

# Vegetation and floristic diversity in Gibraltar Range and part of Washpool National Parks, New South Wales

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**Abstract:** The vegetation of Gibraltar Range National Park and adjoining parts of eastern Washpool National Park, 65 km east of Glen Innes (29° 31'S 152° 18'E) on the eastern escarpment of New South Wales is described. In total 124, 20m x 50m full vascular plant floristic sites were recorded and information from an additional 53 sites was collated. Thirteen vegetation assemblages are defined based on flexible UPGMA analysis of cover-abundance scores of all vascular plant taxa. Many of the vegetation communities are typical of what is found along the north eastern escarpment of NSW. Three communities are considered to be rare and two vulnerable. A total of 878 vascular plant taxa from 138 families were recorded, of which only 21 (2%) were of introduced origin and 81 (9%) were found to be of conservation significance. Pattern diversity, species density, species accumulation and average geographic range size, along with general measures of richness and diversity, were analysed for all communities. Each of the communities described varied considerably in the diversity attributes measured. Communities with a high number of shrubs had greater constancy between sites compared to those that contained a high number of closed forest species. The community from rock outcrops had the largest average geographical range size.

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## Introduction

The Washpool/Gibraltar Group of the Central Eastern Rainforest Reserves of Australia (CERRA) is a World Heritage-listed area that contains the largest expanse of coachwood warm temperate rainforest in the world (RACAC 1996; Adam 1994). It also includes one of the largest areas of un-logged sclerophyll forest in New South Wales, and significant sections of wild and scenic rivers supporting riparian rainforest. Two declared wilderness areas occur within the study area: Bindery-Mann and Washpool.

This paper presents part of the results of a comprehensive flora and vegetation survey of Gibraltar Range National Park and adjoining sections of eastern Washpool National Park. These areas lie approximately 65 km east of Glen Innes and 90 km west of Grafton (Fig. 1) (29°31'S 152°18'E). This investigation was commissioned by the Northern Tablelands Region of the NSW National Parks and Wildlife Service in order to provide baseline information to assist in determining appropriate land management strategies (Sheringham & Hunter 2002). In addition to the descriptions of vegetation communities we have also assessed changes in diversity attributes between the described assemblages. These diversity attributes can be used along with the baseline community information to provide further assess the conservation value and internal dynamics of the vegetation communities described.

## *European landuse history and reservation*

Due to the rugged nature of the local terrain, the region was not accessed by graziers until around 1850. Gibraltar Range was initially used as a stock route linking the tablelands to the coast (Wright 1991). Tin and gold were discovered as early as 1852 leading to an influx of people to the area. Commercial logging followed, particularly in the Washpool and Cangai areas up until the 1980s (Adam 1987).

The Gwydir Highway, opened in 1960, runs through the middle of the study area and provides the main link between Grafton and Glen Innes. The building of this road was the catalyst for the establishment of Gibraltar Range as a reserve in 1963. The original dedication incorporated 14 000 ha for public recreation administered by the Department of Lands. In 1967 Gibraltar Range National Park was gazetted and taken under the management of the newly formed National Parks and Wildlife Service. Adjoining areas of State Forest have been added since that time, and presently Gibraltar Range National Park covers 25 406 ha.

Washpool National Park was gazetted in 1983 as a result of the enactment of legislation designed to resolve disputes over the logging of rainforest in New South Wales. All rainforests on public land in New South Wales were protected as a result of the *Forestry Revocation Act 1983*. Washpool National Park was established following the enactment of the *National Parks Reservation Act 1984*. Washpool National

Park is included on the World Heritage list (Gondwana Rainforests of Australia) and a significant proportion of the park is a declared wilderness area. Large areas of State Forest (Spirabo, Little Spirabo, Curramore, Moogem and Forest Land State Forests) were added to Washpool National Park in 1999 following the Comprehensive Regional Assessment of public forests in upper northeast New South Wales. Further strategic purchases of adjoining private lands consolidated the park. During the 1990s Nymboida and Barool National Parks, which directly adjoin Gibraltar Range and Washpool National Parks, were also added to the reserve network.

#### *Climate and weather*

The climate of the study area is influenced by its location on the edge of the Great Escarpment. Annual rainfall increases with altitude along the eastern edge (1200–1300 mm) to the central plateau (>2000 mm) and decreases to the west (Bureau of Meteorology 1999). Mean annual temperatures range between 12°–13°C on the central plateau and 17°–18°C on the eastern escarpment. Mean maximum temperatures are in the mid thirties on the eastern escarpment edge and the high twenties on the plateau with a mean minimum temperature of 0°–5°C for the plateau and escarpment. The warmest months are November to March.

During the early part of the day, tablelands winds dominate; coastal winds move in during the mid to late afternoon. Late afternoon thunderstorms accompanied by lightning strikes, heavy rain and sometimes hail are a frequent event in summer. Widespread rain of reduced intensity but longer duration is typical of winter weather patterns.

#### *Landform*

Much of the study area is of undulating to steep topography dominated by extensive outcropping and subsurface granite sheets, boulder fields and nubbins. Three main watercourses drain the study area (Dandahra, Coombadjah & Grassy Creeks) frequently following joints and faults within the underlying granite and often forming waterfalls. The flatter terrain on the central plateau contains areas of impeded drainage forming large mires on Quaternary alluvium.

The Demon fault forms the western boundary of the study area. Here the granite plateau drops precipitously into the Cooraldooral Creek valley. This area forms a dividing line between the resistant Dandahra Granite and the weathered metasediments of the Coffs Harbour Association. Boulder and Boundary Creeks drain north and south respectively along this major fault line. The altitude within the study area ranges from 300 m on the lower reaches of Dandahra Creek to over 1170 metres at Waratah Trig and Summit Mountain.

#### *Earlier botanical explorations*

Although botanical exploration took place in the north east of New South Wales in the early 1900s, detailed exploration

of the Gibraltar Range National Park did not take place until the early 1960s. At this time, botanist John Williams, of the University of New England at Armidale, made many plant collections in the Gibraltar Range and compiled an unpublished species list of the rainforest and granite species. Floyd (1990) undertook a detailed inventory of NSW rainforests using random irregular traverses. Many of these were undertaken in the current study area. Hunter (1991) placed belt transects within the reserve in an investigation into the demography of *Brachyloma* species. Some investigations into species biology and fire responses have recently occurred (Caddy & Gross 2006; Croft et al. 2006; Vaughton & Ramsey 2006; Virgona et al. 2006; Williams & Clarke 2006).

Though much botanical exploration has been done in the Gibraltar Range area, particularly within close proximity to the Gwydir Highway, few detailed systematic vegetation surveys have been undertaken. During comprehensive regional surveys in north-eastern New South Wales (NRAC 1995; NPWS 1994; NPWS 1999) over 30 systematic sites were placed in the Gibraltar Range National Park. Hunter (1999) placed 34 systematic sites to describe the granite outcrop communities. Hunter & Clarke (1998) subsequently described nine floristic elements and 28 vegetation communities on the New England Batholith, two of which occur in the study area. Williams (1995) and Williams & Clarke (1997) surveyed the sedge heaths in Gibraltar Range National Park. More recently Hunter & Bell (2007) surveyed the sedge heaths (bogs) of the region, including those in the study area, and described these communities in detail along with aspects of species composition and richness relating to climatic and spatial factors.

Many adjoining areas have been systematically sampled for flora and vegetation and include the state forests of the Glen Innes Management Area (Binns 1992), the western extensions to Washpool National Park (Hunter 1998b; 2000b; 2005a), Nymboida National Park (Benwell 2000) and Mann River Nature Reserve (Hunter 2004b).

## **Methods**

### *Vegetation survey and community classification*

The survey was carried out in a stratified random manner in order to sample and replicate major environmental changes. The strata used were a combination of mapped geological, altitude and broad scale vegetation units (plateau complex, dry open forest, wet open forest, disturbed remnant and rainforest). The combination of these elements produced 24 strata; sites were allocated to these strata based on the number of hectares covered. Additional sites were placed in specialised communities that were not included in the *a priori* sampling strategy or to stratified classes that were not spatially replicated in the sampling design. 124 x 0.1 ha full vascular plant floristic sites were surveyed specifically

for this investigation, together with information from an additional 53 sites; a database of 177 sites.

Good quality voucher material of species that needed confirmation of identification were lodged at the Coffs Harbour Herbarium (CFSHB). Nomenclature follows that of Harden (1993; 2000; 2002) except where more recent taxonomic changes have been made.

Analysis and data exploration were performed using options available in the PATN Analysis Package (Belbin 1995a & b). A scree plot analysis was performed to assess the most appropriate level of dissimilarity for community definition. For final presentation of results all species (including exotics) and their cover abundance scores were used. Analysis was performed using the Kulczynski association measure, which is recommended for ecological applications (Belbin 1995a

& b) along with flexible Unweighted Pair Group arithmetic Averaging (UPGMA) and the default PATN settings.

Rock outcrops were not part of the stratification as these areas were deemed to have been sufficiently surveyed and described (Hunter & Clarke 1998). Evidence for the distinctiveness of outcrop assemblages from the surrounding matrix of the study area is given in Hunter (2002a).

*Geographic range size*

The mean geographic range size of the component flora has been calculated for each of the communities defined to assess their level of endemicity and uniqueness. This was achieved by creating a matrix of all species from each community scored according to their occurrence in each of the 97 'ecological regions' of Australia, as defined by Hnatiuk (1990). The richness of each within each 'ecological region'

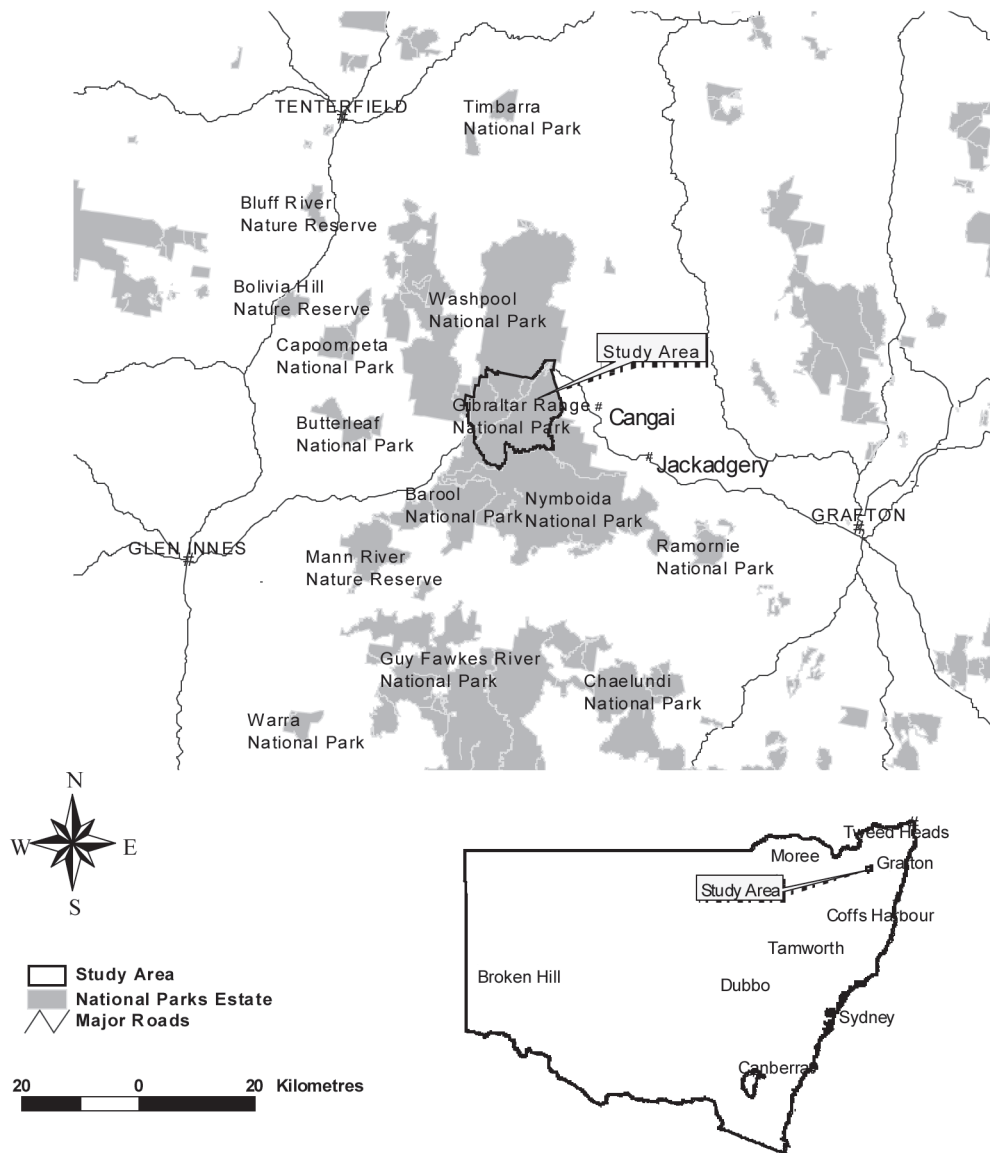


Fig. 1. Location of the study area.

