group B and F, and indicator species *D. rigida*, *E. georgei*, *Cheilanthes sieberi* subsp. *sieberi* and *A. cockertoniana* (Table 1). The community has a mean species richness of 16.3 taxa per quadrat.

Community 2 – This community is represented by only two quadrats found at the southern end of the range near Lake Barlee and growing on a mixture of mafic and banded ironstone. This community was best characterized by Species Group I with *E. platycalyx subsp. platycalyx, O. stuartii, Sida* sp. *Excedentifolia* (J.L. Egan 1925) and *E. georgei* as indicator species (Table 1). Mean species richness was 15.5 taxa per quadrat.

Community 3 – This community was found growing on the crests and midslopes of rocky outcrops of banded ironstone. It is described as shrublands of *Acacia aneura*, *Acacia cockertoniana* and *A. quadrimarginea* over shrublands of *T. decussata*, *Dodonaea petiolaris*, *D. microphylla*, *P. obovatus* var. *obovatus*, *Eremophila glutinosa*, *D. rigida* over shrubland, grassland and fernland of *P. obovatus* var. *obovatus*, *Phyllanthus baeckeoides*, *Sida* sp. *Golden calyces glabrous* (H.N. Foote 32), *Paspalidium basicladum* and *Cheilanthes sieberi* subsp. *sieberi*. It is characterised by taxa from Species Group B, F and G (Table 1). Indicator species were *Ptilotus obovatus* subsp. *obovatus*, *Cheilanthes sieberi* subsp. *sieberi*, *Cheilanthes brownii* and *E. latrobei subsp. latrobei* and has a mean species richness of 16.6 taxa per quadrat.

Community 4a – This community occurred on crests and slopes of the banded ironstone in central part of the range. Shrublands of *Acacia aneura*, *Acacia cockertoniana* and *A. quadrimarginea* over scrubland of *E. glutinosa*, *E. forrestii subsp. forrestii*, *Aluta aspera* subsp. *hesperia*, *Olearia humilis*, *D. microphylla*, *E. latrobei* subsp. *latrobei* and *Prostanthera althoferi* subsp. *althoferi*. It was characterised by Species Group F and indicators species of *E. latrobei subsp. latrobei*, *E. glutinosa*, *Aluta aspera* subsp. *hesperia* and *Olearia humilis* (Table 1). It had a mean species richness of 11.1 taxa per quadrat.

Community 4b – This community was found on rocky upper slopes and crests of banded ironstone found in the central part of the range. It can be described as shrublands of *Acacia aneura*, *A. quadrimarginea* and *A. cockertoniana* over shrublands of *Philotheca brucei* subsp. *brucei*, *E. glutinosa*, *Prostanthera althoferi* subsp. *althoferi*, *Hibbertia arcuata* over fernland of *Cheilanthes seiberi* subsp. *sieberi* and *C. brownii*. The community is characterised by Species Group F and G with indicator species *Acacia cockertoniana*, *A. quadrimarginea*, *E. glutinosa*, *Sida* sp. *Golden calyces glabrous* (H.N. Foote 32), *P. althoferi* subsp. *althoferi*, *Hibbertia arcuata*, and *P. brucei* subsp. *brucei* (Table 1). It had a mean species richness of 12.5 taxa per quadrat.

Community 5 – This community was found on soils derived from ultramafic bedrock, usually heavily weathered and occasionally foliated. It is described as shrublands of *Acacia kalgoorliensis*, *A. burkittii*, *A. tetragonophylla* and *Casuarina pauper* over shrublands of *Senna stowardii*, *Eremophila pantonii*, *Eremophila oppositifolia* subsp. *angustifolia* and *S. spinescens* over shrublands of *P. obovatus* var. *obovatus*, *Olearia muelleri*, *Maireana georgei* and *Sclerolaena densiflora*. It is characterised by Species Group J and many indicator species, *A. burkittii*, *Acacia kalgoorliensis, Alyxia buxifolia*, *C. pauper*, *Eremophila oldfieldii* subsp. *angustifolia*, *Eremophila oppositifolia* subsp. *angustifolia*, *Eremophila pantonii*, *Maireana georgei*, *Maireana trichoptera*, *Ptilotus obovatus* var. *obovatus*, *Rhagodia eremaea*, *S. densiflora*, *Senna artemisioides* subsp. *filifolia* and *Senna stowardii* (Table 1). This community had the highest species richness of 17.8 taxa per quadrat.

Physical Parameters

Univariate analysis on the soil parameters revealed all were significant in differentiating floristic groups (Table 2). Community 4 occurred on less fertile soils, with low values of phosphorus, potassium, and magnesium than Communities 1 and 5, however, it did have significantly higher total nitrogen, molybdenum and sulphur than Community 1. Elements characteristic of mafic and ultramafics (Gray & Murphy 2002), calcium, magnesium, nickel, manganese and copper, were higher in soils from Community 1 and 5, than soils from Communities 3 and 4. In addition, cadmium, cobalt, sodium and molybdenum were also higher in soils from Communities 1 and 5. Community 5 had significantly higher pH than all other communities except Community 1. In contrast, soil derived from ironstone at Communities 3 was more fertile, with higher nitrogen, phosphorus and organic carbon, and had higher in iron than Communities 1 and 5.

