Vegetation and floristics of Warra National Park and Wattleridge, Northern Tablelands, NSW

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Abstract: The vegetation of Warra National Park (29° 29' S, 151° 56' E; 2041 ha in area) and Wattleridge (29°31' S, 151°54' E; 648 ha in area), located approximately 35 km southeast of Glen Innes and 5 km west of Mount Mitchell, within the Guyra and Severn Shires in the New England Tablelands Bioregion NSW, is described. Nine vegetation communities are defined, based on flexible UPGMA analysis of cover-abundance scores of all vascular plant taxa. These communities have been mapped based on analysis of quadrat data, air photo interpretation, substrate variation and ground-truthing.


Of 11 communities within the area, four should be considered as threatened, while 18 taxa are considered to be of conservation significance.


Introduction

Warra National Park (29°29'S, 151°56'E) and the nearby Wattleridge freehold property managed under an Aboriginal trust (29°31'S, 151°54'E) are located within the Northern Tablelands Botanical Division, 35 km southeast of Glen Innes, just north of the township of Backwater. Wattleridge and parts of Warra NP south of the Sara River are within the Guyra Shire. Most of Warra NP however, is within the Severn Shire whose boundaries extend to the northern banks of the Sara River. Warra NP covers 2041 ha, most of which was the former Warra State Forest (including Crown Mountain Flora Reserve) and a small Vacant Crown Land holding on the southern side of the Sara River. The Park is bounded on three sides by private freehold land and on the north side by State Forest. A national park within the Backwater area was originally proposed in 1985 by John Benson. Quinn et al (1995) highlighted the importance of this area as a hotspot for endemics and rare and threatened species, and recommended land acquisition for reservation. Further proposals were supported by Richards (1996) and Morgan and Terrey (1999) and Warra NP was gazetted in 1999.

Wattleridge property (648 ha) approximately 2 km southwest of Warra NP, and supporting a large area of natural vegetation, was purchased by the Indigenous Land Corporation on behalf of the Banbai Traditional Owners in 1998. Wattleridge was formally listed as the first Indigenous Protected Area in 2001; this process included entering into a Voluntary Conservation Agreement.

This paper is based on a flora survey of Warra National Park for the NSW National Parks Service, and Wattleridge for the Banbai Business Enterprises Inc., to provide information for developing appropriate management strategies (Hunter 2001; Hunter 2003d).

Climate

The region receives cold westerly or southwesterly winds in winter, and rain-bearing easterly winds, and cyclonic depressions and thunderstorms in late spring and summer (RACAC 1996). Cold fronts with rain and snow often peak in June. Average yearly rainfall is between 890–970 mm in Warra National Park Areas of high elevation such as Crown
and Nightcap Mountains receive higher rainfall due to fog and cloud cover. At Guyra the average maximum summer temperature in January is 24°C, and the average minimum temperature in July is 0°C. An average of 20 frosts occur annually. Cold air drainage and increased likelihood of frosts occur in river valleys.

**Landform**

Warra National Park and Wattleridge are part of the upper catchment of the Sara River which later joins the Guy Fawkes River. The Sara River runs along the northern boundary of Wattleridge and forms the southern boundary of Warra NP (Fig. 1). Creeks flowing north and northeast out of Warra NP are upper catchment tributaries of the Henry River which flows through to the northern sections of the Guy Fawkes River (Fig. 1).

Much of Warra NP is on a high central plateau dominated by Nightcap Mountain in the north at 1372 m and Crown Mountain to the south at 1360 m. Most of the topography is gentle and undulating. Much of the central plateau area is dominated by extensive areas of exposed sheet granite, interspersed with swampy areas. A steep fall occurs on the southern flanks of Crown Mountain, dropping almost 300 m in a kilometre; the northern slopes of the central plateau fall more gradually. The southern flanks of Crown Mountain and Nightcap Mountain are often boulder strewn. The lowest point is in the southeast, around 980 m altitude.

Wattleridge has very similar landscape features to Warra. It is also dominated by a high ridge which runs along the eastern boundary and then extends west following the Sara River. Much of this high ridge is of sheet granite, or is strewn with large boulders. Flatter areas, which have been selectively cleared, run along the western and southern boundaries. Altitude within Wattleridge ranges from 1160 m to 1340 m.

**Geology**

Warra NP is situated within the Central Block (Gilligan & Brownlow 1987) of the southern New England Orogen, west of the Dyamberin Block and the N-S trending Wongwibinda and Demon Faults. There is only one rock type within its boundaries — the Oban River Leucomonzogranite, an I-type leucocratic granite. This unit is comprised of very coarse-grained, leucocratic, equigranular, biotite granite with phases of fine to very fine-grained saccharoidal, pink, equigranular microleucogranite, the finer grained microleucogranite forming a carapace overlying the coarser grained rock (Gilligan et al. 1992).

**Landuse and fire history**

Mining occurred throughout the region and was particularly prevalent within the Backwater area and especially along the Sara River and its tributaries. Much of the mining was alluvial for tin. Even today sapphires are still worked in the area.

Wildfires are a common feature of this area. High intensity wildfires burnt most of Warra NP in 1988, 1994 and 2001 though Wattleridge was not burnt by these fires. When Warra was managed by NSW State Forests, prescribed fire intervals were 3–5 years for plateau areas, 4–7 years for gorge country and more than 10 years for wetter areas at higher altitudes, though how diligently these regimes were adhered to, is not known. Grazing permits existed within Warra at various times while under State Forest management, and though most leases were only lightly grazed, burning to create ‘green pick’ for cattle, was an integral part of grazing practice.

On much of the better grazing areas, on the more open and less rugged plateau areas, leaseholders probably kept low intensity fire frequency close to every three years.

Wattleridge has always been under private ownership and has been used as a grazing property with sheep, cattle and goats, up to the present. For much of the last 20 years the property has been dually managed as a working grazing property and farmstay. A majority of the property is uncleared, and due to its rugged nature, many areas were not, or at least little, grazed. These uncleared natural areas have been managed informally for conservation for the last thirty years as an attraction for ecotourists, and now more formally as an Indigenous Protected Area.

**Previous investigations**

In the 1920s and 1930s, the Reverend E.N. McKie, a schoolteacher at Backwater, investigated the flora of the region and a significant number of new species were described (usually in conjunction with W.F. Blakely, a botanist at the National Herbarium of NSW) based on his collections, particularly from areas such as Mushroom Rock (Pheasant Mountain), on the boundary of Wattleridge. Investigations into the flora were continued by John Williams of the...

Targeted surveys for rare and threatened plants species have also been conducted within Warra NP. Quinn et al. (1995) surveyed for threatened species as did Richards (1996). Hunter (1996) also conducted surveys and produced a draft recovery plan for the threatened species within the Backwater area.

Methods

Existing information was compiled from previous surveys of the two areas including: Williams (1991), Binns (1992), Hunter (1992), Hunter (1996), Richards (1996), Hunter (1999), Hunter (2001) and Hunter (2003d). Records from Hunter (1999) were taken from surveys of granite outcrops only and were of a nested plot design and an area of 33 × 33 m (see Hunter & Clarke 1998), those of Hunter (1992) were of 120 m × 10 m belt transects, while all other sites were surveyed using the Braun-Blanquet (1982) six point cover abundance scale within a 20 × 50 m plot. An additional 50, 20 × 20 m, sites were recorded in Warra NP over 5 days in January of 2001 (Hunter 2001). A further 15, 20 × 20 m, sites were recorded within Wattleridge over 2 days in August 2003 (Hunter 2003) to assess and align vegetation assemblages with those already described for Warra NP by Hunter (2001). In total, data from 157 sites, each 20 × 20 m, 20 × 50 m or 33 × 33 m, were collated along with existing information from all other previous investigations in the region.

