

# Vegetation and floristics of Kwiambal National Park and surrounds, Ashford, New South Wales

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The vegetation of Kwiambal National Park and surrounds, 30 km north-west of Ashford (29°07'S, 150°58'E) in the Inverell Shire on the North Western Slopes, is described. Eight plant communities are defined based on flexible UPGMA analysis of relative abundance scores of vascular plant taxa. These communities are mapped based on ground truthing, air photo interpretation and geological substrate. All communities are of woodland structure and most are dominated by *Callitris glaucophylla*, *Eucalyptus melanophloia* and *Eucalyptus dealbata*. Communities are: 1) Mixed Stand Woodland (Dry Rainforest), 2) Granite Woodland, 3) Metasediment Woodland, 4) Riverine, 5) Metabasalt Woodland, 6) Granite Open Woodland, 7) Limestone Woodland, and 8) Alluvial Woodland.

Many of the taxa (407 species were recorded) show phytogeographic affinities with western south-east Queensland flora. This is also true of the communities defined. Five ROTAP listed species have been found in the Park: *Acacia williamsiana*, *Astrotricha roddii*, *Euphorbia sarcostemmoides*, *Olearia gravis* and *Thesium australe*, three of these are listed on the NSW Threatened Species Conservation Act (1995). Another ten taxa are considered to be at their geographic limit or disjunct in their distribution. 17% are exotic in origin.

## Introduction

Kwiambal National Park is approximately 130 km north-west of Glen Innes and 30 km north-west of Ashford (29°07'S, 150°58'E) in the Shire of Inverell on the North Western Slopes of NSW (Fig. 1). The most recent proposal for Kwiambal National Park included 3487 ha and included the crown reserves of Macintyre Falls and the Limestone Caves and surrounding land purchases made by the NSW National Parks and Wildlife Service in 1994 (Inverell Shire, County of Arrawatta, Parish of Limestone, Portions 9, 10, 11, 12, 13, 15 and 23). The Park was announced on 17 July 1998 and included the crown reserves and portions 11 and 15 (c. 1200 ha). The National Parks and Wildlife Service owns approximately 2300 ha adjoining the park, which is not yet declared but is expected to be so. The original proposal for a 'Macintyre Falls National Park' included a much larger area of 13 540 ha (Roberts 1982).

Kwiambal National Park is within one of the largest areas of remnant woodlands in the North Western Slopes Botanical District and is in the Northern Complex Province of the Nandewar Biogeographic Region (NAN). These areas are poorly represented in the current reserve network. The junction of the Severn and Macintyre rivers forms the

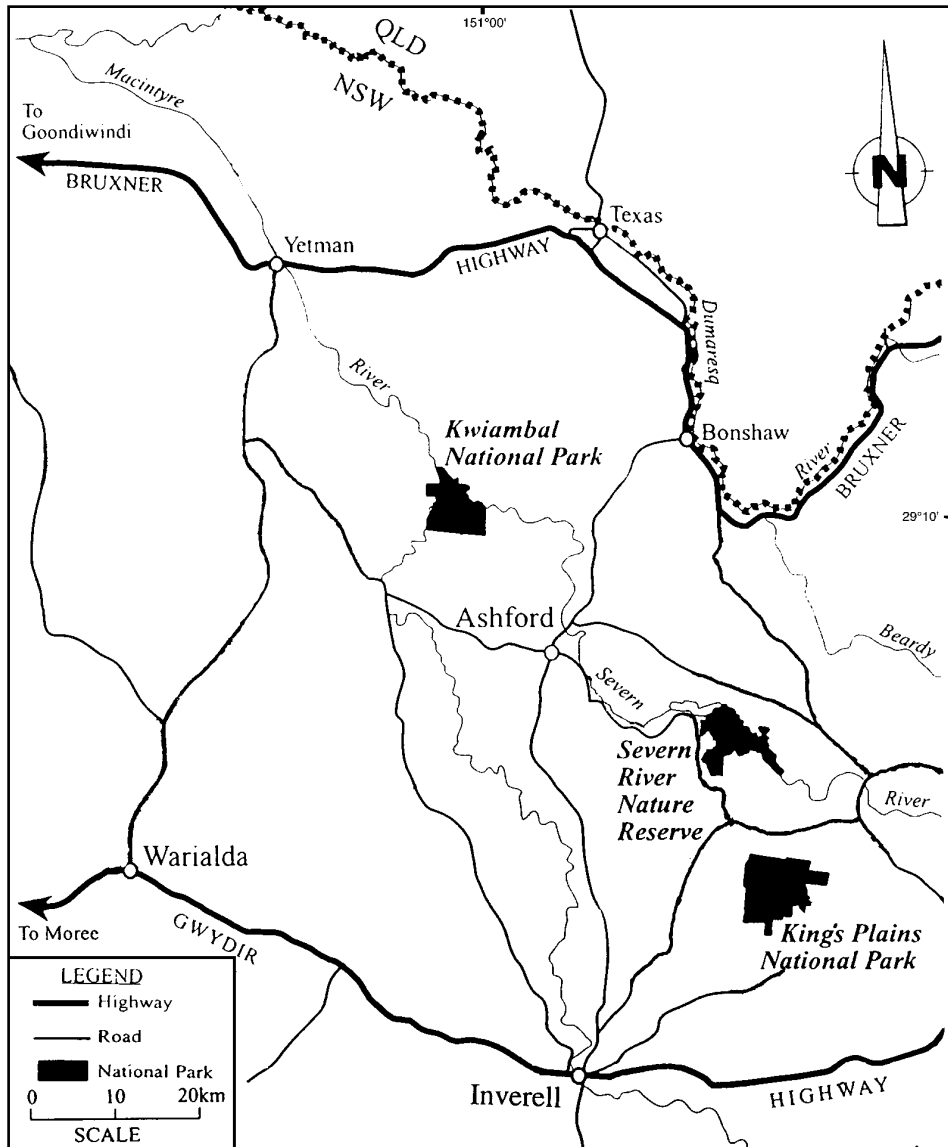


Fig. 1. Map of locality of the Kwiambal National Park.

north-western corner of the Park and both rivers demarcate most of the north and western boundaries. Severn State Forest lies on the northern boundary of the Park. The name Kwiambal is derived from the aboriginal group that originally inhabited the region (Howell 1982).

This paper gives part of the results of a flora survey conducted on behalf of the Glen Innes District of the NSW National Parks and Wildlife Service. The aims of this study were to provide a vegetation map of communities to assist in fire management of the Park and to provide information on the distribution of rare, geographically restricted

or disjunct taxa within the Park. This information will be used to develop appropriate management strategies for the Park (Hunter 1998).

### **Climate**

The climate of Kwiambal is typical of the northern part of the North Western Slopes. Winds are mainly from the south-west in summer. Dry thunderstorms are common throughout spring. On average one in every five years are drought years (Division of National Mapping 1986), however the five years between 1992 and 1996 were drought declared years. Summers are hot with the average maximum temperature for the warmest period being around 31–32°C and winters are cold with the average minimum temperature of the coldest period being between 1–3°C (McMahon 1995). Annual precipitation is around 640 to 670 mm (McMahon 1995). Humidity is low in summer — around 55% — and up to 76% in winter.

### **Geology and geomorphology**

Kwiambal National Park is located in the Kwiambal Terrane (Flood et al. 1994) which is thought to be an accreted seamount. This terrane is situated within the Anaiwan Terrane of the southern New England Orogen of eastern Australia. The New England Orogen is a collage of a number of terranes that amalgamated and accreted to the eastern margin of Gondwana during the late Paleozoic-early Mesozoic (Flood & Aitchison 1993). The seamount formed at a hotspot at the mid-ocean ridge during the Early Carboniferous (Flood & Aitchison 1993).

There are four major rock types within the Park: metabasalts (5%), limestones (3%), greywackes (Texas Bed sediments: 16%) and granites (76%). These rocks have been variously metamorphosed, deformed, mineralised and altered.

The Park landscape is rugged, with low rocky ridges interspersed with small undulating areas of deeper soils in gullies or on plateaus (Roberts 1982). Altitudes are predominantly between 300 and 500 m above sea level. Two large rivers, the Macintyre and Severn, both become entrenched in their lower sections with steep sided valleys. Both river valleys begin with waterfalls 2–3 km upstream from their confluence. The caves area to the south is disjunct from the main section of the Park and has limestone outcrops and a major cave 548.6 m long.

### **History and Landuse**

Settlers arrived in the area prior to 1830. Allan Cunningham in his exploration of the area north of Inverell in 1827 found a squatter's shack and cattle in this supposedly unexplored region (McMinn 1970). Ashford was dedicated as a village in 1860.

The main land uses in Ashford today involve the wool and cattle industries. Tobacco growing was once the largest industry within the area but is no longer carried out. Logging and sawmilling began around 1900.

Selective logging has taken place throughout most areas that are now within Kwiambal National Park, apart from the original crown reserves. Logging began around 1900 and re-logging occurred in the 1940s, 1950s and was being carried out in

portion 13 in the 1980s (Roberts 1982). Clearing for grazing and tobacco has been the other main disturbance. Tobacco growing occurred between 1969 and 1994 within the boundaries of the present Park. There has been guano mining at the caves and mining for marble has been suggested, but has never occurred. Tourism within the Park is concentrated on Macintyre Falls and the limestone caves to the south.