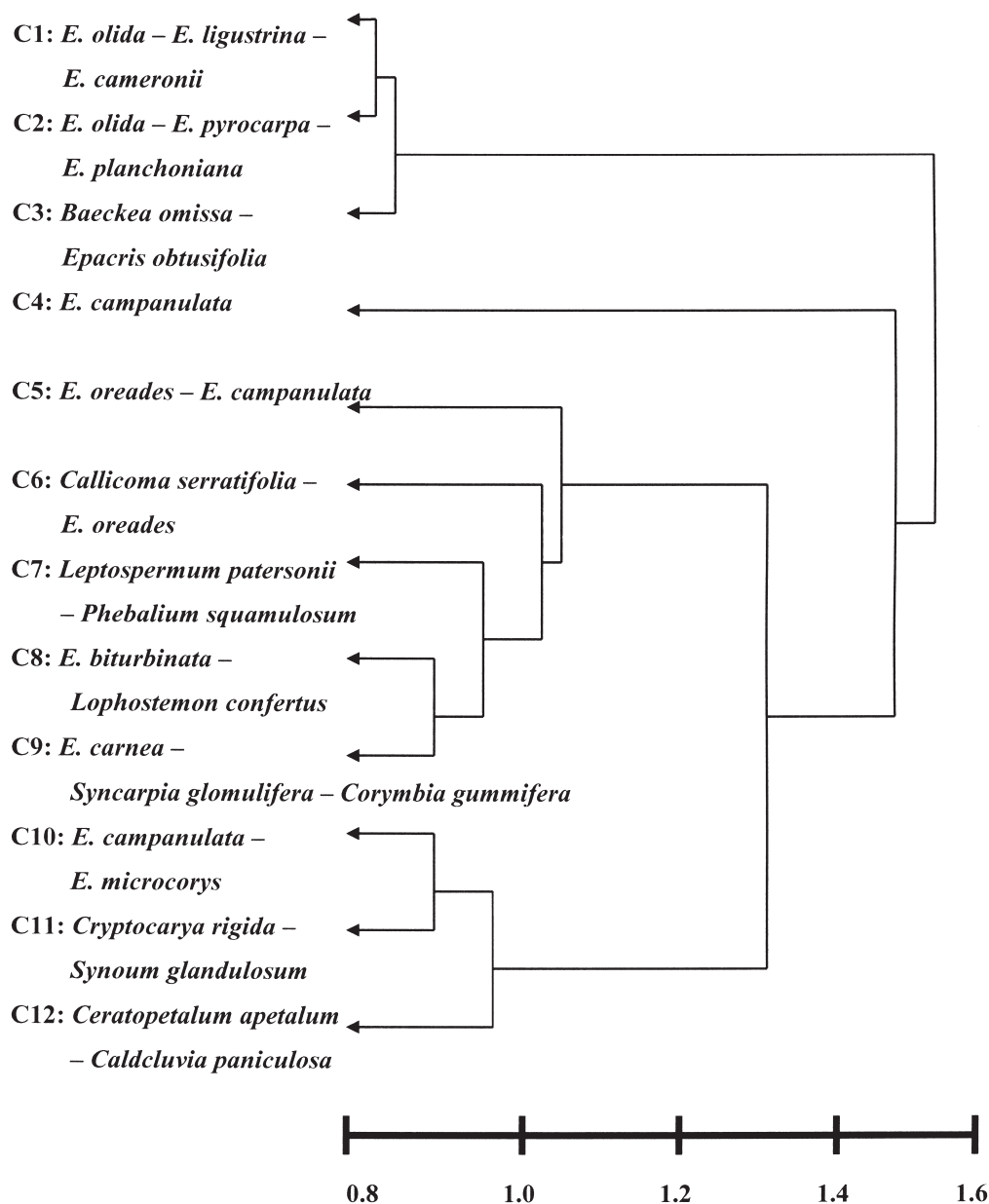
was divided by the total species pool size of each community as captured in survey sites. These scores were then summed across all the 97 ‘ecological regions’ in order to produce a score that represented the average occupancy of the flora of each community across all the ‘ecological regions’. A higher score indicates that on average the flora of the community is more widespread, i.e. occupy more ‘ecological regions’ within Australia.

*Species diversity patterns*

Species diversity is derived from a combination of species richness, measured as the number of species per sample area (density) and the evenness of abundances. Aspects of richness are the most commonly studied, and differences between

their values arise from geographical patterns of speciation, extinction and re-establishment ability (Hunter 2005d) and therefore are of importance in designing management plans for conservation.

Here species density is defined as the number of vascular plant species predicted to be found within 0.1 ha of sample area after 1000 randomised iterations of each community dataset with at least four samples using *EstimateS* (Colwell 1997). Modelling density in this fashion, within each defined community, is advantageous as it avoids spatial pseudo-replication in subsequent between community comparisons (Hurlbert 1984; Srivastava 1999; Gering & Crist 2002; Hunter 2005d).



**Fig. 2.** Summary dendrogram of sites surveyed during this investigation using Kulczynski association and flexible UPGMA fusion strategy. Communities are defined at a dissociation of 0.8.

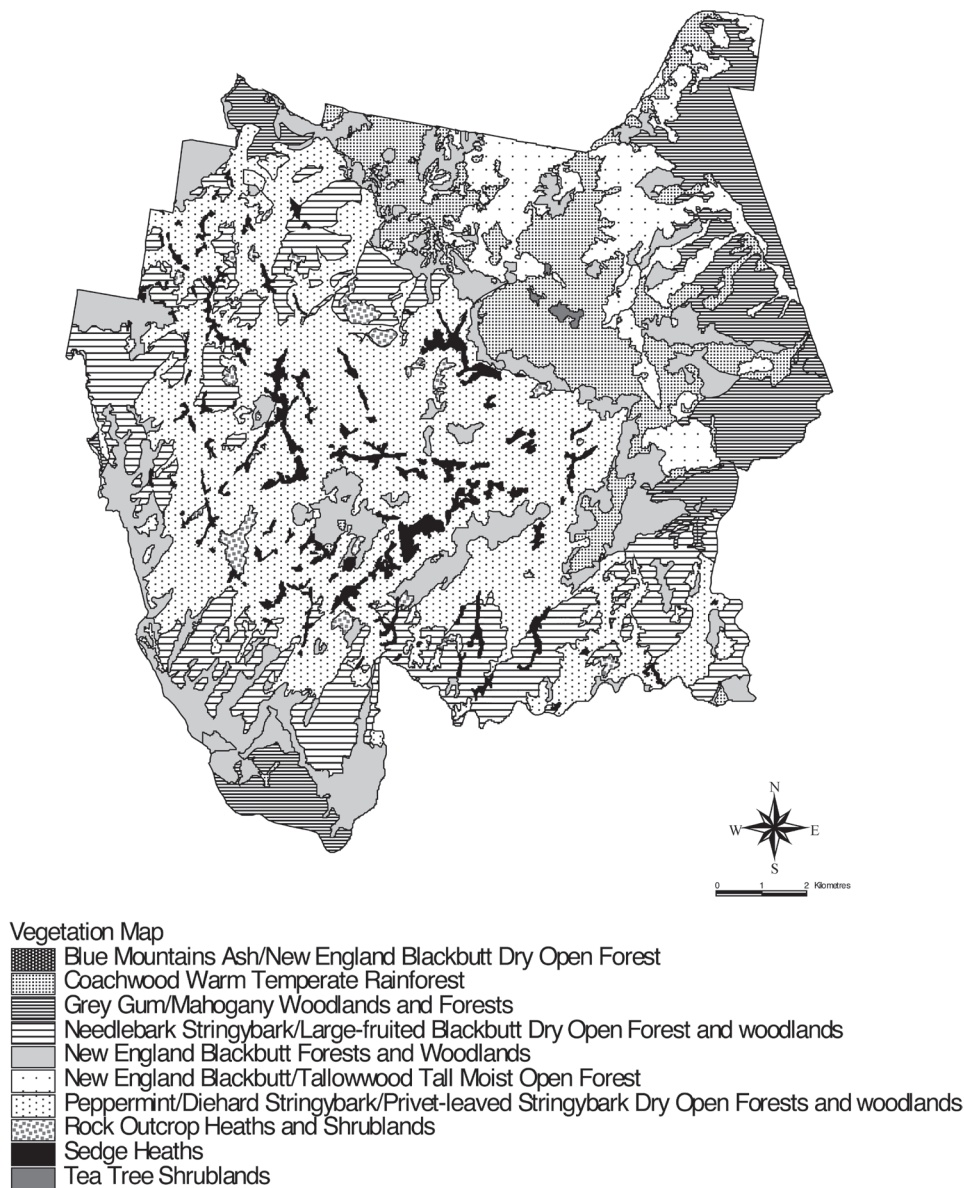
It is of great importance that the method for determining pattern diversity (spatial turnover within a habitat or community) matches the aims of the study, as no single estimator can model all aspects of geographical species turnover (Heegaard 2004). Many issues arise from currently used methods for determining turnover particularly as many measures tend to ignore the magnitude of gains and losses between sample units, or describe compositional differences more than differences in species richness (Whittaker 1960, Koleff et al. 2003). Here the slope of a log-log plot of the discontinuous Coleman curve (species accumulation curves) which has been calculated after 1000 randomisations of each community dataset containing a minimum of four sample sites using *EstimateS* (Coleman 1981, Colwell 1997) is used as a surrogate for pattern diversity. This method was first described and used by Hunter (2005d). As each community

has been delineated at the same dissimilarity they are of at least a minimal and similar floristic independence (Kulczynski dissimilarity of 0.8.).

## Results

### Floristics

A total of 878 vascular plant taxa were recorded from existing site data and subsequent sampling in the present study (Appendix 1). Only 21 (2%) taxa recorded were introduced/exotic. 552 taxa were recorded from the 124 new survey sites and a further 224 were recorded opportunistically. The remaining 97 taxa were recorded from previous surveys but not during this investigation. The recorded taxa represented 450 genera in 138 families. The families with the greatest



**Fig. 3.** Vegetation map of Gibraltar Range National Park and the southern parts of Washpool National Park.

number of taxa recorded were Fabaceae (85 taxa), Myrtaceae (74), Orchidaceae (66), Asteraceae (42), Poaceae (44), Cyperaceae (33), Proteaceae (27), Rutaceae (25), Ericaceae (21), Euphorbiaceae (17) and Lauraceae (16). The richest genera were *Eucalyptus* (30), *Acacia* (24), *Leptospermum* (12), *Hibbertia* (11), *Solanum* (10), *Pterostylis* (8), *Callistemon* (8), *Leucopogon* (8), *Lepidosperma* (7), and *Cryptocarya* (7).

### Vegetation

12 plant communities are described (Figure 2) with species listed in order of decreasing summed cover-abundance score in each stratum. Species with low cover-abundance scores were considered to have low constancy and not included. Introduced taxa are not included. Figure 3 shows a generalised map of vegetation distribution.

#### Community 1: *Eucalyptus olida* (Gibraltar Ash) – *Eucalyptus ligustrina* (Privet-leaved Stringybark) – *Eucalyptus cameronii* (Diehard Stringybark) forest and woodland

**Habitat:** associated with the Dandahra Granite. Found mainly on exposed to intermediate slopes in a range of topographic positions including crests and drainage lines, on sandy granitic soils above 900 m. Soils are shallow to skeletal.

**Structure:** heathy open forest and woodland or shrubland. Upper layer: 4–30 m; 10–40% cover. Upper middle layer: 2–8 m; 10–90% cover. Lower middle layer: 0.5–4 m; 15–80%; 0.1–2 m. Ground layer to 1 m, 10–90% cover.

**Trees:** *Eucalyptus olida*, *Eucalyptus ligustrina*, *Eucalyptus cameronii*, *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus pyrocarpa*, *Eucalyptus oreades*, *Eucalyptus acaciiformis*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Eucalyptus caliginosa*, *Eucalyptus williamsiana*.

**Shrubs:** *Leptospermum trinervium*, *Dillwynia phyllicoides*, *Hakea laevipes* subsp. *granitica*, *Petrophile canescens*, *Persoonia rufa*, *Daviesia umbellulata*, *Monotoca scoparia*, *Dampiera stricta*, *Boronia algida*, *Boronia microphylla*, *Banksia cunninghamii* subsp. A, *Patersonia sericea*, *Leucopogon melaleucoides*, *Melichrus procumbens*, *Grevillea acerata*, *Pimelea linifolia*, *Mirbelia speciosa*, *Comesperma ericinum*, *Styphelia triflora*, *Phyllota phyllicoides*, *Acacia venulosa*, *Leptospermum polygalifolium*, *Acacia barringtonensis*, *Leucopogon* sp. aff. *appressus*, *Hibbertia riparia*, *Hibbertia villosa*, *Conospermum burgessiorum*, *Leucopogon microphyllum*, *Aotus subglauca*.