This paper presents a summary of all the investigations carried out for these two areas. As the aims and methods of the many of the previous investigations varied greatly only one subset of information was used to formally describe the vegetated systems within the two study areas. The fifty sites from Hunter (2001) are the only ones used in the analysis presented here. These fifty sites were placed using a stratified random method within Warra NP; strata included altitude and physiography. The communities defined from this analysis were extrapolated based on the additional information from the 107 other sites to all areas under investigation. Rock outcrops sites were not part of the stratification of Hunter (2001) as these areas were deemed to have been sufficiently described by Hunter (1999); thus although outcrop communities are mapped and described here, they are based on the work of Hunter & Clarke (1998). In addition to surveying outcrop vegetation, Hunter (1999) placed some sites within the surrounding matrix, and analysed their relationships with communities in the nearby matrix (Hunter 2002c).

Good quality specimens were retained as vouchers by the New England Tablelands Region, National Parks and Wildlife Service, and by the NCW Beadle Herbarium of the University of New England (NE). Nomenclature follows that of Harden (1993–2002) except where recent changes have been made.

Analysis and data exploration were performed using options available in the PATN Analysis Package (Belbin 1995a, b). For final presentation of results all species (including exotics) and their cover abundance scores were used. Analysis was performed using 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.

Delineation of community boundaries was based on the location of sites and their position within the multivariate analysis, air photograph interpretation, substrate and ground truthing. The vegetation maps are based on a 1:25 000 scale. Structural names follow Specht et al. (1995) and are based on the most consistent uppermost stratum.

Results

Vegetation communities

The vegetation communities described for Warra NP and Wattleridge are broadly similar to many communities found throughout the central parts of the Northern Tablelands from Ebor to the Queensland border (Binns 1992; Hunter & Clarke 1998; Hunter & Alexander 1999; Hunter et al. 1999; Benwell 2000; Hunter 2000b; Hunter & Sheringham 2002; Hunter 2004b; Hunter 2004d). Most communities are of a woodland or forest structure, and these may have one or two shrub layers, or be primarily grassy. Heaths occur on rock outcrops, and in areas of impeded drainage where Sphagnum may be present.

From the analyses, nine vegetation communities are recognized at the dissimilarity measure of 0.8 in the dendrogram (Fig. 2) which shows three major groups: Communities 1–4 are primarily in waterlogged or periodically waterlogged areas; Communities 5–6 are woodlands to forest with a very shrubby understorey; and Communities 7–9 are primarily taller forests with a grassy understorey.
Within the following summary descriptions extreme values are given in brackets. Exotic species are not listed below but are included within Appendix 1. In all 549 taxa were found from 94 families and 290 genera, of which 495 taxa were recorded in Warra NP and 480 were recorded at Wattleridge. Species from each layer are listed in order of decreasing importance (cover \( \times \) frequency). The number of hectares given is based only on what is formally reserved within Warra NP.

**Community 1:** *Leptospermum novae-angliae* (New England Tea-tree) — *Bursaria spinosa* (Blackthorn) — *Callitris oblonga* (Tasmanian Cypress)

**Distribution:** on skeletal soil on exposed granite rocks associated with river banks, with loamy sand and grey-brown soils. This community occurs in both study areas, where it is restricted to the rockier parts of the Sara River.

**Structure:** riparian scrub and heath, sometimes a low open woodland. Tree layer: 10–15 m tall; 10–15% cover. Tall shrub layer sometimes absent: 8–12 m tall; c. 20%. Low shrub layer: 1–3 m tall; 40–60% cover. Herb layer: > 1 m tall; c. 30% (Fig. 5).
Fig. 3. Map of vegetation communities at Warra National Park.

Fig. 4. Map of vegetation communities at Wattleridge.
Trees: Eucalyptus dalrympleana subsp. heptantha, Eucalyptus caliginosa.

Shrubs: Leptospermum nova-angliae, Bursaria spinosa, Acacia fimbriata, Callitris oblonga subsp. parva, Pomaderris nitidula, Logania albiflora, Leptospermum polygalifolium subsp. transmontanum, Leptospermum brevipes, Leucopogon biflorus, Kunzea obovata, Correa reflexa, Brachylyoma saxicola.

Climbers & trailers: Rubus parviflorus, Persicaria hydropiper.


Variability: by its nature this community has a large edge to area ratio, and even common dominants may be absent due to the variability in substrate and depth of soil and flooding events, thus giving a variable structure. The riverbanks include extensive sheet granite and boulder strewn areas and many species are shared with community 10 where exposed granite platforms are larger and less exposed to riparian influences. Where alluvium is deeper and drainage is impeded, similarities with community 4 are apparent.

Notes: the floristics are probably reliant on a constant cycle of disturbance by flooding and fire. Benson and Ashby (2000) consider this community type to be endangered locally and at least vulnerable within NSW. They also consider the community to be poorly conserved locally. Based on published floristic analyses this community type does not appear to be represented in other reserves and no synonymous assemblages are described. Hence, it is likely that this grouping of taxa is unique to the Tablelands. [6 sites; 15 ha].

Community 2: Eucalyptus pauciflora (Snow Gum) — Eucalyptus nova-anglica (New England Peppermint)

Distribution: found primarily on lower slopes and open depressions with moist soils. Soils are primarily loamy sand, but also sandy, grey to yellow brown, shallow or deep.

Structure: woodlands. Tree layer: 15–20 m tall; 20–30% cover. Tall shrub layer sometimes absent: 2–6 m tall; 10–20% cover. Low shrub layer: 1–2 m tall; 20–60% cover. Herb layer: < 1 m tall; 50–80% cover (Fig. 6).

Trees: Eucalyptus pauciflora, Banksia integrifolia, Eucalyptus nova-anglica, Eucalyptus dalrympleana subsp. heptantha, Eucalyptus viminalis, Eucalyptus camphora, Eucalyptus caliginosa.

Shrubs: Persoonia procumbens, Leptospermum polygalifolium subsp. transmontanum, Aotus subglauca var. subglauca, Grevillea scortechinii var. var. sarmentosa, Brachylyoma daphnoides subsp. glabrum, Monotoca scoparia, Melichrus procumbens, Dillywnia retorta, Bursaria spinosa, Mirbelia confertiflora, Hovea heterophylla, Dillywnia sieberi, Bossiaea neo-anglica, Petrophile canescens, Logania albiflora, Hibbertia riparia, Grevillea juniperina subsp. alalobonsonii, Dodonaea viscosa, Choretrum pauciflorum, Bossiaea scortechinii, Baeckea omissa.

Climbers & trailers: Glycine tabacina, Rubus parviflorus, Glycine clandestina.


