Vegetation of the Holsworthy Military Area

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Vegetation in the Holsworthy Military Area located 35 km south-west of Sydney (33°59'S 150°57'E) in the Campbelltown and Liverpool local government areas was surveyed and mapped. The data were analysed using multivariate techniques to identify significantly different floristic groups that identified distinct communities. Eight vegetation communities were identified, four on infertile sandstones and four on more fertile shales and alluviums. On more fertile soils, Melaleuca Thickets, Plateau Forest on Shale, Shale/Sandstone Transition Forests and Riparian Scrub were distinguished. On infertile soils, Gully Forest, Sandstone Woodland, Woodland/Heath Complex and Sedgelands were distinguished. We identified sets of species that characterise each community either because they are unique or because they contribute significantly to the separation of the vegetation community from other similar communities.

The Holsworthy Military Area contains relatively undisturbed vegetation with low weed invasion. It is a good representation of continuous vegetation that occurs on the transition between the Woronora Plateau and the Cumberland Plain. The Plateau Forest on Shale is considered to be Cumberland Plains Woodland and together with the Shale/Sandstone Transition Forest, are endangered ecological communities under the *NSW Threatened Species Conservation Act 1995*. The Melaleuca Thickets may also be considered part of the endangered ecological community, Sydney Coastal River-flat Forest. As such the area has high conservation significance.

Introduction

Whilst Hawkesbury Sandstone communities are well conserved in the Sydney Region, there are limited areas where shale, riverine and shale/sandstone transition zone communities are protected (Benson 1992). The Holsworthy Military Area comprises 18 000 ha of bushland 35 km south-west of Sydney in the Campbelltown and Liverpool local government areas (33°59'S 150°57'E). It is bordered by Heathcote National Park and the Woronora water catchment area in the east, Dharawal State Recreation Area to the south and suburban areas to the west and north (Holsworthy Vegetation Map). The Military Area occurs largely on the Woronora Plateau that is gently sloping and shows a sharp decline in rainfall from east to west. The remaining area to the north is

part of the Cumberland Plain with shale and tertiary alluvium communities contrasting with the mostly woodland vegetation on Hawkesbury sandstone on the Woronora Plateau. The Military Area covers the boundary between sandstone, shale and Tertiary alluvium and remains one of the few areas in Sydney where this type of transitional vegetation can still be found undisturbed. Prior to this study, there was limited knowledge and understanding of the conservation significance of Holsworthy Military Area.

In response to an increased need to manage their lands in a more ecologically sensitive manner, the Department of Defence undertook the development of a Plan of Management in 1995 (Axis Environmental & Australian Museum Business Services 1995a, 1995b). This paper uses the data from the vegetation audit that formed the basis of the flora section within this Plan of Management. Shortly after the Plan of Management was developed, the area was considered for a second airport for the Sydney Region and part of the area was surveyed again (Biosis Research & PPK 1997). However, the Military Area remains largely unknown and regional maps show either little information or base their interpretation on aerial photographs and limited ground-truthing (Benson & Howell 1990a, Benson 1992, James 1997). This paper, therefore, makes a significant contribution to the knowledge of these vegetation communities and their significance in the Sydney Region.

Plant diversity encompasses species at all strata and yet communities are often classified by management agencies on the basis of larger shrubs and canopy trees to simplify identification. Disturbed areas, such as grazed woodlands, may frequently have canopy and large shrub species present although the other plant species may have vanished. Such a loss of diversity represents a significant change in biological diversity and a management problem that can go unnoticed because of the focus on the canopy and larger shrubs. Furthermore, classification of vegetation communities can result in vague distinctions between similar communities with little understanding of what species (understorey and canopy species) are characteristic of particular communities (French et al. 2000). A more precise characterisation of vegetation communities would enhance management and conservation of many areas, despite the obvious variability that exists from site to site. Whilst a range of possible techniques could be used, we have investigated the use of one method using multivariate techniques.

The aims of the study were to:

1. map the main vegetation types in the area using API,
2. identify distinct vegetation units through multivariate analysis and associate these with identifiable map units,
3. identify a suite of species that characterise each vegetation community,
4. identify exotic species and species of conservation significance.

Methods

Mapping

Vegetation boundaries were initially mapped using aerial photographs. Vegetation was distinguished on the basis of height and cover of the tallest stratum. Six vegetation types were distinguished from the aerial photo interpretation (API) using differences in tonal texture. These API map units were: 1. Melaleuca Thickets, 2. Plateau Forests, 3. Gully Forest, 4. Sandstone Woodlands, 5. Heaths and 6. Sedgelands.

Riparian vegetation on sandstone only occurred along the edges of creeks and rivers in bands too narrow to map. The area of land occupied by this portion of the riparian vegetation type could not be estimated but was small.

Vegetation was plotted on a TOPCON 2000 stereoplotter and transferred to ERMS (National Parks and Wildlife Service) for editing. The TOPCON plotter was used to plot the vegetation boundaries digitally and rectify them to the Australian Map Grid, reducing distortion apparent in aerial photography.

Ground surveys

Seventy-three sites were surveyed from October 1994 to April 1995. Sites were stratified by parent material, topography and vegetation structure. Sites were spread throughout the study area to obtain a representative survey of the area and attempts were made to survey vegetation in accordance with the proportion of the total area each vegetation type represented. Extra sites were surveyed on shale, as these are likely to be regionally important due to extensive clearing throughout the Sydney Basin. Sites were named according to the range (Department of Defence classification) where they occurred, i.e. 12B was a site in B range. Sites and ranges are incorporated into the vegetation map of Holsworthy.

The survey design followed a method used by NSW National Parks and Wildlife Service (e.g. Keith 1994). At each site, a 20 m × 20 m quadrat was established. All vascular plant species within this quadrat were identified and recorded. An abundance measure was assigned to each species based on a Braun-Blanquet scale in Poore (1955) (Table 1). Details of grid references, physiography, soil, disturbance, horizontal elevation and vegetation structure were recorded at each site (Table 2). All sites were digitised onto a map according to the Australian Map Grid Reference. Species were either identified in the field or specimens were collected for identification in the Janet Cosh Herbarium, University of Wollongong or National Herbarium of NSW, Sydney. Voucher specimens of some species are held at the Janet Cosh Herbarium, University of Wollongong. Nomenclature was according to Harden (1990–1993) and Jacobs and Everett (1996).

During the surveys, exotic species were recorded at sites and at other locations visited opportunistically within the area. Species that are rare and threatened were recorded using Briggs and Leigh (1995). Other locations where these species were found were also recorded opportunistically.

Table 1. Values used to record cover/abundance of species in survey sites.

Cover Abundance Value	Description
1	one–a few individuals
2	uncommon and < 5% cover
3	common and < 5% cover
4	very abundant and < 5% or 5–20% cover
5	20–50% cover
6	50–75% cover
7	75–100% cover

Based on Braun-Blanquet scale (Poore 1955).

Table 2. Environmental information recorded at each site.

Environmental Feature	Description	Scale
Map name/scale	1:25 000 map reference	
Location	description using roads, creeks	
AMG Reference	grid reference description	
Physiography	description of site	
Slope	using clinometer	0–90°
Aspect	compass direction	
Elevation	from topographic map	
Soil drainage	subjective assessment	well drained (dry or moist)–water-logged
Soil texture	compared to standard samples	clay/loam/sand
Soil depth	subjective assessment	deep/shallow/skeletal
Geology	based on site inspection	
Horizontal elevation	horizontal azimuths taken at 8 compass points using a compass and clinometer	
Disturbance	Description of type of disturbance	grazing, logging, clearing, erosion, exotic plants and animals
Previous fire history	subjective assessment of signs	
Structure	height, cover and dominant species of major structural levels	trees/shrubs/ground

This information is based on the standard information collected by NSW NPWS (Keith & Sanders 1990).

Analysis of vegetation communities

Multivariate analyses were used to identify floristic groups using the PRIMER package (Carr 1994). Similarity matrices were calculated using the Bray-Curtis index and clustered using group averages on untransformed data. This analysis grouped sites according to their similarity in species composition and abundance. An ordination analysis was undertaken using non-metric multi-dimensional scaling (MDS) to enable visual interpretation and confirmation of major groupings identified in the cluster. Floristic groups are fundamentally based on these two analyses, with some further interpretation from investigating the field notes for each site.

For each floristic group identified, an Analysis of Similarity (ANOSIM) was undertaken to determine if this grouping was significantly different statistically to similar adjacent groups (in the ordination and cluster) and whether it formed a unique vegetation community. To do this, two closely related communities were combined into a new dataset on which an ANOSIM was performed on all species. For all vegetation communities thus identified, an average similarity was calculated and the set of species contributing up to 50% of this similarity within the community identified (SIMPER module). These species, therefore, form the dominant suite of species that identify this community and provide an explicit mechanism for describing vegetation communities. For vegetation communities that are closely related, this analysis also identifies the species that contribute up to 50% of the differences between the two vegetation communities which aids in interpreting the main features that differ between communities. SIMPER analysis can only be performed when species lists are below 160 species and the SIMPER analysis was performed on reduced datasets. Rare species or species whose cover abundance was extremely low will not contribute very much to similarities or differences because the Bray-Curtis measure takes into account abundance as well as presence. Thus, commonly occurring species, or species with high levels of cover, are the species which contribute most to the Bray-Curtis values. The dataset was first reduced by excluding species which only occurred at one site in low abundance (1 or 2) or at two sites (both at abundance level 1). In most cases this reduced the species list to below 160. However, for the comparison between Transition Forests and Gully vegetation, species that occurred at three sites (at abundance level 1) were removed as well. Species that were unique to vegetation communities were identified separately as these species may also be characteristic of communities. This duel approach allowed the inclusion of rare species in characterising communities as well as identifying species on the basis of Bray-Curtis similarity measures.

Results

Vegetation communities

The cluster analysis and ordination distinguished eight vegetation groupings (Figs 1, 2, Table 3). In general, groupings followed soil types and the water-holding capacity of the soils, such that most communities could be aligned with the API and with field notes (Table 2). Four of these groups occurred on more fertile soils (deep sandstones,

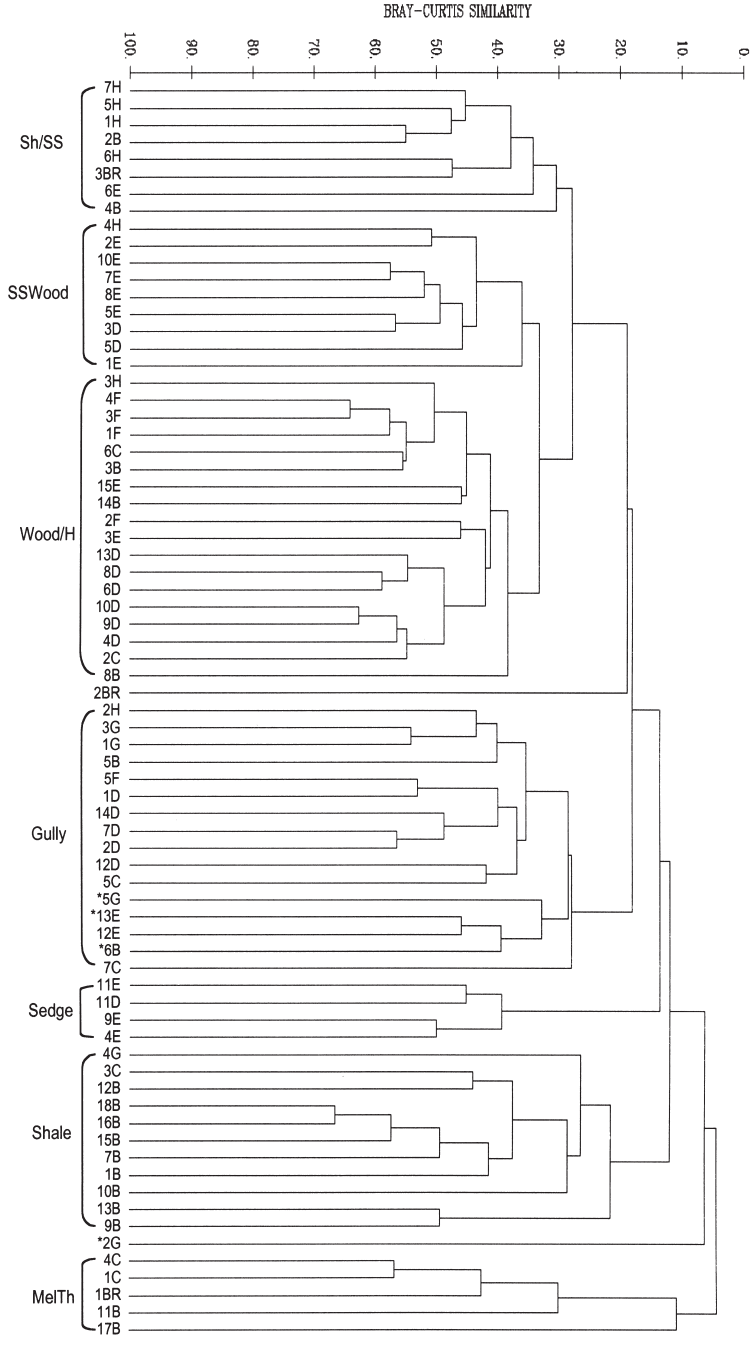

Fig 1. Cluster analysis of 73 sites surveyed in Holsworthy Military Area. Analysis was performed using Bray-Curtis similarities and group averages (PRIMER package, Plymouth Marine Laboratories). Sh/SS = Shale/Sandstone Transition Forest, SSWood = Sandstone Woodland, Wood/H = Woodland/Heath Complex, Gully = Gully Forest, Sedge = Sedgeland, Shale = Plateau Forest on Shale, MelTh = Melaleuca Thicket. Sites marked with an asterisk are Riparian Scrub. The classifications are based on cluster and ordination analysis, field note interpretations and analysis of similarity (see text).