**Climbers & trailers:** *Billardiera scandens*, *Cassytha glabella*, *Cassytha pubescens*.

**Ground cover:** *Caustis flexuosa*, *Platysace ericoides*, *Bossiaea neo-anglica*, *Bossiaea scortechinii*, *Goodenia rotundifolia*, *Xanthorrhoea johnsonii*, *Entolasia stricta*, *Patersonia sericea*, *Gleichenia dicarpa*, *Dianella caerulea*, *Hovea heterophylla*, *Schoenus melanostachys*, *Lindsaea linearis*, *Trachymene incisa*, *Lepidosperma laterale*, *Gonocarpus teucroides*, *Tetrarrhena juncea*, *Pteridium esculentum*, *Poa sieberiana*, *Lomandra filiformis*, *Lomandra longifolia*.

**Variability:** along drainage lines *Eucalyptus radiata* subsp. *sejuncta* is often the dominant tree. *Eucalyptus cameronii* and *Eucalyptus olida* are present in most sites, but are replaced by *Eucalyptus ligustrina* in more exposed situations with skeletal soils. The understorey species composition comprises a uniform cover of shrubs in particular *Leptospermum trinervium* and *Hakea laevipes* subsp. *granitica*.

**Notes:** community 1 is the most widespread community throughout the study area. Closely-related assemblages in which *Eucalyptus olida*-*Eucalyptus ligustrina*-*Eucalyptus williamsiana*-*Eucalyptus cameronii*

co-dominate have been recorded from the Timbarra Plateau, Malara State Forest, Gibraltar Range/Washpool and south to Guy Fawkes River NP. This association is generally found at high altitude in outcropping granite areas with skeletal soils.

**Conservation status:** community 1 is largely restricted to the study area and is reserved elsewhere within Guy Fawkes River and Nymboida NPs. Occurrences of related floristic assemblages on the Timbarra Plateau and north east of Tenterfield (the Desert) are not reserved within Demon NR or Basket Swamp NP (Hunter *et al.* 1999; Hunter 2005ab). It is likely however that the majority of its distribution is contained within reserves and is relatively extensive; it should be considered adequately reserved.

#### Community 2: *Eucalyptus olida* (Gibraltar Ash) – *Eucalyptus pyrocarpa* (Large-fruited Blackbutt) – *Eucalyptus planchoniana* (Needlebark Stringybark) forest and woodland

**Habitat:** granite sites on the plateau above 900 m. Usually found on exposed ridge tops and northerly to westerly slopes on the edge of the granite plateau on shallow to skeletal soils.

**Structure:** mostly dry open forest to low open woodland and mallee shrubland. Upper layer: 4–40 m; 15–50% cover. Middle layer: 1.5–10 m; 5–60% cover. Ground layer; 0.3–4 m; 20–80% cover.

**Trees:** *Eucalyptus olida*, *Eucalyptus pyrocarpa*, *Eucalyptus planchoniana*, *Eucalyptus cameronii*, *Eucalyptus codonocarpa*, *Eucalyptus caliginosa*, *Eucalyptus williamsiana*, *Eucalyptus oreades*.

**Shrubs:** *Leptospermum trinervium*, *Pultenaea tarik*, *Persoonia rufa*, *Acacia obtusifolia*, *Petrophile canescens*, *Monotoca scoparia*, *Banksia cunninghamii* subsp. A, *Leucopogon lanceolatus*, *Lomatia silaifolia*, *Amperea xiphoclada*, *Leucopogon melaleucoides*, *Boronia algida*, *Telopea aspera*, *Hibbertia villosa*, *Acacia novaanglica*, *Hibbertia riparia*, *Acacia ulicifolia*, *Phyllota phyllicoides*, *Hakea laevipes* subsp. *granitica*, *Boronia microphylla*, *Grevillea rhizomatosa*, *Choretrum candollei*, *Xanthosia pilosa*, *Podolobium ilicifolium*, *Grevillea acerata*, *Gompholobium latifolium*, *Elaeocarpus reticulatus*, *Dampiera purpurea*, *Acacia suaveolens*.

**Climbers & trailers:** *Billardiera scandens*, *Smilax glyciphylla*, *Cassytha pubescens*, *Cassytha glabella*.

**Ground cover:** *Platysace ericoides*, *Caustis flexuosa*, *Bossiaea scortechinii*, *Patersonia sericea*, *Entolasia stricta*, *Patersonia glabrata*, *Pteridium esculentum*, *Lepidosperma laterale*, *Dianella caerulea*, *Bossiaea neo-anglica*, *Xanthorrhoea johnsonii*, *Gonocarpus teucroides*, *Lomandra longifolia*, *Lindsaea microphylla*, *Gonocarpus tetragynus*, *Goodenia rotundifolia*, *Gahnia microstachya*, *Cryptostylis subulata*, *Tetrarrhena juncea*.

**Variability:** structure varies considerably from tall open forests to mallee woodland. Three overstorey sub-associations are discernible in the field. Firstly sites in which *Eucalyptus olida* dominates. Secondly an association of *Eucalyptus planchoniana* and *Eucalyptus pyrocarpa* with or without *Eucalyptus olida* and *Eucalyptus williamsiana*. At high altitudes on the larger rock massifs mallee woodland merges with the taller woodlands within this assemblage.

**Notes:** as with Community 1, this assemblage is largely restricted to the Gibraltar Plateau on Dandahra Granite. Within Nymboida NP 583 ha occur along the common boundary with Gibraltar Range NP (Benwell 2000).

**Conservation status:** it is likely that this assemblage is almost entirely restricted to the study area with minor incursions into Nymboida National Park. This community should be considered rare and therefore of importance, however due to its almost complete restriction within the study region, it should be considered adequately reserved.

**Community 3: *Baeckea omissa* (Baeckea) – *Epacris obtusifolia* (Blunt-leaf Heath)–*Leptospermum arachnoides* (Prickly Tea-tree) Bogs (Sedge Heaths)**

**Habitat:** within areas of impeded drainage at high altitude on granite.

**Structure:** most commonly low closed heath or sedgeland but sometimes open woodland with emergent *Banksia marginata* or more rarely *Eucalyptus dissita* or *Eucalyptus ligustrina*. Shrub/sedge layer 0–2 m; 40–90% cover. Often a sparse ground cover (10%) of *Drosera spatulata*, *Goodenia bellidifolia* and *Gonocarpus micranthus*.

**Trees:** rarely emergent *Eucalyptus ligustrina*, *Eucalyptus dissita* or *Banksia marginata*.

**Shrubs:** *Baeckea omissa*, *Epacris obtusifolia*, *Leptospermum arachnoides*, *Banksia marginata*, *Hibbertia rufa*, *Epacris microphylla*, *Boronia polygalifolia*, *Prostanthera saxicola* var. *major*, *Hakea laevipes* subsp. *granitica*, *Notelaea linearis*, *Grevillea acanthifolia* subsp. *stenomera*, *Dampiera stricta*, *Bauera rubioides*, *Mirbelia speciosa*, *Comesperma defoliatum*, *Brachyloma daphnoides* subsp. *glabrum*.

**Climbers & trailers:** *Cassytha glabella*.

**Ground cover:** *Lepidosperma limicola*, *Lepyrodia scariosa*, *Drosera spatulata*, *Baloskion fimbriatum*, *Amphipogon strictus*, *Xyris operculata*, *Entolasia stricta*, *Gonocarpus micranthus*, *Blandfordia grandiflora*, *Goodenia bellidifolia*, *Drosera binata*, *Tetrarrhena juncea*, *Gymnoschoenus sphaerocephalus*, *Logania pusilla*, *Lindsaea linearis*, *Thelionema caespitosum*, *Rhytidosporum diosmoides*, *Panicum paludosum*, *Lycopodium laterale*, *Hypericum gramineum*, *Drosera peltata*, *Boronia parviflora*, *Utricularia dichotoma*, *Trachymene incisa*, *Thelionema grande*, *Sphaerolobium vimineum*, *Schoenus turbinatus*, *Orthoceras strictum*, *Lepyrodia anarthria*, *Hybanthus monopetalus*.

**Variability:** this community has a number of species with high constance and many that were poorly associated, in particular many of the shrub taxa are ubiquitous (Hunter & Bell 2007). These communities are generally isolated, small and of limited distribution in the landscape and as such, although a number of species will usually be present and dominant the other associated taxa are likely to be highly variable. The community as defined here may be separated into indistinct bands of grass and cyperoid dominated areas along with shrubby patches. This is primarily driven by depth and duration of water logging which may vary from year to year (Hunter & Bell 2007). In a very few localities *Sphagnum* bogs have developed along small creek lines and may be only a few metres wide.

**Notes:** similar associations are restricted to higher altitudes on the tablelands particularly along the eastern margin of the divide and are included within Community 8 *Baeckea omissa* – *Epacris obtusifolia* / *Lepidosperma limicola* – *Xyris operculata* Hunter & Bell (2007). This assemblage type is quite unlike other bogs of the Northern New England (Hunter & Bell 2007). Communities such as these are usually highly divergent across relatively small distances and as such most occurrences are unique. This proven by the community scoring the highest pattern diversity score of all communities measured (Table 1). Hunter and Bell (2007) have shown that this community is largely restricted to Gibraltar Range with an outlier on the Malara Plateau to the north.

**Conservation status:** broadly similar assemblages are known to be reserved within Warra NP, New England NP, Basket Swamp NP, Boonoo Boonoo NP, Bald Rock NP, Girraween NP, Demon NR, Cathedral Rocks NP, Mann River NR, Coolah Tops NP, western Washpool Western NP, Werrikimbe NP, Capoompeta NP and Butterleaf NP (Hunter *et al.* 1999; Hunter 2000; Whinam & Chilcott 2002; Hunter 2004b & c; Hunter 2005a & c; Hunter & Bell 2007). In the narrow sense however this assemblage type is known from the Demon NR, Gibraltar Range NP and Carrai NP and SCA (Hunter & Bell 2007). Benson and Ashby (2000) considered this type of assemblage to be moderately conserved within the state. Despite the above, areas which may develop peat are listed as endangered on the under the endangered ecological community *Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions* (17 December 2004) NSW *Threatened Species Conservation Act* (1995). Only a few surviving samples of communities containing significant amounts of *Sphagnum* are in good condition and it is likely that only a few hectares of these bogs occur across the whole tablelands (Whinam & Chilcott 2002; Hunter & Bell 2007).

**Community 4: *Eucalyptus campanulata* (New England Blackbutt)–*Eucalyptus cameronii* (Die-hard Stringybark) forest and woodland**

**Habitat:** all sites are located on Dandahra granite, predominantly on sheltered to intermediate aspects on mid to lower slopes in more exposed aspects or on upper slopes and ridge tops in sheltered to intermediate aspects at altitudes of 800–1000 m. This assemblage usually occurs down slope of communities 1 and 2 but above 7 and 10. Soils are deep to shallow sand or loam.

**Table 1. Summary of selected attributes measured for each described community.**

Community	Mean range size	Pattern diversity	Species density	Site richness range (average)	Number of sites	Area in ha (% of study area)	Number of species recorded
Community 1	14.7	0.423	39.1	29–54 (39)	22	6,826 (31)	156
Community 2	15.7	0.454	39.1	30–62 (39)	18	3,042 (14)	153
Community 3	14.9	0.446	20.9	12–26 (20)	7	567 (3)	50
Community 4	18.8	0.514	38.2	23–51 (38)	28	3,064 (14)	229
Community 5	13.7	NA	NA	25–32 (29)	2	2 (<0.1)	49
Community 6	16.8	NA	NA	20–45 (35)	3	2 (<0.1)	84
Community 7	17.4	NA	NA	21–22 (22)	2	27 (0.1)	31
Community 8	22.9	0.765	38.3	28–54 (43)	4	1,053 (5)	98
Community 9	20.3	0.477	42.6	39–48 (43)	4	1,054 (5)	82
Community 10	14.0	0.621	36.9	30–44 (37)	5	1,699 (8)	100
Community 11	13.4	0.595	30.4	19–35 (31)	5	1,058 (5)	79
Community 12	17.8	0.626	33.8	13–57 (29)	5	1,058 (5)	85
Community 13	17.7	0.440	35.7	25–47 (36)	25	2,373 (11)	164

**Structure:** tall open forests to dry open forests. Upper layer: 10–45 m; 25–50% cover. Upper middle layer: 2–20 m; 5–60% cover. Lower middle layer: 0.5–6 m, 15–80% cover. Ground layer: 0.1–1.5 m, 10–70% cover.