Variability: the height and cover of the tree layer is variable and probably dependent on how exposed the site is to frost. Some localities have an open tree layer that is short to 15 m tall and dominated mainly by Eucalyptus pauciflora and Eucalyptus nova-anglica, however in less exposed situations, particularly if slightly elevated, Eucalyptus caliginosa may become more prominent with an increase in height and density of the trees. This community intergrades with communities 4 and 6, as drainage becomes more impeded, or Community 7 where sites are more elevated.

Notes: this community is associated with low-lying areas, affected by frosts at higher altitudes. Within the study areas it is found associated with low lying sites adjacent to the Sara River, and also in open frost hollows in broader gullies. Broadly similar associations may occur as far north as the Queensland border and as far south as New England and Coolah Tops National Parks. However, communities most closely allied to this assemblage are probably restricted to sporadic localities in the Guyra area, and potentially as far north as Butterleaf and as far south as Cathedral Rock National Park. Benson and Ashby (2000) considered this assemblage to be one of the most endangered communities both within the local area and within NSW. [7 sites; 100 ha].

Community 3: Haloragis heterophylla (Variable Raspwort) — Carex inversa (Sedge)

Distribution: previously cleared land on a lower slope associated with the Sara River.

Structure: herbfield. Herb layer: < 50 cm tall; 100% cover (Fig. 7).

Trees: none apparent.

Shrubs: none apparent.

Climbers & trailers: Rubus parviflorus.


Variability: an assemblage that has only been sampled by one quadrat, hence no variability noted.
Community 4: *Baeckea omissa* (Baeckea) — *Leptospermum gregarium* (Swamp Tea-tree)

**Distribution:** patchily distributed in open or closed depressions associated with areas of impeded drainage along creeks. Soils are damp to waterlogged, usually loamy sand, but also loam to clay, grey-brown to black and deep.

**Structure:** mainly heaths, but also low open woodlands and mallee. Tree layer sometimes absent: (3–) 8–15 (–30) m tall; 10–30% cover. Tall shrub layer often absent: 2–6 m tall; c. 30% cover. Low shrub layer usually absent: 1–2 m tall; 30–80% cover. Herb layer: < 1 m tall; 40–100% cover (Fig. 8).

**Trees:** *Eucalyptus camphora* subsp. *relicta*, *Eucalyptus pauciflora*, *Eucalyptus dallympleana* subsp. *heptantha*, *Banksia integrifolia*, *Eucalyptus acaciiformis*, *Eucalyptus nova-anglica*, *Eucalyptus caliginosa*, *Eucalyptus nobilis*.

**Shrubs:** *Baeckea omissa*, *Leptospermum gregarium*, *Epacris microphylla*, *Callistemon ptyoides*, *Banksia cunninghamii*, *Hakea microcarpa*, *Lomatia fraseri*, *Callistemon pallidus*, *Hakea eriantha*, *Scaevola ramosissima*, *Pimelea linifolia*, *Hibbertia riparia*, *Aotus subglauca* var. *subglauca*, *Petrophile canescens*, *Monotoca scoparia*, *Acacia filicifolia*.

**Climbers & trailers:** *Rubus parvifolius*, *Glycine sp. A*, *Glycine clandestina*.


**Variability:** such assemblages are usually isolated, small and generally of limited distribution, and many associated species are variable in their presence. Often zonation occurs into grass and cyperoid-dominated areas, along with situations with a strong shrub component. Such internal variability is due to depth and duration of waterlogging. In a very few localities *Sphagnum* bogs have developed.

**Notes:** few completely comparable examples of this assemblage can be found within the literature. Similar associations are restricted to higher altitudes on the Tablelands particularly along the eastern margin of the Great Divide. Communities such as these are usually highly divergent across relatively small distances, and as such most occurrences are unique. Benson and Ashby (2000) considered this type of assemblage to be poorly-conserved locally, but moderately conserved within NSW. Similar small isolated occurrences are likely to within most reserves on the escarpment and associated Tablelands areas from the Queensland border to Barrington and Coolah Tops. Broadly similar assemblages are known to be reserved within Gibraltar Range NP, New England NP, Basket Swamp NP, Boonoo Boonoo NP, Bald Rock NP, Girraween NP, Demon NR, Cathedral Rocks NP, Mann River NP, Coolah Tops NP, western Washpool Western NP, Werrikimbe NP, Capoompeta NP and Butterfly NP (Hunter et al. 1999; Hunter 2000b; Whinam & Chilcott 2002; Hunter 2004bc; Hunter 2005). Despite the above, areas which include *Sphagnum* should be considered endangered on the Tablelands as only a few occurrences survive in good condition. It is likely that only a few hectares of these bogs occur across the whole Tablelands (Whinam & Chilcott 2002). [8 sites; 69 ha].

Community 5: *Eucalyptus cameronii* (Diehard Stringybark) — *Eucalyptus caliginosa* (Broad-leaved Stringybark) — *Eucalyptus campanulata* (Eastern New England Blackbutt)

**Distribution:** within Warra NP this community is restricted to Nightcap Mountain in the northeastern corner, and in the upper reaches of Comptons Gully. It is more widespread within *Wattleridge* where it is found in a variety of landscape situations, from upper slopes to open depressions and lower slopes. Soils are usually well drained but can be damp to moist and usually shallow. Soils texture and colour are generally loamy sand and dark-brown, or yellow-brown to black.

**Structure:** open forests. Tree layer: 20–30 m tall; 30–35% cover. Low shrub layer: 1–2 m tall; 30–80% cover. Herb layer: < 1 m tall; 60–80% cover (Fig. 9).

**Trees:** *Eucalyptus cameronii*, *Eucalyptus caliginosa*, *Eucalyptus campanulata*, *Eucalyptus radiata* subsp. *sejuncta*.

**Shrubs:** *Dilbynia phyllicoides*, *Lomatia silaifolia*, *Bassonia neospinosa*, *Banksia cunninghamii*, *Monotoca scoparia*, *Leucopogon lanceolatus*, *Hovea pedunculata*, *Hibbertia* sp. aff. *obtusifolia*.
Pomaderris lanigera, Acacia ulicifolia, Acacia myrtifolia, Pultenaea linophylla, Platyctene lanceolata, Hakea eriantha, Acacia mitchellii, Petrophile canescens, Melichrus procumbens, Grevillea scortechini, Boronia algida, Acacia baixifolia, Prostanthera scutellarioides, Polycias sambucifolia, Pimelea linifolia, Maytenus silvestris, Dodonaea triquetra, Bossiaea scortechini.

Climbers & trailers: Billardiera scandens, Smilax australis, Hardenbergia violacea.


Variability: the structure of this community is constant, despite the often changing understory floristics. These understory changes are probably due to past fires with varying intensities, promoting some species over others. It is likely that, with a longer absence of fire, the understory will become denser and taller and form a thick almost impenetrable layer.

Notes: no truly comparable assemblages were found within the literature. Broadly though, it is synonymous with a number of assemblages along the eastern escarpment on coarse granitic soils from Cathedral Rock NP to the Queensland border. This assemblage intergrades with Community 2 where drainage is better, which is not surprising, as this community occurs on sandier soils it usually boasts a dense heathy understorey, as in Warra NP, but as soils become heavier the heath is replaced by herbs and grasses, as at Wattleridge.