shales and alluvium) and four communities were identified on less fertile, shallow sandstones (Figs 1, 2). Overall, 452 species were recorded in the study area, 414 native species and 38 exotic species. Exotic species at all but a few sites were in low abundance (Table 4).

Vegetation Community: Melaleuca Thicket

Alluvium sites with *Melaleuca linearifolia* and *Eucalyptus botryoides/saligna* complex were separated clearly from the rest (Figs 1, 2). These sites had a dense canopy with a thick sedge groundcover and occurred along some creek beds in the northern part of the area. They were significantly different from the nearest vegetation type in the ordination, Plateau Forests on Shale (ANOSIM: Global $R = 0.951$, $p < 0.001$) but variability within the sites was larger than other groupings with an average similarity (Bray-Curtis) of only 34% (reduced by 43% from a common dataset with Shale). Analysis identified only four species contributing 50% of the similarity amongst sites (Table 5). Despite the small number of sites sampled, 102 species were recorded. Forty-five species were unique to this vegetation community (44% of species found in this community). Only seven of these occurred in more than one quadrat (Table 6). Site 17B was most different from the rest being dominated by *Eucalyptus botryoides/saligna* in the canopy with no *Melaleuca linearifolia* and a significant cover of *Ligustrum lucidum*. This vegetation community is likely to form part of the Sydney Coastal River-flat Forest, an endangered ecological community under the *NSW Threatened Species Conservation Act.*

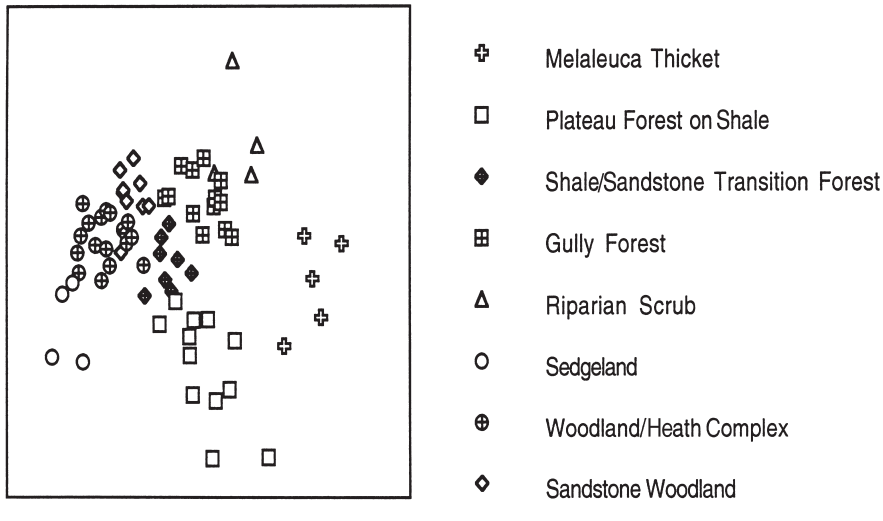

Fig. 2. Ordination analysis of seventy-three sites in Holsworthy Military Area using nonmetric multi-dimensional scaling. The symbols represent site classifications based on cluster and ordination analysis, field note interpretation and analysis of similarity (see text). Each vegetation community corresponds to descriptions in the text. Stress = 0.17.

Table 3. Sites surveyed based on major vegetation units using parent material, topography and structure.

Vegetation Type	Parent Material	Area (ha)	% Total Area	No. Species	No. Sites	Site Names Range: No.
Melaleuca	Alluvium	41+	0.2+	102	5	BR:1 B: 11, 17 C: 1, 4
Riparian	Sandstone/ Alluvium			115	4	B: 6 E: 13 G: 2, 5
Plateau Forest	Shale	1706#	9.5#	177	12	BR: 2 B: 1, 7, 9, 10, 12, 13, 15, 16, 18 C: 3 G: 4
Transition Forest	Shale/Sandstone		113	8	BR: 3	B: 2, 4 E: 6 H: 1, 5, 6, 7
Gully Forest	Sandstone	6917	38.7	213	13	B: 5 C: 5, 7 D: 1, 2, 7, 12, 14 E: 12 F: 5 G: 1, 3 H: 2
Woodland	Sandstone	9164	51.3	136	9	D: 3, 5 E: 1, 2, 5, 7, 8, 10 H: 4
Woodland/Heath Complex	Sandstone		0	165	18	B: 3, 8, 14 C: 2, 6 D: 4, 6, 8, 9, 10, 13 E: 3, 15 F: 1, 2, 3, 4 H: 3
Sedgeland	Sandstone	48	0.3	76	3	D: 11 E: 4, 9, 11

The area represented by each vegetation type and the % of the total area surveyed are based on calculation from the map interpretation. The sites are identified by the range (B-H) and numbered consecutively as they were surveyed. BR = Brigade Training Area.

+: Area could only be estimated for Melaleuca Thickets. Other riparian vegetation was too narrow to be mapped from aerial photoes.

#: This area is combined for both types of Plateau Forest that could not be distinguished from aerial photographs.

Table 4. Exotic species recorded at Holsworthy Military Area listed by family.

#: species classified as noxious either in the Liverpool or Campbelltown Council areas (Liverpool City Council 1998, Campbelltown City Council 1999). **: species considered by the authors to be particularly important as weeds of native areas are also highlighted.

Species	Distribution
APOCYNACEAE	
Nerium oleander Oleander	Under powerlines 1km south of Gate 7, Dump 0.5 km west from gate 7A (off Heathcote Rd)
ASCLEPIDACEAE	
Gomphocarpus fruticosus Narrow-leaved Cotton Bush	Dump 0.5 km west from gate 7A (off Heathcote Rd)
ASPARAGACEAE	
Mysiphyllum asparagoides ** Bridal Creeper	17B
ASTERACEAE	
Ageratina adenophora ** Crofton Weed	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Aster subulatus Bushy Starwort	17B
Bidens pilosa Cobbler's Pegs	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Cirsium vulgare Spear Thistle	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Conyza albida Tall Fleabane	1BR, 11B, 17B, 1G, 2G
Conyza canadensis Canadian Fleabane	17B
Dittrichia graveolens Stinkwort	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Gnaphalium coarctatum Purple Cudweed	17B
Hypochaeris radicata Catsear	Dump 0.5 km west from gate 7A (off Heathcote Rd), 2BR, 12B, 17B, 13E, 1G, 3G
Pseudognaphalium luteoalbum Jersey Cudweed	17B
Senecio madagascariensis Fireweed	Dump 0.5 km west from gate 7A (off Heathcote Rd), 9B, 2G, 3G
Senecio tamoides	17B
Sigesbeckia orientalis Indian Weed	17B
Sonchus oleraceus Common Sowthistle	Dump 0.5 km west from gate 7A (off Heathcote Rd), 11B
CACTACEAE	
Opuntia stricta #** Prickly Pear	Near 'wells' off River Rd, west of site 6B
GENTIACEAE	
Centaurium erythraea Common Centaury	Dump 0.5 km west from gate 7A (off Heathcote Rd), 4B, 17B, 13E

Species	Distribution
LAURACEAE	
Cinnamomum camphora ** Camphor Laurel	Dump 0.5 km west from gate 7A (off Heathcote Rd), 1C
MALVACEAE	
Sida rhombifolia Paddy's Lucerne	Dump 0.5 km west from gate 7A (off Heathcote Rd)
OLEACEAE	
Ligustrum lucidum #** Large-leaved Privet	1BR
Ligustrum sinense #** Small-leaved Privet	Dump 0.5 km west from gate 7A (off Heathcote Rd), 17B
PLANTAGINACEAE	
Plantago lanceolata Plantain	Dump 0.5 km west from gate 7A (off Heathcote Rd), 9B, 2D, 7D
POACEAE	
Andropogon virginicus ** Whisky Grass	4E
Cortaderia selloana #** Pampas Grass	Under powerlines 1km south of Gate 7
Cynodon dactylon Common Couch	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Paspalum dilatatum Paspalum	Dump 0.5 km west from gate 7A (off Heathcote Rd), 11B, 17B
Poa annua Winter Grass	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Setaria gracilis Slender Pigeon Grass	Dump 0.5 km west from gate 7A (off Heathcote Rd), 17B
Stenotaphrum secundatum Buffalo Grass	Dump 0.5 km west from gate 7A (off Heathcote Rd)
POLYGONACEAE	
Acetosella vulgaris or *Rumex angiocarpa* Sheep Sorrel	11B
ROSACEAE	
Prunus sp. Plum	Dump 0.5 km west from gate 7A (off Heathcote Rd)
SALICACEAE	
Populus sp. Poplar	Under powerlines 1 km south of Gate 7
Salix sp.# Willow	Under powerlines 1 km south of Gate 7
SOLANACEAE	
Cestrum parqui #** Green Poisonberry	Dump 0.5 km west from gate 7A (off Heathcote Rd)
Solanum nigrum Blackberry Nightshade	Dump 0.5 km west from gate 7A (off Heathcote Rd), 17B
VERBENACEAE	
Verbena bonariensis Purple Top	Dump 0.5 km west from gate 7A (off Heathcote Rd)

Table 5. Melaleuca Thicket descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Melaleuca linariifolia	4.00	15.63
Pteridium esculentum	2.40	26.87
Viola hederacea	2.60	37.31
Gahnia sieberiana	2.40	45.98

Table 6. Unique species which occur at 2, 3, 4 and more than 4 sites in a vegetation community.

Numbers in brackets indicate the number of sites in each vegetation community. Species which occur only in one vegetation community but which occur at more than one site are likely to be more typical components of the vegetation.