### Previous investigations

In 1827 the botanist Allan Cunningham collected in the general vicinity of Kwiambal crossing ridges covered with stunted ironbark and *Callitris* (McMinn 1970). Turner (1905) traversed much of the North Western Slopes describing the vegetation of the region. Even as early as this, many weeds were found amongst natural vegetation and Prickly Pear (*Opuntia* sp.) at Apple Tree Flat within Kwiambal was described as being so thick that it could not be walked through.

Roberts (1982) produced a proposal for the Macintyre Falls National Park and in his thesis on the vegetation of granite areas of northern New South Wales (Roberts 1983) broadly described the major vegetation types and dominant species. Le Brocque & Benson (1995) surveyed 105 vegetation sites across the Ashford 1:100 000 map sheet and reported on the major vegetation communities. A few of these sites were within the boundaries of the proposed park. The NSW National Parks and Wildlife Service commissioned a survey of 30 sites within land purchased by the Service in what was to become the basis of Kwiambal, though no analyses or vegetation maps were produced. Hunter (Hunter & Clarke 1998) also visited the Kwiambal and Severn State Forest areas in 1995, and 19 floristic sites for a broader survey of the granitic outcrop vegetation of the New England Batholith. Nadolny et al. (1997) surveyed populations of the rare *Astrotricha roddii* and assessed the associated vegetation.

### Methods

The initial procedure for stratifying sites involved the use of previously collected survey data, in particular that of the National Parks and Wildlife Service, Le Brocque & Benson (1995) and Hunter & Clarke (1998). It was envisaged that these sites would provide a basis for development of a vegetation map and that only minimal number of additional sites would be needed. This however, was found inappropriate in the light of the type of information gathered previously and the various methods used, and a new survey was necessary. The new survey involved recording of 42, 20 × 20 m quadrats within which the cover-abundance of all vascular plant species was determined using the Braun-Blanquet (1982) cover abundance scale. Quadrats were placed using a stratified random method. As only a relatively low number of sites was used, only a minimal combination of environmental attributes could be chosen in order to allow for replication. Physiography, geology and altitude were used to stratify sites as these were important in the delineation of communities in trial analyses, and were shown to be important in the study of Le Brocque & Benson (1995). The current survey was conducted over three weeks in late October and early November in 1997.

Good quality material of many taxa was retained as vouchers and sent to the N.C.W. Beadle Herbarium of the University of New England (NE) in the first instance and then to the National Herbarium of New South Wales (NSW) or the Coffs Harbour Herbarium (CFSHB). Taxon nomenclature follows that of Harden (1990–1993) except where recent changes have been made.

Analyses and data exploration were performed using options available in the PATN Analysis Package (Belbin 1995a, b). For final presentation of results all species and their relative abundance scores were used and the analysis performed using Kulczynski association measure which is recommended for ecological applications (Belbin 1995a, b) along with flexible UPGMA and the default PATN settings.

Delineation of community boundaries in Fig. 3 was based on the location of sites and their position within the multivariate analysis and on previous survey plots and their floristic composition, air photograph interpretation and ground truthing. The vegetation map is based on 1:50 000 topographic maps. Structural names follow Specht et al. (1995) and are based on the most consistent uppermost stratum.

## Results

Eight communities were recognised at the dissimilarity measure of 0.72 (Figs 2 and 3). A dissimilarity of 0.72 is similar to the 0.75 used for community definition on the Ashford sheet by Le Brocque & Benson (1995). Community relationships are given by the dendrogram (Fig. 2). This is slightly divergent from the original dendrogram produced by the Kulczynski analysis which recognised an additional community at 0.72 dissimilarity. On inspection of subsequent analyses and the two-way table of species against sites, it was decided that this site was an outlier, divergent from other sites due to the large number of exotic taxa and excessive disturbance. It was removed from the dataset, which was re-analysed.

### Vegetation communities

All plant communities in Kwiambal National Park, except for some riverine areas, are dominated by *Callitris glaucophylla* (White Cypress Pine), *Eucalyptus melanophloia* (Silver-leaved Ironbark) and *Eucalyptus dealbata* (Tumbledown Gum). The relative importance of these three tree species changes within different communities. More important in defining the communities are the additional co-dominants and the understorey taxa. Some communities have very few species with high fidelity. For example Community 2 is defined primarily by widespread taxa and those that are lacking. In contrast, other communities such as 1 and 3 contain distinct assemblages and have a number of indicator species. The eight communities are mapped (Fig. 3). Selected attributes of each of the defined communities are given in Table 1.

#### Community 1: Mixed Stands Woodland (Dry Rainforest)

*Alphitonia excelsa* (Red Ash)–*Corymbia dolichocarpa* (Large-fruited Bloodwood)–*Eucalyptus caleyi* (Caley's Ironbark)–*Angophora leiocalyx* (Smooth-barked Apple) Woodland.

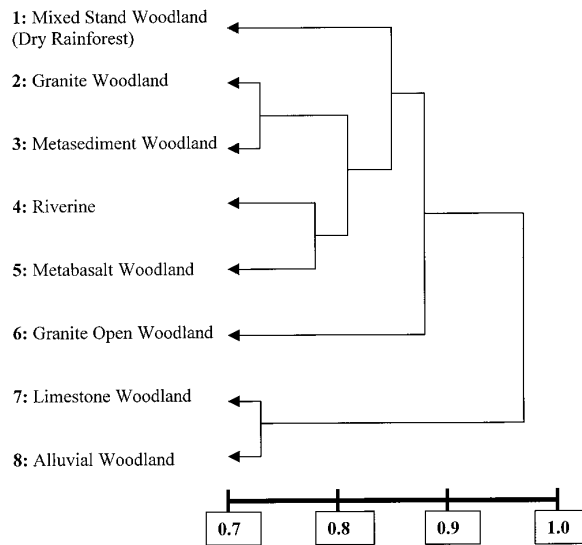


Fig. 2. Summary dendrogram of the full floristic dataset of site using Kulczynski association and flexible UPGMA fusion strategy and a  $\beta$  value of -0.1. Communities have been defined at a dissimilarity level of 0.72.

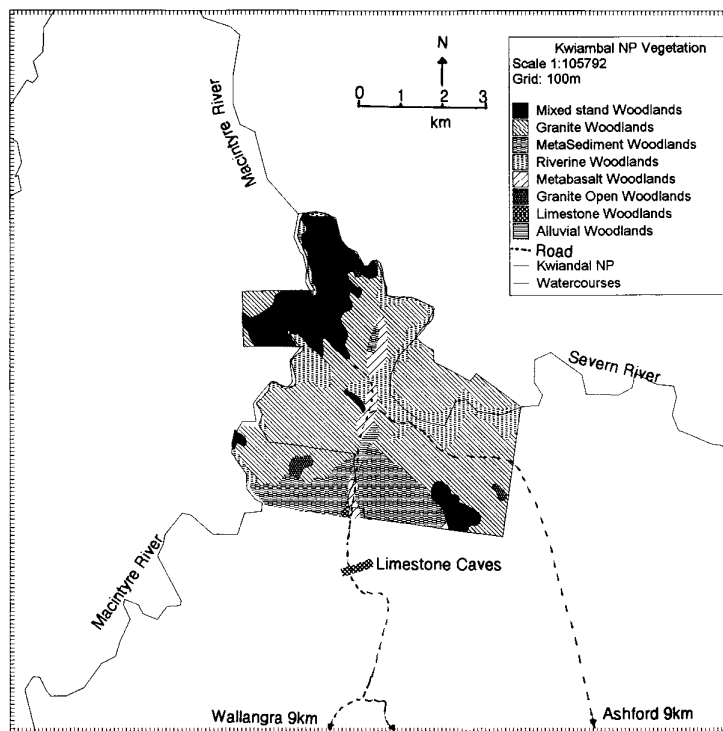


Fig. 3. Map of vegetation communities for Kwiambal National Park and adjoining lands purchased by the NSW National Parks and Wildlife Service. The disjunct limestone caves area is not yet joined to the main Park. Scale = 1:50 000.

**Structure:** Woodland: Tree layer usually 15–20 m or to 30 m tall, 15–40% cover. Shrubs or small trees often in two layers 10–15 m and 3–10 m tall, 30–50% cover. Ground cover variable, 40–90%.

**Trees:** *Alphitonia excelsa*, *Eucalyptus dealbata*, *Callitris glaucophylla*, *Brachychiton populneus*, *Eucalyptus melanophloia*, *Acacia williamsiana*, *Corymbia dolichocarpa*, *Eucalyptus caleyi*, *Angophora leiocarpa*, *Eucalyptus populnea*, *Eucalyptus crebra*.

**Shrubs:** *Acacia leiocalyx*, *Leptospermum brevipes*, *Notelaea microcarpa*, *Melichrus urceolatus*, *Breynia cernua*, *Alstonia constricta*, *Bertya oleifolia*, *Olearia gravis*, *Acacia pruinosa*, *Santalum lanceolatum*, *Santalum acuminatum*, *Ficus rubiginosa*, *Astrotricha roddii*, *Hovea lanceolata*, *Phyllanthus carpentariae*, *Abutilon oxycarpum*, *Canthium odoratum*, *Petalostigma pubescens*, *Beyeria viscosa*, *Alectryon subdentatus*.