**Trees:** *Eucalyptus campanulata*, *Eucalyptus cameronii*, *Eucalyptus brunnea*, *Eucalyptus microcorys*, *Banksia integrifolia* subsp. *monticola*, *Allocasuarina torulosa*, *Allocasuarina littoralis*, *Eucalyptus obliqua*, *Eucalyptus olida*, *Corymbia intermedia*, *Eucalyptus caliginosa*, *Eucalyptus saligna*, *Eucalyptus notabilis*, *Eucalyptus oreades*, *Lophostemon confertus*, *Caldcluvia paniculosa*.

**Shrubs:** *Acacia nova-anglica*, *Dampiera purpurea*, *Leucopogon lanceolatus*, *Pultenaea tarik*, *Lomatia silaifolia*, *Polyscias sambucifolius*, *Acacia obtusifolia*, *Persoonia rufa*, *Hakea eriantha*, *Amperea xiphoclada*, *Elaeocarpus reticulatus*, *Podolobium aestivum*, *Choretrum candollei*, *Monotoca scoparia*, *Cooperookia chishomii*, *Boronia algida*, *Leucopogon melaleuoides*, *Grevillea rhizomatosa*, *Trochocarpa laurina*, *Persoonia adenantha*, *Ozothamnus diosmifolius*, *Hibbertia riparia*, *Hibbertia aspera*, *Hakea salicifolia*, *Cryptocarya rigida*, *Hibbertia empetrifolia*, *Acrotriche aggregata*, *Acacia ulicifolia*.

**Climbers & trailers:** *Glycine clandestina*, *Hibbertia dentata*, *Billardiera scandens*, *Hibbertia scandens*, *Eustrephus latifolius*, *Kennedia rubicunda*, *Hardenbergia violacea*, *Desmodium varians*, *Cissus hypoglauca*, *Clematis aristata*, *Clematis glycinoides*, *Smilax glycyphylla*, *Pandorea pandorana*, *Geitonoplesium cymosum*, *Rubus parviflorus*, *Palmeria scandens*, *Muehlenbeckia gracillima*, *Morinda jasminoides*, *Desmodium rhytidophyllum*, *Desmodium gangeticum*, *Cissus antarctica*.

**Ground cover:** *Calochlaena dubia*, *Pteridium esculentum*, *Imperata cylindrica*, *Lomandra longifolia*, *Dianella caerulea*, *Gonocarpus teucrioides*, *Entolasia stricta*, *Poa sieberiana*, *Viola betonicifolia*, *Viola hederacea*, *Blechnum cartilagineum*, *Patersonia glabrata*, *Lepidosperma urophorum*, *Platysace ericoides*, *Lepidosperma laterale*, *Lagenifera gracilis*, *Corybas aconitiflorus*, *Bossiaea scortechinii*, *Opercularia hispida*, *Sorghum leiocladum*, *Patersonia sericea*, *Tetrarrhena juncea*, *Hydrocotyle peduncularis*, *Goodenia rotundifolia*, *Gonocarpus tetragynus*, *Xanthorrhoea glauca*, *Sticherus lobatus*, *Pomax umbellata*, *Lomandra confertifolia*, *Lepidosperma elatius*, *Goodenia hederacea*, *Geranium solanderi*, *Cyathea australis*.

**Variability:** there are three field definable overstorey floristic sub-assemblages. The first and most widespread is a tall open forest dominated by *Eucalyptus campanulata*, with a tall shrub layer of *Acacia nova-anglica*, a dense low shrub layer of *Pultenaea* sp. 'Gibraltar Range' and a ground layer of grass and ferns. The second sub-association of *Eucalyptus obliqua* with a mesic middle layer of tree ferns and a dense ground layer of water and bracken fern. The third sub-association is of a dry open forest dominated by *Eucalyptus campanulata* with *Corymbia intermedia* and *Allocasuarina torulosa* as a small tree layer, with a sparse shrub layer and a dense cover of ferns and herbs.

**Notes:** *Eucalyptus campanulata* has an almost ten-fold greater cover than the nearest tree in this grouping. The assemblage is allied to Beadles' (1981) *E. campanulata* Alliance that is described as occurring at higher altitudes from just over the Queensland border to the Barrington Tops area (McDonald & Whiteman 1979; Binns & Chapman 1993; Binns 1995a & b; Hunter 2004; 2005a & c). All described occurrences are at altitudes above 900 m. Binns (1995b) considered this association as possibly the most widespread community in the Tenterfield district above 900 m on all geological substrates. Clarke *et al.* (1998) describe a slightly divergent but very similar community as occurring on a metasediment pendant at Torrington.

**Conservation status:** this assemblage is well-represented locally and across its range. Despite being fairly extensive in the broad sense, as described here the assemblage is probably fairly restricted and centred on the escarpment from Guy Fawkes River north to the Timbarra Plateau. It is well reserved in Nymboida NP (3,530ha) (Benwell 2000),

western areas of Washpool NP (9,363 ha) (Hunter 2005), Mann River NR (1,834 ha) (Hunter 2004), Guy Fawkes River NP (6,783 ha) (Hunter & Alexander 1999), Basket Swamp NP (1,059 ha) (Hunter 2004c) and the present study area (3,064ha).

### **Community 5: *Eucalyptus oreades* (Blue Mountains Ash) – *Eucalyptus campanulata* (New England Blackbutt) woodland and shrubland**

**Habitat:** restricted to fugitive outcrops particularly in riparian areas.

**Structure:** upper layer: 8–30 m; 10–30% cover; Upper mid layer: 4–10 m; 5–60% cover. Lower mid layer: 1–4 m; 30–50% cover. Ground layer: <1 m, 10–30% cover.

**Trees:** *Eucalyptus oreades*, *Eucalyptus campanulata*, *Ceratopetalum apetalum*, *Banksia integrifolia* subsp. *monticola*.

**Shrubs:** *Leionema dentatum*, *Pultenaea tarik*, *Prostanthera caerulea*, *Persoonia rufa*, *Leptospermum novae-angliae*, *Dillwynia rupestris*, *Leptospermum trinervium*, *Kunzea bracteolata*, *Hakea salicifolia*, *Epacris longiflora*, *Cassinia aureonitens*, *Brachyloma saxicola*, *Boronia angustisepala*, *Polyscias sambucifolius*, *Orites excelsa*, *Lomatia silaifolia*, *Leucopogon lanceolatus*, *Elaeocarpus reticulatus*, *Comesperma ericinum*, *Callitris monticola*, *Boronia anethifolia*, *Bauera rubioides*, *Alyxia ruscifolia*, *Allocasuarina rigida* subsp. *rigida*.

**Climbers & trailers:** *Smilax australis*, *Billardiera scandens*.

**Ground cover:** *Schoenus melanostachys*, *Lepidosperma urophorum*, *Lepidosperma laterale*, *Pteridium esculentum*, *Lomandra longifolia*, *Gonocarpus teucrioides*, *Dianella caerulea*, *Caustis flexuosa*, *Trachymene incisa*, *Thelionema grande*, *Patersonia sericea*, *Laxmannia compacta*, *Gleichenia dicarpa*, *Gahnia sieberiana*, *Entolasia stricta*, *Calochlaena dubia*, *Blechnum cartilagineum*, *Asplenium flabellifolium*.

**Variability:** the two sampled sites vary structurally but are share many taxa including the overstorey dominants. *Eucalyptus oreades* is generally restricted in extent in the study area and is usually associated with riparian areas on the granitic plateau.

**Notes:** overstorey associations of *Eucalyptus oreades* have been recorded in disjunct occurrences from the Border Ranges NP to Werrikimbe NP. These other occurrences, however, differ considerably in understorey floristics compared to those recorded in Community 5.

**Conservation status:** this is one of the most limited communities within the reserve. The assemblage should be considered vulnerable due to its limited occurrence. Its full extent appears to be completely within the study area, although a somewhat similar grouping of taxa is known to occur in a limited area on rock outcrops in Basket Swamp NP (Hunter 2004c).

### **Community 6: *Callicoma serratifolia* (Black Wattle) – *Eucalyptus oreades* (Blue Mountains Ash) open forest and shrubland**

**Habitat:** restricted to open granite surfaces or fugitive outcrops in riparian areas.

**Structure:** shrubby open forest or shrubland.

**Trees:** *Callicoma serratifolia*, *Eucalyptus oreades*, *Ceratopetalum apetalum*.

**Shrubs:** *Leptospermum polygalifolium*, *Callistemon pallidus*, *Callistemon sieberi*, *Prostanthera caerulea*, *Hakea salicifolia*, *Bauera rubioides*, *Baekkea omissa*, *Allocasuarina rigida* subsp. *rigida*, *Acacia venulosa*, *Prostanthera scutellarioides*, *Leptospermum trinervium*, *Hibbertia rufa*, *Epacris obtusifolia*, *Epacris microphylla*, *Acacia floribunda*.

**Climbers & trailers:** *Billardiera scandens*, *Cassytha glabella*.



**Ground cover:** *Gleichenia dicarpa*, *Sticherus lobatus*, *Schoenus melanostachys*, *Tetrarrhena juncea*, *Pteridium esculentum*, *Lepyrodia scariosa*, *Gonocarpus teucroides*, *Entolasia stricta*, *Drosera spatulata*, *Drosera binata*, *Corybas acontiflorus*, *Chiloglottis silvestris*, *Blechnum cartilagineum*.

**Variability:** the two sampled sites vary structurally but are share many taxa including the overstorey dominants. *Eucalyptus oreades* is generally restricted in extent in the study area and is usually associated with shallow soils in riparian areas on the granitic plateau.

**Notes:** overstorey associations of *Eucalyptus oreades* have been recorded in disjunct occurrences from the Border Ranges NP to Werrikimbe NP. These other occurrences, however, differ considerably in understorey floristics compared to those recorded here.

**Conservation status:** this is a very limited community within the reserve. The assemblage should be considered vulnerable due to its limited occurrence. Similar diverse shrubby communities area described for riparian margins on granite in Warra, Basket Swamp and Washpool (western) NPs (Hunter 1998; Benson and Ashby 2000; Hunter 2004c; Hunter 2005c).

**Community 7: *Leptospermum petersonii* subsp. *petersonii* (Lemon-scented Tea-tree) – *Phebalium squamulosum* subsp. *squamulosum* (Phebalium) closed scrub.**

**Habitat:** at high altitude on sedimentary rocks.

**Structure:** closed scrub. Upper layer: 4–18 m; 70% cover. Middle layer: to 8 m; 30% cover. Ground layer: <1.5 m, 20–80% cover.

**Shrubs:** *Leptospermum petersonii* subsp. *petersonii*, *Phebalium squamulosum* subsp. *squamulosum*, *Banksia integrifolia* subsp. *monticola*, *Alyxia ruscifolia*, *Leucopogon lanceolatus*, *Trochocarpa laurina*, *Tasmania insipida*, *Zieria smithii*, *Notelaea longifolia*, *Acmena smithii*.

**Climbers & trailers:** *Pyrrosia rupestris*, *Hibbertia scandens*, *Pandorea pandorana*, *Cissus hypoglauca*, *Rubus nebulosus*, *Rubus moluccanus*, *Parsonsia straminea*.

**Ground cover:** *Lomandra longifolia*, *Hydrocotyle peduncularis*, *Dianella caerulea*, *Asplenium flabellifolium*, *Oplismenus aemulus*, *Carex appressa*, *Galium propinquum*, *Aneilema acuminatum*, *Plectranthus parviflorus*, *Oplismenus imbecillis*, *Histiopteris incisa*, *Davallia solida* var. *pyxidata*, *Asplenium australasicum*.

**Variability:** though varying in structure both sites were floristically very similar.

**Notes:** this assemblage is included within Floyd's (1990) sub-alliance 46 and is described as a closed scrub community characterised by the occurrence of *Leptospermum* spp. *Notelaea venosa* and *Prostanthera* spp. Such closed scrubs are described as occurring on high altitude ridge tops with shallow soils in seasonally dry locations (Floyd 1990) such as the summit of Wilson's Peak, Mt Lindesay, Mt Warning and on high exposed aspects in Washpool NP, including Hayden's Trig. It differs from other occurrences of sub alliance 46 at Mt Nothofagus, New England NP, and Werrikimbe NP, due to the absence of *Cryptocarya nova-anglica* and at Mt Hyland, Dorrigo Escarpment by the replacement of *Leptospermum petersonii* with *Leptospermum polygalifolium*. Some broadly synonymous assemblages at high altitudes dominated by *Leptospermum petersonii* have been described within New England NP and further south within the Kempsey/Wauchope area (Binns & Chapman 1993).

**Conservation status:** in the broad sense Community 6 is reserved in the Border Ranges, Washpool, Gibraltar Range and Mt Warning NPs. In the strict sense, there appears to be a significant structural and floristic variation within sub-alliance 46, which requires more detailed study. It should be considered vulnerable due to its limited extent.

**Community 8: *Eucalyptus biturbinata* (Grey Gum) – *Lophostemon confertus* (Brush Box) woodland and forest**

**Habitat:** lower to mid slopes (300–900 m) on the eastern escarpment on sedimentary soils.

**Structure:** grassy open forest or woodland. Upper layer: 8–30 m; 10–45% cover. Upper mid layer: 10–15 m, 20–55% cover. Lower mid layer: 2–6 m; 10–30%. Ground layer: < 2 m; 40–90% cover.