(No. sites)	2 times	3 times	4 times	> 4 times
Melaleuca (5)	*Adiantum aethiopicum* *Blechnum cartilagineum* *Baumea rubiginosa* *Eleocharis sphacelata*	*Eucalyptus botryoides/saligna* *Hydrocotyle laxiflora* *Isolepis cernua* *Acacia irrorata*		
Plateau Forest	*Acacia penninervis*	*Comesperma*	*Danthonia longifolia*	*Eucalyptus*
on Shale (12)	*Chorizema parviflorum* *Eucalyptus crebra* *Eucalyptus resinifera* *Goodenia paniculata* *Macrozamia spiralis* *Paspalidium distans*	*sphaerocarpum* *Daviesia ulicifolia* *Lagenifera stipitata* *Opercularia diphylla* *Pultenaea villosa* *Vernonia cinerea*	*Senecio hispidula*	*fibrosa* *Eucalyptus globoidea* *Oxalis* sp.
Shale/ Sandstone Transition Forest (8)	*Dillwynia floribunda*			
Riparian Scrub (4)	*Leptospermum morrisonii* *Phebalium dentatum* *Todea barbata*			
Gully Forest (13)	*Gompholobium latifolium* *Leucopogon lanceolata* *Leucopogon amplexicaulis* *Persoonia laurina*	*Eriostemon scaber*	*Actinotus helianthi*	
Woodland/ Heath (18)	*Cryptandra ericoides* *Hibbertia sericea* *Schoenus moorei*	*Allocasuarina diminuta* *Leucopogon appressus*	*Baeckea brevifolia*	
Woodland (9)	*Eucalyptus sieberi*		*Schoenus turbinatus* *Epacris obtusifolia*	*Eucalyptus consideniana*
Sedgeland (4)	*Schoenus paludosa* *Symphionema paludosum*	*Sprengelia incarnata*		

Sites: 1BR, 11B, 17B, 1C, 4C.

Habitat: Waterlogged creek beds on deep alluvium.

Distribution: 41 ha and 2% of the study area. Melaleuca Thickets occur mostly in the north of the study area, where large deposits of fertile, recent river alluvium occur.

Trees: 20 m (average height) and 10% cover (average cover). *Melaleuca linearifolia* and *Eucalyptus botryoides/saligna* intergrade.

Shrubs: 2 m and 10% cover. *Melaleuca linearifolia* and *Gahnia sieberiana*. Other species include *Callistemon citrinus, Ligustrum lucidum, Leptospermum juniperinum, Backhousia myrtifolia* and *Phyllanthus gastroemii*.

Groundcover: 0.5 m and 50% cover. *Isolepis cernua*, with *Entolasia marginata, Pteridium esculentum, Viola hederacea, Austrostipa ramosissima, Hydrocotyle laxiflora* and *Themeda australis*. Other species include *Calochlaena dubia, Eleocharis sphacelata* and *Adiantum aethiopicum*.

Vegetation Community: Plateau Forest on Shale.

Plateau Forest on Shale sites were distinguished from a Shale/Sandstone Transition Forest where sandstone influences were more obvious (ANOSIM: Global R = 0.392, p = 0.001). Plateau Forest on Shale was very variable with an average similarity between sites of 31% but in general was dominated by *Themeda australis* with an overstorey of *Eucalyptus crebra*, *Eucalyptus fibrosa*, *Eucalyptus punctata* and *Eucalyptus globoidea*. These shale communities are the most diverse in the study area with 177 species recorded. Seven species contributed up to 50% of the similarity between sites, most species occurring in the groundcover (Table 7). Forty-eight species (representing 27% of the shale flora) were unique to this vegetation community, indicating the importance of Plateau Forests on Shale, like Melaleuca Thickets, to the plant biodiversity of the area. Nineteen occurred in more than one quadrat (Table 6). These forests are box-ironbark Cumberland Plain woodlands, an endangered ecological community classified under the *NSW Threatened Species Conservation Act 1995*.

Sites: 2BR, 1B, 7B, 9B, 10B, 12B, 13B, 15B, 16B, 18B, 3C, 4G.

Habitat: Flat plateau tops on shale or Tertiary alluvium.

Distribution: 1706 ha (9.5% of the study area). This estimate includes both plateau forest types; Plateau Forest on Shale and Shale/Sandstone Transition Forest. It is found mostly in B range in the north-western corner of the study area. Some smaller patches occur in the north-east where shale lenses are overlying sandstone.

Trees: 15 m and 30% cover. *Eucalytpus fibrosa* and *Eucalytpus punctata*, with *Eucalytpus globoidea* and *Eucalytpus crebra*. Other species included *Eucalytpus tereticornis, Eucalytpus eugenioides, Eucalytpus moluccana, Eucalytpus longifolia* and occasionally *Angophora bakeri.*

Table 7. Plateau Forest on Shale descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative percentage contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Themeda australis	4.17	17.45
Aristida vagans	2.42	25.71
Dianella revoluta	2.42	32.58
Entolasia stricta	2.17	37.65
Goodenia hederacea	1.83	41.75
Lomandra multiflora	1.58	45.32
Lissanthe strigosa	1.5	48.30

Table 8. Shale/Sandstone Transition Forest descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative%
Entolasia stricta	3.88	10.25
Cyathochaeta diandra	2.87	16.59
Acacia linifolia	2.63	22.66
Banksia spinulosa	2.88	28.58
Lomandra obliqua	2.63	34.35
Leptospermum trinervium	2.13	39.25
Phyllanthus hirtellus	2.25	43.95
Ptilothrix deusta	2.38	47.53

Table 9. Gully Forest descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Entolasia stricta	3.15	7.25
Xanthosia pilosa	2.38	12.33
Lomandra gracilis	2.31	16.71
Angophora costata	2.54	21.07
Pteridium esculentum	2.08	25.21
Acacia linifolia	2.08	28.73
Banksia spinulosa	2.00	32.12
Lepidosperma laterale	1.92	35.43
Lomatia silaifolia	1.54	38.32
Lomandra obliqua	1.85	41.20
Platysace linearifolia	2.08	44.02
Corymbia gummifera	1.77	46.66
Banksia serrata	1.69	49.11

Shrubs: Little shrub layer is present though patches of *Bursaria spinosa, Dillwynia parviflora, Pultenaea villosa, Daviesia ulicifolia* and *Lissanthe strigosa* occur throughout the area.

Groundcover: 0.2 m and 40% cover. *Themeda australis* with *Entolasia stricta, Glycine tabacina* and *Dianella revoluta*. Other species include *Aristida vagans, Lomandra filiformis* ssp. *coriacea, Goodenia hederacea, Lomandra multiflora, Hardenbergia violacea, Ptilothrix deusta* and *Brunoniella australis.*

Vegetation Community: Shale/Sandstone Transition Forest.

Shale/Sandstone Transition Forest had a higher average similarity (40%) than the Plateau Forest on Shale, indicating that sites were reasonably similar in this community. These forests were either on shale or sandstone but were clearly influenced by both geology types. All sites occurred on more isolated plateaus with shale cappings or on the southern edge of the main shale plateau in the north. Although the geology of the area appears equivocal, it is possible that this area is influenced by the Mittagong Formation, a geology producing intergrading shale and sandstone based soils. Unlike the Plateau Forest on Shale, these forests had a more significant shrub layer with *Themeda australis* less dominant in the ground layers. Together with five species in the groundcover, these made up to 50% of the similarity between sites (Table 8). Only five species (4% of the flora) were unique to Shale/Sandstone Transition Forest of which only one occurred in more than one quadrat (Table 6), supporting its status as transition between sandstone and shale communities. These forests are likely to be Shale/Sandstone Transition Forest, an endangered ecological community classified under the *NSW Threatened Species Conservation Act 1995*.

Shale/Sandstone Transition Forest and Plateau Forest on Shale could not be distinguished easily using aerial photo interpretation as although differences in canopy trees could often be distinguished, canopy species occurred in small patches throughout the plateau and changed over smaller spatial scales than reasonable to map. Consequently, the map only shows the combined region as plateau forest. In general, however, the northern part of the plateau was largely Plateau Forest on Shale and the southern part, Shale/Sandstone Transition Forest.

This vegetation community differed from Gully Forest in having a significant groundcover of *Cyathochaeta diandra*, *Themeda australis* and *Ptilothrix deusta*. Site 4B is least similar to other sites as it is a heath area with no overstorey species.

Sites: 3BR, 2B, 4B, 6E, 1H, 5H, 6H, 7H.

Habitat: Flat plateau tops on shale or sandstone.

Distribution: 1706 ha (9.5% of the study area) includes both plateau forest types. Found mostly in the south of B range and in the south west of the study area.

Trees: 17 m and 25% cover. *Eucalyptus punctata, Angophora costata, Corymbia gummifera* and *Eucalyptus sparsifolia.* Other species include *Angophora bakeri, Angophora floribunda, Eucalyptus globoidea, Eucalyptus haemastoma/racemosa, Eucalyptus squamosa* and *Eucalyptus pilularis.*

Shrubs: 1 m and 20% cover. *Banksia spinulosa, Acacia linifolia, Leptospermum trinervium, Dillwynia parviflora* and *Isopogon anemonifolius*. Other species include *Hakea sericea, Hakea dactyloides, Acacia longifolia, Lissanthe strigosa* and *Grevillea mucronulata.*

Groundcover: 0.3 m and 50% cover. *Entolasia stricta, Cyathochaeta diandra, Lomandra obliqua*, *Themeda australis* and *Ptilothrix deusta*. A variety of other *Lomandra* species were also frequently encountered.

Vegetation Community: Gully Forest

Gully Forest on sandstone differed significantly from Shale/Sandstone Transition Forest (Global R = 0.663, $p < 0.001$). The main differences were in the replacement of a significant cover of grass with a more diverse shrub layer. Thirteen sites were grouped as Gully Forest occurring on the slopes falling away from the plateaus and into the gullies. This vegetation type is very common in the study area. Thirteen species contributed up to 50% of the average similarity (40%), mostly woody shrubs and canopy species (Table 9). Gully Forest included 34 species that were unique which represented 16% of the floral diversity. This community differed from the forests on the plateau and from Riparian Scrub in being dominated by *Angophora costata* with *Pteridium esculentum* and *Platysace linearifolia* in the understorey. Most sites in the west had a taller overstorey, with trees up to 30 m. Sites to the east and central parts of the area tended to have a smaller overstorey with trees from 8 to 20 m tall. Some sites to the west do not have a steep slope gradient. In these areas, Gully Forest occasionally grow to the ridge tops.

Sites: 5B, 5C, 7C, 1D, 2D, 7D, 12D, 14D, 12E, 5F, 1G, 3G, 2H.

Habitat: Slopes of sandstone gullies. Soils are well-drained, moist to dry, sandy loam in texture and either shallow or skeletal in depth.

Distribution: 6917 ha (38.7% of the study area). Most major gullies in the study area, but predominant in the southern part of the area, dominated by sandstone parent geology. Some Gully Forest appears on the top of ridges to the west.

Trees: 20 m and 25% cover. *Angophora costata* with *Eucalyptus piperita, Eucalyptus pilularis* and *Corymbia gummifera*. Other species co-occurring were *Banksia serrata*, *Eucalyptus punctata* and *Eucalytpus agglomerata*.

Shrubs: Tall shrubs were 3 m and 5% cover. *Ceratopetalum gummiferum* and *Banksia serrata* were dominant with *Allocasuarina littoralis* being common. Smaller shrubs were 1.5m and 20% cover. *Grevillea mucronulata, Banksia spinulosa, Lomatia silaifolia* and *Platysace linearifolia* were common. Other common species were *Xanthorrhoea arborea, Doryanthes excelsa* and *Acacia linifolia*.

Groundcover: 0.3 m and 10% cover. *Entolasia stricta, Xanthosia pilosa, Lomandra gracilis* and *Pteridium esculentum*. Other species co-occurring were *Lomandra multiflora, Lomandra obliqua, Lepidosperma laterale, Austrostipa pubescens*, *Gonocarpus teucrioides* and *Cyathocheata diandra*.

Vegetation Community: Riparian Scrub

Gully Forest merged with Riparian Scrub close to watercourses. Four sites were classified as Riparian Scrub which differed from the gully vegetation (ANOSIM: Global R = 0.660, p = 0.002). These sites were variable (average similarity only 30%). Part of this variation is due to the small sample size of this unit. Despite the small sample size, 115 species were identified in this area of which 16 species (14%) were unique to the community (Table 10). One site 5G occurred on much deeper alluvial deposits and was not as diverse, whilst 2G seemed most distinct from other riparian sites and gully vegetation. This was probably due to significant cover of species not occurring in other sites such as *Daviesia corymbosa, Restio dimorpha, Lomandra fluviatilis, Pseudanthus pimelioides, Grevillea oleoides* and *Monotoca scoparia.*

Sites: 6B, 13E, 2G, 5G.

Habitat: Along creek beds with alluvium on sandstone.