Three of the eight site parameters were significantly different between communities (Table 3). Community 3, located on rocky outcrops on the crests and upper slopes of banded ironstone, had a greater slope, larger surficial (coarse fragments) rock size and a high cover of exposed bedrock than community 1 and 5. Community 4 had similar slope and rock outcrop cover to Community 3.

An initial 3-dimensional ordination showed that sites from Community 5 (quadrats on ultramafic substrates) were well separated from all other quadrats (not shown), it was subsequently removed from the final analysis to better elucidate the relationships between the remaining communities. The final ordination (Figure 3A & 3B; stress = 0.1778) showed similar patterns to the univariate analyses and clear separation of groups, especially communities 1 and 4. Many of the environmental variables, cover of rock outcrop, slope, % organic carbon, total nitrogen, coarse fragment size, iron, phosphorus, zinc and slope were higher in the direction of Community types 2, 3 and 4b, in the lower left quadrant (Figure 3C). Sulphur was higher in the upper half of the ordination with Community 4a, the same result as the univariate statistics. Higher values of potassium, magnesium, calcium, ECEC, cobalt and nickel occurred with sites from Community 1a and 1b, in the lower right quadrant of the ordination.

DISCUSSION

A total of 144 taxa were recorded for the range, with approximately 30% consisting of annual flora. This figure of taxa is much lower than other ranges in the region (*cf.* 287 and 238 on the Hunt and Mount Manning Ranges (Gibson & Lyons 2001b; Gibson 2004a) but comparable to the Mount Forrest – Mount Richardson Range 30 km east (114 taxa). Due to below average rainfall, a low number of annuals (41 taxa) was recorded for the Cashmere Downs Range. The nearest range, Mount Forrest – Mount Richardson Range, had even less annuals, with only 23 taxa recorded. One hundred and two perennial taxa were recorded on the Cashmere Downs Range compared to 148 and 142 the Hunt and Mount Manning Ranges (Gibson & Lyons 2001b; Gibson