**Trees:** *Eucalyptus biturbinata*, *Lophostemon confertus*, *Allocasuarina torulosa*, *Eucalyptus saligna*, *Eucalyptus pyrocarpa*, *Eucalyptus microcorys*, *Eucalyptus fibrosa*, *Eucalyptus carnea*, *Eucalyptus campanulata*, *Eucalyptus acmenoides*.

**Shrubs:** *Ricinocarpos speciosus*, *Persoonia sericea*, *Persoonia oleoides*, *Ozothamnus diosmifolius*, *Monotoca scoparia*, *Maytenus bilocularis*, *Lomatia silaifolia*, *Leucopogon lanceolatus*, *Indigofera australis*, *Clerodendrum tomentosum*, *Brachylooma daphnoides* subsp. *glabrum*, *Acacia melanoxylon*.

**Climbers & trailers:** *Desmodium varians*, *Rubus parviflorus*, *Hibbertia scandens*, *Hardenbergia violacea*, *Glycine tabacina*, *Glycine clandestina*, *Eustrephus latifolius*, *Desmodium rhytidophyllum*, *Desmodium brachypodium*, *Commelina cyanea*, *Cissus hypoglauca*.

**Ground cover:** *Poa sieberiana*, *Imperata cylindrica*, *Xanthorrhoea glauca*, *Viola betonicifolia*, *Vernonia cinerea*, *Senecio prenanthoides*, *Pratia purpurascens*, *Plectranthus parviflorus*, *Lomandra longifolia*, *Helichrysum scorpioides*, *Goodenia bellidifolia*, *Entolasia stricta*, *Dichondra repens*, *Dianella caerulea*, *Cymbopogon refractus*, *Cheilanthes sieberi*, *Arthropodium milleflorum*, *Wahlenbergia luteola*, *Viola hederacea*, *Veronica calycina*, *Trachymene incisa*, *Themeda triandra*, *Stackhousia viminea*, *Senecio quadridentatus*, *Senecio lautus*, *Senecio amygdalifolius*, *Ranunculus lappaceus*, *Pteris tremula*, *Pteridium esculentum*, *Pseuderanthemum variabile*, *Pomax umbellata*, *Polygala japonica*, *Plantago debilis*, *Pellaea falcata*, *Panicum simile*, *Oxalis exilis*, *Oplismenus imbecillis*, *Oplismenus aemulus*, *Opercularia hispida*, *Lomandra multiflora*, *Lomandra filiformis*, *Lagenifera gracilis*, *Hypericum gramineum*, *Hydrocotyle peduncularis*, *Hydrocotyle laxiflora*, *Haloragis heterophylla*, *Gonocarpus teucroides*, *Gonocarpus tetragynus*, *Geranium solanderi*, *Euchiton sphaericus*, *Eragrostis brownii*, *Echinopogon caespitosus*, *Doodia aspera*, *Dichelachne micrantha*, *Capillipedium spicigerum*, *Botrychium australe*, *Asplenium flavellifolium*.

**Variability:** it is likely that this assemblage was under-sampled. *Lophostemon confertus* becomes more dominant in gullies and in other protected localities.

**Notes:** this assemblage appears to be broadly related to grassy to shrubby foothill and escarpment woodlands or forests that occur from the Queensland border to the Hunter region.

**Conservation status:** in the broadest terms this community appears to be represented within reserves across its range and locally is well represented within the study area and also potentially within Nymboida NP (10,645 ha) (Benwell 2000), Washpool (western) NP (4,578 ha) (Hunter 2005), Mann River NR (1,737 ha) (Hunter 2004) and within Guy Fawkes River NP (2,555 ha) (Hunter & Alexander 1999).

**Community 9: *Eucalyptus carnea* (Thick-leaved Mahogany) – *Syncarpia glomulifera* (Turpentine) – *Corymbia intermedia* (Pink Bloodwood) forest and woodland**

**Habitat:** on granite at lower altitudes (300–400 m), upper to lower slopes on exposed, intermediate and sheltered slopes.

**Structure:** grassy dry open forest. Upper layer: 18–35 m; 25–45% cover. Upper mid layer often present: 5–16 m; to 25% cover. Lower mid layer: 1.5–7 m; 35–55% cover. Ground layer: to 2 m; 70–80% cover.

**Trees:** *Eucalyptus carnea*, *Syncarpia glomulifera*, *Corymbia intermedia*, *Allocasuarina torulosa*, *Eucalyptus microcorys*, *Eucalyptus pyrocarpa*, *Eucalyptus planchoniana*, *Eucalyptus biturbinata*, *Lophostemon confertus*.

**Shrubs:** *Leucopogon juniperinus*, *Dodonaea triquetra*, *Acacia blakei*, *Hibbertia obtusifolia*, *Persoonia adenantha*, *Jacksonia scoparia*, *Trochocarpa laurina*, *Pimelea linifolia*, *Orites excelsa*, *Dampiera purpurea*, *Acrotriche aggregata*.

**Climbers & trailers:** *Desmodium rhytidophyllum*, *Desmodium varians*, *Glycine clandestina*, *Hardenbergia violacea*, *Pandorea pandorana*, *Hibbertia scandens*, *Geitonoplesium cymosum*, *Cassytha glabella*.

**Ground cover:** *Deyeuxia parviseta*, *Oplismenus imbecillis*, *Vernonia cinerea*, *Panicum simile*, *Opercularia hispida*, *Lepidosperma laterale*, *Imperata cylindrica*, *Pomax umbellata*, *Lomandra confertifolia*, *Lagenifera gracilis*, *Eragrostis brownii*, *Entolasia stricta*, *Dianella caerulea*, *Glossogyne tannensis*, *Digitaria parviflora*, *Cymbopogon refractus*, *Corybas aconitiflorus*, *Cheilanthes sieberi*, *Aristida queenslandica*, *Pterostylis nutans*, *Phyllanthus virgatus*, *Oplismenus aemulus*, *Lomandra multiflora*, *Lomandra filiformis*, *Lepidosperma urophorum*, *Goodenia hederacea*, *Brunoniella pumilio*, *Adiantum hispidulum*.

**Variability:** there are a range of overstorey associations that occur within this assemblage in which either *Syncarpia glomulifera*, *Eucalyptus carnea* and/or *Eucalyptus microcorys* may dominate.

**Conservation status:** in the broadest terms this community appears to be represented within reserves across its range such as at Nymboida NP [10645 ha] (Benwell 2000), Western Washpool NP [2828 ha] (Hunter 2000) and Guy Fawkes NP (Hunter & Alexander 1999).

#### **Community 10: *Eucalyptus campanulata* (New England Blackbutt) – *Eucalyptus microcorys* (Tallowood) open forest**

**Habitat:** on sedimentary or acid volcanic rock types from 300–1000+ m. Usually on intermediate to sheltered aspects with deep soils.

**Structure:** tall open forest. Upper layer: 25–45 m; 30–45% cover. Upper mid layer: 4–20 m; 15–40% cover. Lower mid layer: 1–8 m; 15–80% cover. Ground layer: <1 m; 10–60% cover.

**Trees:** *Allocasuarina torulosa*, *Eucalyptus campanulata*, *Eucalyptus microcorys*, *Caldcluvia paniculosa*, *Lophostemon confertus*, *Eucalyptus carnea*, *Schizomeria ovata*, *Banksia integrifolia* subsp. *monticola*, *Syncarpia glomulifera*, *Eucalyptus saligna*, *Eucalyptus obliqua*, *Eucalyptus caliginosa*.

**Shrubs:** *Trochocarpa laurina*, *Acacia irrorata*, *Elaeocarpus reticulatus*, *Lomatia silaifolia*, *Leucopogon lanceolatus*, *Archirhodomyrtus beckeri*, *Zieria smithii*, *Archontophoenix cunninghamiana*, *Acacia nova-anglica*, *Wilkiea huegeliana*, *Synoum glandulosum*, *Polyscias sambucifolius*, *Pittosporum undulatum*, *Endiandra sieberi*.

**Climbers & trailers:** *Palmeria scandens*, *Hibbertia dentata*, *Smilax glycyphylla*, *Smilax australis*, *Cissus hypoglauca*, *Eustrephus latifolius*, *Hibbertia scandens*, *Rubus nebulosus*, *Parsonia induplicata*, *Glycine clandestina*, *Geitonoplesium cymosum*, *Billardiera scandens*, *Streptothamnus moorei*, *Piper novae-hollandiae*, *Morinda jasminoides*, *Parsonia velutina*, *Marsdenia rostrata*, *Desmodium gangeticum*, *Cephalalaria cephalobotrys*.

**Ground cover:** *Lomandra longifolia*, *Calochlaena dubia*, *Oplismenus aemulus*, *Lepidosperma laterale*, *Dianella caerulea*, *Blechnum cartilagineum*, *Viola hederacea*, *Lepidosperma elatius*, *Gonocarpus oreophilus*, *Gahnia aspera*, *Xanthorrhoea glauca*, *Pteridium esculentum*, *Oplismenus imbecillis*, *Lobelia trigonocaulis*, *Galium propinquum*, *Entolasia stricta*, *Doodia aspera*, *Cyperus disjunctus*, *Corybas aconitiflorus*.

**Variability:** at higher altitudes *Eucalyptus campanulata* dominates in association with *Eucalyptus microcorys* while at lower altitudes *Eucalyptus carnea* may become more prominent along with an occasional occurrence of *Eucalyptus crebra* or *Eucalyptus tereticornis* particularly along drainage lines.

**Notes:** this community appears to be intermediate between many currently described associations with *E. campanulata*, *E. microcorys* and *E. saligna* as dominants. Differences with other similar communities in the north-east of New South Wales are the lack of dominant and closed mesomorphic understorey of rainforest taxa and few or no sclerophyll species. Communities with similar overstorey components are described by Young and McDonald (1989) with a patchy distribution on the McPherson Range along the Queensland/New South Wales Border near Mount Nothofagus and Mount Ernest. In the survey of the Demon Nature Reserve a similar forest is described with a more or less prominent mesomorphic understorey fringing closed forests (Hunter *et al.* 1999). Binns (1995c) describes a similar community in the Casino Management Area. Binns & Chapman (1993) also describe a somewhat similar community in the Kempsey-Wauchope area. From these accounts it is likely that similar, if not the same floristic associations, may occur from as far north as the McPherson Ranges along the Queensland border along the edge of the escarpment to as far south as Clouds Creek or possibly to the Wauchope and Kempsey region. As described here however this assemblage is largely restricted to the Washpool to northern Guy Fawkes River region. In the strictest sense, this assemblage appears to be largely centred around the study region with a few occurrences extending not far north or south.

**Conservation status:** well reserved locally e.g. Washpool (western) NP (2,075 ha) (Hunter 2005), Nymboida NP (3,530 ha, possibly a further 6388 ha) (Benwell 2000) and Guy Fawkes NP (northern section; 1,031 ha) (Hunter & Alexander 1999). This assemblage should be considered adequately reserved.

#### **Community 11: *Cryptocarya rigida* (Forest Maple) – *Synoum glandulosum* (Scentless Rosewood) closed forest**

**Habitat:** sediment and acid volcanic rock types above 700 m. Soils are deep clay loams.

**Structure:** Emergent layer: 20–50 m; 20–40% cover. Closed forest layer: 4–25 m; 60–80% cover. Ground cover: < 2 m; 15–20% cover.

**Trees:** *Cryptocarya rigida*, *Archontophoenix cunninghamiana*, *Synoum glandulosum*, *Sloanea woollsi*, *Orites excelsa*, *Lophostemon confertus*, *Eucalyptus saligna*, *Eucalyptus microcorys*, *Eucalyptus campanulata*, *Cryptocarya obovata*, *Caldcluvia paniculosa*.

**Shrubs:** *Tasmannia insipida*, *Trochocarpa laurina*.

**Climbers & trailers:** *Parsonia velutina*, *Palmeria scandens*, *Morinda jasminoides*, *Cephalalaria cephalobotrys*, *Tylophora paniculata*, *Smilax glycyphylla*, *Smilax australis*, *Rubus nebulosus*, *Piper novae-hollandiae*, *Parsonia induplicata*, *Pandorea pandorana*, *Legnephora moorei*, *Eustrephus latifolius*, *Clematis glycinoides*, *Clematis aristata*.

**Ground cover:** *Lomandra spicata*, *Linospadix monostachya*, *Lastreopsis microsora*, *Blechnum cartilagineum*.

**Variability:** this structurally divergent assemblage commonly straddles the ecotone between open forest and closed forest at higher altitudes and thus usually contains a dense closed forest understorey with various overstorey eucalypt taxa.