**Climbers:** *Jasminum lineare*, *Pandorea pandorana*, *Euphorbia sarcostemmoides*, *Parsonsia eucalyptophylla*.

**Ground cover:** *Aristida vagans*, *Cymbopogon refractus*, *Wahlenbergia communis*, *Cheilanthes distans*, *Commelina cyanea*, *Lomandra longifolia*, *Sigesbeckia australis*, *Microlaena stipoides*, *Scleria mackaviensis*, *Austrostipa drummondii*, *Calotis dentex*, *Lepidosperma laterale*, *Daucus glochidiatus*, *Dichondra* sp. A, *Cheilanthes sieberi* subsp. *sieberi*, *Einadia hastata*.

**Variability:** This group contains a variable assemblage of dominants or co-dominants. Woodlands of *Alphitonia excelsa*, *Eucalyptus dealbata*, *Callitris glaucophylla*, *Brachychiton populneus* and *Corymbia dolichocarpa* on the sides of rocky hills are the most common. However, on higher ridge tops particularly on the western side of the Macintyre River, *Alphitonia excelsa*, *Acacia williamsiana* and *Brachychiton populneus* may dominate. Often a dense layer of *Plectranthus parviflorus* is present. On valley floors with deeper alluvium or more gently sloping hillsides a mixture of *Angophora leiocarpa*, *Eucalyptus dealbata*, *Callitris glaucophylla*, *Eucalyptus crebra* and *Eucalyptus populnea* may become common with a dense understorey of *Acacia leiocalyx* and or *Leptospermum brevipes*.

## Community 2: Granite Woodlands

*Callitris glaucophylla* (White Cypress Pine)–*Eucalyptus dealbata* (Tumbledown Gum)–*Angophora floribunda* (Rough-barked Apple)–*Eucalyptus melanophloia* (Silver-leaved Ironbark) Woodland.

**Structure:** Woodland: Tree layer usually 15–20 m or to 30 m, 30–50% cover. Shrubs 3–10 m tall, 15–20% or sometimes to 40% cover. Ground cover 70–90%.

**Trees:** *Callitris glaucophylla*, *Eucalyptus dealbata*, *Angophora floribunda*, *Eucalyptus melanophloia*, *Brachychiton populneus*, *Eucalyptus caleyi*.

**Shrubs:** *Leptospermum brevipes*, *Melichrus urceolatus*, *Desmodium brachypodum*, *Acacia leiocalyx*, *Acacia pruinosa*, *Hibbertia obtusifolia*, *Notelaea microcarpa*, *Canthium odoratum*, *Correa reflexa*, *Hovea lanceolata*, *Acacia neriifolia*, *Alphitonia excelsa*, *Breynia cernua*, *Calytrix tetragona*, *Olearia elliptica*, *Brachyloma daphnoides*.

**Climbers:** *Pandorea pandorana*.

**Ground cover:** *Aristida vagans*, *Cymbopogon refractus*, *Dichondra* sp. A, *Aristida ramosa*, *Cheilanthes sieberi* subsp. *sieberi*, *Vittadinia sulcata*, *Cheilanthes distans*, *Austrostipa drummondii*, *Cyperus gracilis*, *Echinopogon ovatus*, *Senecio diaschides*, *Wahlenbergia communis*, *Arthropodium milleflorum*, *Calotis lappulaceae*, *Commelina cyanea*, *Daucus glochidiatus*, *Lomandra multiflora*, *Dianella caerulea*, *Entolasia stricta*.

**Variability:** This assemblage is usually dominated by *Callitris glaucophylla*, *Eucalyptus dealbata* and *Eucalyptus melanophloia*. In rockier situations, *Brachychiton populneus* and *Eucalyptus caleyi* may become more common. In places with a deeper soil profile near creek lines, *Angophora floribunda* becomes prominent.

### Community 3: Metasediment Woodlands

*Callitris glaucophylla* (White Cypress Pine)–*Eucalyptus melanophloia* (Silver-leaved Ironbark)–*Eucalyptus albens* (White Box)–*Eucalyptus dealbata* (Tumbledown Gum).

**Structure:** Woodland: Tree layer usually 15–20 m tall but to 30 m, cover 20–40%. Shrubs 1–5 m tall, 15–30% or sometimes to 40% cover. Ground cover 40–90%.

**Trees:** *Callitris glaucophylla*, *Eucalyptus melanophloia*, *Eucalyptus albens*, *Eucalyptus dealbata*, *Brachychiton populneus*.

**Shrubs:** *Olearia elliptica*, *Acacia leiocalyx*, *Notelaea microcarpa*, *Desmodium brachypodum*, *Canthium odoratum*, *Cassinia uncata*, *Hibbertia obtusifolia*, *Eremophila debilis*, *Styphelia triflora*, *Dodonaea viscosa*, *Swainsona queenslandica*, *Leucopogon muticus*.

**Climbers:** *Pandorea pandorana*, *Jasminum lineare*, *Parsonsia eucalyptophylla*, *Jasminum sauvisimum*.

**Ground Cover:** *Aristida ramosa*, *Cheilanthes distans*, *Dichondra* sp. A, *Desmodium varians*, *Cheilanthes sieberi* subsp. *sieberi*, *Panicum simile*, *Glossogyne tannensis*, *Thonandia longifolia*, *Aristida vagans*, *Calotis lappulaceae*, *Wahlenbergia communis*, *Scleria mackaviensis*, *Stemodia glabella*, *Austrostipa drummondii*, *Vittadinia sulcata*, *Chamaesyce drummondii*, *Cyperus gracilis*, *Goodenia hederacea*, *Brachyscome microcarpa*, *Commelina cyanea*.

**Variability:** Community 3 is restricted to the metasediments that form a large portion south of the current reserve. *Eucalyptus albens* forms a conspicuous part of this association on deeper soils on portion 13. *Eucalyptus albens* is sometimes interspersed within Community 8 where the two communities abut. This type of mosaic was recognised by Beadle (1981) who describes *E. albens* as usually occurring on elevated sites but intergrading with *E. blakelyi* and *E. melliodora* which occur along watercourses. This kind of interchange is common throughout the range of these species (Prober 1996, Fisher & Goldney 1997). *Eucalyptus melanophloia* is known to replace *E. albens* on poorer soils (Prober & Theile 1993) and this occurs away from the road to the south of the current reserve.

### Community 4: Riverine Woodlands

*Eucalyptus blakelyi* (Blakely's Red Gum)–*Angophora floribunda* (Rough-barked Apple)–*Eucalyptus camaldulensis* (River Red Gum).

**Structure:** Woodland: Tree layer 20–30 m tall, 20–30% cover. Shrubs 3–10 m tall, 5–20% cover. Ground cover 90–100%.



**Trees:** *Eucalyptus blakelyi*, *Callitris glaucophylla*, *Angophora floribunda*, *Eucalyptus camaldulensis*, *Brachychiton populneus*, *Eucalyptus melanophloia*, *Casuarina cunninghamiana*.

**Shrubs:** *Leptospermum brevipes*, *Swainsona galegifolia*, *Acacia leiocalyx*, *Notelaea microcarpa*, *Callistemon viminalis*, *Hibbertia obtusifolia*, *Hovea lanceolata*, *Solanum americanum*.

**Climbers:** *Parsonsia eucalyptophylla*, *Jasminum lineare*, *Clematis glycinoides*, *Eustrephus latifolius*.

**Ground cover:** *Arundinella nepalensis*, *Vittadinia sulcata*, *Cyperus gracilis*, *Juncus ochrocoleus*, *Lomandra longifolia*, *Oxalis perennans*, *Aristida ramosa*, *Aristida vagans*, *Commelina cyanea*, *Dichondra* sp. A, *Ranunculus sessiliflorus*, *Daucus glochidiatus*, *Panicum simile*, *Rumex brownii*, *Austrostipa drummondii*, *Carex incomitata*, *Cheilanthes sieberi* subsp. *sieberi*, *Poa sieberiana*, *Pratia purpurascens*, *Ajuga australis*, *Cymbopogon refractus*, *Dichondra repens*, *Dichonopogon fimbriatus*, *Echinopogon ovatus*, *Einadia hastata*, *Haloragis heterophylla*, *Lomandra multiflora*.

**Variability:** Non-rocky areas on the river banks with deeper alluvium have *Eucalyptus camaldulensis* as a dominant, areas further from the river banks on alluvium and even along minor creeks *Eucalyptus blakelyi* becomes prominent. Where the riverbanks become rockier *Casuarina cunninghamiana* becomes more prominent.

#### Community 5: Metasediment Woodlands

*Eucalyptus melanophloia* (Grey Ironbark)–*Callitris glaucophylla* (White Cypress Pine).

**Structure:** Woodland: Trees usually only 15 m tall but to 20 m, cover 20–40%. Shrubs 2–4 m tall, with 10–40% cover. Ground cover 90–100%.

**Trees:** *Eucalyptus melanophloia*, *Callitris glaucophylla*.

**Shrubs:** *Swainsona galegifolia*, *Desmodium brachypodum*, *Olearia elliptica*, *Hibbertia obtusifolia*, *Notelaea microcarpa*, *Pimelea neo-anglica*, *Bertya oleifolia*, *Melichrus urceolatus*, *Cassinia uncata*.

**Climbers:** *Parsonsia eucalyptophylla*, *Jasminum lineare*.

**Ground cover:** *Dichondra* sp. A, *Daucus glochidiatus*, *Ajuga australis*, *Cymbopogon refractus*, *Austrostipa drummondii*, *Vittadinia sulcata*, *Cyperus gracilis*, *Ranunculus sessiliflorus*, *Calotis lappulaceae*, *Brunoniella australis*, *Lomandra longifolia*, *Thesium australe*, *Aristida ramosa*, *Arthropodium milleflorum*, *Cheilanthes distans*, *Cheilanthes sieberi* subsp. *sieberi*, *Desmodium varians*, *Einadia hastata*, *Galium gaudichaudii*, *Mentha diemenica*, *Plantago varia*, *Vernonia cinerea*, *Wahlenbergia communis*.

