Vegetation and Floristics of Ironbark Nature Reserve & *Bornhardtia* Voluntary Conservation Area

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A Report to the New South Wales National Parks and Wildlife Service

Summary

The vegetation of Ironbark Nature Reserve and the *Bornhardtia* Voluntary Conservation Area is described and mapped (scale 1:25 000). Eleven communities are defined based on classification (Kulczynski association) with further sub-assemblages described. These eleven communities were mapped based on ground truthing, air photo interpretation and landform. One community is listed as Endangered on state and federal acts (*TSC* & *EPB&C* Acts), three are considered here to be vulnerable and all others are considered to be poorly or inadequately reserved across their range. Most communities are of woodland and open forest structure. The communities show considerable variation and intergrade along common boundaries and in particular on intermediate soil types. Drainage, Easting, Soil Depth, Physiography and protection from the North were the major correlative influences on community distribution, however Northing and Rock Type were also strongly correlated.

A total of 477 vascular plant taxa were found from 93 families and 269 genera. At least 39 species are considered of significance, 30 are of regional significance and a further nine are of state or national significance. Two species are listed on the *TSC* Act, one as Endangered and one as Vulnerable nine are RoTAP listed species or are listed under this criteria in other publications. At present 9% of the flora is exotic in origin (41 taxa).

Most management issues are related to appropriate fire regimes, weed and feral animal control with some revegetation needed and control of Reserve usage. Appropriate fire regimes will need to be researched and implemented. It is suggested that a variable and adaptive fire regime is adopted. Monitoring of a subset of the survey plots in subsequent years will enable a review of management practices to allow modification as new information is forthcoming. Introduced plants, pigs, goats, rabbits and stray cattle are sources of disturbance and will need to be controlled.

Currently few problems exist in terms of invasive weeds, Blackberry being the most significant. Pigs and goats are a serious threat to some areas. The conservation areas alone are not large enough to ensure continued ecosystem processes or the long-term viability of all species.

The study area represents a crossover of the floras of the North Western Slopes and the Northern Tablelands and is a significant remnant highlighted under the major North South-western Regional Corridor. The representation of high quality (old growth) woodlands across many vegetation assemblages is as important a feature of these conservation areas as endangered species and communities. Addition of lands or the incorporation of lands under conservation agreements around these areas is needed to ensure the continuing values and processes within the study area.

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Introduction

1.1 Objectives

This survey of the vegetation of the Ironbark Nature Reserve and the *Bornhardtia* Voluntary Conservation Area was prepared by Dr John T. Hunter. Aims included the collation of existing information from previous floristic surveys and that the surveying of up to 100 stratified sites be carried out in order to complete a comprehensive investigation of the vegetation and flora of Ironbark NR and *Bornhardtia* VCA. This report represents the findings of this study. The collated information is to be used as a guide for management purposes.

The requirements of the investigation were:

1. Collate existing information from previous vegetation surveys conducted within the conservation areas (30 sites; Hunter 1999).
2. Site placement to be based on selected environmental variables and be distributed based on the area they occupy.
3. Identify weed species and their occurrence.
4. Identify ROTAP and *TSC* Act species and their occurrence.
5. Identify regionally significant species.
6. Provide known fire ecology information on species and communities.
7. Construction of a vegetation map based on communities as defined by classification and ordination analyses.
8. Analyses of biogeographic patterns.
9. Provide management recommendations.
10. Collection of voucher specimens for reference.

1.2 Study area

Ironbark Nature Reserve and the *Bornhardtia* VCA are located on the Northern Tablelands 30 km east north east of Barraba and 75 km north west of Armidale (Figure 1). The VCA and the Reserve lie in the New England Tablelands Bioregion though the western boundary of Ironbark NR and the southern boundary of the VCA correspond with the Nandewar and Northern Tablelands Bioregions' common boundary. Both areas are within the Northern Tablelands Botanical Division and the local government areas of the Barraba Shire and the County and Parish of Darling (Figure 2). At present, the Reserve contains 1603 ha and *Bornhardtia* contains an additional 750 ha (excluding road reserves, 714 ha). The Ironbark 9037-II-N 1:25 000 map sheet covers the majority of the study area with a small portion on the Linton 9037-II-S 1:25 000 sheet. All current boundaries are with freehold lands.

1.3 Conservation gains and gazettal of the conservation areas

Ironbark Nature Reserve was gazetted on the 29 of November 1985. The original gazettal included only 1230 ha however an additional 373 ha was purchased in 1988 to the east incorporating a significant Aboriginal site. The *Bornhardtia* VCA was subdivided from Granite Heights and purchased from by Bill and June Allen on the 21st of November 1997. 704 ha which excluded road reserves and also excluded 9.5 ha in the south eastern corner, were gazetted under a Voluntary Conservation Agreement on the 18th of October 2001. The derivation of the property name is from the geomorphological term 'Bornhardt', which is a basic inselberg feature described as a large dome-shaped monolith, bald and steeply sided with few fractures whereas the surrounding landscape is highly fractured (Twidale 1982). Several bornhardts are on *Bornhardtia* two of which are gazetted cadastral features, 'Bald Rock' and 'Little Bald Rock'.