Notes: this community often occurs in areas that may be periodically inundated. Beadle (1981) states that Eucalyptus radiata is commonly associated with Eucalyptus acaciiformis where rainfall is generally greater than 1000 mm annually, and where soils are of low fertility and especially where drainage is impeded. It is therefore likely that this assemblage is restricted to low-lying areas with impeded drainage, but not areas that are waterlogged. This community naturally intergrades with Community 4 where waterlogging is more prolonged, and with Community 2 where drainage is better, which is not surprising, as Eucalyptus pauciflora replaces Eucalyptus acaciiformis where soils are less prone to waterlogging. Some intergradations occur with Community 5 which commonly borders this assemblage. Benson and Ashby (2000) consider this community to be vulnerable and poorly conserved across both locally and across NSW.
Community 7: *Eucalyptus cameronii* (Diehard Stringybark) — *Eucalyptus caliginosa* (Broad-leaved Stringybark)

**Distribution:** sampled primarily from lower slopes, but also on middle to upper slopes. Soils are well-drained to moist, loamy sand to sandy loam, predominantly grey-brown in colour but also yellow-brown, light-brown to dark-brown with a variable depth.

**Structure:** mainly woodlands to open forests, occasionally tall open forests. Tree layer: 20–40 m tall; 30–40% cover. Tall shrub layer sometimes absent: (3–) 4–8 (–15) m tall; (10–) 20–40 (–70)% cover. Low shrub layer usually not present: 1–2 m tall; (10–) 20–60% cover. Herb layer: < 1 m tall; 60–90% cover (Fig. 11).

**Trees:** *Eucalyptus cameronii*, *Eucalyptus caliginosa*, *Banksia integrifolia*, *Allocasuarina littoralis*, *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus nobilis*, *Eucalyptus nova-anglica*, *Eucalyptus pauciﬂora*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Eucalyptus viminalis*, *Eucalyptus obliqua*, *Eucalyptus stellulata*.


**Climbers & trailers:** *Desmodium varians*, *Billardiera scandens*, *Hardenbergia violacea*, *Rubus parvifolius*, *Glycine sp. A*, *Glycine clandestina*, *Eustrephus latifolius*.


**Variability:** this is the most widespread community within the study area. A small and taller shrub layer are normally present, however, either may be missing and usually this is the lower shrub layer. This variability may in a large part by due to differences in fire regimes, both frequency and intensity. In some locations where only the upper shrub layer is present, it is rather sparse, and a dense layer of grasses may be prominent (particularly *Imperata cylindrica*).

**Notes:** this community occurs on more exposed sites than Community 8 with which it often intergrades. This assemblage also intergrades with the ‘heathier’ communities such as community 5 and 6. It is probably largely restricted to the Backwater area, however similar assemblages occur from as far south as New England NP to the Washpool Western Additions NP. [20 sites; 1058 ha].

Community 8: *Eucalyptus nobilis* (Manna Gum) — *Eucalyptus obliqua* (Messmate)

**Distribution:** usually on steeper slopes or in protected locations. Sampled on upper to lower slopes, primarily facing south or in protected localities. Floating boulders are common. Soils are generally moist to well drained, loamy sand, brown to dark-brown or grey, and shallow.

**Structure:** mainly open forest, but also tall open forest and occasionally woodland. Tree layer: (20–) 25–40 m tall; (20–) 30–40% cover. Tall shrub layer often absent: (3–) 5–12 m tall; (10–) 20–40% cover. Low shrub layer rarely present: 1–6 m tall; (10–) 20–60 (~90%) cover. Herb layer: < 1 m tall; 60–100% cover (Fig. 12).

**Trees:** *Eucalyptus caliginosa*, *Banksia integrifolia*, *Eucalyptus nobilis*, *Eucalyptus obliqua*, *Eucalyptus cameronii*, *Eucalyptus radiata*, *Allocasuarina littoralis*, *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus eugenioides*, *Eucalyptus integrifolia*, *Eucalyptus stellulata*, *Eucalyptus cameronii*.

**Shrubs:** *Acacia filicifolia*, *Leucopogon lanceolatus*, *Bursaria spinosa*, *Lomatia silaifolia*, *Indigofera australis*, *Solanum campanulatum*, *Monotoca scoparia*, *Bossiaea neo-anglica*.

**Climbers & trailers:** *Rubus parvifolius*, *Desmodium varians*, *Billardiera scandens*, *Hardenbergia violacea*, *Rubus parvifolius*, *Glycine clandestina*, *Billardiera scandens*, *Hardenbergia violacea*, *Eustrephus latifolius*.


**Variability:** this is the most widespread community within the study area. A small and taller shrub layer are normally present, however, either may be missing and usually this is the lower shrub layer. This variability may in a large part by due to differences in fire regimes, both frequency and intensity. In some locations where only the upper shrub layer is present, it is rather sparse, and a dense layer of grasses may be prominent (particularly *Imperata cylindrica*).

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**Fig. 11.** Community 7: *Eucalyptus cameronii* – *Eucalyptus caliginosa* grassy open forest and woodland.

**Fig. 12.** Community 8: *Eucalyptus nobilis* – *Eucalyptus obliqua* open forest.

Variability: tree height can be dramatically variable forming low open forests to tall open forests. Shrubs are not a prominent component and a shrub layer is not always present. This may in part be due to variation in fire frequency and intensity, particularly in relation to the germination of cohorts of Acacia.

Notes: this community is the second most common assemblage within the study area. Similar assemblages occur in comparable situations in high altitude areas of Capoornpeta and western Washpool NPs (Hunter 2000b; Hunter 2005), in high altitude areas around Scott Trig in Butterleaf NP (Binns, 1992). Similar assemblages are sporadically distributed at high altitudes (1000–1400 m) between Guyla and Tenterfield, though broadly similar communities are also described for the Barrington Tops and New England NPs (Binns 1995; Clarke et al. 2000). Intergradation occurs with community 7 and the similar community 9. [15 sites; 705 ha].

Community 9: Eucalyptus obliqua (Messmate) — Eucalyptus nobilis (Manna Gum)

Distribution: only known from very protected sites in upper catchments around Crown and Nightcap Mountains. The soils are damp, loamy, dark brown and often shallow with many floating boulders.

Structure: tall open forest. Tree layer: 35–40 m tall; c. 30% cover. Tall shrub layer: 4–10 m tall; 20–30% cover. Low shrub layer not always present: 2–3 m tall; c. 20% cover. Understorey layer: < 1 m tall; c. 90% cover (Fig. 13).

Trees: Eucalyptus obliqua, Eucalyptus nobilis, Eucalyptus cameronii, Eucalyptus radiata subsp. sequjunct, Eucalyptus campanulata.

Shrubs: Coprosma quadrifida, Notelaea sp. A, Lomatia silaflolia, Solanum elegans, Solanum denseveistum, Rapanea variabilis, Acacia melanoxylon, Solanum campanulatum, Notelaea longifolia, Correa reflexa.

Climbers & trailers: Desmodium varians, Clematis aristata, Glycine clandestina, Geitonoplesium cymosum, Eustrephus laxifolius, Rubus parvifolius, Smilax australis.


Fig. 13. Community 9: Eucalyptus obliqua — Eucalyptus nobilis tall open forest with a mesic understorey.

Variability: this community has many closed forest elements and their abundance and dominance vary according to time since the last fire incursion.