**Variability:** The presence or absence of *Olearia elliptica* is the main visual difference within this community.

#### Community 6: Granite Open Woodlands

*Callitris endlicheri* (Black Cypress Pine)–*Callitris glaucophylla* (White Cypress Pine)–*Eucalyptus dealbata* (Tumbledown Gum).

**Structure:** Open Woodland: Trees when dominant to 15 m tall, 10–20% cover. Shrubs 1.5–5 m tall, 10–30% cover. Ground cover variable 20–80% depending on the amount of exposed rock.

**Trees:** *Callitris endlicheri*, *Callitris glaucophylla*, *Eucalyptus dealbata*, *Eucalyptus melanophloia*, *Brachychiton populneus*.

**Shrubs:** *Leptospermum brevipes*, *Melichrus urceolatus*, *Acacia leiocalyx*, *Canthium odoratum*, *Calytrix tetragona*, *Cryptandra amara*, *Hovea lanceolata*, *Acacia williamsiana*, *Alphitonia excelsa*, *Leucopogon muticus*, *Phyllanthus carpentariae*.

**Climbers:** None apparent.

**Ground cover:** *Aristida ramosa*, *Tripogon loliiformis*, *Aristida vagans*, *Eragrostis elongata*, *Cheilanthes sieberi* subsp. *sieberi*, *Digitaria breviglumis*, *Cheilanthes distans*, *Commelina cyanea*, *Goodenia hederacea*, *Laxmannia compacta*, *Lepidosperma laterale*, *Phyllanthus virgatus*, *Actinotus helianthi*, *Brachycome microcarpa*, *Evolvulus alsinoides*, *Fimbristylis dichotoma*, *Glossogyne tannensis*, *Goodenia bellidifolia*, *Murdannia graminea*, *Stypandra glauca*, *Wahlenbergia communis*.

**Variability:** This community type is highly variable. Due to its disjunct nature, opportunistic occurrences of taxa may often give a different appearance. For example, the presence or absence of *Callitris endlicheri* or some other major component will visually change the community; however, the overall floristics are relatively similar. The major differences are between rock outcrops and dry hillsides, again mainly in visual appearance.

#### **Community 7: Limestone Woodlands**

*Callitris glaucophylla* (White Cypress Pine)–*Angophora floribunda* (Rough-barked Apple)–*Brachychiton populneus* (Kurrajong)–*Eucalyptus albens* (White Box).

**Structure:** Woodland: Tree layer 20–25 m tall, 20–30% cover. Shrubs 1–3 m tall. 5–10% cover. Ground cover 90–100%.

**Trees:** *Callitris glaucophylla*, *Angophora floribunda*, *Brachychiton populneus*, *Eucalyptus albens*, *Eucalyptus melanophloia*.

**Shrubs:** *Notelaea microcarpa*, *Desmodium brachypodum*, *Pimelea neo-anglica*, *Solanum cinereum*, *Canthium odoratum*.

**Climbers:** *Glycine latifolia*, *Eustrephus latifolius*, *Clematis glycinoides*, *Rubus parvifolius*, *Parsonsia straminea*.

**Ground cover:** *Dichondra* sp. A., *Microlaena stipoides*, *Adiantum aethiopicum*, *Plantago debilis*, *Geranium solanderi*, *Lomandra longifolia*, *Aristida ramosa*, *Cheilanthes sieberi*, *Wahlenbergia communis*, *Lomandra confertifolia*, *Glycine tabacina*, *Glycine clandestina*, *Cymbopogon refractus*, *Stemodia glabella*, *Desmodium varians*, *Daucus glochidiatus*, *Calotis lappulaceae*, *Veronica calycina*, *Oxalis perennans*, *Eremophila deserti*, *Dianella caerulea*.

**Variability:** Only a small amount of this community exists within the park and therefore the variability is minimal. The amount of limestone outcrop affects the density of the tree layer.

**Community 8: Alluvial Woodlands**

*Eucalyptus melliodora* (Yellow Box)–*Eucalyptus blakelyi* (Blakely's Red Gum)–*Callitris glaucophylla* (White Cypress Pine).

**Structure:** Woodland: Trees 20–25 m tall, c. 30% cover. Shrubs to 5 m tall, 5% cover. Ground cover 100%.

**Trees:** *Eucalyptus melliodora*, *Callitris glaucophylla*, *Brachychiton populneus*, *Eucalyptus blakelyi*.

**Shrubs:** *Notelaea microcarpa*, *Swainsona queenslandica*, *Acacia leiocalyx*.

**Climbers:** None apparent.

**Ground cover:** *Dichondra* sp. A, *Aristida ramosa*, *Cheilanthes sieberi* subsp. *sieberi*, *Stemodia glabella*, *Desmodium varians*, *Daucus glochidiatus*, *Calotis lappulaceae*, *Mentha satureioides*, *Mentha diemenica*, *Lomandra multiflora*, *Euchiton sphaericus*, *Cyperus squarrosus*, *Brunoniella australis*, *Microlaena stipoides*, *Plantago debilis*, *Geranium solanderi*, *Veronica calycina*, *Oxalis perennans*, *Vittadinia dissecta*, *Ranunculus lappaceus*, *Einadia hastata*, *Cynoglossum australe*, *Chamaesyce drummondii*, *Arthropodium milleflorum*.

**Variability:** Very little of this community exists to the south of the current reserve and so little variation is noticeable, most of which is probably due to intergradation with other defined communities. *Callistemon viminalis* becomes dominant in the understorey closer to the creek line. *Eucalyptus albens* grades into this community further away from the creek.

**Discussion****Vegetation communities**

The presence of dry rainforest taxa is a feature of the Mixed Stands and distinguishes it from all other communities recognised within the Park. Beadle (1981) named associations such as these 'mixed stands' and described them as occurring on rocky outcrops as far south as Gunnedah. Such communities fit into the Webb (1978) structural category of semi-evergreen vine thicket. Floyd (1990) placed such assemblages within his Suballiance No. 32 *Notelaea microcarpa*–*Ehretia membranifolia*–*Geijera parviflora* for his rainforest classification of New South Wales and includes vegetation as far south as the Hunter Valley and north to Toowoomba. The annual rainfall of around 660 mm for Kwiambal is close to the range specified by Floyd (1990) for optimal development of this community type (i.e. 575–650 mm).

Benson et al. (1996) present a review of current knowledge of dry rainforest communities of north-eastern New South Wales in their discussion of Derra Derra Ridge. Although they have mapped major and minor occurrences of this assemblage, those at Kwiambal are not included. Almost all previous occurrences of this association are on deep, loamy and high nutrient soils derived from basalt (Benson et al. 1996). At Kwiambal, this community type is restricted to granite and this may explain why it is depauperate in comparison to those described at Derra Derra Ridge.

Community 1 is unlike the dry rainforest described for the Hunter region (Floyd 1990; Turner & Vernon 1994) or Mt Kaputar (Fox 1994). However, there is a remarkable overall resemblance to communities and taxa described and listed for Derra Derra Ridge (Benson et al. 1996) and Planchonella Hill (Henderson 1997, Williams 1998). A similar community is defined by Le Brocque & Benson (1995) as Community 9 *Eucalyptus melanophloia*/*Callitris glaucophylla* association with a dry rainforest sub-component. Le Brocque and Benson (1995) describe their community as being confined to the north of the Ashford map sheet, particularly in Queensland where it is found on granite and sedimentary soils. Further extensions of this community are known within the Severn State Forest and on private property to the north and west of the national park. It is apparent the mixed stands at Kwiambal are directly synonymous with those stands found on granite on the Ashford sheet by Le Brocque & Benson (1995). Further research into the variability of these communities and their relationships is warranted for a greater understanding of their threats, processes and floristic resemblances to other semi-evergreen vine thickets.

*Angophora leiocarpa* is usually only known from wide sandy valleys derived from sandstone primarily on the North Western Slopes and Plains of New South Wales and also central Queensland (Neldner 1984, Leach 1986, Young & McDonald 1989, Hill 1991, Carr 1996). Beadle (1981) placed *Angophora leiocarpa* in a Suballiance of *Eucalyptus crebra* and refers to it being common in sandstone areas and notes that they have been termed 'sandstone woodlands' by other authors. This assemblage occurring on granite was recognised by Le Brocque & Benson (1995) and termed Community 2 *Eucalyptus crebra*/*Angophora leiocarpa* association in their report on the vegetation of the Ashford sheet.

Community 2 can be recognised by the lack of species that are used to distinguish other communities. Most of the species within Granite Woodland are ubiquitous, in particular the overstorey components. This association of dominants is widespread in central Queensland (Neldner 1984) but appears to be of limited extent within New South Wales. Granite Woodland is probably synonymous with Community 11 *Eucalyptus dealbata*/*E. caleyi*/*E. melanophloia*/*Callitris* spp. association of Le Brocque & Benson (1995). Their community was located near Kwiambal on the Ashford map sheet, apart from a single occurrence near the Beardy River.