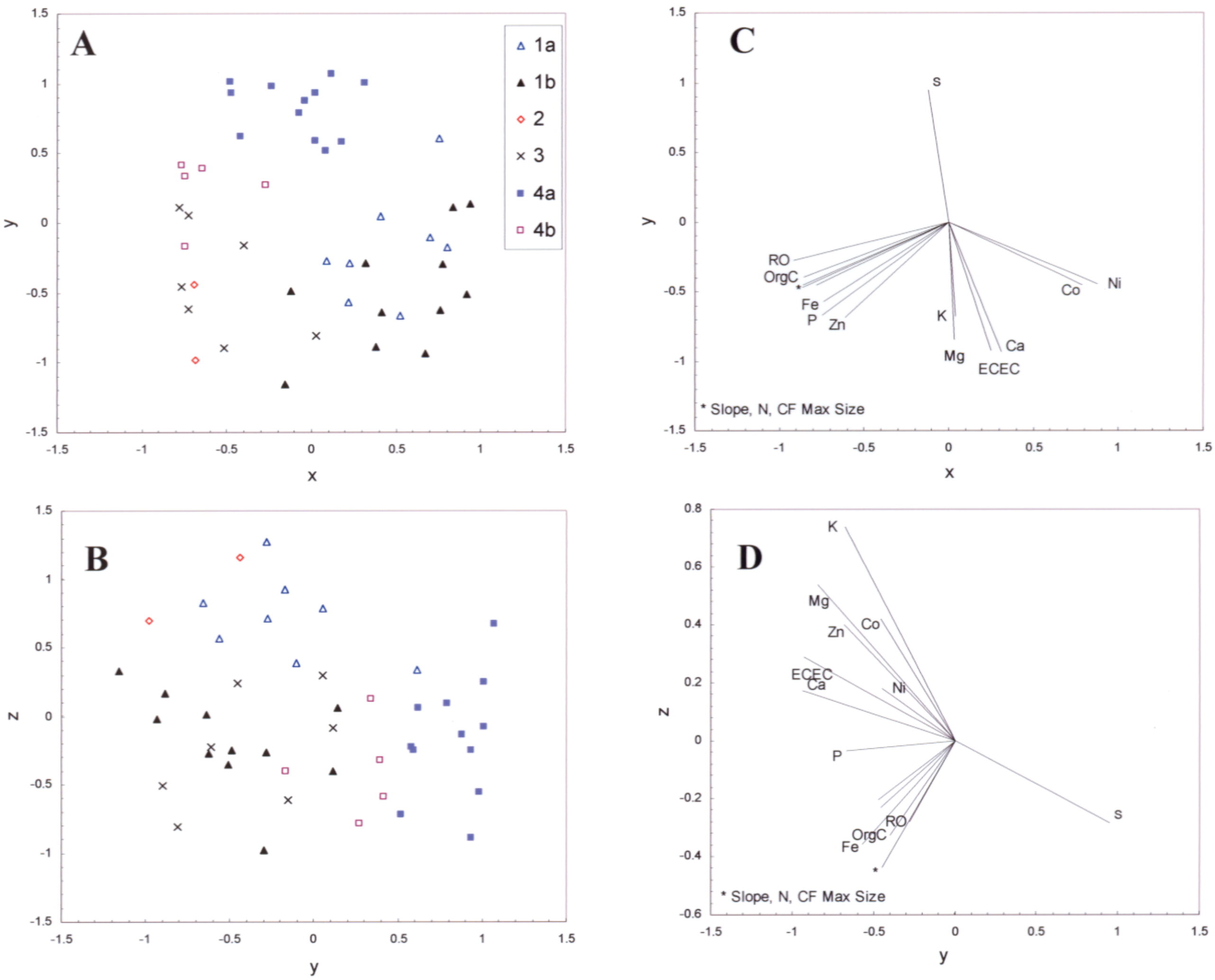

Figure 3. . Three dimensional ordination of the 45 quadrats established on ironstone range on the Cashmere Downs pastoral station and represented by community type (A & B). Community 5 was not included. Lines represent the strength and direction of the best fit linear correlated variables (C & D).

2004a), and 93 perennial taxa at Mount Forrest – Mount Richardson Range. Mount Manning and Hunt Ranges occur in the more mesic south west interzone, where mulga communities are gradually replaced by eucalypt woodlands.

Few priority species were found on the Cashmere Downs Range and no new taxa discovered. New populations of *Phyllanthus baeckeoides*, a Priority one species, were found on Cashmere Downs. Only two collections were made of this species, with the main population found in the central part of the range, in Community 1b. However, it is not an ironstone endemic but rather restricted to rocky outcrops, such as granite, red-lateritic and sandy clay soils (Hunter & Bruhl 1997). In contrast, *Acacia cockertoniana*, formerly Priority 3, is largely restricted ironstone substrates, and was originally found on the Windarling Range, approximately 140 km south of Cashmere Downs. This species was one of the dominant acacias found on the range and also on the Mount Forrest – Mount Richardson Range.

A preliminary comparison of the community composition on Cashmere Downs and Mount Forrest – Mount Richardson Ranges, found that the floristic communities on the two ranges were significantly different (ANOSIM Global $R = 0.115$, $P < 0.01$, Clarke and Warwick 2001). These ranges are approximately 30km apart and highlight the high species turnover between the ironstone ranges, even over short distances. The Mount Elvire and Illaara greenstone belts, represented by Cashmere Downs and Mount Forrest – Mount Richardson Ranges respectively, have similar stratigraphic units (Stewart *et al.* 1983), probably due to their proximity to one another, however Cashmere Downs Range appears to have a more complex geology, with many more different rock types and may provide a greater number of different habitats.

The two quadrats removed from the final analysis were similar to the Community 2 sites. These sites were all located in the southern part of the range, close to Lake Barlee, as well as close to an existing watering bore. This may have increased the grazing activity of goats, which tend to prefer the rocky habitats as refugia. Although not high in weedy species, there was a higher number of annual species.

The main communities found on the Cashmere Downs and Mount Forrest – Mount Richardson Ranges, to some extent, overlap in composition, but each has unique species, or species common on one range but rare on the other. For example, *P. baeckeoides* and *Beyeria* sp. Murchison (B. Jeanes s.n. 7/7/2005) were found only on Cashmere Downs and Mount Forrest – Mount Richardson respectively. While *Aluta aspera* subsp. *hesperia* was a common species and an indicator for Community 4a on Cashmere Downs, it was only found at 3 sites on Mount Forrest – Mount Richardson Range.

In terms of previous surveys, the communities on Cashmere Downs Range correspond to the broad classification of *Acacia* scrub described by Milewski and Dell (1992) and the stony ironstone Mulga shrublands class of Payne *et al.* (1998). However, the communities described in this paper provide a greater amount of detail, separating the initial broad classifications into distinct communities located on the different parts of the range based upon soil type and bedrock.

Soil type on Cashmere Downs Range determined the flora and communities found on the range. Community 5 was found only on ultramafic sites with high pH, calcium, magnesium, nickel, manganese and copper. It was characterised by chenopods and *Senna* not recorded in other communities. As well as separating the ultramafic sites, which had a evidently different vegetation composition (Table 1), communities 1 and 4 are clearly separated based upon their geology, although not as distinctly different from each other as from Community 5. These were the main communities found on the Cashmere Downs Range and occurred on different soils and different bedrock. Community 4 consisted of two subtypes, separated by the amount of exposed banded iron bedrock. Community 4 was found in the eastern area of the range and only on banded ironstone.

Community 1 also consisted of two subtypes, with Community 1a occurring on the lower slopes and Community 1b on the midslope to crests of the range. Community 1 was located on the western part of the range with banded ironstone intercalated with mafic (metabasalt and metagabbro) bedrock. The soils derived from the mafic bedrocks resulted in shared similarities in soil chemistry with Community 5 but still had different communities. None of the vegetation communities found on the range is known from secure conservation reserves.