Notes: no directly comparable communities were found in the literature, however similar assemblages were described for the Washpool NP Western Additions. It is likely that under more favourable conditions, particularly a reduced fire regime, a mixed closed forest stand may develop in these localities. Intergradation occurs with community 8, or at times with community 7. [2 sites; 6 ha].

Community 10: Leptospermum novae-angliae (New England Tea-tree) — Kunzea obovata (Burgan) — Brachyloma saxicola (New England Daphne Heath)

Caveat: this community description is based on the work of Hunter (1999) presented in Hunter & Clarke (1998) and was not incorporated in the analyses of the other nine communities described here. Hunter (1999; 2002c) demonstrated by analysis that this assemblage was different from the other assemblages within the area.

Distribution: restricted to exposed granitic outcrops scattered throughout both study areas and particularly well-developed on extensive granite sheets between Crown and Nightcap Mountains.

Fig. 14. Community 10: Leptospermum novae-angliae — Kunzea obovata — Brachyloma saxicola open scrub and heath, overtopped here by the mallee Eucalyptus codonocarpa.
Structure: structurally they are 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 caliginosa, Eucalyptus acaciiformis and Eucalyptus cameronii, giving a shrubby low open woodland structure. In some instances Leptospermum novae-angliae at its tallest and densest will form closed scrub (Fig. 14).

Trees: Eucalyptus codonocarpa, Eucalyptus caliginosa, Eucalyptus acaciiformis, Eucalyptus cameronii, Eucalyptus campanulata.

Shrubs: Leptospermum novae-angliae, Kunzea obovata, Leucopogon neoanglicus, Allocasuarina rigida subsp. rigida, Brachyloma saxicola, Mirbelia confertiflora, Calytrix tetragona, Prostanthera scutellarioides, Hovea pedunculata, Boronia ammonifolia var. variabilis, Acacia venulosa, Acacia ulicina, Hibbertia acicularis, Leucopogon microphyllus, Acacia falciformis, Dodonaea viscosa, Zieria cytosoides, Dillwynia phylloclada, Hakea laevipes subsp. graniticola, Persoonia cornifolia, Monotoca scoparia, Acacia viscidula.

Climbers & trailers: Muehlenbeckia costata, Billardiera scandens.

Ground cover: Lepidosperma gunnii, Gonocarpus teucrioides, Entolasia stricta, Platysace lanceolata, Schoenus apogon, Brachycome stuartii, Lomandra longifolia, Monotaxis macrophylla, Gonocarpus micranthus, Gahnia sieberiana, Actinotus sieberi, Austrodanthonia monticola, Thelionema caespitosum, Cheilanthes sieberi, Stypandra micranthus, Gahnia sieberiana, Actinotus gibbonsii, Austrodanthonia cornifolia, Monotoca scoparia, Acacia viscidula.

Variability: highly stochastic. The small population sizes and the harsh environment afforded by rock outcrop habitats, necessarily means that even adjacent occurrences are likely to contain very different species assemblages (Hunter 2000a; Hunter 2002c; Hunter 2003bc; Hunter 2004a). Although a few species may be dominant in most situations, they may be inexplicably 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).

Notes: this element is restricted to high altitude areas north and south-east of Glen Innes. The community described here is Element 1 as given by Hunter & Clarke (1999) in their synopsis of the New England granitic outcrop communities. This element is further divided into three communities by Hunter & Clarke (1999) all of which occur in Warra NP and Wattleridge. This community type is also reserved at Butterleaf NP, and could be considered sufficiently reserved, but due to the stochasticity in floristics and small population sizes, further inclusions of this assemblage are important. Hunter (2000a; 2002c; 2003c) has shown that because of the nature of naturally fragmented ecosystems, any addition to the reserve network would significantly increase species richness and resilience of this assemblage. [39 sites; 129 ha].

Discussion

Warra NP and Wattleridge share a very similar composition of species and communities. Warra NP in general had a greater number of communities and species but this is not surprising as it is more than twice the size of Wattleridge. Within the 2689 ha investigated, 549 vascular plant taxa were found. Though this would likely increase with opportunistic sightings, the number found is high, especially considering that only around 8% of taxa were non-natives. The site richness (41 species per 0.04 ha) is similar to that recorded by Benson and Ashby (2000) in the same area.

Phytogeography

Floristic similarity is greatest overall with the floras further south, rather than those north or to the west. This is not surprising considering the number of species that appear to be disjunctions from taxa further south (e.g. Acacia mitchellii) or are taxa derived from species now occurring in more southern localities (e.g. Eucalyptus camphora subsp. relicta). Most communities showed affinities with others that are typical of those found along the higher parts of the eastern escarpment from Ebor to east of Tenterfield.

Although communities dominated by Eucalyptus obliqua and Eucalyptus nobilis (community 7 & 8) occur throughout the eastern side of the New England Tableland, the prominence of Eucalyptus nobilis drops considerably further north and is replaced generally by Eucalyptus brunnnea. Communities similar to that of 7 and 8 are probably near their northern limits within the study area but are well developed locally.

The heathy/sedgelands (community 4) found within Warra are typical of those found at higher altitudes to the east. Whinam and Chilcott (2002) showed that the Sphagnum bogs at Warra NP were floristically grouped with others restricted to the eastern parts of the Northern Tablelands at altitudes above 1050 m. Though Whinam and Chilcott (2002) did not sample them, Sphagnum bogs do occur as far north as the Queensland border, such as at Demon NR (Hunter et al. 1999) and Basket Swamp NP (Hunter 2004b). However, those of Warra NP are the most northerly of those that have developed very deep and distinctive hummock and hollow systems, and are of great regional importance.

Conservation issues

Approximately 60% of the woody vegetation in the New England Bioregion has been cleared (Benson 1999) and within the local area more than 70% has probably been cleared (Benson & Ashby 2001).

Two communities identified by Benson and Ashby (2001) as endangered locally, and endangered or vulnerable within NSW, occur within Warra NP. These are the Leptospermum novae-angliae – Bursaria spinosa, and the Eucalyptus pauciflora – Eucalyptus nova-anglica communities. The Eucalyptus radiata – Eucalyptus acaciiformis community was considered to be vulnerable, locally and within NSW (Benson & Ashby 2001). Additionally it is suggested that Eucalyptus obliqua – Eucalyptus nobilis is vulnerable, at least locally, and that the Sphagnum component of the Baeckea omissa – Leptospermum gregarium community should be considered endangered. Thus, of eleven communities within Warra, four should be considered as threatened.

There are 18 taxa considered of conservation significance due to their occurrence on state and federal lists. Five species occur on the NSW Threatened Species Conservation Act 1995, one on the Federal Environment Protection and Biodiversity Conservation Act and 17 on RoTAP (Briggs & Leigh 1996).
The larger rock outcrops, and more significantly the Sara River Falls (on the south-eastern boundary of Warra NP) were the most significant sites in terms of rare or threatened species occurrences. The Sara River Falls had the highest concentration of significant species in a 10 ha area, many of which were not found anywhere else in the area. Rare or threatened species found within Warra NP and/or Wattleridge are:

*Acacia brunioides* subsp. *brunioides* (3RC-) is known from the Backwater area north to the McPherson Range near Toowoomba. This species has been recorded from Gibraltar Range NP, Mann River NR, Mt Barney NP, Mount French NP, Mt Greville NP and Nymboida NP. It was found in low numbers around the Sara River Falls within Warra NP.