Metasediment Woodlands often contained *Eucalyptus albens*, which was not noted on granite within the Park. *Brunoniella australis* is a good indicator species for metasediments. Often where granite and metasediments abut, the two communities (2 and 3) can be separated visually by the presence of either *Olearia elliptica* on metasediments or *Leptospermum brevipes* on granite. It is interesting to note that both *Olearia elliptica* and *Leptospermum brevipes* will grow well on either rock type, however they grow in different topological positions. These preferences mean that where the two geological strata are together, *Olearia elliptica* is usually present on the metasediments and *Leptospermum brevipes* is present on the granite. Another noticeable difference with Metasediment Woodlands is the rarity of *Alphitonia excelsa* and lack of the dry rainforest species found in Mixed Stands. Young and McDonald (1989) describe *Eucalyptus melanophloia*, *E. dealbata*, *E. albens* communities with a similar

understorey as occurring along the Severn River west of Ballandean on traprock on their map of the vegetation of Warwick. Benson et al. (1996) describe a *Eucalyptus melanophloia*, *Eucalyptus albens* and *Callitris glaucophylla* association with similar understorey on basalt for Derra Derra Ridge. The only other occurrences of this type of association appears to be restricted to the Peel and Gwydir Valleys (Prober 1996). Le Brocque & Benson (1995) did not record *Eucalyptus albens* in their survey of the Ashford sheet but did record the often associated *Eucalyptus moluccana*. Beadle (1981) describes *Eucalyptus albens* as being particularly common on soils with a high base status particularly in calcium and generally of high fertility.

Shrubs are rare in the Riverine community, however introduced species are widespread. *Eucalyptus blakelyi* associations usually contain *Eucalyptus melliodora* and the reason why this species is absent from this community is unknown. This community has a very sparse or sometimes non-existent shrub layer but has a very diverse exotic forb component that appears to be common wherever it occurs (Beadle 1981, Sivertsen & Metcalf 1995). Communities similar to these probably occur from Victoria through the western slopes of New South Wales and into Queensland (Specht et al. 1995).

With the exception of *Olearia elliptica*, which forms a dense stand across the top of the Metabasalt lenses, shrubs are also rare in Metabasalt Woodland. Forbs form a major component of this community. Stunted, almost mono-specific stands of *Eucalyptus melanophloia* dominate. Neldner (1984) notes that it is common for *Eucalyptus melanophloia* to form mono-dominant stands on clay soils derived from basalt colluvium.

Most rock outcrop areas within Kwiambal have Mixed Stands however, this community also occurs below outcrops and along the riverbanks. Granite Open Woodland is entirely restricted to rock outcrops. Hunter and Clarke (1998) in their survey of granite outcrop communities term Community 6 *Aristida vagans*–*Tripogon loliiformis* grassland.

Limestone Woodland is restricted in its distribution and is found only on limestone areas particularly where this outcrops. There is a high incidence of introduced taxa on limestone outcrops within Limestone Woodland, and in particular *Hyparrhenia hirta* is prevalent. A unique assemblage of herbs is found in areas with this community.

### Phytogeography

Kwiambal National Park lies within the Northern Complex Province of the Nandewar Biogeographic Region (NAN). However, there is a high affinity of taxa found within Kwiambal for south central Queensland (Hunter 1998). Kwiambal has many species that are at or somewhat near their southern limit of distribution. For instance, the trees *Corymbia dolichocarpa* and *Angophora leiocarpa* have their main occurrence within central Queensland. Shrub species such as *Phyllanthus carpentariae* or *Euphorbia sarcostemmoides* are more common in the Northern Territory. Mixed Stand has its greatest affinities with other communities found in Queensland and its southern affinities probably lie only as far south as Derra Derra Ridge. Kwiambal does fit within interzone 3 of Burbidge (1960), a much older representation of biogeographical

regions. Certainly, the communities and many of the species show little resemblance to other areas within the Nandewar Biogeographic Region.

### Species richness

The total number of taxa is of note as Le Brocque & Benson (1995) in their survey of 105 sites across the Ashford map sheet found 290 taxa. They also noted that only a further 213 species had been previously recorded for the map sheet (503 taxa in total).

The current survey of the Park and nearby areas followed a period of good rainfall; many taxa found were ephemeral in nature. The low numbers of taxa found by Le Brocque & Benson (1995) were attributed to drought conditions within the area. This difference in floristic richness highlights the importance of timing in floristic surveys in semi-arid regions of Australia. A total of 407 vascular plant taxa was recorded from the collation of existing site data and this present survey. Approximately 17% (69) of all taxa recorded were exotic. From the 42 new survey sites, 266 taxa were recorded (65%) with the addition 59 sites from the previous surveys a total of 378 taxa were recorded from survey plots. A further 28 taxa were recorded opportunistically.

The 407 taxa occurred in 86 families and 257 genera (Appendix). Of the exotic taxa, ten were recorded opportunistically. Several of these were only recorded once others however, were very common and at times could be considered ubiquitous for all communities. The ten most frequent and abundant exotic species found in quadrats in decreasing order of relative abundance are: *Opuntia stricta*, *Hypochaeris radicata*, *Opuntia aurantiaca*, *Chloris virgata*, *Conyza albida*, *Bidens pilosa*, *Sonchus olearceus*, *Stellaria media*, *Hyparrhenia hirta*, *Verbena rigida* and *Foeniculum vulgare*.

### Rare or restricted plant species

There are 15 taxa considered significant within Kwiambal National Park or on adjoining lands purchased by the National Parks and Wildlife Service. Five of these taxa are listed nationally as rare or threatened (ROTAP) species (Briggs & Leigh 1996), three of which are also included within the *NSW Threatened Species Conservation Act* (1995).

*Acacia williamsiana* (2RCa) is a rare shrub with a disjunct distribution on the North Western Slopes of NSW, known from Torrington SRA, Kings Plains NP and Severn River NR. At Kwiambal this species was found to be very common on exposed ridges, rock outcrops and within areas dominated by Mixed Stands.

*Astrotricha roddii* (3VCa, listed Endangered under the TSC Act) is found in Kings Plains NP and Severn River NR in NSW and Mt Bullagang in Queensland. It was found to be widespread but scattered throughout the Park on outcrops and rocky ridge areas. Populations were also found on adjoining properties and in the neighbouring Severn SF.

*Euphorbia sarcostemmoides* (3KCa, listed Endangered under the TSC Act) is a poorly-known species mainly from tropical and arid Australia and has only been found in a few localities within NSW. Only one plant was seen within Mixed Stands on land that has not been included within the current Park but on land that is owned by the Service.

*Olearia gravis* (3KC-) is a poorly known taxon that has a disjunct and sporadic distribution from Murgon to Sundown and Girraween NP in Queensland, and Torrington SRA, Kings Plains NP and Gibraltar Range NP in NSW. Many hundreds of plants were found within Kwiambal and surrounding areas including Severn SF, particularly on rocky ridges and around outcrops. With large populations within Kwiambal, Torrington, Kings Plains, Sundown and Girraween it is suggested that a more appropriate ROTAP code for this species would be 3RCa.

*Thesium australe* (3VCi, listed as Vulnerable under the TSC Act) is a herb that has a widespread but sporadic distribution from Queensland to Victoria, and within the Park was found from only one locality, on Metabasalt. No *Themeda australis* was found at the locality which is often associated within this species. *Cymbopogon refractus* was the dominant grass at the site.

Ten other taxa considered to be of conservation significance include those that are disjunct or thought to be at or near their geographic limit. Many of these taxa have not until now been included within, or are poorly represented within the reserve network and add to the overall importance of Kwiambal regionally. These taxa are: *Angophora leiocarpa*, *Bertya oleifolia*, *Corymbia dolichocarpa*, *Eucalyptus populnea* subsp. *bimbil*, *Haemodorum planifolium*, *Parsonsia straminea*, *Phyllanthus carpentariae*, *Santalum acuminatum*, *Stylidium debile* var. *paniculatum* and *Zornia muriculata* subsp. *angustata*. *Euphorbia sarcostemmoides*, *Santalum acuminatum* and *Stylidium debile* var. *paniculatum* are not currently within the Park boundaries but are within land owned and controlled by the National Parks and Wildlife Service.

## Conclusion

Eight distinct vegetation communities have been identified within the Kwiambal National Park. A number of these are notable due to their restricted occurrence and poorly conserved nature, in particular Mixed Stands with its 'dry rainforest' affinities. Rock type was one of the main environmental correlates associated with the delineation of communities.

Kwiambal National Park is an area that has been disturbed in the past. This is particularly so for the *Eucalyptus albens* (White Box) associated and the 'dry rainforest' influence communities. A number of rare species have been recorded including three species at present included on the *NSW Threatened Species Conservation Act* (1995).

The affinities of many of the vegetation assemblages in Kwiambal are with south central Queensland rather than most areas within New South Wales. Most of the taxa within Kwiambal are restricted to the north-east of the state and not commonly found further south.