Distribution: Occurs on many of the creeks in the southern part of the study area at the bottom of deeper gorges with more frequent water. Also along the Georges River to the south of the study area.

Trees: These sites often have many of the tree species occurring in Gully Forest hanging over the creeks. These species add to the coverage of the community, but are not actually growing in the same substrate.

Shrubs: 4 m and 30% cover. *Tristaniopsis laurina, Lomatia myricoides, Ceratopetalum apetalum, Ceratopetalum gummiferum, Acacia obtusifolia* and *Allocasuarina littoralis* are common species. *Leptospermum polygalifolium, Daviesia corymbosa, Smilax glyciphylla* and *Cassytha pubescens* are frequently encountered.

Groundcover: 0.8 m and 10% cover. *Schoenus melanostachys, Entolasia stricta, Sticherus flabellatus, Xanthosia tridentata, Pteridium esculentum, Gleichenia dicarpa* and *Todea barbara*.

Vegetation Community: Sedgeland

Four sites in the south east were distinguished as Sedgeland with few overstorey shrubs and high similarity between sites (43%). These sites were poorly drained and occurred as small patches throughout the sandstone areas, although only four were sampled in this study. There were 76 species identified with 11 species (14%) unique to these sites of which four species occurred in more than one quadrat (Table 6). Five species contributed up to 50% of the average similarity between sites (Table 11).

Sites: 4E, 9E, 11E, 11D.

Habitat: Seepage slopes with underlying sandstone, usually above drainage lines. Soils are shallow, damp sandy loams with organics.

Distribution: 48 ha (0.3% of study area). The swamps largely occur to the south of the study area and are influenced by the sandstone geology. All sites recorded occurred in E or D range, where large sandstone outcrops and shelves are present. Other Sedgelands were present in C and B range.

Table 10. Riparian Scrub descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Tristaniopsis laurina	3.00	10.14
Lomatia myricoides	2.50	19.41
Entolasia stricta	2.00	26.27
Ceratopetalum apetalum	2.25	32.18
Ceratopetalum gummiferum	2.25	37.34
Smilax glyciphylla	2.00	42.41
Xanthosia tridentata	1.25	47.04

Table 11. Sedgeland descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Leptocarpus tenax	5.00	12.02
Schoenus brevifolius	4.25	21.89
Baeckea imbricata	4.00	31.27
Ptilothrix deusta	3.50	39.74
Stylidium graminifolium	3.25	46.69

Table 12. Woodland/Heath Complex descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average abundance	Cumulative %
Cyathochaeta diandra	3.61	7.08
Actinotus minor	3.28	12.77
Angophora hispida	3.17	18.45
Petrophile sessilis	2.89	23.70
Ptilothrix deusta	3.17	28.87
Leptospermum trinervium	2.56	33.38
Lepyrodia scariosa	2.67	37.39
Hakea dactyloides	2.11	40.78
Banksia oblongifolia	2.33	44.04
Pultenaea elliptica	2.11	47.00
Lomandra glauca	2.17	49.80

Trees: No trees are present at the swampy sites.

Shrubs: Two sites had a shrub substratum of 0.7 m and 10–30% cover. *Banksia oblongifolia, Hakea teretifolia* and *Symphionema paludosa* dominated.

Groundcover: 0.5 m and 90% cover. *Leptocarpus tenax, Schoenus brevifolius* and *Baeckea imbricata* are common. Other species included *Stylidium graminifolium, Lepyrodia scariosa, Dampiera stricta, Epacris obtusifolia, Selaginella uliginosa, Drosera spathulata, Dillwynia floribunda* var. *floribunda* and *Sprengelia incarnata*.

Vegetation Community: Woodland/Heath Complex

Woodland/Heath Complex sites with poor drainage, but with more significant tall shrub and canopy layers, were distinguished from Sedgelands (ANOSIM: Global R = 0.854, $p < 0.001$). These sites had an average similarity of 45% but varied in the presence and cover of canopy species. Consequently, whilst aerial photo interpretation distinguished heath, this graded into woodland and could not be readily distinguished on species composition in the multivariate analysis. Overall, 165 species were identified in this community. Eleven species contributed up to 50% of the similarity (Table 12) and 14 species (8%) were unique to this vegetation type of which six were found in more than one quadrat (Table 6).

This woodland type differs markedly from the Sandstone Woodland in that the tree overstorey is not as tall and covers much less area within the site. Unlike the Sandstone Woodland, these sites have *Angophora hispida* in the shrub layer, indicating a wetter soil substrate, with laterite being the predominant parent material. Some of the sites in this community have no tree substratum.

Sites: 3B, 8B, 14B, 2C, 6C, 4D, 6D, 8D, 9D, 10D, 13D, 3E, 15E, 1F, 2F, 3F, 4F, 3H.

Habitat: Ridge tops with little to no slope. Soils are well drained to damp, shallow sandy loams. Sandstone or laterite over sandstone. Often situated in shallow depressions at the heads of creek tributaries.

Distribution: This vegetation type is found mainly in the central and north-eastern part of the study area with most sites occurring in F and D ranges. There are outlier sites that occur to the west in B and H ranges. In terms of the API map units, it includes all heath sites (146 ha, 0.8% of the study area) and some open moister parts of the woodland complex.

Trees: 6 m and 15% cover. *Eucalyptus haemastoma/racemosa, Eucalyptus squamosa* and *Corymbia gummifera* although a number of sites have no overstorey (6D, 13D, 3E, 15E, 2F).

Shrubs: 1.5 m and 30% cover. *Angophora hispida* with *Leptospermum trinervium, Banksia oblongifolia, Hakea dactyloides* and *Lambertia formosa*. Other common species were *Kunzea capitata, Isopogon anemonifolius, Banksia spinulosa* and *Phyllota phylicoides*.

Groundcover: 0.4 m and 68% cover. *Cyathochaeta diandra, Actinotus minor* with *Ptilothrix deusta* and *Lepyrodia scariosa*. Other common species were *Lomandra glauca, Lomandra obliqua, Lindsaea linearis* and *Entolasia stricta*.

Vegetation Community: Sandstone Woodland

In the southern part of the area a drier woodland was distinguished from the moister widespread Woodland/Heath Complex (ANOSIM: Global R = 0.646, p < 0.001). Nine sites formed the Sandstone Woodland community with an average similarity of 45%. There were 136 species identified of which 14 species contributed up to 50% of the similarity (Table 13). Seven species were unique to this community, three of these were common eucalypt species and three species occurred in more than one quadrat (Table 6).

Most sites to the south of D range had taller overstorey trees, with some specimens up to 25 m. This type of woodland differs from the others in that the vegetation occurs on dry ridges, all with sandstone parent material. These sites tend to be confined to E range and southern areas in D range with *Corymbia gummifera* as the dominant eucalypt. Sites had an average Bray-Curtis similarity value of 45%.

Sites: 3D, 5D, 1E, 2E, 5E, 7E, 8E, 10E, 4H.

Habitat: Dry sandstone ridges in the south of the study area. Soils are well-drained and usually dry, sandy loam and shallow. Sandstone outcrops are common.

Distribution: 9018 ha (50.5% of the study area. NB: this figure is for the whole of the woodland complex). The dry open woodland occurs along most of the sandstone ridges in the southern part of the range, with some ridges extending into the central and western areas.

Trees: 10 m and 30% cover. *Corymbia gummifera, Eucalyptus oblonga, Eucalyptus consideniana* with *Eucalyptus haemastoma/racemosa*. Other common species were *Banksia serrata, Banksia ericifolia, Eucalyptus sieberi*, and *Eucalyptus multicaulis.*

Shrubs: 2 m and 40% cover. *Leptospermum trinervium* with *Banksia serrata, Platysace linearifolia, Platysace ericoides* and *Isopogon anemonifolius*. Other common species were *Eriostemon australasius, Lambertia formosa* and *Petrophile sessilis*.

Groundcover: 0.2 m and 30% cover. *Cyathochaeta diandra* with *Lomandra glauca*. Other common species included *Xanthorrhoea media, Caustis flexuosa, Schoenus ericetorum* and *Lepyrodia scariosa*.

Exotic species

Thirty-eight exotic species were found in the Military Area (Table 4). Observations of weeds in areas other than the surveyed sites were noted and are included in this list. Six species are considered noxious in the area and are an immediate management issue. These are *Cestrum parqui, Cortaderia selloana, Opuntia stricta , Ligustrum lucidum, Ligustrum sinense* and *Salix* sp. Noxious classification is largely based on threats to agriculture and differs between local government areas. Seven exotic species, are considered to pose serious threats to native plant communities and are listed (Table 4). Most species occurred in the shale areas, emphasising the importance of management for these areas. Most exotic species were found at the dump in the northern part of the area and at site 17B, which is close to urban development. Few exotic species were found away from roadsides and highly disturbed areas.

Table 13. Sandstone Woodland descriptors.

These species contributed up to 50% of the average similarity between sites within this community. Average abundance is the average Braun-Blanquet cover value. The cumulative % contribution of each species to the total average Bray-Curtis value is given.

Species	Average Abundance	Cumulative %
Corymbia gummifera	3.11	5.55
Leptospermum trinervium	3.22	10.41
Cyathochaeta diandra	2.89	14.48
Lomandra glauca	3.11	18.32
Isopogon anemonifolius	2.33	21.75
Xanthorrhoea media	2.33	25.13
Platysace ericifolia	2.44	28.46
Eriostemon australasius	2.33	31.68
Caustis flexuosa	2.33	34.78
Dampiera stricta	2.11	37.70
Lambertia formosa	2.00	40.53
Platysace linearifolia	2.44	43.27
Cassytha pubescens	1.78	45.98
Bossiaea heterophylla	2.00	49.37

Table 14. Species of conservation significance found in the Holsworthy Military Area.

(a) Benson and McDougall (1991), (b) Benson and McDougall (1995), (c) Benson and McDougall (1996), (d) Benson and McDougall (1998), (e) Briggs and Leigh (1995), nl = not listed.

Species	Status	ROTAP Listing At 1995 (e)	Sites
Dilleniaceae			
Hibbertia nitida (b)	Uncommon in Sydney	2RC-	5D,7D
Fabaceae			
Chorizema parviflorum (c)	Vulnerable in western Sydney	nl	12B, 15B
Pultenaea hispidula (c)	Uncommon in Sydney	nl	1D
Zornia dyctiocarpa (b)	Vulnerable in western Sydney	nl	3C
Epacridaceae			
Leucopogon exolasius	V(TSCA), V(ESPA)	2VC-	5F, 5H
Myrtaceae			
Darwinia diminuta (d)	Rare local endemic	nl	4D, 6D, 8D, 9D, 10D, 11D, 13D
Eucayptus baueriana (a)	Uncommon in western Sydney	nl	Williams Creek
Melaleuca deanei	V(TSCA2000), V(ESPA 1999)	3RC-	8B, 8D, 1E, 1H, 3H
Proteaceae			
Grevillea longifolia (a)	Rare in Sydney	2RC-	11B, 7C, 12E

Rare or threatened species

Ten rare or threatened species were found at the survey sites (Table 14). According to Briggs and Leigh (1995), three of these species are classified as rare (R) and have very restricted distributions in Australia with a maximum geographic range of less than 100 km (2) and one species is considered vulnerable (V). A further four are considered of conservation importance because they are uncommon. One has been listed since Briggs and Leigh (1995).

Discussion

Vegetation communities

Holsworthy Military Area is a species rich, relatively undisturbed example of Sydney vegetation, encompassing riverine communities (Riparian Scrub and Melaleuca Thickets), shale communities (Plateau Forest on Shale and Shale/Sandstone Transition Forest) and Hawkesbury Sandstone communities (Gully Forest, Sandstone Woodland, Woodland/Heath Complex and Sedgelands). All communities were significantly different when analysed on the basis of species composition and abundance.

Although not surveyed in this study, there are also considerable areas of Tertiary alluvium with *Melaleuca decora* and ironbark forests (Benson & Howell 1990a) to the north of the Holsworthy Military Area. These have been interpreted as Castlereagh Scribbly Gum Woodland (map unit 14a) (Benson 1992, James 1997) with some areas of Grey-box Ironbark Forest (map unit 10d) (James 1997), however this area requires ground surveys and analysis to classify correctly.