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REFERENCES

Atkins KJ (2008) *Declared Rare and Priority Flora List for Western Australia, 26 February 2008.* Dept of Environment and Conservation. Como, W.A.

Beard JS (1976) *Vegetation Survey of Western Australia. Murchison 1:1000000 Vegetation Series. Explanatory Notes to Sheet6. Vegetation of the Murchison Region.* University of Western Australia Press, Perth.

Beard JS (1990) *Plant Life of Western Australia*. Kangaroo Press, Kenthurst, NSW.

Belbin L (1989) *PATN Technical Reference*. CSIRO Division of Wildlife and Ecology, ACT.

Belbin L Faith DP Milligan GW (1992) A comparison of two approaches to beta-flexible clustering. *Multivariate Research*, **27**, 417–433.

Belbin L McDonald C (1993) Comparing 3 classification strategies for use in ecology. *Journal of Vegetation Science* **4**, 341–348.

Blakemore LC Searle PL Daly BK (1987) *Methods for chemical analysis of soils.* New Zealand Soil Bureau Scientific Report 80

Cassidy KF Champion DC Krapež B Barley ME Brown SJA Blewett RS Groenewald, PB Tyler IM (2006) *A revised geological framework for the Yilgarn Craton, Western Australia* Western Australia Geological Survey, Record 2006/8, 8p.

Chen SF (2004) *1: 100 000 Geological Series – Explanatory Notes. Marmion andRichardson, Western Australia.* Geological Survey of Western Australia, Perth.

Clarke KR Warwick RM (2001) *Change in marine communities: an approach to statistical analysis and interpretation*, 2nd edition. PRIMER-E: Plymouth.

Clarke KR Somerfield PJ Chapman MG (2006) On resemblance measures for ecological studies, including taxonomic dissimilarities and zero-adjusted Bray-Curtis coefficient for denuded assemblages. *Journal of Marine Experimental Marine Biology and Ecology* **330**, 55–80.

Dufrene M Legendre P (1997) Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* **67**, 345–366.

Eggleton RA (2001) The regolith glossary: surficial geology, soil and landscapes. CRC LEME Australia.

Gibson N (2004a) Flora and vegetation of the eastern goldfields ranges: Part 6. Mt Manning Range. *Journal of the Royal Society of Western Australia* **87**, 35–47.

Gibson N (2004b) Flora and vegetation of the eastern goldfields ranges: Part 7. Middle and South Ironcap, Digger Rock and Hatter Hill. *Journal of the Royal Society of Western Australia* **87**, 49–62.

Gibson N Lyons MN (1998a) Flora and vegetation of the eastern goldfields ranges: Part 2. Bremer Range. *Journal of the Royal Society of Western Australia* **81**, 107–129.

Gibson N Lyons MN (1998b) Flora and vegetation of the eastern goldfields ranges: Part 3. Parker Range. *Journal of the Royal Society of Western Australia* **81**, 119–117.

Gibson N Lyons MN (2001a) Flora and vegetation of the eastern goldfields ranges: Part 4. Highclere Hills. *Journal of the Royal Society of Western Australia* **84**, 71–81.

Gibson N Lyons MN (2001b) Flora and vegetation of the eastern goldfields ranges: Part 5. Hunt Range, Yendeliberin and Watt Hills. *Journal of the Royal Society of Western Australia* **84**, 129–142.

Gibson N Lyons MN Lepschi BJ (1997) Flora and vegetation of the eastern goldfield ranges, 1 Helena and Aurora Range. *CALMScience* **2**, 231–246.

Gray J Murphy B (2002) Parent material and soil distribution. *Natural Resource Management* **5**, 2–12.

Hunter JT Bruhl JJ (1997) Three new species of *Phyllanthus* (Euphorbiaceae: Phyllantheae) for the Northern Territory, one new species for Western Australia, and notes on other *Phyllanthus* species occurring in these regions. *Nuytsia* **11**, 147–163.

Jessop J (editor) (1981) *Flora of Central Australia*. Reed, Frenchs Forrest, NSW.

Markey AS Dillon SJ (2008a) Flora and vegetation of the banded iron formations of the Yilgarn Craton: the central Tallering Land System. *Conservation Science of Western Australia* 7, 121–149.

Markey AS Dillon SJ (2008b) Flora and vegetation of the banded iron formations of the Yilgarn Craton: the Weld Range. *Conservation Science of Western Australia* 7, 153–178.

McCune B Mefford MJ (1999) *PC-ORD. Multivariate Analysis of Ecological Data, Version 4.* MjM Software Design, Gleneden Beach, Oregon, USA.

McDonald RC Isbell RF Speight JG Walker J Hopkins MS (1990) *Australian soil and land survey: field handbook*. Second Edition. Department of Primary Industries and Energy and CSIRO Australia.

Mehlich A (1984) Mehlich 3 soil test extractant: A modification of Mehlich 2. *Communications of Soil Science and Plant Analysis* **15**, 1409–1416.