*Brachyloma saxicola* (3RCa) (Hunter & Williams 1994; Richards & Hunter 1997) is known from Chaelundi north to Torrington. It is reserved within Guy Fawkes River NP, Bolivia Hill NR, Torrington SRA, Butterleaf NP, Gibraltar Range NP, Nymboida NP and Cathedral Rocks NP. This species is very abundant within both Warra NP and Wattleridge. The type location for the species is from Wattleridge.

*Brasenia schreberi* (3RC-) is known from a sporadic distribution throughout eastern Australia and also Africa, Asia and America. It is reserved within the nearby Llangotholin Lagoon NR and Crowdy Bay NP. Within Warra it was found only near the Sara River Falls.

*Callitris oblonga* subsp. *parva* (3VCa; Schedule 2, Vulnerable, *TSC Act*) is known from the Mooraback area of Werrikimbe NP to Boonoo Boonoo NP. It is reserved within Werrikimbe NP, Basket Swamp NP and Boonoo Boonoo NP. Within the study areas this species was restricted to the banks of the Sara River where about 300 individuals are known, 50 of which are within Warra NP near the Sara River Falls.

*Chiloglottis sphyrnoides* (3RCa) (Copeland & Hunter 1999) is an orchid known from Barrington Tops NP in the south to just over the Queensland border. It is reserved within Werrikimbe NP, Guy Fawkes River NP, Barool NP, Gibraltar Range NP, New England NP, Capoompeta NP, Mann River NR, Western Washpool NP and Lamington NP. The species was found opportunistically within Warra NP in moist forest.

*Cryptandra lanosiflora* (3RCa) has been recorded from the Stanthorpe south to Werrikimbe NP. It is reserved within Girraween NP, Bald Rock NP, Boonoo Boonoo NP, Gibraltar Range NP, New England NP, Werrikimbe NP, Butterleaf NP, Mann River NR, Bolivia Hill NR and Torrington SRA. Populations of this species were found near the Sara River Falls and between Crown and Nightcap Mountains within Warra NP, though it was more common on outcrops on Wattleridge.

*Eucalyptus camphora* subsp. *relicta* (3VC-; Schedule 1, Endangered, *TSC Act*) is restricted to the Backwater area in NSW. Two populations are known within Warra NP with an estimated combined population size of around 10 000 individuals (Hunter 1996).
Muehlenbeckia costata (3VCa; Schedule 2, Vulnerable, TSC Act) (Hunter et al. 1998) has a highly disjunct distribution and is only known from a handful of locations which include Mt Kaputar, Bald Rock, Backwater and the Blue Mountains (unconfirmed). This species is another disturbance ephemeral restricted to rock outcrops (Hunter et al. 1998; Hunter 2003b). It was estimated that around 5000 individuals were counted within Warra NP in 1995, however none are known at present due to its short life span and longlived seedbank (Hunter et al. 1998).

Persoonia procumbens (2RC-) is restricted to Backwater and the Round Mountain area east of Armidale. The species is reserved within Cathedral Rock NP. This taxon was found in 25% of all sites, and was abundant in five communities.

Pseudanthus divaricatissimus (3RCa) is known primarily south of Musswellbrook, south to Bega (Halford & Henderson 2003) with some disjunct locations as far north as Urbenville and Dubbo. This species was found on Wattleridge in only one location, where only three plants were seen (Hunter & Bruhl 1997).

Thelionema grande (3RCa) (Hunter & Copeland 1999) is known from south of Bundarra north to the Stanthorpe area in Queensland. The species is reserved within Girraween NP, Mt Barney NP, Bald Rock NP, Boonoo Boonoo NP, Gibraltar Range NP, Ironbark NR, Werrikimbe NP, Torrington SRA and Bolivia Hill NR. Within the study area the species was not found within Warra NP, but was found sporadically on rock outcrops within Wattleridge.

Acknowledgements

The author would like to thank the staff of the Glen Innes area of the Northern Tablelands Region of the National Parks Service, in particular Jennifer Kingstown for managing this project at Warra NP and Peter Croft and Rod Spark for assistance in the field. Vanessa Hunter aided in data compilation and field assistance at Wattleridge. Neva Beresford-Smith kindly compiled geological information. The previous owners of Wattleridge Brian and Judy Humphries are thanked for allowing access on numerous occasions for flora survey work and to the Banbai Business Enterprises Inc. for allowing more recent access.

References


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Appendix 1: Flora of Warra National Park and Wattleridge.

Taxa found within the survey sites are scored according to their presence in each of the ten communities defined. Some taxa were found in previous surveys or opportunistically and therefore are not assigned to a specific community. Some orchid identifications may be identified in a broad taxonomic sense (sens. lat.). Nomenclature follows that of Harden (1990–1993) except where recent changes have occurred. Introduced taxa are indicated by *. 

1 = Leptospermum novae-angliae – Bursaria spinosa – Riparian Scrub and Heath 
2 = Eucalyptus pauciflora – Eucalyptus nova-anglica Woodland 
3 = Haloragis heterophylla – Carex inverse Herbfield 
4 = Baeekea omissa – Leptospermum gregarium Closed Wet Heath 
5 = Eucalyptus cameronii – Eucalyptus cameronii – Eucalyptus campanulata Shrubby Open Forest 
6 = Eucalyptus radiata – Eucalyptus acaciiformis Woodland 
7 = Eucalyptus nobilis – Eucalyptus obliqua Tall Open Forest 
8 = Eucalyptus obliqua – Eucalyptus nobilis Tall Open Forest 
9 = Leptospermum novae-angliae – Kunzea obovata – Brachyloma saxicola Open scrub and Closed Heath

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Stypandra glauca  10
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Empodisma minus  10
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Leporydium leptocephalus  4

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Xanthorrhoeaceae
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Xyridaceae
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Xyris operculata  4
GYMNOSPERMS

Cupressaceae
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Amaranthaceae
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Daucus glochidiatus  8
Hydrocotyle geraniifolia  4, 7, 8, 9
Hydrocotyle laxiflora  7, 8
Hydrocotyle peduncularis  4, 7, 8
Hydrocotyle tripartita  4, 7, 8
Oreomrynchis eriopoda  10
Platysace ericoides  5, 7, 8
Platysace lanceolata  5, 7, 10
Trachymene incisa subsp. incisa  2, 4, 7, 10
Trachymene sp. aff. pilosa  10