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## References

- Beadle, N.C.W. (1981) *The vegetation of Australia*. (Cambridge University Press: Cambridge).
- Belbin, L. (1995a) *Users guide: PATN pattern analysis package*. (Division of Wildlife & Ecology CSIRO: Canberra).
- Belbin, L. (1995b) *Technical reference: PATN pattern analysis package*. (Division of Wildlife & Ecology CSIRO: Canberra).
- Benson, J.S., Dick, R. & Zubovic, A. (1996) Semi-evergreen vine thicket vegetation at Derra Derra Ridge, Bingara, New South Wales. *Cunninghamia* 4: 497–510.
- Braun-Blanquet, J. (1982) *Plant sociology: the study of plant communities*. (McGraw Hill: New York).
- Briggs, J.D. & Leight, J.H. (1996) *Rare or threatened Australian plants*. (CSIRO/Australian Nature Conservation Agency: Canberra).
- Burbidge, N.T. (1960) The phytogeography of the Australian region. *Australian Journal of Botany* 8: 75–211.
- Carr, D. (1996) *A field guide to the trees and tall shrubs of the North-West Slopes*. (Greening Australia: Armidale).
- Division of National Mapping (1986) *Atlas of Australian resources third series: Climate*. (Division of National Mapping: Canberra).
- Fisher, A.M. & Goldney, D.C. (1997) Use by birds of riparian vegetation in an extensively fragmented landscape. *Pacific Conservation Biology* 3: 275–288.
- Flood, P.G. & Aitchison, J.C. (1993) Understanding the New England geology: the comparative approach. Pp. 1–10 In P.G. Flood & J.C. Aitchison (eds) *New England Orogen Eastern Australia*. (Department of Geology and Geophysics, University of New England: Armidale).
- Flood, P.G., Aitchison, J.C., & Lennox, P.G. (1994) Limestone-capped seamounts within the late Paleozoic accretionary prism of the New England Orogen, Eastern Australia. *Geological Survey of Australia Abstracts* 36: 110–111.
- Floyd, A.G. (1990) *Australian rainforests in New South Wales*. Vol. 2. (Surrey Beattie & Sons Pty Ltd: Sydney).
- Fox, P. (1994) *Mt Kaputar National Park*. (NSW National Parks & Wildlife Service: Narrabri).
- Henderson, A. (1997) Planchonella Hill Nature Reserve biodiversity report. Unpublished report to the Narrabri District National Parks & Wildlife Service.
- Hill, K.D. (1991) *Angophora*. Pp. 73–76 In: G.J. Harden (ed.) *Flora of New South Wales* Vol. 2. (University of New South Wales Press: Sydney).
- Howell, R. (1982) *The History and Culture of the Aboriginal People of the Ashford District*. (New South Wales Department of Education: Sydney).
- Hunter, J.T. (1998) Vegetation Survey of the Proposed Kwiambal National Park. Unpublished report to the Glen Innes District National Parks & Wildlife Service. (J.A. Hunter Pty Ltd: Armidale).
- Hunter, J.T. & Clarke, P.J. (1998) The vegetation of granitic outcrop communities on the New England Batholith of eastern Australia. *Cunninghamia* 5: 547–618.



- Le Brocq, A.F. & Benson, J.S. (1995) 'Report on Stage 2 of the Task 5 Pilot Survey for Basincare M305 Project: An investigation into the methodology, costs and logistics involved in the collection of floristic data'. Unpublished report. (Royal Botanic Gardens: Sydney).
- Leach, G.J. (1986) A revision of the genus *Angophora* (Myrtaceae). *Telopea* 2: 749–779.
- Makinson, R.O. (1991) Two new species of *Astrotricha* (Araliaceae) from New South Wales. *Telopea* 4: 313–319.
- McMahon, J. (1995) 'BIOCLIM — the BIOCLIMatic Prediction System' Version 3.6. (Centre for Resource and Environmental Studies, Australian National University: Canberra).
- McMinn, W.G. (1970) *Allan Cunningham: Botanist and Explorer*. (Melbourne University Press: Melbourne).
- Nadolny, C., Benson, J.S., & Hunter, J.T. (1997) Recovery Plan for *Astrotricha roddii*. (Unpublished report for NSW National Parks & Wildlife Service).
- Neldner, V.J. (1984) Vegetation survey of Queensland: South Central Queensland. *Queensland Botany Bulletin* 3. (Queensland Department of Primary Industries: Brisbane).
- Prober, S.M. (1996) Conservation of the grassy White Box woodlands: rangewide floristic variation and implications for reserve design. *Australian Journal of Botany* 44: 57–77.
- Prober, S.M. & Theile, K.R. (1993) The ecology and genetics of remnant grassy White Box woodlands in relation to their conservation. *Victorian Naturalist* 110: 30–36.
- Roberts, G.W. (1982) Macintyre Falls National Park Proposal. Unpublished report for NSW National Parks & Wildlife Service.
- Roberts, G.W. (1983) *A vegetation survey of granitic areas on part of the Northern Tablelands and upper North Western Slopes, New South Wales*. Master of Science Preliminary Thesis. (University of New England: Armidale).
- Sivertsen, D. & Metcalfe, L. (1995) Natural vegetation of the southern Wheat-belt (Forbes and Cargelligo 1:250 000 map sheets). *Cunninghamia* 4: 103–128.
- Specht, R.L., Specht, A., Whelan, M.B. & Hegarty, E.E. (1995) *Conservation atlas of plant communities in Australia*. (Centre for Coastal Management & Southern Cross University Press: Lismore).
- Turner, F. (1905) Botany of north-western New South Wales. *Proceedings of the Linnean Society of New South Wales* 30: 23–91.
- Turner, J.C. & Vernon, S.L. (1994) Rainforest stands between Barrington Tops and the Hunter River, New South Wales. *Cunninghamia* 3: 465–514.
- Webb, L.J. (1978) Environmental relationships of the structural types of Australian rainforest vegetation. *Ecology* 49: 296–311.
- Wilkie, A.M.D.G. (1996) 'The Kwiambal Terrane: An accreted seamount in the Southern New England Orogen'. B.Sc. (Hons.) Thesis. (Department of Geology and Geophysics, University of New England: Armidale).
- Williams, J.B. (1998) 'Plant list for Planchonella Hill'. (Division of Botany, University of New England: Armidale).
- Young, P.A.R. & McDonald, T.J. (1989) Vegetation map and description of Warwick South-Eastern Queensland. *Queensland Botany Bulletin* 8. (Queensland Department of Primary Industries: Brisbane).

**Appendix: Flora of Kwiambal National Park and surrounds. Based primarily on collections made during this survey with the additional records from previous surveys. Nomenclature follows that of Harden (1990–1993) except where recent changes have occurred, and authorities have been given for these species. Taxa found within the survey sites are scored according to their occurrence in each of the 8 flexible UPGMA communities defined, some taxa were found in previous surveys or opportunistically and therefore are not assigned to a specific community. C1 = Mixed Stand Woodland; C2 = Granite Woodland; C3 = Metasediment Woodland; C4 = Riverine; C5 = Metabasalt Woodland; C6 = Granite Open Woodland; C7 = Limestone Woodland; C8 = Alluvial Woodland.**

**\* denotes introduced taxa**

Community	No. of sites	Richness per 400 m <sup>2</sup> (average)				No. of introduced taxa			No. of taxa
		C1	C2	C3	C4	C5	C6	C7	C8
C1: Mixed Stand Woodland	10	25–50 (42)				145			17
C2: Granite Woodland	8	35–55 (45)				130			16
C3: Metasediment Woodland	9	27–53 (35)				112			12
C4: Riverine	5	41–51 (46)				118			22
C5: Metabasalt Woodland	3	36–44 (42)				74			11
C6: Granite Open Woodland	4	26–31 (28)				67			2
C7: Limestone Woodland	2	31–40 (36)				52			10
C8: Alluvial Woodland	1	41				41			9
<b>PTERIDOPHYTES AND ALLIES</b>									
<b>Adiantaceae</b>									
<i>Adiantum aethiopicum</i>	1							7	
<i>Adiantum hispidulum</i>									
<b>Aspleniaceae</b>									
<i>Asplenium flabellifolium</i>									
<i>Pleurosorus rutifolius</i>									
<i>Pleurosorus subglandulosus</i>			3	4	5				
<b>Azollaceae</b>									
<i>Azolla filiculoides</i> var. <i>rubra</i>									
<b>Marsileaceae</b>									
<i>Marsilea costulifera</i> D.L.Jones					4				
<b>Psilotaceae</b>									
<i>Psilotum nudum</i>									
<b>Sinopteridaceae</b>									
<i>Cheilanthes distans</i>	1	2	3	4	5	6			
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	1	2	3	4	5	6	7	8	
<i>Pellaea falcata</i> var. <i>nana</i>									
<b>GYMNOSPERMS</b>									
<b>Cupressaceae</b>									
<i>Callitris endlicheri</i>					3	5			
<i>Callitris glaucophylla</i>	1	2	3	4	5	6	7	8	
<b>MONOCOTYLEDONS</b>									
<b>Anthericaceae</b>									
<i>Arthropodium milleflorum</i>	1	2	4		5	6			8
<i>Caesia parviflora</i> var. <i>parviflora</i>		2	3						
<i>Dichopogon strictus</i>								5	
<i>Laxmannia gracilis</i>									