Meissner R Caruso Y (2008a) Flora and vegetation of the banded iron formations of the Yilgarn Craton: Koolanooka and Perenjori Hills. *Conservation Science of Western Australia* 7, 73–88.

Meissner R Caruso Y (2008b) Flora and vegetation of the banded iron formations of the Yilgarn Craton: Jack Hills. *Conservation Science of Western Australia* 7, 89–103.

Meissner R Caruso Y (2008c) Flora and vegetation of the banded iron formations of the Yilgarn Craton: Mount Gibson and surrounding area. *Conservation Science of Western Australia* 7, 105–120.

Metson A J (1956) Methods of chemical analysis for soil survey samples. *New Zealand Department of Scientific and Industrial Research Soil Bureau Bulletin* **12**, 1–108.

Milewski AV Dell J (1992) III Vegetation and Flora In: The Biological Survey of The Eastern Goldfields of Western Australia Part 6. Youanmi – Leonora Study Area. Records of the Western Australian Museum Supplement Number 40

Paczkowska G Chapman AR (2000) *The Western Australian Flora: A Descriptive Catalogue*. Wildflower Society of Western Australia, Western Australian Herbarium, CALM and Botanic Garden Authority.

Payne AL Van Vreeswyk AME Pringle HJR Leighton KA Henning P (1998) *An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia*. Agriculture Western Australia, Technical Bulletin No. 90, South Perth.

Radford IJ Cousens RD Michael PW (2004) Morphological and genetic variation in the *Senecio pinnatifolius* complex: are variants worthy of taxonomic recognition? *Australian Systematic Botany* **17**, 29–48.

Rayment GE Higginson FR (1992) *Australian Laboratory Handbook of Soil and Water Chemical Methods*. Inkata Press, Melbourne.

Rengasamy P Churchman GJ (1999) *Cation exchange capacity, exchangeable cations and sodicity*. **In**: Peverill, K.I., Sparrow, L.A. and Reuter, D.J. (eds.) Soil analysis: an interpretation manual. CSIRO Publishing, Collingwood, Victoria.

Searle PL (1984) The Berthelot or indophenol reaction and its use in the analytical chemistry of nitrogen. A review. *Analyst* **109**, 549–68.

Siegel S (1956) *Non-Parametric statistics for behavioural sciences*. McGraw-Hill, New York.

Stewart AJ Williams IR Elias M (1983) *1: 250 000 Geological Series – Explanatory Notes. Youanmi, Western Australia*. Geological Survey of Western Australia, Perth.

Walkley A (1947) A critical examination of a rapid method for determining organic carbon in soils – effect of variations in digestion conditions and of inorganic constituents. *Soil Science* **63**, 251–64.

Walton K Allen D (2004) *Mehlich No. 3 Soil Test – The Western Australian Experience*. **In**: Singh, B. (ed) SuperSoil 2004: Proceedings of the 3rd Australian New Zealand Soils Conference, University of Sydney, Australia, 5–9 December 2004. pp 1–5.

Zar JH (1999) *Biostatistical Analysis*. 4th ed. Prentice-Hall, New Jersey.

Table 1

Sorted two-way table of quadrats established at Cashmere Downs Range showing species by community type. Taxa shaded grey within a community are indicator species identified by INDVAL > 17 (Dufrene and Legendre 1997) at the 7 group level (* indicates P< 0.05; ** indicates P<0.01; statistical significance tested by randomisation procedures).