**Conservation status:** similar assemblages are considered adequately reserved across their range at present.

#### **Community 12: *Ceratopetalum apetalum* (Coachwood) – *Caldcluvia paniculosa* (Soft Corkwood) closed forest**

**Habitat:** on granite usually at high altitudes on lower to mid slopes in sheltered to intermediate aspects.

**Structure:** Upper layer: 15–55 m; 80% cover. Mid layer rarely present: 1–6 m; 70%. Ground cover: < 1m; 20–40% cover.

**Trees:** *Ceratopetalum apetalum*, *Caldcluvia paniculosa*, *Sloanea woollsii*, *Quintinia sieberi*, *Orites excelsa*, *Endiandra sieberi*, *Endiandra discolor*, *Callicoma serratifolia*, *Cryptocarya meissneriana*, *Callicoma serratifolia*, *Anopterus macleayanus*, *Acradenia euodiiformis*.

**Shrubs:** *Citriobatus pauciflorus*, *Tasmannia insipida*.

**Climbers & trailers:** *Smilax australis*, *Parsonia induplicata*, *Palmeria scandens*, *Morinda jasminoides*, *Tylophora paniculata*, *Rubus moluccanus*, *Pandorea pandorana*, *Marsdenia rostrata*, *Hibbertia scandens*, *Eustrephus latifolius*, *Clematis glycinoides*, *Cissus hypoglauca*, *Cephalalaria cephalobotrys*.

**Ground cover:** *Microsorium scandens*, *Lomandra spicata*, *Lobelia trigonocaulis*, *Linospadix monostachya*, *Histiopteris incisa*, *Cyathea australis*, *Carex appressa*, *Asplenium australasicum*.

**Variability:** in general this association would be included within sub alliance 35 of Floyd (1990) though at some localities the assemblage is more like sub-alliance 33.

**Conservation status:** similar assemblages are considered adequately reserved across their range at present.

### Community 13: *Kunzea bracteolata* (Granite *Kunzea*) – *Leptospermum nova-angliae* (New England Tea-tree) heaths and shrubland

**Habitat:** restricted to exposed granitic outcrops, particularly on sheet granite where the community grows within crevices, cracks and shallow soil islands, but may occasionally occur in a shallow soil skirt around the margins of outcrops.

**Structure:** mainly closed heaths although the mallee *Eucalyptus codonocarpa* may be present forming shrubby open scrubs (mallee). Occasionally other trees species occur, such as *Eucalyptus campanulata*, *Eucalyptus olida*, *Eucalyptus caliginosa*, giving a shrubby low open

woodland structure. In some instances *Leptospermum nova-angliae* at its tallest and densest will form closed scrub.

**Trees:** *Eucalyptus codonocarpa*, *Eucalyptus notabilis*, *Eucalyptus ligustrina*, *Eucalyptus cameronii*, *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus acaciiformis*.

**Shrubs:** *Kunzea bracteolata*, *Leucopogon neoanglicus*, *Leptospermum nova-angliae*, *Boronia anethifolia*, *Calytrix tetragona*, *Callistemon comboynensis*, *Allocasuarina rigida* subsp. *rigida*, *Acacia suaveolens*, *Mirbelia confertiflora*, *Grevillea acerata*, *Epacris microphylla*, *Phebalium squamulosum*, *Ozothamnus diosmifolius*, *Dampiera stricta*, *Leptospermum trinervium*, *Acacia brunioides* subsp. *brunioides*, *Mirbelia rubiifolia*, *Brachyloma saxicola*, *Pseudanthus pauciflorus* subsp. *pauciflorus*, *Persoonia rufa*, *Callitris monticola*.

**Climbers & trailers:** *Cassytha filiformis*, *Smilax glyciphylla*, *Smilax australis*.

**Ground cover:** *Lepidosperma laterale*, *Lepidosperma gunnii*, *Trachymene incisa* var. *incisa*, *Entolasia stricta*, *Laxmannia compacta*, *Brachyscome stuartii*, *Lomandra longifolia*, *Schoenus melanostachys*, *Aristida ramosa*, *Xanthorrhoea glauca*, *Schoenus apogon*, *Platysace ericoides*, *Lepyrodia scariosa*, *Austrodanthonia richardsonii*, *Gonocarpus teucroides*, *Caustis flexuosa*, *Austrostipa scabra*, *Goodenia bellidifolia*, *Gahnia sieberiana*, *Bulbostylis densa*, *Tetrarrhena juncea*, *Lepidosperma neesii*, *Gonocarpus oreophilus*, *Cheilanthes sieberi*.

**Variability:** The small population sizes and the harsh environment afforded by the rock outcrop habitat necessarily means that even adjacent occurrences are likely to contain very different species assemblages (Hunter 2000a; Hunter 2002; Hunter 2003a; Hunter 2004a). Although a few species may be dominant in most situations they may inexplicably be missing, at least above ground, from nearby sites. Disturbances such as fire can dramatically change the floristics and structure temporarily as a suite of short lived disturbance ephemerals establish (Hunter 1995; Hunter 1998a; Hunter *et al.* 1998; Hunter 2003b).

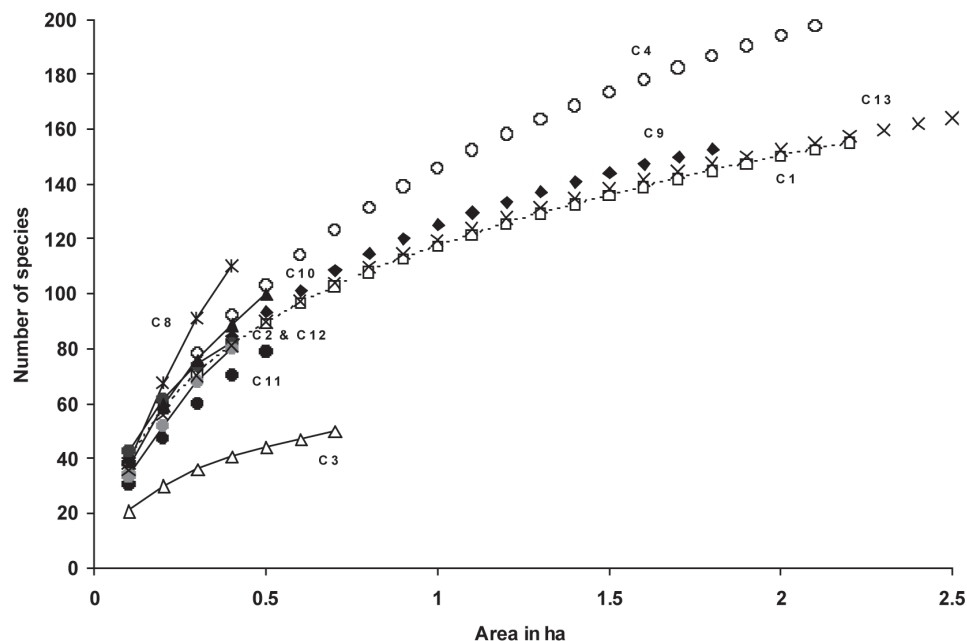


Fig. 4. Rarefaction curves for each community with at least four sample sites.

**Notes:** this grouping includes three of the nine elements of granitic outcrop vegetation delineated by Hunter and Clarke (1998). Two of these elements are only sparingly represented within the reserve, with the majority of the rock outcrop communities within Gibraltar Range constituting Element 3 of Hunter and Clarke (1998). This element and its single constituent community are entirely restricted to Gibraltar Range. This endemic community, though quite divergent, is broadly related to other outcrop associations that occur along the eastern escarpment of the New England Batholith from Cathedral Rocks to Boonoo Boonoo (Hunter and Clarke 1998).

**Conservation status:** considered adequately reserved and well represented both locally and across its range, and currently not under any considerable threat. The assemblage is largely restricted to Gibraltar Range NP.

#### *Community attributes*

Species accumulation varied greatly across communities (Fig. 4). The highest accumulating curve was achieved by Community 8 (*Eucalyptus biturbinata* – *Lophostemon confertus*) followed by Community 4 (*Eucalyptus campanulata*) and Community 10 (*Eucalyptus campanulata* – *E. microcorys*). The least accumulating curve was Community 3 (*Baeckea omissa* – *Epacris obtusifolia*) which was substantially lower than all others measured, with second lowest being Community 11 (*Cryptocarya rigida* – *Synoum glandulosum*). At the level of four sample sites (0.4 ha) it is expected that Community 3 will contain 41 taxa and Community 8, 110 taxa. Modelled species density however was highest within Community 9 (*Eucalyptus carnea* – *Eucalyptus microcorys*) with 42.6 taxa per 0.1 ha (Table 1). This is in contrast to the Community 3 (*Baeckea omissa* – *Epacris obtusifolia*) which contained only 20.9 taxa per 0.1 ha. Spatial turnover within communities (pattern diversity) was also highly variable with Community 8 (*Eucalyptus biturbinata* – *Lophostemon confertus*) having almost twice as much turnover compared to Community 1 (*Eucalyptus olida* – *E. ligustrina* – *E. carnea*) and Community 13 (*Kunzea bracteolata* – *Leptospermum novae angliae*) (Table 1). Comparatively high turnover was also found within Community 10 (*Eucalyptus campanulata* – *E. microcorys*), Community 11 (*Cryptocarya rigida* – *Synoum glandulosum*) and Community 12 (*Ceratopetalum apetalum* – *Caldcluvia paniculosa*).

Cumulative species occupancy as measured by average geographic range size was highest in community 13 (*Kunzea bracteolata* – *Leptospermum novae angliae*) followed by community 8 (*Eucalyptus biturbinata* – *Lophostemon confertus*) and community 9 (*Eucalyptus carnea* – *Syncarpia glomulifera* – *Corymbia gummifera*) (Table 1). The lowest average range size was obtained by Community 11 (*Cryptocarya rigida* – *Synoum glandulosum*) and then Community 5 (*Eucalyptus oreades* – *E. campanulata*) and Community 10 (*Eucalyptus campanulata* – *E. microcorys*) (Table 1).

#### *Rare and threatened species*

81 species of special conservation significance were recorded from Gibraltar Range National Park and the southern section of Washpool National Park (Table 2). Seven taxa are listed or should be considered for listing on the *NSW Threatened Species Conservation Act 1995*, including five listed as endangered and two vulnerable (Table 2). 35 species are listed in Briggs and Leigh (1996) as 'Rare or Threatened Australian Plants' (ROTAPs) or have since been coded and published by other authors according to ROTAP criteria (Table 2). A further 40 species are considered to be of regional or local conservation significance according to Sheringham and Westaway (1995) (Table 2).

## Discussion

### *Significance and conservation issues*

The total of 878 taxa recorded within the study area (Gibraltar Range & southern Washpool NPs) represents a relatively high species richness and is similar to that found for other recently surveyed large reserves on the eastern escarpment (Hunter 1998b; Hunter 2004b; Benwell 2000). The vegetation reflects its placement within the north east of New South Wales. Many of the major assemblages along the eastern escarpment of the Northern Tablelands have distributions that range from just over the border in Queensland to Barrington in New South Wales. Gibraltar Range lies almost in the centre of this distribution pattern. It is not surprising therefore that many of the communities circumscribed herein, in the strict sense, radiate from the study area north and south and in the broad sense occur as far north as the Queensland border and as far south as Barrington. It is also not surprising that several communities are apparently endemic to the study area, with few correlates, even in the broad sense, occurring elsewhere.

Approximately 60% of the woody vegetation in the New England Bioregion has been cleared (Benson 1999). Half of the communities described for the study area (Communities 1, 2, 5, 6 and 7) are endemic, or almost exclusively restricted to, the area including Community 1 which is the most widespread of those mapped. Communities 1, 4 and 10 are considered rare, in terms of distributional extent, and Communities 5 and 7 should be considered as vulnerable, due to their very limited natural distribution. Despite half of these assemblages being rare in the landscape, all are considered to be adequately reserved, as much of their natural extent is currently within conservation reserves. The remaining communities are thought to radiate further north and south from the study area, but with significant local variation that is centred, in terms of distribution, within the study area.

81 species of special conservation significance have been recorded from Gibraltar Range National Park and southern section of Washpool National Park representing 10% of the

**Table 2. Summary of rare, threatened and regionally uncommon species. Codes in brackets are suggested but not yet ratified.** Upper North East Codes are those given by Sheringham and Westaway (1995).