	C1	C2	C3	C4	C5	C6	C7	C8
<b>Poaceae cont.</b>								
<i>Aristida psammophila</i>								
<i>Aristida ramosa</i>	1	2	3	4	5	6	7	8
<i>Aristida vagans</i>	1	2	3	4		6		
<i>Arundinella nepalensis</i>	1	2		3				
<i>Austrodanthonia bipartita</i> (Link) H.P.Linder								
<i>Austrodanthonia monticola</i> (Vickery) H.P.Linder	1							
<i>Austrostipa aristiglumis</i> (F.Muell.) S.W.L.Jacobs & J.Everett								
<i>Austrostipa drummondii</i> (Steud.) S.W.L.Jacobs & J.Everett	1	2	3	4	5			
<i>Austrostipa nitida</i> (Summerh. & C.E.Hubb.) S.W.L.Jacobs & J.Everett								
<i>Austrostipa scabra</i> (Lindl.) S.W.L.Jacobs & J.Everett								
<i>Austrostipa setacea</i> (R.Br.) S.W.L.Jacobs & J.Everett								
<i>Austrostipa verticillata</i> (Nees ex Spreng.) S.W.L.Jacobs & J.Everett								
* <i>Briza maxima</i>								
* <i>Bromus diandrus</i>								
* <i>Chloris virgata</i>	1	2	3		5			
<i>Chrysopogon fallax</i>								
<i>Cymbopogon oblectus</i>	1							
<i>Cymbopogon refractus</i>	1	2	3	4	5	6	7	
<i>Cynodon dactylon</i>				4				
<i>Dichelachne micrantha</i>								
<i>Digitaria breviglumis</i>	1					6		
<i>Digitaria brownii</i>	1							
* <i>Digitaria ischaemum</i>								
* <i>Digitaria sanguinalis</i>								
<i>Echinopogon intermedius</i>								
<i>Echinopogon ovatus</i>	1	2	3	4				
* <i>Ehrharta calycina</i>								
<i>Enneapogon gracilis</i>	1		3					
<i>Enneapogon nigricans</i>				4				
<i>Entolasia stricta</i>	1	2	3	4		6		
<i>Eragrostis elongata</i>		2	3			6		
<i>Eragrostis leptostachya</i>				4				
<i>Eulalia aurea</i>			3					
* <i>Hyparrhenia hirta</i>	1	2		4	5		7	
<i>Imperata cylindrica</i>				4				
* <i>Lolium temulentum</i>			3					
<i>Microlaena stipoides</i>	1	2	3			6	7	8
<i>Oplismenus aemulus</i>	1	2						
* <i>Panicum antidotale</i>								
<i>Panicum effusum</i>								
<i>Panicum simile</i>		2	3	4	5			
<i>Paspalidium distichum</i>	1		3					
* <i>Paspalum dilatatum</i>								
<i>Plinthanthesis urvillei</i>	1			4				
<i>Poa sieberiana</i> var. <i>hirtella</i>								
* <i>Setaria pumila</i>	1			4				
<i>Sorghum leiocladum</i>								
<i>Sporobolus creber</i>	1			4				



	C1	C2	C3	C4	C5	C6	C7	C8
<b>Asteraceae cont.</b>								
<i>Chrysocephalum apiculatum</i>	1	2		4				
* <i>Cirsium vulgare</i>				4				
* <i>Conyza albida</i>	1	2	3	4	5		7	8
* <i>Conyza bonariensis</i>								
* <i>Crepis capillaris</i>							7	
<i>Cymbonotus lawsonianus</i>	1			4	5			
<i>Euchiton involucratus</i> (G.Forst.) Holub								
<i>Euchiton sphaericus</i> (Willd) Holub	1	2						8
<i>Glossogyne tannensis</i>	1	2	3		5	6		
* <i>Gnaphalium coarctatum</i>		2		4				
* <i>Gnaphalium polycaulon</i>				4				
<i>Hyalosperma semisterile</i>								
* <i>Hypochoeris radicata</i>	1	2		4	5			
* <i>Lactuca serriola</i>			3				7	
<i>Olearia elliptica</i>		2	3		5			
<i>Olearia gravis</i>	1	2						
<i>Olearia ramosissima</i>								
* <i>Schkuhria pinnata</i> var. <i>abrotanoides</i>								
<i>Senecio diaschides</i>	1	2	3	4				
<i>Senecio lautus</i> subsp. <i>dissectifolius</i>			3					
<i>Senecio murrayanus</i>								
<i>Senecio</i> sp. E		2						
<i>Senecio tenuiflorus</i>								
<i>Sigesbeckia australiensis</i>	1	2	3	4	5			
<i>Solenogyne belloides</i>			3					
* <i>Sonchus asper</i> subsp. <i>glaucescens</i>	1							8
* <i>Sonchus olearceus</i>	1	2	3	4	5		7	
* <i>Taraxacum officinale</i>	1			4				
<i>Triptilodiscus pygmaeus</i>		2		4		6		
<i>Vernonia cinerea</i> var. <i>cinerea</i>	1	2	3		5			
<i>Vittadinia cuneata</i>						6		
<i>Vittadinia dissecta</i> var. <i>hirsuta</i>		2	3					8
<i>Vittadinia hispidula</i>								
<i>Vittadinia muelleri</i>								
<i>Vittadinia sulcata</i>	1	2	3	4	5			
* <i>Xanthium spinosum</i>								
* <i>Zinnia peruviana</i>								
<b>Bignoniaceae</b>								
<i>Pandorea pandorana</i>	1	2	3					
<b>Boraginaceae</b>								
* <i>Amsinckia intermedia</i>								
<i>Cynoglossum australe</i>	1	2		4	5			8
* <i>Myosotis intermedia</i>								
<b>Brassicaceae</b>								
<i>Cardamine paucijuga</i>				4	5			
* <i>Hirschfeldia incana</i>								
* <i>Lepidium bonariense</i>		2						
* <i>Rapistrum rugosum</i>								
<b>Cactaceae</b>								
* <i>Opuntia aurantiaca</i>	1	2	3	4	5	6		
* <i>Opuntia stricta</i> var. <i>stricta</i>	1							
* <i>Opuntia tomentosa</i>	1	2	3	4		6	7	

	C1	C2	C3	C4	C5	C6	C7	C8
<b>Campanulaceae</b>								
<i>Wahlenbergia communis</i>	1	2	3	4	5	6	7	
<i>Wahlenbergia gracilentia</i>								
<i>Wahlenbergia gracilis</i>								
<i>Wahlenbergia graniticola</i>		2	3		5			
<i>Wahlenbergia planiflora</i> subsp. <i>longipila</i>				4				
<i>Wahlenbergia stricta</i>								
<b>Caryophyllaceae</b>								
* <i>Arenaria leptoclados</i>	1	2					7	
* <i>Paronychia brasiliiana</i>								
* <i>Petrorhagia nanteuillii</i>							7	
<i>Polycarpha corymbosa</i> var. <i>minor</i>	1	2						
* <i>Polycarpon tetraphyllum</i>	1	2	3		5			8
<i>Scleranthus biflorus</i>						6		
* <i>Stellaria media</i>	1	2		3	4			
<i>Stellaria multiflora</i>								
* <i>Stellaria pallida</i>								
<b>Casuarinaceae</b>								
<i>Casuarina cunninghamiana</i>	1							
<b>Chenopodiaceae</b>								
<i>Chenopodium carinatum</i>	1							
<i>Chenopodium pumilio</i>								
<i>Einadia hastata</i>	1	2	3	4	5			8
<i>Einadia polygonoides</i>								
<i>Einadia trigonus</i> subsp. <i>stellutlata</i>					5			
<b>Clusiaceae</b>								
<i>Hypericum gramineum</i>	1	2	3	4		6		
<b>Convolvulaceae</b>								
<i>Convolvulus erubescens</i>								
<i>Dichondra repens</i>	1	2	3					
<i>Dichondra</i> sp. A	1	2	3	4	5	6	7	8
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>		2	3		5	6		
<b>Crassulaceae</b>								
<i>Crassula colorata</i> var. <i>acuminata</i>		2	3			6		
* <i>Bryophyllum delagoense</i>								
<b>Dilleniaceae</b>								
<i>Hibbertia acicularis</i>								
<i>Hibbertia kaputarensis</i>								
<i>Hibbertia obtusifolia</i>	1	2	3	4	5			
<b>Droseraceae</b>								
<i>Drosera peltata</i>								
<b>Epacridaceae</b>								
<i>Brachyloma daphnoides</i> subsp. <i>glabrum</i> (Blakely) J.T.Hunter								
<i>Brachyloma daphnoides</i> subsp. <i>pubescens</i> J.T.Hunter								
<i>Leucopogon attenuatus</i>								
<i>Leucopogon muticus</i>		2	3			6		
<i>Melichrus erubescens</i>								
<i>Melichrus urceolatus</i>	1	2	3		5	6		
<i>Styphelia triflora</i>		2	3					