	Species	1a	1b	2	3	4a	4b	5
a	Abutilon cryptopetalum	* *			*			
	Senna cardiosperma	* *						
	Solanum ashbyae	* *	*				*	
	Acacia aneura terete + pungent	* *	*					
	Calytrix amethystina		* *					
b	Acacia exocarpoides	* *	* * * * * *	*	*			*
	Sida sp. unisexual (N.H. Speck 574)	* * *	* * * * *	*				
	Acacia tetragonophylla	* * * * *	* * * *	*	*			* * *
	*Ptilotus obovatus var. obovatus	* * * * * * *	* * * * * *		* * * * * * *			* * * *
	**Dodonaea rigida	* * *	* * * * * * * * * * *		* *		*	
	*Eremophila georgei	* * * * * *	* * * * * * * * * *	* *	*		*	
	Marsdenia australis	* * * * * * *	* * * * * * *	* *	* * *	* *	* * *	*
c	**Acacia ramulosa var. ramulosa	* * * * * * *						
	*Eragrostis eriopoda	* * * * *	*			* *		
	*Eremophila forrestii subsp. forrestii	* * * * *	*			* * * *		
	Dianella revoluta var. divaricata	* *	* *					
	Eucalyptus lucasii	* *	* *					
d	Grevillea haplantha subsp. haplantha		* *					
	Ptilotus schwartzii	*	*					
e	Grevillea berryana	*	*		*	* *		
	Sida atrovirens	* *	*					
	Solanum ellipticum	*			*		*	
	Solanum nummularium	*						*
f	Acacia aneura var. aneura/intermedia	* * * * * * *	* * *		* * * *	* * * * * * *	*	*
	Acacia aneura var. microcarpa	* * * * * * *	* * * * * * *	* *	* * * *	* * * * * * * * * *	* * * * *	
	**Cheilanthes sieberi subsp. sieberi	* * * * * * *	* * * * * * * * * * *		* * * * * * *	* * * * * *	* * * *	
	**Acacia cockertoniana	* *	* * * * * * * * * *		* *	* * * * * * * * *	* * * * *	*
	**Eremophila latrobei subsp. latrobei	* * * * *	* * * * * *		* * * * * *	* * * * * * * * * * *	*	
	**Acacia quadrimarginea	* * * *	* * * * * *		* * *	* * * * * * *	* * * * *	
	**Eremophila glutinosa		*		* * * *	* * * * * * * * * * * *	* * * * *	
	**Sida chrysocalyx	*			* * * * *	* * * * * * * *	* * * * *	*
	*Prostanthera althoferi subsp. althoferi				* *	* * * * *	* * * *	
	*Aluta aspera subsp. hesperia				*	* * * * * *	*	
	*Olearia humilis	*	*			* * * * * * * * * *		
g	Acacia aneura var. argentea x minyura					*	* *	
	**Hibbertia arcuata					* *	* * *	
	Prostanthera magnifica				*	*	*	
	Austrostipa scabra		* *		*		*	
	*Philotheca brucei subsp. brucei		* *		* *		* * * *	
	*Cheilanthes brownii			*	* * * * * *		*	
	Dodonaea petiolaris		* * *	* *	* * * * * *	*	*	
	Thryptomene decussata		* * *	*	* * * * * *		* * *	
	Psydrax suaveolens				*		*	
h	Austrostipa nitida	*			*			
	Eriachne helmsii	*			*			
	Santalum spicatum				*			*
	Drummondita microphylla		*		* * *	* *		
	Monachather paradoxus	*			* * *	* *		
	Phyllanthus baeckeoides	*			*			
i	Acacia aneura flat + green	*		*				
	Dodonaea lobulata		*	*				*
	**Eremophila platycalyx subsp. platycalyx	*	*	* *				
	**Olearia stuartii		*	* *				
	**Sida excedentifolia			* *	*	*		
j	*Acacia burkittii	*	* *					* *
	*Maireana georgei	*						* *
	**Maireana trichoptera							* *
	**Eremophila oldfieldii subsp. angustifolia		* * * *					* * * *
	**Alyxia buxifolia		*					* * *
	Scaevola spinescens	* *	* * * * * *					* * *
	*Rhagodia eremaea	*	*					* *
	**Senna artemisioides subsp. filifolia		*					* * *
	**Acacia kalgoorliensis							* * *
	**Eremophila oppositifolia subsp. angustifolia							* * *
	**Senna stowardii							* * *
	**Eremophila pantonii							* * * *
	**Sclerolaena densiflora	*						* * *
	**Casuarina pauper							* *

Table 2

Plant community mean values for soil chemistry parameters (measured mg/kg except eCEC, pH, Total N, Org C and EC). Differences between ranked values tested using Kruskall – Wallis non parametric analysis of variance. Standard error in parentheses. a,b,c denote significant difference between groups by post hoc test (P < 0.05). (P = probability, n = number of quadrats, ns = not significant). Community 2 was excluded from analysis due to smaller sample size.

	Community Type					
	1	**2**	**3**	**4**	**5**	**P**
pH	4.8 (0.2)ab	4.8 (0.0)	4.2 (0.1)bc	4.3 (0.1)c	5.9 (0.2)a	0.000
EC	4.5 (0.9)ab	5.5 (0.5)	3.6 (0.4)ab	2.7 (0.5)b	12.5 (2.7)a	0.001
Total N	0.061 (0.003)b	0.128 (0.000)	0.102 (0.005)a	0.074 (0.006)a	0.061 (0.007)ab	0.002
P	5.8 (0.5)b	92.5 (7.5)	47.1 (18.0)a	7.5 (1.2)b	4.8 (0.5)b	0.000
K	147.1 (11.6)a	230.0 (70.0)	122.3 (13.3)a	75.9 (3.5)b	139.5 (19.1)a	0.000
Org C	0.77 (0.06)b	1.72 (0.21)	1.45 (0.07)a	1.04 (0.10)ab	0.73 (0.08)b	0.000
Mg	70.9 (9.7)a	124.5 (45.5)	48.7 (6.9)ab	19.9 (2.1)b	295.0 (87.0)a	0.000
eCEC	3.6 (1.0)a	4.6 (0.9)	1.9 (0.2)ab	0.9 (0.1)b	8.0 (1.8)a	0.000
Ca	524.8 (195.4)a	590.0 (60.0)	228.3 (29.1)ab	113.6 (15.4)b	1008.0 (210.3)a	0.000
Cd	0.014 (0.002)ab	0.020 (0.000)	0.007 (0.002)bc	0.005 (0.000)c	0.020 (0.004)a	0.000
Co	1.15 (0.28)a	0.41 (0.37)	0.05 (0.01)b	0.05 (0.01)b	2.36 (0.11)a	0.000
Cu	1.1 (0.1)a	0.7 (0.1)	0.7 (0.1)b	0.7 (0.0)b	1.7 (0.2)	0.000
Fe	42.0 (3.1)b	170.0 (10.0)	147.6 (36.5)a	57.7 (4.7)ab	38.0 (3.0)b	0.000
Mn	47.7 (7.9)a	24.5 (10.5)	15.7 (3.7)b	16.0 (1.3)b	67.5 (12.5)a	0.000
Mo	0.016 (0.002)b	0.005 (0.000)	0.005 (0.000)ab	0.005 (0.000)a	0.009 (0.004)ab	0.017
Na	5.6 (1.2)b	6.3 (3.8)	4.1 (0.8)b	2.5 (0.0)b	37.0 (14.0)a	0.000
Ni	1.1 (0.2)a	0.5 (0.3)	0.2 (0.0)b	0.2 (0.0)b	2.8 (0.7)a	0.000
S	10.9 (0.6)b	11.0 (0.0)	12.7 (0.6)ab	14.8 (0.7)a	9.3 (2.9)ab	0.003
Zn	1.0 (0.1)ab	2.3 (0.4)	1.3 (0.2)a	0.8 (0.1)b	0.9 (0.1)ab	0.014
n=	19	2	7	17	4	