It is assumed that the plateau forests are formed on shale, however, Tertiary alluvium does occur in the area and due to the weathered nature of the rocks with few outcrops, the determination of soil type remains to be confirmed (I. Paterson pers. comm). It is feasible that some of the plateau forests in the north of the study area are on the Mittagong formation, intergrading sandstone and shale which lie between the Wianamatta shale beds and the underlying Hawkesbury Sandstone. This is consistent with the composition of the plant communities as transitional. It is also possible for alluvium to be present in small patches. However, geology maps do not appear accurate in this area (Sherwin & Holmes 1986, Jones & Clark 1991) and no new geological surveys have been completed. Confirmation of the soils therefore awaits further research.

It is appropriate to identify the characteristic species using an analysis that distinguishes the common important species independent of the knowledge of the observer. Vegetation classifications often rely on the extensive knowledge of the observer who determines the relative abundances of particular species while visiting sites. Knowledge of other sites is essential for reference. The classification is prone to bias if particular plant species are observed more readily by individuals and because variability in the system has not been quantified. It would be useful to characterise communities more precisely, providing 'less skilled managers' with a method of

determining the similarity of the sites they are observing, with established criteria. We used SIMPER to characterise the communities in the study area. This method has a number of advantages. Firstly, it provides a way of measuring variation in abundance of species, particularly canopy species, by identifying the average abundance of important taxa. Secondly, it uses the majority of species to do this, rather than only those large species obvious to an observer. Only rare species that had low percentage cover at one or two sites were removed for this analysis because of the limitations of the program. This ensures that features of the understorey and groundcover are used to describe communities, these strata, after all, are where the majority of plant diversity lies. By setting these species and abundance measures, these sites can be better compared to other sites within the Sydney area and the classification of particular vegetation communities (defined in this way) is not prone to subjective interpretation by others. Furthermore, this process will identify more clearly disturbed sites, as these areas often have reduced understorey diversity of native species.

An alternative way of describing vegetation units was used by Biosis (1997) which listed the frequency of species occurrence in sites. This method does not use high cover abundance as a criterion in choosing typical species. Instead, species which are widespread are included. The main disadvantage is that obvious species that contribute to the biomass of sites but which are aggregated and patchy, but nevertheless typical, are less likely to be included.

This point is kept in mind in determining the relationship of vegetation communities identified here (Table 3) with those of Benson (1992), Keith (1994) and Biosis Research and PPK (1997). In general, most communities encountered are similar to other vegetation communities described. Melaleuca Thickets equate closely to River-flat forest (Biosis Research 1997), and Riparian Scrub equates to descriptions under the same name in both Keith (1994) and Biosis Research and PPK (1997). However, for Riparian Scrub the variablity in species dominating sites is evident, corroborating the high variability found between sites in this study. Clearly this community is spatially variable or is made up of a number of communities. Comparison with other datasets may improve our understanding of these sites.

The forests on the plateau appear to be an area of contention. Benson (1992) describes the area as Grey-box Woodland (map unit 10C) and Biosis Research (1997) defines the area as Grey-box Ironbark Woodland (map unit 10D). Our classification is in agreement with Biosis Research and PPK like that analysis, distinguishes a transition forest where it grades into sandstone. This area appears similar to the Shale Forest described in Keith (1994), however, Holsworthy forest had lower cover with *Cyathochaeta diandra* and *Entolasia stricta* being dominant groundcover species. The Gully Forest at Holsworthy are more similar to the Eastern Gully Forests described by Keith (1994) and equate with Sydney Sandstone Gully Forest described in Biosis Research (1997) and Benson (1992; map unit 10agiii). The sandstone communities follow Keith's descriptions for Sedgeland and Sandstone Woodland. However, the Woodland/Heath Complex appears to be a combination of Ironstone Heath and Heath Woodland in the O'Hares Creek area.

Unique species in each vegetation community are the result of two factors. A number of species are likely to be specific to particular communities and therefore of importance for the conservation of that community. However, these cannot be separated from a suite of rare species that may occur in more than one habitat but which are too rare to be encountered in this study. This is particularly true of those species that only occur at one site in the study. Species occurring at more than two sites within a vegetation community are more likely to be particular to that community (Table 6).

Few orchid species were identified during the study, due to the timing of the survey over a very dry summer. Only one species, *Thelymitra* sp. occurred in Shale/Sandstone Transition Forest. This study found only four species, however Biosis Research (1997) sampled at a wetter time and identified 21 species of orchid. Further work in the area has identified many other orchids including a number of new populations of the endangered *Pterostylis saxicola* (S. Hill unpub. data).

The conservation significance of Holsworthy Military Area

The Military Area has high conservation value for a number of reasons. Firstly it contains a large remnant of Cumberland Plain Woodlands, classified here as Plateau Forests on Shale. This community is listed under the *NSW Threatened Species Conservation Act 1995* (TSCA) due to its ecological significance. With only 6% of original woodland left in the Sydney Region (Benson & Howell 1990b), the Holsworthy remnant represents an important part of its survival. The distinction/similarity between these woodlands and other woodlands across the Cumberland Plain was not part of this study, but the classification of this community relative to other sites has shown that Holsworthy probably contains both 10C and 10D vegetation map units (Benson 1992, French et al. 2000). However, Holsworthy was distinguishable from other sites around Sydney in having few exotic species.

Secondly the closeness of these shale communities on the Cumberland Plains to the sandstone communities of the Woronora Plateau suggests that Shale/Sandstone Transition Forests could occur which are also listed under the TSCA. Again the Transition Forests identified in this study are likely to fall into such a classification but more work is required to determine the relationship of the vegetation communities described in this study to the described communities in the legislation. There are many similarities with the description of Shale/Sandstone Transition Forest listed within NPWS (2000) which sampled all Cumberland Plain vegetation except the area within the Holsworthy Military Area.

Thirdly, past landuse of Holsworthy, has resulted in few areas of human disturbance. Holsworthy has been restricted to Military personnel since 1912 (Axis Environmental & Australian Museum Business Services 1995b), ensuring that only the edges of the study area are disturbed by urban recreation, runoff and pollution. As a result, weed infestation is minimal. However, fire frequency is likely to have been high given the difficulty of controlling fires in the presence of unexploded ordinances which occur throughout the range and the use of this area as a firing range.

Four threatened species were identified in this study: *Hibbertia nitida* (2RC-), *Leucopogon exolasius* (2VC-), *Melaleuca deanei* (3RC-) and *Grevillea longifolia* (2RC-). The Environmental Impact Statement for the second airport (Biosis Research 1997) identified a further five species, one of which occurs on the Tertiary alluvium sites in the north (*Allocasuarina glareicola*), two on shale (*Persoonia nutans* and *Pterostylis saxicola*) and two on sandstone in the south (*Pultenaea aristata* and *Monotoca ledifolia*). The EIS also identified five other species as being of state significance: *Eucalyptus ligustrina, Hakea salicifolia, Persoonia mollis* subsp. *nectens, Tetratheca shiressii* and *Westringia longifolia*.

Holsworthy Military Area is an area of high conservation significance, not only in terms of biological diversity but also in terms of cultural heritage (Axis Environmental & Australian Museum Business Services 1995a). It represents an area of relatively undisturbed vegetation at the extreme west of the Woronora Plateau where rainfall is at its lowest and where it grades into the Cumberland Plain vegetation. This area complements the National Parks to the East and forms an important element in the conservation of the water quality of the Georges River.

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Appendix. Species list and sites where each species occurred.

Nomenclature follows Harden (1990–1993) and Jacobs and Everett (1996). Sh/SS Trans Forest = Shale/Sandstone Transition Forest.

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Acanthaceae								
Brunoniella australis		9B,12B,13B,15B, 16B,18B,3C	2B					
Adiantaceae								
Adiantum aethiopicum	1BR,11B							
Antheriaceae								
Caesia parviflora var. *parviflora*		10B					4D	
Caesia parviflora var. *vittata*		18B						
Laxmannia gracilis		10B,16B,18B,3BR					8B	8E
Thysanotus juncifolius						9E	8B,6C	3D
Tricoryne simplex		10B				4E	10D	
Apiaceae								
Actinotus helianthi				5F,3G,2H,			6C	
Actinotus minor				7C,2D,5C	2G	4E,11E	3B,8B,2C,6C, 4D,8D,9D,10D, 13D,3E,1F,2F, 3F,4F,3H	3D,5D,5E,7E 8E,4H
Hydrocotyle laxiflora	1BR,1C,4C							
Hydrocotyle peduncularis	11B							
Platysace ericoides		7B,10B,18B	4B,6E,1H, 5H,7H	5C,1D,7D,5F, 12D			3B,8B,2C,6C, 4D,8D,9D,10D, 13D,4F,3H	5D,1E,2E,5E, 7E,8E,10E,4H
Platysace lanceolata				14D				3D,5D,8E
Platysace linearifolia		7B,10B		5C,7C,1D,2D, 12E,5F,1G,2H	6B,13E	11D,11E	4D,6D,9D,10D, 13D,2F,3F,5H	3D,5D,12D,5E, 7E,8E,10E,4H
Trachymene incisa		2BR,10B	3BR					
Xanthosia pilosa		10B	5H	5B,5C,7C,1D, 2D,7D,12D,14D, 12E,5F,1G,3G, 2H	2G			5E,7E,3D,5D, 4H
Xanthosia tridentata			5H	5C,7C,2D,7D, 12D,12E,2H	6B,13E,2G,5G		9D,10D,13D,2F	5D,8E

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Araliaceae								
Astrotricha latifolia				1G				
Asclepiadaceae								
Marsdenia suaveolens	11B			2D,7D	6B			
Asparagaceae								
**Myrsiphyllum asparagoides*	17B							
Asteraceae								
**Aster subulatus*	17B							
Cassinia aureonitens				2H				
Cassinia denticulata				7D				
**Cirsium vulgare*	17B							
**Conyza albida*	1BR,11B,17B		3BR	1G	2G			
**Conyza canadensis*	17B							
Gnaphalium gymnocephalum				12D				
**Gnaphalium coarctatum*	17B							
Helichrysum collinum			3BR,1H				8B	
Helichrysum scorpioides		7B,10B,18B	4B,6E					
**Hypochaeris radicata*	17B	2BR,12B		1G,3G	13E			
Lagenifera stipitata		7B,15B,18B						
**Pseudognaphalium luteoalbum*	17B							
Senecio hispidulus		2BR,9B,12B,13B						
Senecio lautus				2H				
**Senecio madagascariensis*		9B		3G	2G			
**Senecio tamoides*	17B							
**Sigesbeckia orientalis*	17B							
**Sonchus oleraceus*	11B							
Sonchus sp.	1BR							
Vernonia cinerea		13B,16B,3C						
Baueraceae								
Bauera rubioides				7C	13E			
Bignoniaceae								
Pandorea pandorana		2BR		1G				

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Blandfordiaceae								
Blandfordia nobilis				2D		11D,4E,9E		5D
Blechnaceae								
Blechnum ambiguum					13E			
Blechnum cartilagineum	1C,4C							
Campanulaceae								
Wahlenbergia gracilis		10B	6E	3G,2H		9E		
Wahlenbergia stricta		10B	3BR,7H					
Cassythaceae								
Cassytha glabella					2G	11D	6C,4D,6D,9D 10D	
Cassytha pubescens	17B		3BR,2B,6E,1H, 5H,6H,7H	5C,12E,3G	6B,13E,5G	9E,11E	3B,8B,8D,13D, 3E,15E,1F,2F, 3F,4F,3H	3D,5D,1E,2E, 5E,7E,8E,10E, 4H
Casuarinaceae								
Allocasuarina diminuta							8B,14B,8D	
Allocasuarina distyla				7C				8E
Allocasuarina littoralis		4G	2B,4B	5B,5C,1D,1G, 3G	2G,5G		3B	
Allocasuarina torulosa	17B	16B						
Chenopodiaceae								
Einadia trigonos subsp. *trigonos*		17B						
Clusiaceae								
Hypericum gramineum		10B,13B,16B,18B	6E					
Colchicaceae								
Burchardia umbellata			6H				6D	
Commelinaceae								
Commelina cyanea	17B							
Cunoniaceae								
Ceratopetalum apetalum				7C	13E,2G,5G			
Ceratopetalum gummiferum				5C,2D,7D,12D, 14D,12E,1G,3G, 2H	6B,13E,5G			