Araliaceae
Polyscias sambucifolia  5, 7, 8, 10

Asclepiadaceae
*Gomphocarpus fruticosus

Asteraceae
Brachyscome microcarpa  10
Brachyscome nova-anglica  2, 4, 7, 8
Brachyscome scapigera  10
*Carduus tenuiflorus  10
Chrysocephalum semipapposum  2, 4, 7, 8
*Cirsium vulgare  7, 8
*Conyza albida  1, 2, 3, 7, 8, 9, 10
*Conyza bonariensis  3
Craspedia canens  4, 7, 8
Craspedia variabilis  4, 7, 8
Eschitom gynnocephalus  7
Eschitom involucrus  1, 2, 4, 7, 8, 10
*Gnaphalium americanum  1, 7
Helichrysum elatum  7
Helichrysum patulum  7, 8
Helichrysum scorpioides  2, 4, 5, 7, 8
*Hyphaenias glabra  3, 4, 7, 8
*Hyphaenias radicata  1, 2, 4, 6, 7, 8, 9, 10
Lagenifera stipitata  6, 7, 8, 9
Leptochrysum albicans  10
*Leucanthemum vulgare  3
Olearia microphylloides  10
Olearia oppositifolia  8
Olearia stellulata  8
Ozothamnus diosmifolius  10
Podolepis jaceoides  7, 8
Podolepis neglecta  7, 8
Senecio davisii  2, 4, 7, 8, 9
Senecio hispidulus  9
Senecio laetus subsp. lanceolatus  7, 8
*Senecio madagascariensis  1, 7, 9
Senecio prenanthoides  7, 8, 10
Sugesbeckia australiensis  9
Solenogyne belliioides  7, 8, 10
Solenogyne dominii  10
*Sonchus asper subsp. glaucescens
*Taraxacum officinale  1
Vernonia cinerea var. cinerea  8
Xerophyllum dissectum  1, 10
Zelkova serrata  7, 8, 9

Cabombaceae
Braesia schreberi  1

Campanulaceae
Wahlenbergia ceracea  4, 6
Wahlenbergia communis  1, 2, 4, 7, 8, 9
Wahlenbergia gracilis  10
Wahlenbergia latifolia  10
Wahlenbergia planifolia subsp. longifolia  7, 8
Wahlenbergia stricta subsp. stricta

Caryophyllaceae
*Petrorhagia nanteuilii
Scleranthus biflorus  3, 8
Stellaria angustifolia  4
Stellaria flaccida  3
*Stellaria media

Casuarinaceae
Allocasuarina littoralis  7, 8
Alloscaurina rigida subsp. rigida  10
Allocasuarina torulosa  5

Celastraceae
Maytenus silvestris  5, 7, 8

Chenopodiaceae
Chenopodium pumilio  10

Chloanthaceae
Chloanthus parviflorus  10

Clusiaceae
Hypericum gramineum  2, 4, 6, 7, 8
Hypericum japonicum

Convolvulaceae
Dichondra repens  2, 3, 4, 7, 8, 9
Dichondra sp. A  10

Crassulaceae
Crassula sieberiana  1, 10

Dilleniaceae
Hibbertia acicularis  4, 6, 10
Hibbertia aspera  10
Hibbertia monogyna  10
Hibbertia obtusifolia  3, 4, 7
Hibbertia riparia  2, 4, 7
Hibbertia rufa  7
Hibbertia scandens  10
Hibbertia serpyllifolia  5, 7, 8
Hibbertia sp. B  10
Hibbertia vestita  10

Droseraceae
Drosera binata  4
Drosera burmannii  4
Drosera peltata  4, 10
Drosera spatulata

Epacridaceae
Brachycome daphnoides subsp. glabrum  2, 7, 10
Brachycome saxicola  1, 10
Epacris breviflora
Epacris microphylla var. microphylla 2, 4, 6, 10
Epacris obtusifolia 1
Leucopogon biflorus 5, 7, 8, 9, 10
Leucopogon lanceolatus var. lanceolatus 10
Leucopogon microphyllus 1, 10
Leucopogon neoanglicus 2, 4, 5, 6, 7, 8, 10
Lissanthe strigosula
Melichrus procmiens 2, 4, 5, 7
Melichrus urceolatus 1, 7, 8
Monotoca scoparia 2, 4, 5, 6, 7, 8, 10

Escalloniaceae
Quintinia sieberi

Euphorbiaceae
Monochaeta macrophylla 10
Phyllanthus virgatus 3, 7, 10
Poranthera microphylla 2, 4, 5, 6, 7, 8, 10
Pseudanthus divaricatissimus 10

Fabaceae
Acacia brunioides subsp. brunioides 1
Acacia buxifolia subsp. buxifolia 5, 6
Acacia dealbata 10
Acacia falciformis 2, 4, 7, 8
Acacia filicifolia 2, 4, 7, 8
Acacia fimbriata 1, 2, 7, 8
Acacia melanoxylon 9
Acacia mitchellii 5
Acacia myrtifolia 5
Acacia penninervis 2, 7
Acacia stricta 1, 2
Acacia stricta 5, 6, 7, 8, 10
Acacia venulosa 10
Acacia viscidula 10
Aotus subglaucu var. subglaucu 2, 4, 6, 7, 10
Bassiaea neo-anglica 2, 5, 7, 8, 10
Bassiaea rhombifolia 10
Bassiaea scortechinii 2, 4, 5, 7, 10
Cullen tenax 1, 4, 7, 8, 9
Dillwynia phylicoides 4, 5, 6, 7, 8, 10
Dillwynia retorta 2, 4, 7
Dillwynia sieberi 1, 2, 4
Glycine clandestina 1, 2, 4, 5, 7, 8, 9
Glycine microphylla 7, 8
Glycine sp. A 4, 7
Glycine tabacina 2, 7, 8
Glycine tomentella 7
Gompholobium huegelii 7
Hardenbergia violacea 5, 7, 8
Hovea purpurea 1
Hovea heterophylla 2, 7
Hovea lanceolata 1, 5, 10
Indigofera australis 8, 9
Jacksonia scoparia 7
Lampetra juncea subsp. sericea 1
Lotus cruentus 1
*Medicago arabica 1, 3
*Medicago lupulina 1
*Medicago polymorpha 1
*Melilotus indicus 1, 2, 10
Mirbelia confertiflora 6
Mirbelia pungens 7
Mirbelia rubifolia 7

Pultenaea altissima
Pultenaea linifolia 5, 8
Pultenaea myriotydes 5
Sphaerolobium vinifoe
*Trifolium arvense
*Trifolium repens 4
*Trifolium subterraneum

Gentianaceae
*Centaurium erythraea 1, 3, 4, 8
*Centaurium tenifolia

Geraniaceae
Geranium neglectum
Geranium potentilloides
Geranium solandei var. grande 4
Geranium solandei var. solandei 4, 7, 8, 9
Pelargonium inodorum 10

Goodeniaceae
Dampiera stricta 10
Goodenia bellidifolia subsp. argentea 10
Goodenia bellidifolia subsp. bellidifolia 4, 5, 6, 7
Goodenia hederacea subsp. hederacea 2, 4, 5, 6, 7, 8, 10
Scaevola hookeri subsp. ramosissimus 4
Velleia paradoxa 10

Haloragaceae
Gonocarpus micranthus subsp. micranthus 10
Gonocarpus micranthus subsp. ramosissimus 2, 4, 6
Gonocarpus oreophilus 5, 9
Gonocarpus tetragynus 2, 4, 5, 6, 7, 8, 10
Gonocarpus teucrioides 2, 4, 7, 8, 9, 10
Haloragis heterophylla 3, 4, 8
Myriophyllum crispatum 1

Lamiaceae
Ajuga australis 8, 10
Mentha diemenica 7, 8
Mentha elwesioides 1, 8, 10
Plectranthus graveolens 5
Prostanthera howelliae 7, 8, 9
Prostanthera saxicola 5, 10
Prostanthera scutellarioides 3, 4, 8
Teucrium corymbosum