Table 3

Plant community mean values for physical site parameters; elevation (m), aspect (16 cardinal directions), slope (degrees), coarse fragment (CF) abundance (0 – no coarse fragments to 6 very abundant coarse fragments), maximum size of coarse fragments (CF) (1 – fine gravelly to 7 – large boulders), rock outcrop (RO) abundance (0 – no bedrock exposed to 5 – rockland), runoff (0 – no runoff to 5 – very rapid), % leaf litter (1 – >70% to 4 – <10%). Differences between ranks tested using Kruskall –Wallis non-parametric analysis of variance. Standard error in parentheses. a and b represent significant differences between community types at P < 0.05. * represents not significant. Community 2 was excluded from analysis due to smaller sample size.

	Community Type					
	1	**2**	**3**	**4**	**5**	**P**
Elevation	467.9 (5.6)	445.0 (2.1)	475.9 (4.1)	483.1 (5.3)	475.0 (4.2)	0.277
Aspect*	8.0 (1.0)	7.5 (5.5)	7.6 (2.1)	8.0 (1.2)	11.0 (2.7)	0.659
Slope	4.7 (0.8)b	18.5 (4.5)	14.3 (2.4)a	7.5 (1.2)ab	2.8 (0.9)b	0.002
CF Abundance*	3.6 (0.3)	4.0 (0.0)	4.4 (0.1)	4.1 (0.1)	4.0 (0.4)	0.326
CF Max	3.8 (0.2)b	6.0 (0.0)	6.0 (0.2)a	4.4 (0.3)b	4.3 (0.3)ab	0.002
RO Abundance	0.7 (0.2)b	2.5 (0.5)	4.0 (0.2)a	2.0 (0.5)ab	0.0 (0.0)b	0.000
Runoff*	1.4 (0.3)	3.0 (1.0)	2.4 (0.4)	2.1 (0.2)	1.5 (0.3)	0.074
%Leaf Litter*	1.5 (0.1)	1.0 (0.0)	1.3 (0.2)	1.8 (0.2)	1.0 (0.0)	0.082
n=	19	2	7	17	4	

APPENDIX

Flora list for Cashmere Downs, including all taxa from the sampling quadrats and adjacent areas. Nomenclature follows Paczkowska and Chapman (2000), * indicates introduced taxon. Vouchers for each taxon were lodged at Western Australian Herbarium (PERTH).

Adiantaceae
- *Cheilanthes adiantoides*
- *Cheilanthes brownii*
- *Cheilanthes sieberi* subsp. *sieberi*

Amaranthaceae
- *Ptilotus aervoides*
- *Ptilotus drummondii*
- *Ptilotus exaltatus*
- *Ptilotus gaudichaudii*
- *Ptilotus helipteroides*
- *Ptilotus obovatus* var. *obovatus*
- *Ptilotus schwartzii*

Apiaceae
- *Trachymene ornata*

Apocynaceae
- *Alyxia buxifolia*

Asclepiadaceae
- *Marsdenia australis*

Asteraceae
- *Cephalipterum drummondii*
- *Erymophyllum ramosum* subsp. *ramosum*
- *Gilberta tenuifolia*
- *Helipterum craspedioides*
- *Myriocephalus guerinae*
- *Olearia humilis*
- *Olearia muelleri*
- *Olearia stuartii*
- *Podolepis canescens*
- *Rhodanthe citrina*
- *Senecio pinnatifolius* var. *pinnatifolius*

Caesalpiniaceae
- *Senna artemisioides* subsp. aff. *helmsii* (R. Meissner & B. Bayliss 1432)
- *Senna artemisioides* subsp. *filifolia*
- *Senna cardiosperma*
- *Senna glaucifolia*
- *Senna stowardii*