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Cyperaceae								
Baumea juncea	1BR				2G			
Baumea rubiginosa	1C,4C							
Caustis flexuosa			6E,1H,5H	5C,1D,2D,7D, 12D,1G,3G,2H			2C,10D,4F	3D,5D,1E,2E, 5E,7E,8E,10E, 4H
Caustis pentandra				5C,12E	13E,2G		9D,10D	3D,8E
Chorizandra cymbaria	11B	10B			2G			
Cyathochaeta diandra		2BR,7B,10B,16B, 18B	3BR,2B,4B,1H, 5H,6H,7H	5C,12D,3G			3B,8B,14B,2C, 6C,4D,6D,8D, 9D,10D,13D,3E, 15E,1F,2F,3F,4F, 3H	3D,5D,1E,5E, 7E,8E,10E,4H
Eleocharis sphacelata	1BR,1C							
Gahnia sieberiana	1BR,11B,1C,4C			7C,12E	13E			7E,10E
Isolepis cernua	1BR,1C,4C							
Lepidosperma concavum			5H	3G				
Lepidosperma filiforme				5C			4D,9D	1E,7E
Lepidosperma laterale		10B,12B,3C,4G	2B,4B,6H	5B,5C,7C,1D, 2D,12D,14D,12E, 5F,1G,2H	13E,2G,5G		3B,14B,2C,4D, 10D	3D,2E,10E
Lepidosperma gunnii		1B,7B,9B,13B, 15B,16B,18B	3BR,7H	5B				
Lepidosperma neesii						4E	2F	
Lepidosperma concavum		2BR						
Ptilothrix deusta		1B,7B,12B,15B, 16B,18B,3C	2B,4B,6E,5H, 6H,7H			11D,4E,9E,11E	14B,2C,6C,4D, 6D,8D,9D,10D, 13D,3E,15E,2F, 3F,3H	3B,5D,1E,7E, 10E
Schoenus brevifolius	4C	10B		7C		11D,4E,9E,11E	6D,13D,3E	
Schoenus ericetorum			3BR,1F,5H				2C,6C,4D,8D, 9D,4F	3D,5E,7E,8E, 10E,4H
Schoenus lepidosperma subsp. *pachylepsis*					6B		8D	
Schoenus melanostachys		10B		2D,2H	13E,2G,5G			
Schoenus moorei							14B,1F	
Schoenus paludosus						9E,11E		
Schoenus turbinatus								3D,5E,7E,10E

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Cyperaceae cont.								
Schoenus villosus						2C	14B,2F,3H	3D
Tricostularia pauciflora	11B	10B						7E
Dennstaedtiaceae								
Hypolepis muelleri	1C							
Pteridium esculentum	1BR,11B,17B,1C, 4C	2BR		5B,5C,7C,1D, 2D,7D,14D,12E, 5F,1G,3G,2H	6B,5G	4E		
Dicksoniaceae								
Calochlaena dubia	1BR,11B,4C			1D,7D,12E,1G	13E,5G			
Dilleniaceae								
Hibbertia acicularis				7C				
Hibbertia aspera	11B	10B,12B						
Hibbertia circumdans				5C				
Hibbertia diffusa		7B						
Hibbertia empetrifolia					6B			
Hibbertia linearis		2BR						8E
Hibbertia monogyna			5H	1D,12D			3D	
Hibbertia nitida				7D			5D	
Hibbertia riparia			1H	1D			3B,4D,8D,9D, 13D,4F,3H	3D,1E,2E,5E, 10E,4H
Hibbertia sericea							4D,8D	
Hibbertia serpyllifolia		12B	6H				8B,14B,10D,3E, 2F	5D
Doryanthaceae								
Doryanthes excelsa				5B,1D,2D,7D, 14D				5D
Droseraceae								
Drosera peltata		10B						
Drosera spatulata				7C,2D	13E	4E,9E	6D	
Elaeocarpaceae								
Elaeocarpus reticulatus				1G				
Epacridaceae								

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Brachyloma daphnoides		2BR	1H,7H				2C,4D,10D,1F, 4F	3D,5D,2E,10E, 4H
Epacris longiflora			3BR	7D,12E	13E			
Epacris microphylla				5C		4E,9E,11E	2C,4D,6D,9D, 10D,13D,3E,2F	5E,7E
Epacris obtusifolia						11D,4E,9E		
Epacris pulchella			2B,6E,6H	7C,2D	6B		4D	5D,1E,7E
Leucopogon amplexicaulis				2D,7D				
Leucopogon appressus							8B,2F,3H	
Leucopogon ericoides	1BR	2BR	3BR,6H	5C,7C,2D,7D			2C,15E	
Leucopogon esquamatus						11D,4E	8D	
Leucopogon exolasius			5H	5F				
Leucopogon juniperinus			7H				2F	2E
Leucopogon lanceolatus				14D,12E				
Leucopogon microphyllus						11D,11E	3B,8B,2C,6C, 4D,6D,8D,9D, 10D,13D,3E,1F, 2F,4F	3D,5D,1E,5E, 7E,8E,10E
Lissanthe strigosa		1B,7B,10B,12B, 15B,16B,18B,3C	2B,6E,1H,5H, 6H,7H	3G			6C,1F	5D,1E,7E,8E, 4H
Melichrus procumbens							4F	
Melichrus sp.								8E
Monotoca elliptica				5C			9D	
Monotoca scoparia		2BR,7B	3BR,2B,1H	5B,1D,2D,7D, 14D,3G	2G		4D,9D,3F	3D,5D,2E,5E, 7E,8E,10E,4H
Sprengelia incarnata						11D,4E,9E		
Styphelia sp.				7D				
Woollsia pungens				5C			9D	3D,5E,7E
Euphorbiaceae								
Amperea xiphoclada	11B			7D,14D				5D
Bertya pomaderroides				7C				
Beyeria lasiocarpa					2G			
Micrantheum ericoides			2B,4B	7C	6B		8B,14B,2C,6D, 15E,1F,2F,3F, 4F	

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Euphorbiaceae cont.								
Phyllanthus gasstroemii	17B							
Phyllanthus hirtellus		1B,7B,10B,16B, 18B	3BR,2B,6E,1H, 5H,6H,7H	5B,7C,1D,12D, 14D,5F,1G,3G, 2H	6B		2C,3F,4F,15E, 4H	5D,2E,8E
Poranthera ericifolia				5C,2D	6B		4H	
Poranthera microphylla	17B	12B						
Pseudanthus pimeleoides					2G			
Ricinocarpos pinifolius				5C,7D				5D
Fabaceae								
Acacia binervia	17B							
Acacia decurrens	1BR	12B						
Acacia falcata		3C						
Acacia floribunda	11B				5G			
Acacia hispidula			1H	2H				
Acacia implexa	17B							
Acacia irrorata subsp. *irrorata*		2BR,10B,18B						
Acacia linifolia			3BR,2B,4B,6E, 1H,5H,6H,7H	5C,1D,2D,12D, 14D,12E,5F,1G, 2H	13E		3B,2C,15E,1F, 2F	5D,7E,8E,10E
Acacia longifolia	1C,4C	2BR,9B	7H	12E	6B,13E			
Acacia longissima				7C				
Acacia mearnsii		9B						
Acacia myrtifolia		7B	2B,6E,1H,6H, 7H				2C,15E	5D,1E,5E,7E, 8E
Acacia obtusifolia				7C	2G,5G			
Acacia penninervis		12B,15B						
Acacia suaveolens		1B,7B	1H,7H	2D,7D,12D,14D 5F,2H		11D,11E	3B,2C,9D,13D, 15E,3F	3D,5E,7E,8E
Acacia terminalis		1B,4G	3BR,5H,6H,7H	5C,7C,2D,7D, 14D,12E,5F,1G, 3G,2H	6B,13E,5G	4E	2C,3E	
Acacia ulicifolia		1B,7B,16B,4G	2B,4B,6E,1H, 5H,6H,7H	5B,5C,7C,1D, 2D,7D,14D,1G, 3G,2H			3B,2C,1F,2F	1E,2E,5E,4H
Aotus ericiodes				7D,14D		11E		

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Fabaceae cont.								
Bossiaea ensata			7H				2C,8D,9D,10D	3D,1E,5E,7E, 10E
Bossiaea heterophylla		2BR	1H,5H	5C,7C,1D,2D, 7D,12D,14D,5F, 3G,2H	6B	11D,11E	14B,6C,3F,4F, 3H	3D,5D,1E,5E, 7E,8E,10E,4H
Bossiaea obcordata			7H					
Bossiaea prostrata		1B,12B,15B,16B, 18B,3C,4H	3BR					
Bossiaea stephensonii				5C				
Chorizema parviflorum		12B,15B						
Daviesia corymbosa					6B,2G			2E,10E
Daviesia ulicifolia		9B,13B,15B						
Dillwynia floribunda var. *floribunda*			3BR,7H			4E,9E	3H,3E,1F,2F,3F	
Dillwynia floribunda var. *teretifolia*							4F	4H
Dillwynia parviflora		1B,12B,4G	2B					
Dillwynia retorta			4B,1H,5H,6H, 7H	5C,7C,1D,2D, 12D,12E,5F,2H	6B		2C,9D	3D,5D,8E,10E
Dillwynia sericea			6E				3B,8B,6C,6D, 8D,15E	1E
Glycine clandestina	17B	1B,7B,9B,10B, 12B,15B,16B,18B, 4G	6E	5B,1G				
Glycine tabacina	4C	9B,13B,15B,16B, 3C						
Gompholobium glabratum		3BR,6H					8B,2C,4D,6D, 8D,9D,15E,4F	3D,5E,10E
Gompholobium grandiflorum			1H,5H	7C,5F,2H			2C,9D,10D,15E	3D,5D,2E,5E, 7E,10E,4H
Gompholobium latifolium				7D,14D				
Gompholobium minus		2BR,7B,10B,16B, 18B	3BR,2B,5H,6H	3G				4H
Gompholobium sp.*B*		4G						
Hardenbergia violacea		12B,13B,15B,16B, 18B,3C	6E,5H	7C,1D,2D,7D, 14D,5F,1G,3G	6B,13E			
Hovea linearis		2BR,7B,10B	3BR,2B,1H,7H	5B,1D,2D,12D, 2H			9D,10D,15E,4F	3D,5D,7E

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Fabaceae cont.								
Indigofera australis		13B						
Kennedia rubicunda	11B,4C			5B				
Mirbelia rubiifolia			2B			11D,9E	6D	1E
Mirbelia speciosa			1H,6H				15E	2E,5E,7E,10E
Phyllota phylicoides		2BR					8B,14B,2C,6C, 4D,6D,8D,9D, 10D,15E,4F	
Pultenaea daphnoides			6E	5C,2D,7D,14D				
Pultenaea elliptica			2B,4B,1H	5C,7C		11D	3B,8B,14B,2C, 6C,4D,6D,8D, 9D,10D,13D,3E, 15E,1F,2F	3D,5D,5E,7E, 8E,10E
Pultenaea flexilis				5B,1D,12E,1G	13E,2G			
Pultenaea hispidula				1D				
Pultenaea scabra var. *scabra*		10B		5D,7D				
Pultenaea stipularis				12D,12E				3D,5E
Pultenaea villosa		12B,15B,3C						
Viminaria juncea			6E			11D,9E		
Zornia dyctiocarpa		3C						
Gentianaceae								
**Centaurium erythraea*	17B		4B		13E			
Geraniaceae								
Geranium sp.			3BR					
Gleicheniaceae								
Gleichenia dicarpa	1BR,4C			7C	6B,13E	4E		
Gleichenia microphylla					2G			
Gleichenia rupestris				2D				
Sticherus flabellatus				7C	6B,13E,2G			
Goodeniaceae								
Dampiera purpurea	11B	10B	5H	5B,7C,1D,14D, 12E,1G,3G,2H				
Dampiera stricta			1H,5H	7C		4E,9E,11D,11E	3B,8B,14B,2C, 6C,4D,6D,9D, 10D,13D,3E,15E, 1F,3F,4F,3H	3D,1E,2E,5E, 7E,8E,10E,4H