	C1	C2	C3	C4	C5	C6	C7	C8
<b>Euphorbiaceae</b>								
<i>Bertya oleifolia</i>	1		3		5			
<i>Beyeria viscosa</i>								
<i>Breynia cernua</i> (Poir.) Muel.Arg.	1	2						
<i>Chamaesyce drummondii</i>	1	2	3		5			8
<i>Euphorbia Eremophila</i>		1						
<i>Euphorbia planticola</i>								
<i>Euphorbia sarcostemmoides</i>								
<i>Petalostigma pubescens</i>	1							
<i>Phyllanthus carpentariae</i> Muell.Arg.	1					6		
<i>Phyllanthus virgatus</i>	1	2	3	4		6		
<i>Poranthera microphylla</i>		2	3			6		
<b>Fabaceae</b>								
<i>Acacia cheelii</i>	1					6		8
<i>Acacia decora</i>								
<i>Acacia farnesiana</i>								
<i>Acacia leiocalyx</i>	1	2	3	4		6		
<i>Acacia leptoclada</i>						6		
<i>Acacia neriifolia</i>		2						
<i>Acacia pruinosa</i>	1	2						
<i>Acacia williamsiana</i> J.T.Hunter	1					6		
<i>Crotalaria mitchellii</i> subsp. <i>mitchellii</i>		1						
<i>Cullen tenax</i>				4				
<i>Desmodium brachypodum</i>	1	2	3		5	6	7	
<i>Desmodium varians</i>	1	2	3	4	5	6	7	8
<i>Glycine clandestina</i>	1	2	3	4			7	
<i>Glycine latifolia</i>							7	
<i>Glycine tabacina</i>							7	
<i>Glycine tomentella</i>	1	2	3	4	5		7	
* <i>Hirschfeldia incana</i>								
<i>Hovea lanceolata</i>				4				
<i>Hovea linearis</i>	1	2	3	4		6		
<i>Indigophora adesmiifolia</i>								
<i>Jacksonia scoparia</i>		2						
<i>Lespedeza juncea</i> subsp. <i>sericea</i>	1							
<i>Lotus australis</i>		2						
<i>Medicago polymorpha</i>				4	5		7	8
* <i>Melilotus indicus</i>			3					
<i>Mirbelia pungens</i>								
<i>Pultenaea flexilis</i>								
<i>Pultenaea foliolosa</i>								
<i>Rhychosia minima</i>								
<i>Senna barklayana</i>								
<i>Swainsona cadellii</i>								
<i>Swainsona galegifolia</i>				4	5			
<i>Swainsona luteola</i>								
<i>Swainsona queenslandica</i>			3				7	8
<i>Swainsona sericea</i>	1	2						
* <i>Trifolium arvense</i>				4	5			
* <i>Trifolium dubium</i>								
* <i>Trifolium campestre</i>				4	5			
* <i>Trifolium repens</i>				4				
<i>Zornia dyctiocarpa</i> var. <i>dyctiocarpa</i>	1	2	3					
<i>Zornia dyctiocarpa</i> var. <i>angustata</i>								
<b>Geraniaceae</b>								
* <i>Geranium molle</i> var. <i>molle</i>								
<i>Geranium solanderi</i> var. <i>solanderi</i>			3	4			7	8



	C1	C2	C3	C4	C5	C6	C7	C8
<b>Goodeniaceae</b>								
<i>Goodenia bellidifolia</i>		2	3			6		
<i>Goodenia glabra</i>		2						
<i>Goodenia hederacea</i> subsp. <i>hederacea</i>	1		3			6		
<i>Dampiera stricta</i>								
<b>Haloragaceae</b>								
<i>Gonocarpus elatus</i>								
<i>Gonocarpus tetragynus</i>								
<i>Haloragis glauca</i> forma <i>glauca</i>	1							
<i>Haloragis heterophylla</i>		2		4				
<b>Lamiaceae</b>								
<i>Ajuga australis</i>	1		3	4	5			
<i>Mentha diemenica</i>				4	5			8
<i>Mentha satuireioides</i>				4				8
<i>Plectranthus parviflorus</i>	1					6		
<i>Prostanthera saxicola</i>	1							
<i>Scutellaria humilis</i>	1							
<i>Westringia longifolia</i>								
<b>Lobeliaceae</b>								
<i>Isotoma axillaris</i>								
<i>Isotoma fluviatilis</i> subsp. <i>borealis</i>								
<i>Lobelia gracilis</i>						6		
<i>Pratia purpurascens</i>				4				
<b>Loganiaceae</b>								
<i>Logania albiflora</i>								
<b>Loranthaceae</b>								
<i>Amyema miquelii</i>								
<i>Dendrophthoe glabrescens</i>	1							
<i>Muellerina bidwillii</i>								
<i>Muellerina eucalyptoides</i>		2	3					
<b>Malaceae</b>								
* <i>Malus x domestica</i>								
<b>Malvaceae</b>								
<i>Abutilon oxycarpum</i>	1							
* <i>Malvastrum americanum</i>								8
* <i>Pavonia hastata</i>			3	4				
<i>Sida cunninghamii</i>								
<i>Sida filiformis</i>								
* <i>Sida rhombifolia</i>				4				
<i>Sida ?spinosa</i>								
<b>Moraceae</b>								
<i>Ficus rubiginosa</i>	1							
* <i>Maclura pomifera</i>				4				
<b>Myoporaceae</b>								
<i>Eremophila debilis</i>			3		5		7	
<i>Eremophila deserti</i>							7	
<i>Myoporum montanum</i>								
<b>Myrtaceae</b>								
<i>Angophora floribunda</i>		2		4			7	
<i>Angophora leiocarpa</i>	1							
<i>Callistemon citrinus</i>								
<i>Callistemon viminalis</i>	1							

	C1	C2	C3	C4	C5	C6	C7	C8
<b>Myrtaceae cont.</b>								
<i>Calytrix tetragona</i>		2	3			6		
<i>Corymbia dolichocarpa</i> (D.J.Carr & S.G.M.Carr) K.D.Hill & L.A.S.Johnson	1							
<i>Eucalyptus albens</i>			3				7	
<i>Eucalyptus blakelyi</i>				4				8
<i>Eucalyptus caleyi</i> subsp. <i>caleyi</i>	1							
<i>Eucalyptus camaldulensis</i>				4				
<i>Eucalyptus dealbata</i>	1	2	3			7		
<i>Eucalyptus melanophloia</i>	1	2	3	4	5	6	7	
<i>Eucalyptus melliodora</i>								8
<i>Eucalyptus populnea</i> subsp. <i>bimbill</i>	1							
<i>Leptospermum brachyandrum</i>	1							
<i>Leptospermum brevipes</i>	1	2	3	4		6		
<b>Nyctaginaceae</b>								
<i>Boerhavia dominii</i>	1	2	3					
<b>Oleaceae</b>								
<i>Olex stricta</i>								
<b>Oleaceae</b>								
<i>Jasminum lineare</i>	1		3	4	5			
<i>Jasminum sauvisimum</i>			3					
<i>Notelaea microcarpa</i> var. <i>microcarpa</i>	1	2	3	4	5		7	8
<b>Onagraceae</b>								
* <i>Oenothera rosea</i>				4				
<b>Oxalidaceae</b>								
<i>Oxalis chnoodes</i>	1		3					
<i>Oxalis perennans</i>	1	2	3	4	5		7	8
<b>Phytolaccaceae</b>								
* <i>Phytolacca octandra</i>								
<b>Pittosporaceae</b>								
<i>Pittosporum phylliraeoides</i>								
<i>Rhytidosporum procumbens</i>								
<b>Plantaginaceae</b>								
<i>Plantago varia</i>	1	2	3	4	5			
<b>Polygalaceae</b>								
<i>Polygala linariifolia</i>								
<b>Polygonaceae</b>								
<i>Persicaria decipiens</i>								
<i>Rumex brownii</i>	1		3	4	5			
<b>Portulacaceae</b>								
<i>Anocampseros australiana</i>								
<i>Calandrinia eremaea</i>			3					8
<i>Portulaca bicolor</i> var. <i>rosea</i>	1							
<i>Portulaca fillifolia</i>	1					7		
<i>Portulaca oleracea</i>								
<b>Primulaceae</b>								
* <i>Anagallis arvensis</i>		2		4				8

	C1	C2	C3	C4	C5	C6	C7	C8
<b>Proteaceae</b>								
<i>Grevillea ramosissima</i>								
<i>Persoonia sericea</i>								
<b>Ranunculaceae</b>								
<i>Clematis glycinoides</i>				4			7	
<i>Ranunculus lappaceus</i>		2		4	5			8
<i>Ranunculus sessiliflorus</i>	1			4	5			
<b>Rhamnaceae</b>								
<i>Alphitonia excelsa</i>	1	2	3			6		
<i>Cryptandra amara</i> var. <i>floribunda</i>						6		
<i>Pomaderris andromedifolia</i>								
<b>Rosaceae</b>								
<i>Rubus parvifolius</i>							7	
* <i>Rubus rubiginosa</i>								
<b>Rubiaceae</b>								
<i>Asperula conferta</i>				4			7	
<i>Asperula subulifolia</i>								
<i>Canthium odoratum</i>	1	2	3			6	7	
<i>Canthium oleifolium</i>								
<i>Galium gaudichaudii</i>	1	2	3		5			
<i>Galium migrans</i>	1	2			5			
<i>Opercularia diphylla</i>								
<i>Opercularia hispida</i>								
<b>Rutaceae</b>								
<i>Correa reflexa</i> var. <i>reflexa</i>	1	2						
<i>Geijera parviflora</i>								
<i>Philotheca myoporoides</i>								
subsp. <i>conduplicatus</i> (Paul G. Wilson) M.J. Bayly								
<i>Zieria fraseri</i>								
<b>Santalaceae</b>								
<i>Santalum acuminatum</i>								
<i>Santalum lanceolatum</i>	1							
<i>Thesium australe</i>					5			
<b>Sapindaceae</b>								
<i>Alectryon subdentatus</i>								
forma <i>subdentatus</i>								
<i>Dodonaea sinuolata</i>								
subsp. <i>sinuolata</i>								
<i>Dodonaea viscosa</i> var. <i>angustifolia</i>	1		3					
<i>Dodonaea viscosa</i> var. <i>mucronata</i>								
<b>Scrophulariaceae</b>								
<i>Gratiola peruviana</i>								
<i>Stemodia glabella</i>	1		3				7	8
* <i>Verbascum thapsus</i> subsp. <i>thapsus</i>								
<i>Veronica calycina</i>	1	2		4			7	8
<b>Simaroubaceae</b>								
* <i>Ailanthus altissima</i>								
<b>Solanaceae</b>								
<i>Datura stamonium</i>								
<i>Solanum americanum</i>				4				
<i>Solanum brownii</i>		2	3		5			
<i>Solanum cinereum</i>			3				7	