Taxon	TSC Act Listing	RoTAP Code	Upper NE NSW Code
1: <i>Eucalyptus dissita</i>	Endangered	2RC-	-
2: <i>Grevillea mollis</i>	Endangered	2ECi	-
3: <i>Hibbertia rhynchocalyx</i>	[Endangered]	[2ECi]	-
4: <i>Marsdenia longiloba</i>	Endangered	3RC-	-
5: <i>Tylophora woollsii</i>	Endangered	2E	-
6: <i>Cryptostylis hunteriana</i>	Vulnerable	3VC-	-
7: <i>Grevillea rhizomatosa</i>	Vulnerable	2VC-t	-
8: <i>Solanum nobile</i>	-	3VC-	-
9: <i>Acacia barringtonensis</i>	-	3RCa	-
10: <i>Acacia beadleana</i>	-	2VCit	-
11: <i>Acacia brunioides</i> subsp. <i>brunioides</i>	-	3RC-	[Disjunct]
12: <i>Acacia cangaiensis</i>	-	2RC-	-
13: <i>Boronia angustisepala</i>	-	2RCa	-
14: <i>Brachyloma saxicola</i>	-	2RCa	-
15: <i>Callitris monticola</i>	-	3RC-	-
16: <i>Chiloglottis sphyrnoides</i>	-	3KC-	-
17: <i>Conospermum burgessiorum</i>	-	3RCa	-
18: <i>Cryptandra lanosiflora</i>	-	3RCa	-
19: <i>Dillwynia rupestris</i>	-	3RC-t	-
20: <i>Dodonaea serratifolia</i>	-	2RC-	-
21: <i>Eucalyptus codonocarpa</i>	-	3RC-	-
22: <i>Eucalyptus olida</i>	-	2RCa	-
23: <i>Grevillea acanthifolia</i> subsp. <i>stenomera</i>	-	3RC-	-
24: <i>Grevillea acerata</i>	-	2RC-t	-
25: <i>Hakea macrorhyncha</i>	-	[3RC-]	-
26: <i>Keraudrenia corollata</i> var. <i>denticulata</i>	-	3RC-	-
27: <i>Kunzea bracteolata</i>	-	3RC-	-
28: <i>Marsdenia liisae</i>	-	3RC-	-
29: <i>Leonema ambiens</i>	[Vulnerable]	3RC- [3VC-]	-
30: <i>Melaleuca tortifolia</i>	-	2RC-t	-
31: <i>Podolobium aestivum</i>	-	3RC-	-
32: <i>Persoonia rufa</i>	-	2RCa	-
33: <i>Pultenaea pycnocephala</i>	-	3RCa	-
34: <i>Pultenaea</i> sp. B	-	2RC-t	-
35: <i>Ricinocarpos speciosus</i>	-	3RCi	-
36: <i>Telopea aspera</i>	-	2RCa	-
37: <i>Thelionema grande</i>	-	3RC	-
38: <i>Westringia sericea</i>	-	3RC-	-
39: <i>Hibbertia villosa</i>	-	3KC-	-
40: <i>Plectranthus suaveolens</i>	-	3KC-	-
41: <i>Acacia mitchellii</i>	-	-	Disjunct; Northern Limit
42: <i>Acianthus caudatus</i>	-	-	Regionally Rare; Northern Limit
43: <i>Actinotus gibbonsii</i>	-	-	Regionally Rare
44: <i>Bulbophyllum bracteatum</i>	-	-	Rare in NSW; Southern Limit
45: <i>Caladenia alata</i>	-	-	Regionally Rare
46: <i>Callistemon</i> sp. 'Big Red'	-	-	Regionally Rare
47: <i>Callistemon linearis</i>	-	-	Regionally Rare; Disjunct
48: <i>Callitriche muelleri</i>	-	-	Regionally Rare
49: <i>Cassinia aureonitens</i>	-	-	Regionally Rare; Disjunct; Northern Limit
50: <i>Cassinia compacta</i>	-	-	Regionally Rare; Endemic
51: <i>Cooperookia barbata</i>	-	-	Regionally Rare; Northern Limit
52: <i>Correa lawrenciana</i> var. <i>glandulifera</i>	-	-	Regionally Rare
53: <i>Daviesia wyattiana</i>	-	-	Disjunct; Northern Limit
54: <i>Euphrasia collina</i> subsp. <i>paludosa</i>	-	-	Regionally Rare

55: <i>Desmodium giganticum</i>	-	-	Regionally Rare; Southern Limit
56: <i>Gahnia microstachya</i>	-	-	Regionally Rare; Disjunct; Northern Limit
57: <i>Genoplesium bishopii</i>	-	-	Endemic
58: <i>Gompholobium inconspicuum</i>	-	-	Regionally Rare; Disjunct; Northern Limit
59: <i>Gompholobium pinnatum</i>	-	-	Disjunct; Northern Limit
60: <i>Hibbertia rufa</i>	-	-	Regionally Rare; Northern Limit
61: <i>Kunzea opposita</i>	-	-	Regionally Rare
62: <i>Lasiopetalum ferrugineum</i> var. <i>cordatum</i>	-	-	Regionally Rare
63: <i>Leionema dentatum</i>	-	-	Disjunct; Northern Limit
64: <i>Lepidosperma neesii</i>	-	-	Disjunct; Northern Limit
65: <i>Myriophyllum pedunculatum</i> ssp. <i>pedunculatum</i>	-	-	Regionally Rare; Northern Limit
66: <i>Nertera granadensis</i>	-	-	Regionally Rare; Disjunct; Northern Limit
67: <i>Patersonia fragilis</i>	-	-	Disjunct
68: <i>Pelargonium inodorum</i>	-	-	Regionally Rare
69: <i>Pomaderris intermedia</i>	-	-	Regionally Rare; Northern Limit
70: <i>Pomaderris ledifolia</i>	-	-	Regionally Rare; Northern Limit
71: <i>Prostanthera howelliae</i>	-	-	Regionally Rare; Disjunct; Northern Limit
72.: <i>Prostanthera saxicola</i> var. <i>major</i>	-	-	Regionally Rare; Disjunct
73: <i>Pseudanthus pimeleoides</i>	-	-	Regionally Rare
74: <i>Pterostylis daintreana</i>	-	-	Regionally Rare
75: <i>Pultenaea linophylla</i>	-	-	Regionally Rare
76: <i>Pultenaea petiolaris</i>	-	-	Disjunct
77: <i>Sphaerolobium minus</i>	-	-	Regionally Uncommon
78: <i>Sprengelia incarnata</i>	-	-	Regionally Rare; Northern Limit
79: <i>Telfordia whitei</i>	-	-	Regionally Rare
80: <i>Thelymitra cyanea</i>	-	-	Regionally Rare; Northern Limit
81: <i>Tricostularia pauciflora</i>	-	-	Regionally Rare; Disjunct; Northern Limit

total flora, many of which are endemic to the study area. This number of rare and threatened species is the highest yet recorded for a single reserve within the Bioregion indicating the significance of this conservation area in terms of the conservation of both regionally and continentally important taxa.

### **Community attributes**

Community 3, *Baeckea omissa*-*Epacris obtusifolia* Bog, has the lowest modelled species density (per 0.1 ha), a low pattern diversity (species turnover) and the component flora has on average low range sizes. In other words this community has comparatively few species but most of them have a generally strong constance between sample sites and a relatively narrow range distribution (Table 1). The taxa of Community 3 are more highly restricted to their habitat, which may not be surprising as this is a community restricted to wetlands at high altitudes, a situation that is poorly-represented across Australia as a whole (Hunter & Bell 2007). The highest turnover was observed within Community 8, *Eucalyptus biturbinata*-*Lophostemon confertus* forest, which also had a comparatively high species density (Table 1). There is generally poor constancy between sample sites within this assemblage; many new taxa are found in each additional site. The flora of Community 8 had the highest general range sizes.

In general the higher turnover was found within Communities 10, 11 and 12. All three of these assemblages share a prominent closed forest component; this is also partially true for Community 8 (Table 1). In contrast the lower pattern diversity scores were found within Communities 1, 2 and 3 all of which share a prominent shrub component. This may imply that closed forest species are locally clumped in distribution and poorly shared between sites, whereas shrubby species have a more general dispersion, and locally will be found within many sites. These proposals would, however, require further investigation.

The flora of Community 11 had the lowest average geographic range sizes in the study area; its component flora was the most restricted in terms of Australian distribution. Restriction may be caused by a number of factors that may occur independently or together within an assemblage. Reasons for such general low broader distribution or restriction may include: the component taxa have poor dispersal abilities, there may be high numbers of endemic taxa, the taxa have restrictive requirements or that many taxa may be refugial. The flora of Community 13 had one of the highest average geographic range sizes. Surprisingly, this same assemblage, when compared with other rock outcrop communities, had one of the lowest range size scores (Hunter 2003a) but a high score for taxa restricted to the habitat (Hunter 2002). Larger geographic range sizes have been linked

to increasing available energy (light and heat) inputs and larger available habitats (Kelly 1996; Hunter 2003a; Hunter 2005b). Rock outcrops are very exposed environments and may be considered to have higher levels of available energy than other systems in the study area. The other two assemblages with high average geographic ranges were from Communities 8 and 9 (Table 1). Both these assemblages are generally restricted to lower altitudes and have potentially higher energy inputs from heat. However on this regional scale, differences in the average range sizes are likely to be due to a multitude of factors which would need much more intensive investigation.

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**Asteliaceae**

<i>Cordyline petiolaris</i>						11	12		
<i>Cordyline rubra</i>									O
<i>Cordyline stricta</i>									O

**Asteraceae**

<i>Arrhenechthites mixta</i>		4							
<i>Bidens pilosa*</i>					8				
<i>Brachyscome stuartii</i>				6					13
<i>Cassinia aureonitens</i>			5						
<i>Cassinia compacta</i>									O
<i>Centratherum punctatum</i> ssp. <i>australianum</i>									O
<i>Chrysocephalum apiculatum</i>		4							
<i>Cirsium vulgare*</i>									O
<i>Conyza bonariensis*</i>									O
<i>Euchiton gymnocephalus</i>									
<i>Euchiton involucratus</i>									O
<i>Euchiton sphaericus</i>									13
<i>Glossogyne tannensis</i>						9			
<i>Helichrysum elatum</i>		4					10		13
<i>Helichrysum rutidolepis</i>									O
<i>Helichrysum scorpioides</i>		4			8	9			
<i>Hypochaeris radicata*</i>		4		6	8	9			13
<i>Lagenifera gracilis</i>	1	4			8	9			
<i>Lagenifera stipitata</i>		4							
<i>Olearia elliptica</i>									O
<i>Olearia gravis</i>									O
<i>Olearia microphylla</i>									O
<i>Olearia nernstii</i>		4				9			
<i>Olearia oppositifolia</i>	1	4							
<i>Olearia ramosissima</i>									O
<i>Ozothamnus diosmifolius</i>	2	4							13
<i>Ozothamnus ferrugineus</i>									O
<i>Podolepis jaceoides</i>									O
<i>Pseudognaphalium luteoalbum</i>									O
<i>Senecio amygdalifolius</i>					8	9			
<i>Senecio bipinnatisectus</i>									O
<i>Senecio madagascariensis*</i>									O
<i>Senecio minimus</i>									O
<i>Senecio prenanthoides</i>					8				
<i>Senecio quadridentatus</i>					8				
<i>Senecio tenuiflorus</i>									O
<i>Senecio vagus</i>									O
<i>Sigesbeckia orientalis</i> subsp. <i>orientalis</i>		4			8				
<i>Solenogyne bellioides</i>									13
<i>Sonchus oleraceus*</i>									O
<i>Taraxacum afficinale*</i>									13
<i>Telfordia whitei</i>									O
<i>Vernonia cinerea</i> var. <i>cinerea</i>		4			8	9			

**Athyriaceae**

<i>Diplazium australe</i>									O
<i>Diplazium dilatatum</i>									O

**Baueraceae**

<i>Bauera rubioides</i> var. <i>rubioides</i>	1	3		5	6				
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**Bignoniaceae**

<i>Pandorea pandorana</i>		4			7	9		11	12
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**Blechnaceae**

<i>Blechnum cartilagineum</i>	2	4	5	6		10	11	12	13
<i>Blechnum nudum</i>		4						12	