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Goodeniaceae cont.								
Goodenia bellidifolia		12B	3BR,2B,4B,6H				3B,14B,6C,10D, 3H	1E
Goodenia dimorpha var. *angustifolia*						9E		
Goodenia hederacea	3BR	1B,7B,10B,12B, 15B,16B,18B,3C	6E	5B,3G				
Goodenia paniculata		2BR,10B						
Scaevola ramosissima			2B,7H	14D			15E,2F	3D,5D,8E
Haemodoraceae								
Haemodorum corymbosum	6B		5H			11D,4E,11E	2C,4D,13D,3E, 1F,3H	7E
Haloragaceae								
Gonocarpus micranthus	11B							
Gonocarpus tetragynus		7B,10B,12B,15B, 16B,18B	6E				2C,6D,3E	7E
Gonocarpus teucrioides	11B	1B,10B,12B,3C	4B,6E,6H	5B,7C,2D,7D, 14D,12E	6B,13E,2G		6C,9D,10D	
Iridaceae								
Patersonia glabrata			5H	5B,5C,7C,1D, 7D,2H			1F,3H	2E
Patersonia sericea		7B,10B,15B,16B, 18B,2C	3BR,2B,6H			11E	3B,8B,14B,6C, 4D,6D,8D,9D, 10D,13D,3E,4F	3D,1E,5E,7E, 10E
Juncaceae								
Juncus continuus	1BR,11B				2G			
Juncus planifolius					2G			
Juncus usitatus					2G			
Juncaginaceae								
Triglochin procerum					2G			
Lamiaceae								
Hemigenia purpurea							8B	
Plectranthrus graveolens	17B							

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Lauraceae								
**Cinnamomum camphora*	1C							
Lindsaeaceae								
Lindsaea linearis		7B,4G	4B		2G	11D,4E	3B,8B,2C,6C, 4D,6D,8D,9D, 10D,15E,1F,4F, 3H	5D,1E
Lindsaea microphylla				5C,1D,2D,7D, 12D,12E,2H	6B,13E			
Lobeliaceae								
Lobelia alata	4C							
Lobelia dentata		10B						
Pratia purpurascens	1BR,11B,1C	3C						
Loganiaceae								
Logania albiflora				7C	6B,13E			
Mitrasacme polymorpha		10B				11E	4F	7E,8E,10E
Lomandraceae								
Lomandra cylindrica		2BR,7B	5H,6H	5B,5C,12D,1G			1F	7E,8E,10E,4H
Lomandra filiformis subsp. *coriacea*		10B,15B,16B,18B, 4G	4B,6H	14D			2C,6C,9D,15E	5D
Lomandra filiformis subsp. *filiformis*		1B,7B,	2B,1H,5H	5C,1D,7D,12D, 14D,5F,2H			3B	3D
Lomandra fluviatilis		10B		7C	2G			
Lomandra glauca		7B,9B	3BR,2B,5H,6H	12D,5F			8B,14B,2C,6C, 4D,8D,9D,10D, 15E,1F,3F,4F, 3H	3D,5D,2E,5E, 7E,8E,10E,4H
Lomandra gracilis		4G	6E,5H,7H	5B,7C,1D,2D, 7D,12D,14D,12E 5F,1G,3G	6B,13E		8B,14B,4F	8E,4H
Lomandra longifolia	1BR,11B,17B,1C	2BR,10B,13B,16B	3BR,6B,6E	1D,2D,7D,14D, 12E,1G	13E,5G			
Lomandra multiflora		7B,9B,10B,12B, 15B,16B,18B,3C, 4G	4B,6E,1H,6H, 7H	5B,5C,7C,12D, 1G,3G,2H			2C,6C	8E,4H
Lomandra obliqua		2BR,1B,7B,10B, 16B,18B	3BR,2B,4B,6E, 1H,5H,6H,7H	5B,5C,7C,1D, 2D,7D,14D,5F, 1G,3G,2H		11E	3B,8B,2C,6C, 8D,9D,10D,15E, 1F,2F,3F,4F,3H	3D,1E,7E,8E, 10E

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Lycopodiaceae								
Lycopodium laterale						9E		
Myrsinaceae								
Rapanea variabilis				5B				
Myrtaceae								
Angophora bakeri		10B,12B,15B,16B, 3C	3BR,6H	5F				
Angophora costata		1B,7B,18B,4G	2B,6E,1H,5H	5B,1D,2D,7D, 12D,14D,12E,5F 1G,3G,2H	6B,13E,2G			5D,8E
Angophora floribunda		2BR						
Angophora hispida				7C		11D	3B,8B,14B,2C, 6C,4D,6D,8D, 9D,10D,13D,3E, 15E,1F,2F,3F,4F, 3H	
Austromyrtus tenuifolia					2G			
Backhousia myrtifolia	17B							
Baeckea brevifolia							8B,4D,6D,2F	
Baeckea diosmifolia						4E	13D,3E,3H	
Baeckea imbricata						11D,4E,9E,11E	6D,13D	
Baeckea linifolia				7C	5G			
Baeckea ramosissima							8B,2C,4D,8D, 2F,3H	5E
Callistemon citrinus	1BR,11B			7C,2G		11D	2F	
Callistemon linearis			2B,4B			4E	3B,13D	
Calytrix tetragona				7C	2G		9D,10D	
Darwinia diminuta						11D	4D,6D,9D,10D, 13D	
Darwinia fascicularis					2G	11E		
Eucalyptus agglomerata				2H				
Eucalyptus beyeriana		18B						
Eucalyptus botryoides/saligna	17B,1C,4C							
Eucalyptus consideniana								3D,1E,2E,5E, 4H
Eucalyptus crebra		9B,13B						

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Myrtaceae cont.								
Eucalyptus eugenioides		9B						
Eucalyptus fibrosa		9B,12B,13B,15B, 16B,3C						
Eucalyptus globoidea		12B,15B,16B,18B, 3C,4G						
Eucalyptus gummifera		1B,7B,16B,18B	2B,6E,1H,6H, 7H	5B,5C,7C,1D, 2D,7D,12D,12E, 5F,3G			2C,6C,4D,9D, 15E,1F,3F,4F	3D,5D,1E,2E, 5E,7E,8E,10E, 4H
Eucalyptus haemastoma/ racemosa intergrade		10B	4B,6E				2C,6C,4D,6D, 9D,10D,3E,15E, 3F,4F,5F	3D,5D,8E,10E
Eucalyptus longifolia		12B						
Eucalyptus moluccana		9B						
Eucalyptus multicaulis								5D
Eucalyptus oblonga		4G	3BR,5H				2C,6D,9D,4F	2E,5E,7E,10E, 4H
Eucalyptus pilularis			7H	1G,3G,2H	6B,5G			
Eucalyptus pilularis/ piperita intergrade				5B				
Eucalyptus piperita	1BR			5C,7C,2D,7D, 12D,14D,12E,1G, 2H	6B			8E
Eucalyptus punctata	11B	7B,10B,16B,18B, 4G	2B,1H,5H,6H, 7H	1G,2H			15E	
Eucalyptus resinifera		1B,18B						
Eucalyptus sclerophylla		2BR						
Eucalyptus sieberi								7E,10E
Eucalyptus sparsifolia		1B,7B	2B					
Eucalyptus squamosa			1H,6H,7H				8B,14B,4D,8D, 10D	3D
Eucalyptus tereticornis		9B,16B						
Kunzea ambigua		4G					8B,1F	8E
Kunzea capitata		7B	4B,6H				3B,8B,14B,2C, 6D,8D,9D,15E, 1F,2F,3F,4F	
Leptospermum arachnoides				7C		11D,11E	3B,2C,6C,4D, 6D,8D,9D,10D, 13D,2F,3F	

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Myrtaceae cont.								
Leptospermum continentale						4E	3E	
Leptospermum juniperinum	1BR,11B,4C				13E			
Leptospermum morrisonii					2G,5G			
Leptospermum parvifolium			2B				3B	
Leptospermum polygalifolium		2BR,10B		5C,7C,2D,12E, 1G	6B,13E,5G	11D		
Leptospermum squarrosum						9E		
Leptospermum trinervium		2BR,7B,10B,15B, 16B,18B	3BR,2B,4B,6E, 1H,5H,6H,7H	5C,7C,2D,7D, 12D,14D,1G,3G, 2H		11D	3B,8B,14B,2C, 6C,4D,6D,8D, 9D,10D,13D,3E, 15E,1F,2F,3F, 4F,3H	3D,5D,1E,2E, 5E,7E,8E,4H
Melaleuca deanei			1H				8B,8D,3H	1E
Melaleuca decora		12B						
Melaleuca linariifolia	1BR,11B,1C,4C	10B			5G			
Melaleuca nodosa		10B						
Melaleuca thymifolia		12B	4B					
Syncarpia glomulifera		16B		1G,3G				
Tristania neriifolia				7C	2G			
Tristaniopsis laurina	17B				13E,2G,5G			
Olacaceae								
Olax stricta							10D	
Oleaceae								
**Ligustrum lucidum*	1BR							
**Ligustrum sinense*	17B							
Notelaea longifolia		10B						
Orchidaceae								
Caleana major				5F				
Cryptostylis erecta				14D				
Dendrobium linguiforme				1D,7D,12D	6B			
Dipodium punctatum		9B		12D				
Liparis reflexa				7D	13E			
Thelymitra sp.			4B					

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Osmundaceae								
Todea barbara					6B,13E			
Oxalidaceae								
Oxalis perennans	17B							
Oxalis radicosa	4C							
Oxalis sp.		2BR,9B,13B,15B, 3C						
Phormiaceae								
Dianella caerulea var. *caerulea*	1C		4B	5B,5C,7C,1D, 7D,14D,12E,1G, 2H	6B	11B	9D	
Dianella caerulea var. *producta*								5D
Dianella longifolia		13B						
Dianella revoluta		1B,7B,9B,10B, 12B,15B,16B,18B, 3C,4G	3BR,2B,6E,1H, 5H,7H	5B,1D,5F,1G, 3G	6B		15E	
Thelionema caespitosum						4E	6D	
Pittosporaceae								
Billardiera scandens	11B	2BR,7B,10B,18B	6E,7H	5C,14D,5F,1G, 3G,2H	6B		9D,4F	5D,4H
Bursaria lasiophylla var. *atriplicina*				5B				
Bursaria spinosa		9B,10B,12B,3C		5B				
Hymenosporum flavum	17B							
Rhytidosporum procumbens			2B				1F	
Plantaginaceae								
**Plantago lanceolata*		9B		2D,7D				
Poaceae								
Amphipogon strictus						4E	14B,6D	
Andropogon virginicus						4E		
Anisopogon avenaceus			3BR	5C,7C,7D			14B,2C,6C,4D, 6D,8D,9D,10D, 15E,4F	5E,7E
Aristida ramosa var. *ramosa(?)*		2BR						
Aristida ramosa var. *speciosa*		4G						

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Poaceae cont.								
Aristida vagans		1B,7B,9B,10B, 12B,13B,15B,16B, 18B,3C,4G	3BR,6H,7H	1G,3G			15E	
Aristida warburgii		4G	4B,6E				8B	
Austrodanthonia longifolia		7B,12B,15B,18B						
Austrostipa pubescens		7B,10B	2B,4B,1H,5H	5B,7C,1G,3G			3B,6C,15E,1F, 3F,4F,4H	5D,1E,2E,10E
Austrostipa ramosissima	17B							
**Chianochloa pallida*		1B,12B		2D,7D				
Deyeuxia contracta		10B						
Deyeuxia quadriseta		10B	4B					
Dichelachne micrantha		2BR,7B,15B,18B		1G				
Digitaria parviflora				1G				
Echinopogon ovatus	4C	10B,12B						
Entolasia marginata	11B,4C							
Entolasia stricta	17B,1C,4C	1B,7B,10B,12B, 15B,16B,18B,3C, 4G	3BR,2B,4B,6E, 1H,5H,6H,7H	5B,5C,7C,1D, 2D,7D,12D,14D, 12E,5F,1G,3G 2H	6B,13E,2G,5G	4E	3B,8B,14B,2C, 6D,3E,15E,1F, 3F,4F	5D,1E,5E,8E, 4H
Eragrostis brownii		4G						
Eragrostis parviflora		10B						
Hemarthia uncinata var. *uncinata*		10B						
Imperata cylindrica	11B,17B,1C,4C	2BR,1B,10B,4G	6E					
Microlaena stipoides var. *stipoides*		1BR,11B,17B	3C	7C				
Oplismenus aemulus	17B							
Panicum simile		1B,9B,12B,18B, 3C,4G	7H	1G				
Paspalidium distans		9B,13B						
**Paspalum dilatatum*	11B,17B							
Plinthanthesis paradoxa			6E					
Poa labillardieri	1BR							
**Setaria gracilis*	17B							
Tetrarrhena juncea				2D				