Lauraceae
Cassytha glabella

Lentibulariaceae
Utricularia dichotoma 4

Linaceae
Linum marginale 1, 2

Lobeliaceae
Isotoma axillaris 4
Lobelia gracilis 8
Pratia purpurascens 7, 8, 9

Loganiaceae
Logania albiflora 1, 2

Loranthaceae
Amyema miqelii
Amyema pendulum 8
Muellerina eucalyptoides

Lythraceae
Lythrum salicaria 4
### Malvaceae

*Modiola caroliniana* 3

### Myrsinaceae

*Rapanea howittiana* 8, 9

### Myrtaceae

*Baeekea gunniana* 2, 4, 6, 7

*Callistemon pallidus* 4, 6, 10

*Calytrix tetragona* 1, 10

*Eucalyptus acaciiformis* 1, 2, 4, 5, 7, 8, 10

*Eucalyptus caliginosa* 5, 7, 8, 9

*Eucalyptus cameronii* 5, 6, 8, 9

*Eucalyptus codonocarpa* 10

*Eucalyptus dalrympleana* subsp. *heptantha* 1, 2, 4, 7, 10

*Eucalyptus dorrigoensis* 1, 4, 6, 10

*Eucalyptus radiata* subsp. *sejuncta* 5, 6, 7, 8, 9

*Eucalyptus stellulata* 7, 8

*Eucalyptus viminalis* 2, 7

*Kunzea bracteolata* 1, 10

*Leptospermum arachnoides* 2

*Leptospermum brevipes* 1, 4, 6, 10

*Leptospermum gregarium* 2, 4

*Leptospermum hystrix* 1, 2, 7, 8

*Leptospermum polygalifolium* subsp. *montanum* 1, 2, 4, 8

*Polygalaceae*

*Comesperma ericinum* 4, 10

*Comesperma sphaerocarpum* 4

### Polygonaceae

*Acetosella vulgaris* 3, 10

*Muehlenbeckia costata* 10

*Persicaria decipiens* 1, 3, 4

*Persicaria hydropiper* 1

*Rumex brownii* 3

### Portulacaceae

*Calandrinia sp. A* 1, 2, 10

*Portulaca bicolor* 10

### Potamogetonaceae

*Potamogeton ochreatus* 10

### Primulaceae

*Anagallis arvensis* 4, 5, 6, 7, 8

### Proteaceae

*Banksia cunninghamii* subsp. *cunninghamii* 4, 5, 6, 7, 8

*Banksia integrifolia* subsp. *integrifolia* 1, 2, 4, 5, 7, 8

*Banksia spinulosa* var. *collina* 10

*Grevillea juniperina* subsp. *allojohnsonii* 2, 4

*Grevillea scortechinii* subsp. *sermentosa* 2, 5, 6

*Hakea eriantha* 4, 5, 8

*Hakea laevipes* subsp. *graniticola* 10

*Hakea microcarpa* 4

*Lomatia fraseri* 2, 4, 10

*Lomatia silaifolia* 2, 5, 6, 7, 8, 9, 10

*Persoonia cornifolia* 2, 4, 7, 10

*Persoonia oleoides* 5, 7, 8

*Persoonia procumbens* 2, 4, 6, 7

*Persoonia sericea* 7, 8

*Petrophile canescens* 2, 4, 5, 6, 7, 8

### Ranunculaceae

*Clematis aristata* 8, 9

*Clematis glycinoides* var. *glycinoides* 8

*Rununculus lappaceus* 7, 8, 9

### Rhamnaceae

*Cryptandra amara* var. *amara* 1

*Cryptandra amara* var. *longiflora* 10

*Cryptandra lanosiflora* 1, 10

*Pomaderris andromedifolia* 5

*Pomaderris lanigera* 1, 5, 10

### Rosaceae

*Acaena novae-zelandiae* 3, 4, 8

*Acaena ovina* 8

*Rubus cichlodes* 1

*Rubus parvifolius* 1, 2, 3, 4, 7, 8, 9

### Rubiaceae

*Asperula conferta* 7, 8, 9

*Coprosma quadrifida* 7, 8

*Galium bifolium* 7

*Galium ciliare* 7

*Galium duchesnii* 2, 4, 7, 8

*Galium migrans* 7

*Galium propinqua* 7

*Opercularia aspera* 7, 10

*Opercularia diphylla* 1, 2, 7, 8

*Opercularia hispida* 4, 7, 8, 10

*Pomax umbellata* 5, 7, 8, 10

### Oleaceae

*Noteleae linearis* 2, 10

*Noteleae longifolia* 9

*Noteleae microcarpa* var. *microcarpa* 2

*Noteleae ovata* 8, 9, 10

### Onagraceae

*Epilobium billardierianum* subsp. *billardieri* 3, 8

*Epilobium gunnianum* 1, 4

### Oxalidaceae

*Oxalis chnoodes* 2, 7, 8, 9

*Oxalis perennans* 10

### Pittosporaceae

*Billardiera scandens* var. *scandens* 5, 6, 7, 8, 10

*Bursaria spinosa* subsp. *obovata* 10

*Bursaria spinosa* var. *microphylla* 7

*Bursaria spinosa* var. *spinosa* 1, 2, 7, 8

*Pittosporum multiflorum* 10

*Rhytidosporum procumbens* 10

### Plantaginaceae

*Plantago debilis* 7, 8

*Plantago hispida* 8

*Plantago lanceolata* 8

*Plantago varia* 8
Rutaceae
Boronia algida 5, 10
Boronia anemonifolia subsp. variabilis 10
Boronia microphylla
Correa reflexa var. reflexa 1, 2, 9, 10
Leionema ambiens 10
Phebalium ozothamnoides 10
Zieria cytisoides 10
Zieria fraseri subsp. compacta 1, 10
Zieria laevigata 10
Zieria smithii subsp. smithii 8

Santalaceae
Choretrum candollei
Choretrum pauciflorum 2, 7
Exocarpos cupressiformis 10

Sapindaceae
Dodonaea triquetra 5, 7
Dodonaea viscosa var. angustissima 1, 2, 10

Scrophulariaceae
Derwentia arcuata 2
Gratiola peruviana 1, 2, 4
Stemodia glabella
*Verbascum thapsus subsp. thapsus
*Verbascum virgatum
Veronica calycina 7, 8
Veronica plebeia 4, 9

Solanaceae
Cyphanthera albicans subsp. albicans 10
Solanum aviculare
Solanum brownii
Solanum campanulatum 7, 8, 9
Solanum densevestitum 7, 8, 9
Solanum elegans 8, 9
Solanum linearfolium
Solanum nobile 8
Solanum opacum 10
Solanum prinophyllum

Stackhousiaceae
Stackhousia monogyna 5, 10
Stackhousia viminea 2, 7, 8, 10

Stylidiaceae
Stylidium graminifolium 2, 4, 5, 6, 7, 8

Thymelaeaceae
Pimelea linifolia subsp. linifolia 2, 4, 5, 10
Pimelea neo-anglica

Urticaceae
Urtica incisa

Verbenaceae
*Verbena bonariense
*Verbena officinalis

Violaceae
Hybanthus monopetalus 7, 8
Viola betonicifolia 7, 8, 9
Viola hederacea 2, 4, 8, 9

Winteraceae
Tasmania insipida 10