<i>Polyosma cunninghamii</i>								11	
<i>Quintinia sieberi</i>						10	11	12	
<i>Quintinia verdonii</i>									O
<b>Euphorbiaceae</b>									
<i>Amperea xiphoclada</i> var. <i>xiphoclada</i>	1	2		4		6		8	
<i>Baloghia inophylla</i>									O
<i>Breynia cernua</i>				4				11	
<i>Claoxylon australe</i>									O
<i>Cleistanthus cunninghamii</i>									O
<i>Drypetes australasica</i>									O
<i>Glochidion ferdinandi</i>									O
<i>Mallotus philippensis</i>									O
<i>Micranthemum hexandrum</i>									O
<i>Omolanthus populifolius</i>								11	
<i>Phyllanthus gunnii</i>									O
<i>Phyllanthus hirtellus</i>		2		4		6			13
<i>Phyllanthus similis</i>				4					
<i>Phyllanthus virgatus</i>								9	
<i>Poranthera microphylla</i>				4					
<i>Pseudanthus pauciflorus</i> subsp. <i>pauciflorus</i>		2							13
<i>Ricinocarpos speciosus</i>							8	9	
<b>Eupomatiaceae</b>									
<i>Eupomatia laurina</i>								11	
<b>Fabaceae</b>									
<i>Acacia baeuerlenii</i>	1								
<i>Acacia barringtonensis</i>	1	2	3	4					13
<i>Acacia beadleana</i>									13
<i>Acacia blakei</i> subsp. <i>diphylla</i>							9		
<i>Acacia brunioides</i> subsp. <i>brunioides</i>									13
<i>Acacia brunioides</i> subsp. <i>granitica</i>	1								
<i>Acacia cangaiensis</i>				4					
<i>Acacia falciformis</i>	1	2		4				10	13
<i>Acacia filicifolia</i>	1	2		4		6			
<i>Acacia fimbriata</i>									O
<i>Acacia floribunda</i>				4		6		10	12
<i>Acacia hispidula</i>		2							
<i>Acacia irrorata</i>				4		6		10	12
<i>Acacia maidenii</i>									O
<i>Acacia melanoxylon</i>							8		
<i>Acacia mitchellii</i>	1	2							
<i>Acacia myrtifolia</i>				4					
<i>Acacia neriifolia</i>									O
<i>Acacia nova-anglica</i>									O
<i>Acacia obtusifolia</i>	1	2		4		6	8		13
<i>Acacia rubida</i>									O
<i>Acacia stricta</i>	1					6			
<i>Acacia suaveolens</i>	1	2							13
<i>Acacia terminalis</i>							8		
<i>Acacia torulosa</i>				4					
<i>Acacia ulicifolia</i>	1	2		4			8		13
<i>Acacia venulosa</i>	1	2				6			13
<i>Acacia viscidula</i>									13
<i>Aotus subglauca</i> var. <i>filiformis</i>									O
<i>Aotus subglauca</i> var. <i>subglauca</i>	1	2							
<i>Austrosteenisia blackii</i>								11	
<i>Austrosteenisia glabristyla</i>									O
<i>Bossiaea buxifolia</i>									O
<i>Bossiaea neo-anglica</i>	1	2		4			8		13
<i>Bossiaea prostrata</i>							8		





**Flacourtiaceae**

<i>Berberidopsis beckleri</i>									11	12
<i>Streptothamnus moorei</i>								10		

**Gentianaceae**

<i>Centaurium erythraea</i> *											O
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**Geraniaceae**

<i>Geranium neglectum</i>											O
<i>Geranium retrorsum</i>											O
<i>Geranium solanderi</i> var. <i>solanderi</i>			4		6		8				
<i>Pelargonium inodorum</i>											O

**Gesneriaceae**

<i>Fieldia australis</i>										12	
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**Gleicheniaceae**

<i>Gleichenia dicarpa</i>	1	2			5	6					
<i>Gleichenia microphylla</i>											O
<i>Gleichenia rupestris</i>											O
<i>Sticherus lobatus</i>				4		6			10		

**Goodeniaceae**

<i>Cooperhookia barbata</i>											
<i>Cooperhookia chisholmii</i>					4						
<i>Dampiera purpurea</i>	1	2			4			9	10		
<i>Dampiera stricta</i>	1	2	3	4	6		8				13
<i>Goodenia bellidifolia</i>	1	2	3	4	6		8				13
<i>Goodenia gracilis</i>											O
<i>Goodenia hederacea</i> subsp. <i>hederacea</i>				4				9			13
<i>Goodenia heterophylla</i> subsp. <i>eglandulosa</i>											
<i>Goodenia ovata</i>											O
<i>Goodenia rotundifolia</i>	1	2		4							
<i>Velleia spathulata</i>											

**Grammitaceae**

<i>Grammitis billardieri</i>											
<i>Grammitis stenophylla</i>						6					

**Haemodoraceae**

<i>Haemodorum planifolium</i>											13
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**Haloragaceae**

<i>Gonocarpus micranthus</i> subsp. <i>ramosissimus</i>			3		6						13
<i>Gonocarpus oreophilus</i>					6			10		12	13
<i>Gonocarpus tetragynus</i>	1	2		4			8				
<i>Gonocarpus teucrioides</i>	1	2		4	5	6	8				13
<i>Haloragis aspera</i>											O
<i>Haloragis heterophylla</i>											O
<i>Myriophyllum pedunculatum</i>						6					

**Hymenophyllaceae**

<i>Cephalomanes caudatum</i>											O
<i>Crepidomanes venosum</i>											O
<i>Hymenophyllum cupressiforme</i>											O
<i>Polyphlebium venosum</i>						6					

**Hypoxidaceae**

<i>Hypoxis hygrometrica</i>											O
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**Icacinaceae**

<i>Citronella moorei</i>										12	
<i>Pennantia cunninghamii</i>											O

**Iridaceae**

<i>Patersonia fragilis</i>						6					
<i>Patersonia glabrata</i>	1	2		4			8				13





<i>Myrsine richmondensis</i>										10	
<i>Myrsine variabilis</i>			4								
<b>Myrtaceae</b>											
<i>Acmena smithii</i>					7					12	
<i>Angophora subvelutina</i>											O
<i>Archirhodomyrtus beckleri</i>			4				9	10			
<i>Backhousia myrtifolia</i>											O
<i>Baeckea gunniana</i>											O
<i>Baeckea ommissa</i>	1		3		6						13
<i>Callistemon comboynensis</i>											13
<i>Callistemon linearis</i>											O
<i>Callistemon pallidus</i>	1	2			6						13
<i>Callistemon pityoides</i>											O
<i>Callistemon salignus</i>											O
<i>Callistemon sieberi</i>					6						
<i>Callistemon</i> sp. aff. <i>montanus</i>		2									
<i>Callistemon viminalis</i>					6						
<i>Calytrix tetragona</i>		2									13
<i>Corymbia citriodora</i> subsp. <i>variegata</i>											O
<i>Corymbia gummifera</i>			4				9				
<i>Corymbia intermedia</i>											O
<i>Eucalyptus acaciiformis</i>	1										13
<i>Eucalyptus acmenoides</i>							8				
<i>Eucalyptus biturbinata</i>							8	9			
<i>Eucalyptus brunnea</i>				4							
<i>Eucalyptus caliginosa</i>	1	2		4					10		
<i>Eucalyptus cameronii</i>	1	2		4			8				13
<i>Eucalyptus campanulata</i>		2		4	5		8		10	11	
<i>Eucalyptus carnea</i>							8	9	10		
<i>Eucalyptus codonocarpa</i>		2									13
<i>Eucalyptus crebra</i>											O
<i>Eucalyptus dalrympleana</i> subsp. <i>heptantha</i>	1										O
<i>Eucalyptus dissita</i>											O
<i>Eucalyptus fibrosa</i>							8				
<i>Eucalyptus laevopinea</i>											O
<i>Eucalyptus ligustrina</i>	1										13
<i>Eucalyptus microcorys</i>			4				8	9	10	11	12
<i>Eucalyptus notabilis</i>			4								13
<i>Eucalyptus obliqua</i>			4						10		12
<i>Eucalyptus olida</i>	1	2		4							
<i>Eucalyptus oreades</i>	1	2		4	5	6					
<i>Eucalyptus planchoniana</i>		2					8	9			
<i>Eucalyptus pyrocarpa</i>	1	2					8	9			
<i>Eucalyptus radiata</i> subsp. <i>sejuncta</i>	1										13
<i>Eucalyptus saligna</i>			4						10	11	12
<i>Eucalyptus siderophloia</i>											O
<i>Eucalyptus subcaerulea</i>								9			
<i>Eucalyptus tereticornis</i>											O
<i>Eucalyptus tindaliae</i>											O
<i>Eucalyptus williamsiana</i>	1	2									O
<i>Kunzea bracteolata</i>	1	2			5						13
<i>Kunzea ericoides</i>											O
<i>Kunzea opposita</i>											O
<i>Leptospermum arachnoides</i>	1		3								13
<i>Leptospermum brachyandrum</i>											13
<i>Leptospermum brevipes</i>											13
<i>Leptospermum microcarpum</i>	1										
<i>Leptospermum minutifolium</i>	1										13
<i>Leptospermum novae-angliae</i>	1				5						13





**Phytolaccaceae**

*Phytolacca octandra*\* 13

**Piperaceae**

*Piper novae-hollandiae* 10 11

**Pittosporaceae**

*Billardiera scandens* var. *scandens* 1 2 4 5 6 10  
*Bursaria spinosa* subsp. *obovata* 4 9  
*Hymenophyllum flavum* O  
*Pittosporum multiflorum* 11 12  
*Pittosporum revolutum* O  
*Pittosporum undulatum* 4 10 11  
*Rhytidosporum procumbens* 1 3

**Plantaginaceae**

*Plantago debilis* 4

**Poaceae**

*Amphipogon strictus* 3 13  
*Aristida queenslandica* 9  
*Aristida ramosa* 2 13  
*Aristida vagans* 4  
*Austrodanthonia bipartita* O  
*Austrodanthonia monticola* O  
*Austrodanthonia richardsonii* 13  
*Austrostipa bigeniculata* 13  
*Austrostipa pubescens* 1 2  
*Austrostipa ramosissima* O  
*Austrostipa rudis* subsp. *nervosa* O  
*Austrostipa scabra* 13  
*Austrostipa* sp. A. 1  
*Axonopus affinis*\* 3 6  
*Bothriochloa macra* O  
*Capillipedium parviflorum* O  
*Capillipedium spicigerum* 4 8  
*Cleistochloa rigida* 13  
*Cymbopogon refractus* 8 9  
*Deyeuxia mckiei* O  
*Deyeuxia parviseta* 9  
*Dichelachne micrantha* 8  
*Digitaria breviglumis* 13  
*Digitaria diffusa* O  
*Digitaria parviflora* 9  
*Echinopogon caespitosus* var. *caespitosus* 8  
*Enneapogon nigricans* O  
*Entolasia stricta* 1 2 3 4 5 6 8 9 10 13  
*Eragrostis brownii* 8 9  
*Eragrostis elongata* O  
*Eragrostis leptostachya* 2  
*Eragrostis tenuifolia*\* O  
*Imperata cylindrica* var. *major* 1 2 4 8 9  
*Joycea pallida* O  
*Lachnagrostis aemula* 10  
*Lachnagrostis filiformis* O  
*Microlaena stipoides* var. *stipoides* 2 4 8  
*Oplismenus aemulus* 4 7 8 9 10  
*Oplismenus imbecillis* 4 7 8 9 10 11  
*Panicum paludosum* 3  
*Panicum simile* 4 6 8 9 12  
*Paspalidium constrictum* 13  
*Pennisetum clandestinum*\* O









<i>Solanum campanulatum</i>			4			10			
<i>Solanum mauritanium*</i>			4						
<i>Solanum nemophilum</i>			4			10			
<i>Solanum neoanglicum</i>									O
<i>Solanum nobile</i>									O
<i>Solanum opacum</i>									O
<i>Solanum prinophyllum</i>									O
<i>Solanum pungetium</i>									O
<i>Solanum stelligerum</i>									O
<b>Stackhousiaceae</b>									
<i>Stackhousia viminea</i>	1		4			8			
<b>Sterculiaceae</b>									
<i>Brachychiton acerifolius</i>									O
<i>Keraudrenia corollata</i> var. <i>denticulata</i>									O
<i>Lasiopetalum ferrugineum</i> var. <i>cordatum</i>	2								
<i>Rulingia dasyphylla</i>									O
<i>Rulingia salviifolia</i>									O
<i>Seringia arborescens</i>									O
<b>Stylidiaceae</b>									
<i>Stylidium graminifolium</i>			4						
<i>Stylidium laricifolium</i>			4					13	
<b>Surianaceae</b>									
<i>Guilfoylia monostylis</i>									O
<b>Symplocaceae</b>									
<i>Symplocos stawellii</i>									O
<i>Symplocos thwaitesii</i>									O
<b>Thelypteridaceae</b>									
<i>Christella dentata</i>									O
<b>Thymelaeaceae</b>									
<i>Pimelea latifolia</i>									O
<i>Pimelea ligustrina</i>									O
<i>Pimelea linifolia</i>	1	2	4			9		13	
<i>Pimelea neo-anglica</i>									O
<b>Tremandraceae</b>									
<i>Tetratheca thymifolia</i>	1								
<b>Trimeniaceae</b>									
<i>Trimenia moorei</i>								11	
<b>Ulmaceae</b>									
<i>Aphananthe philippinensis</i>									O
<b>Urticaceae</b>									
<i>Dendrochlide excelsa</i>									O
<i>Dendrochlide photinophylla</i>									O
<i>Elatostema stipitatum</i>									O
<i>Urtica incisa</i>									O
<b>Verbenaceae</b>									
<i>Clerodendrum tomentosum</i>			4			8		10	
<i>Gmelina leichhardtii</i>								10	
<i>Lantana camara*</i>								10	
<i>Verbena rigida*</i>									O
<b>Violaceae</b>									
<i>Hybanthus enneaspermus</i>							9		
<i>Hybanthus monopetalus</i>			3	4					
<i>Hybanthus vernonii</i> subsp. <i>vernonii</i>									O
<i>Viola betonicifolia</i>	1		4		6	8			
<i>Viola hederacea</i>		2	4			8	10	12	