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Poaceae cont.								
Tetrarrhena turfosa					6B			
Themeda australis	4C	2BR,1B,7B,9B, 10B,12B,13B,15B, 16B,18B,3C,4G	3BR,4B,6E,6H	7C			15E	
Polygalaceae								
Comesperma defoliatum			3BR,4B				14B	
Comesperma sphaerocarpum		12B,16B,18B						
Comesperma volubile				5B				
Polygonaceae								
**Acetosella vulgaris*	11B							
Persicaria praetermissa	1BR,1C							
Persicaria strigosa					2G			
Proteaceae								
Banksia ericifolia			6E	7C,12D	5G	11D,4E,9E,11E	2C,6D,8D,9D, 10D,13D,3E,2F	3D,5D,1E,5E, 7E,8E
Banksia integrifolia subsp. *integrifolia*		2BR						
Banksia marginata				7C,12D,12E	6B,5G		4D,6D,8D,9D, 10D,3E,3H	1E,2E,5E,8E, 10E,4H
Banksia oblongifolia	11B	2BR	4B	7C		11D,4E	3B,14B,2C,6C, 4D,6D,8D,9D, 13D,3E,1F,2F, 3F,4F	
Banksia serrata				5C,7C,2D,7D, 12D,14D,12E,5F, 1G,3G	6B		2C,9D,10D,3F	5D,3D,2E,7E, 8E,10E,4H
Banksia spinulosa		2BR,1B,7B,10B, 18B	3BR,2B,4B,6E, 1H,5H,6H,7H	5C,7C,1D,2D, 7D,14D,12E,5F 1G,3G,2H	6B		3B,14B,2C,6C, 15E,1F,2F,3F, 4F,3H	5D,1E,2E,8E, 10E,4H
Conospermum ellipticum						11E	13D	3D,7E
Conospermum longifolium subsp. *angustifoli*um			1H				10D	3D,5D,2E,5E, 7E,8E,10E,4H
Grevillea buxifolia				1G			9D	5D,5E,7E
Grevillea diffusa		10B	2B,6E,1H	2D			3B,8B,6C,9D, 1F,2F,3F	5D,1E,2E,7E, 8E,10E
Grevillea linearifolia			4B	12D			3B	

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Proteaceae cont.								
Grevillea longifolia	11B			7C,12E				
Grevillea mucronulata		2BR	3BR,1H,5H,6H, 7H	5B,5C,7C,2D, 7D,12D,14D,12E, 5F,1G,2H	6B,13E,5G		15E	2E,8E
Grevillea oleoides				7C,	2G	4E	3E	
Grevillea sericea		2BR,7B	3BR	5C,12D,12E,5F		11D,9E	2C,6D,8D,9D, 10D,13D,15E,2F, 4F	
Grevillea sphacelata			5H	5F			8B,14B,6C,4D, 9D,10D,2F,3F, 4F,3H	3D,5D,2E,5E, 7E,10E,4H
Hakea dactyloides			2B,4B,6H	12D			3B,8B,14B,2C, 6C,4D,6D,8D, 9D,10D,13D,3E, 15E,1F,2F,3F, 4F,3H	3D,5D,1E,2E, 5E,7E
Hakea dactyloides(ss)				7C,1G				8E,10E
Hakea propinqua		9D,10D,12D						
Hakea salicifolia	1BR			2D	2G			
Hakea sericea		4G	3BR,4B,6E,1H, 6H	5C,7C,2D,12E, 5F,1G	6B,13D,5G		3B,2C,15E,1F, 3F,4F,3H	5D,1E,2E,5E, 7E,8E,10E
Hakea teretifolia						11D,4E,9E	4D,6D,8D,10D, 13D,3E,2F	
Isopogon anemonifolius		2BR,7B,10B	3BR,2B,4B,1H, 5H,6H,7H	5C,7C		11D	3B,8B,14B,2C, 4D,6D,8D,9D, 10D,3E,15E,1F, 3F,4F,3H	3D,5D,1E,2E, 5E,7E,8E,10E, 4H
Isopogon anethifolius					2G	11E		
Lambertia formosa		2BR	3BR	5B,5C,7C,2D, 7D,3G		11D	3B,14B,2C,6C, 4D,8D,9D,10D, 3E,15E,1F,2F, 3F,4F,3H	3D,5D,2E,5E, 7E,8E,10E,4H
Lomatia myricoides			7C	6B,13E,2G,5G				
Lomatia silaifolia		2BR	6E,5H,7H	5B,5C,1D,2D, 7D,12D,14D,12E 5F,1G,3G,2H	3B,6B,2C,5D		9D,3E,2F,3F	5E,7E,8E,10E, 4H
Persoonia lanceolata				7C			8B,6D,8D,1F	2E
Persoonia laurina subsp. *laurina*				7D,3G				

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Proteaceae cont.								
Persoonia levis		1B,15B,18B	2B,4B,6E,1H, 5H,6H,7H	5B,5C,2D,7D, 12D,14D,12E,5F, 1G,3G,2H	6B,13E	11D	3B,2C,9D,10D, 13D,3E,2F,3F, 4F,3H	3D,5D,1E,2E, 5E,7E,8E,10E, 4H
Persoonia linearis	11B	1B,7B,12B,15B, 16B,18B,4G	2B,1H,5H,7H	5B,1D,7D,14D, 5F,1G,3G,2H	6B,13E			5D,7E
Persoonia pinifolia				5B,5C,7C,2D, 12D,12E	13E		4D,6D,9D,10D, 13D	5E,8E
Petrophile pulchella				12E	2G			3D,9D
Petrophile sessilis		2BR	3BR,2B,4B,1H, 5H	7C,2D,7D,5F	6B	11D,4E	3B,8B,14B,2C, 6C,4D,6D,8D,9D, 10D,13D,3E,15E, 1F,2F,3F,4F,3H	1E,2E,5E,7E, 8E,10E,4H
Stenocarpus salignus	17B				5G			
Symphionema paludosum						4E,9E		
Telopea speciosissima				5C,7D	6B,5D			7E
Xylomelum pyriforme		7B		1D,7D,1G,3G				5D,2E,4H
Ranunculaceae								
Clematis aristata	17B			5B				
Restionaceae								
Empodisma minus						4E		
Leptocarpus tenax		10B				11D,4E,9E,11E	3E	7E
Lepyrodia scariosa			4B	5C,7C,2D		11D,9E,11E	3B,8B,2C,6C, 4D,6D,8D,9D, 10D,13D,3E,1F, 2F,3F,4F,3H	3D,5D,2E,5E, 8E,10E
Restio dimorphus					2G			
Restio fastigatus						11E		
Rhamnaceae								
Cryptandra amara							8B,9D,10D	10E
Cryptandra ericoides							6D,8D	
Pomaderris ferruginea				7C	6B,5G			
Pomaderris intermedia				12E	5G			
Rubiaceae								
Opercularia aspera	11B	4G		7D,12E	5G			

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Rubiaceae cont.								
Opercularia diphylla		13B,16B,18B						
Opercularia varia	11B	1B,10B,	4B	2D				
Pomax umbellata		2BR,10B,4G	3BR,4B,1H,5H, 7H	5B,1D,5F			1F	8E
Rutaceae								
Boronia ledifolia			5H	5B,5C,1G			2C	
Boronia parvifolia		12B,15B				11D,4E,9E		
Boronia ruppii								4H
Eriostemon australasius			1H,5H,7H	5C,1D,12D,5F, 1G,3G			8B,2C,4D,9D, 10D,15E,1F,3F, 4F,3H	3D,5D,2E,5E, 7E,8E,10E,4H
Eriostemon scaber subsp. *scaber*				7C,3G,2H				
Phebalium dentatum					6B,5G			
Phebalium diosmeum				7C				
Phebalium squamulosum subsp. *squamulosum*		17B			12D			
Ziera fraseri subsp. *B*				12D				
Ziera pilosa				2D,7D,12D	6B			
Santalaceae								
Exocarpus strictus		1B,7B,16B,18B 4G	5H	5C				7E
Omphacomeria acerba							8B	
Sapindaceae								
Alectyron subcinereus	17B							
Dodonaea triquetra	11B	10B	5H	5B,7C,12D,1G, 3G,2H	5G			
Schizaeaceae								
Schizaea bifida			4B	2D,12D,5F			6C,4D,8D,3E, 1F	5D,1E,5E,7E
Selaginellaceae								
Selaginella uliginosa	11B					4E,9E	3E	
Sinopteridaceae								
Cheilanthes sieberi		9B,10B,12B,15B, 18B,3G	3BR					

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Smilacaceae								
Smilax glyciphylla				5C,2D,7D,12D, 14D,12E,1G,3G, 2H	6B,13E,5G			
Solanaceae								
**Solanum nigrum*	17B							
Solanum prinophyllum	17B							
Solanum pungetium	11B	9B						
Stackhousiaceae								
Stackhousia nuda							6D	
Stackhousia viminea		18B,3C		2D,12D,12E			9D	
Sterculiaceae								
Lasiopetalum ferrugineum var. *ferrugineum*	11B			7C,2H	2G,5G			8E
Lasiopetalum macrophyllum				3G				
Lasiopetalum parviflorum							10D	
Stylidiaceae								
Stylidium graminifolium		2BR,10B	4B	5C,12E	13E	11D,4E,9E,11E	2C,6C,2F,3F	1E,5E,8E,10E
Stylidium laricifolium				3G				
Stylidium lineare		12B					3B,8B,14B,4D, 6D,8D,9D,10D, 13D	3D,5D
Stylidium productum			6H	1D,2D,7D,14D	6B			
Thymelaeaceae								
Pimelea linifolia	11B	2BR,7B,10B,18B	3BR,2B,1H,5H, 6H	5C,7C,7D		11D,4E,9E,11E	3B,14B,2C,4D, 6D,8D,10D,3E, 1F,2F,3F,4F,3H	3D,1E,2E,5E, 6E,7E,4H
Tremandraceae								
Tetratheca ericifolia							1F	10E,4H
Tetratheca neglecta			2B	5C,14D			2C,8D,9D,10D	3D,5D,1E,2E, 7E
Violaceae								
Hybanthus monopetalus				1G				
Viola hederacea	1BR,11B,1C,4C	9B,10B,12B,13B						

Family Species	Melaleuca Thicket	Plateau Forest on Shale	Sh/SS Trans Forest	Gully Forest	Riparian Scrub	Sedgeland	Woodland/ Heath Complex	Sandstone Woodland
Xanthorrhoeaceae								
Xanthorrhoea arborea				5B,7C,1D,2D, 12D,14D,5F,3G	6B,13E			
Xanthorrhoea concava		2BR,10B,12B	2B,5H	1D,2D,7D,5F	6B		4D,3H	3D,5D,5E,7E, 8E,10E
Xanthorrhoea media			6E,1H,7H	7C,12D	6B	11E	3B,8B,2C,4D, 15E,1F,4F,3H	3D,5D,1E,2E, 7E,8E,10E,4H
Xanthorrhoea resinifera		1B,7B,16B	3BR,4B,6H	5C		11D,4E	14B,6C,6D,8D, 9D,13D,3E,2F	
Xyridaceae								
Xyris gracilis						11D	4D,6D,8D,9D, 10D,13D	7E
Xyris gracilis ssp.*laxa*							6D	
Xyris operculata						9E		
Zamiaceae								
Macrozamia communis		1B						
Macrozamia spiralis		15B,18B						