Casuarinaceae
- *Allocasuarina acutivalvis* subsp. *acutivalvis*
- *Casuarina pauper*

Chenopodiaceae
- *Chenopodium cristatum*
- *Chenopodium melanocarpum*
- *Chenopodium saxatile*
- *Eriochiton sclerolaenoides*
- *Maireana carnosa*
- *Maireana georgei*
- *Maireana trichoptera*
- *Rhagodia eremaea*
- *Sclerolaena densiflora*
- *Sclerolaena diacantha*
- *Sclerolaena eriacantha*
- *Sclerolaena patenticuspis*

Cucurbitaceae
- **Cucumis myriocarpus*

Cupressaceae
- *Callitris columellaris*

Dilleniaceae
- *Hibbertia arcuata*

Euphorbiaceae
- *Euphorbia australis*
- *Euphorbia boophthona*
- *Euphorbia drummondii* subsp. *drummondii*
- *Phyllanthus baeckeoides*

Frankeniaceae
- *Frankenia irregularis*

Geraniaceae
- *Erodium cygnorum*

Goodeniaceae
- *Goodenia macroplectra*
- *Goodenia mimuloides*
- *Goodenia occidentalis*
- *Scaevola spinescens*

Haloragaceae
- *Haloragis odontocarpa* forma *pterocarpa*
- *Haloragis trigonocarpa*

Lamiaceae
- *Hemigenia exilis*
- *Prostanthera althoferi* subsp. *althoferi*
- *Prostanthera magnifica*
- *Spartothamnella teucriiflora*

Lobeliaceae
- *Isotoma petraea*

Loranthaceae
- *Lysiana murrayi*

Malvaceae
- *Abutilon* sp. (R. Meissner & B. Bayliss 1086)
- *Abutilon cryptopetalum*
- *Abutilon oxycarpum* subsp. *prostratum*
- *Sida* sp. dark green fruits (S. van Leeuwen 2260)
- *Sida atrovirens*
- *Sida chrysocalyx = sida* sp. Golden calyces glabrous (H.N. Foote 32)
- *Sida* sp. Excedentifolia (J.L. Egan 1925)
- *Sida excedentifolia*
- *Sida ectogama*

Mimosaceae
- *Acacia aneura*
- *Acacia burkittii*
- *Acacia cockertoniana*
- *Acacia coolgardiensis* subsp. *effusa*
- *Acacia erinacea*
- *Acacia exocarpoides*
- *Acacia kalgoorliensis*
- *Acacia quadrimarginea*
- *Acacia ramulosa* var. *ramulosa*
- *Acacia tetragonophylla*

Myoporaceae
- *Eremophila forrestii* subsp. *forrestii*
- *Eremophila georgei*

Eremophila glutinosa
Eremophila latrobei subsp. *latrobei*
Eremophila oldfieldii subsp. *angustifolia*
Eremophila oppositifolia subsp. *angustifolia*
Eremophila pantonii
Eremophila platycalyx subsp. *platycalyx*
Eremophila youngii subsp. *youngii*

Myrtaceae
Aluta aspera subsp. *hesperia*
Calytrix amethystina
Eucalyptus leptopoda subsp. *elevata*
Eucalyptus lucasii
Homalocalyx thryptomenoides
Thryptomene decussata

Papilionaceae
Swainsona kingii

Phormiaceae
Dianella revoluta var. *divaricata*

Pittosporaceae
Bursaria occidentalis

Poaceae
Aristida contorta
Austrostipa elegantissima
Austrostipa nitida
Austrostipa scabra
Enneapogon caerulescens
Eragrostis dielsii
Eragrostis eriopoda
Eragrostis lacunaria
Eriachne helmsii
Eriachne pulchella
Monachather paradoxus
Paspalidium basicladum
**Pentaschistis airoides* subsp. *airoides*
Triodia lanigera
Tripogon loliiformis

Portulacaceae
Calandrinia cf. *creethae*
Calandrinia eremaea
Portulaca aff. *oleracea* (R. Meissner & B. Bayliss 963)

Proteaceae
Grevillea berryana
Grevillea haplantha subsp. *haplantha*
Hakea preissii

Rubiaceae
Psydrax rigidula
Psydrax suaveolens

Rutaceae
Drummondita microphylla
Phebalium canaliculatum
Philotheca brucei subsp. *brucei*

Santalaceae
Santalum spicatum

Sapindaceae
Dodonaea lobulata
Dodonaea petiolaris
Dodonaea rigida

Solanaceae
Nicotiana cavicola
Nicotiana rosulata subsp. *rosulata*
Solanum ashbyae
Solanum coactiliferum
Solanum ellipticum
Solanum nummularium

Sterculiaceae
Brachychiton gregorii
Keraudrenia velutina subsp. *elliptica*

Violaceae
Hybanthus floribundus subsp. *curvifolius*
Zygophyllaceae
Zygophyllum eremaeum
Zygophyllum iodocarpum
Zygophyllum ovatum