Within close proximity and in many cases conserving similar vegetation types are: Stoney Batter Nature Reserve, which incorporates 563 ha and was gazetted on 17th of December 1999; Linton Nature Reserve with 161 ha gazetted on 6th of July 1979; and Warrabah National Park which is the largest in the local region containing 3556 ha, gazetted on 6th of July 1984. Despite the number of reserves in the general vicinity, all combined on a small percentage of the local region is managed for conservation, only 6587 ha in total.

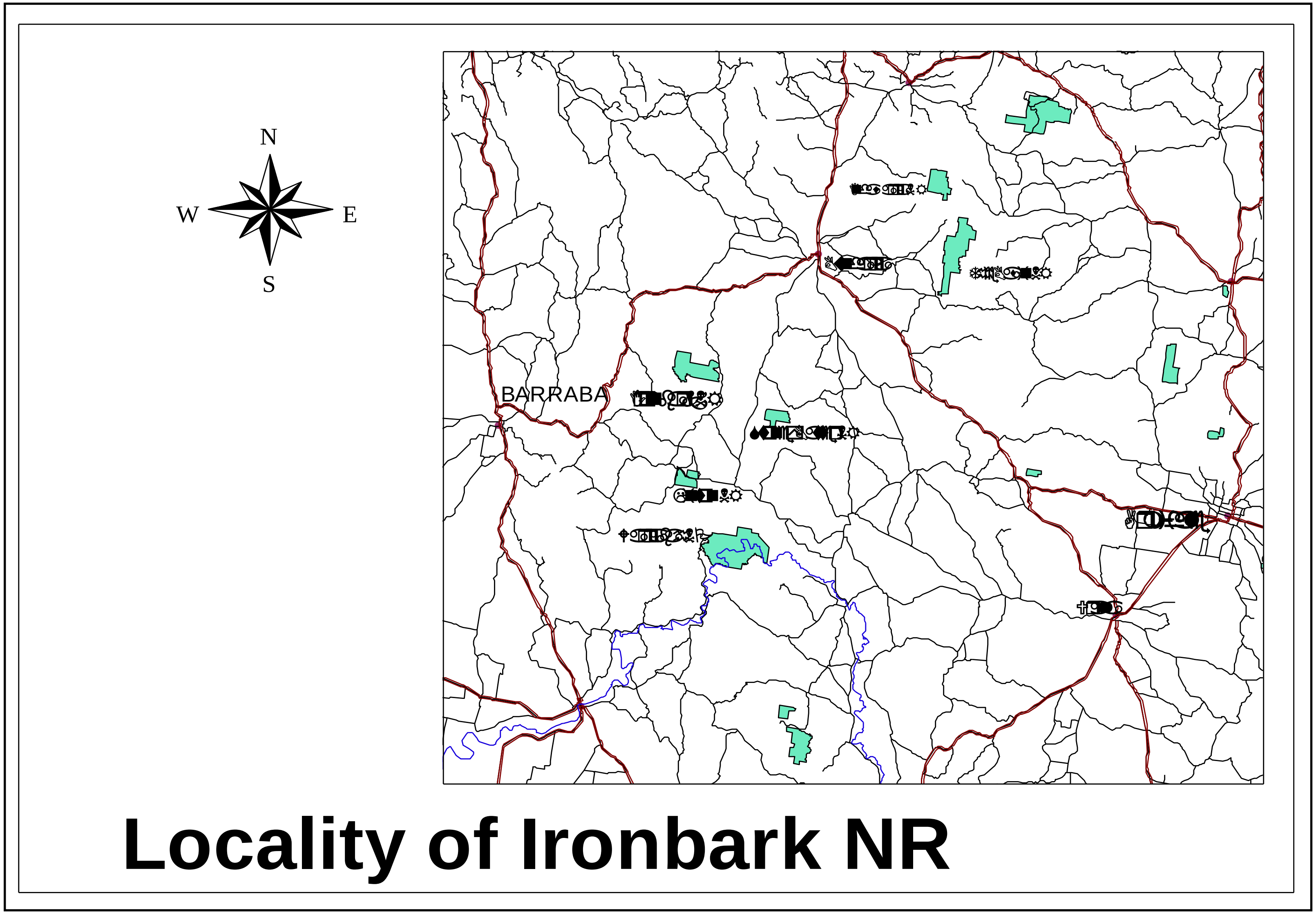


Figure 1: Locality of Ironbark Nature Reserve.

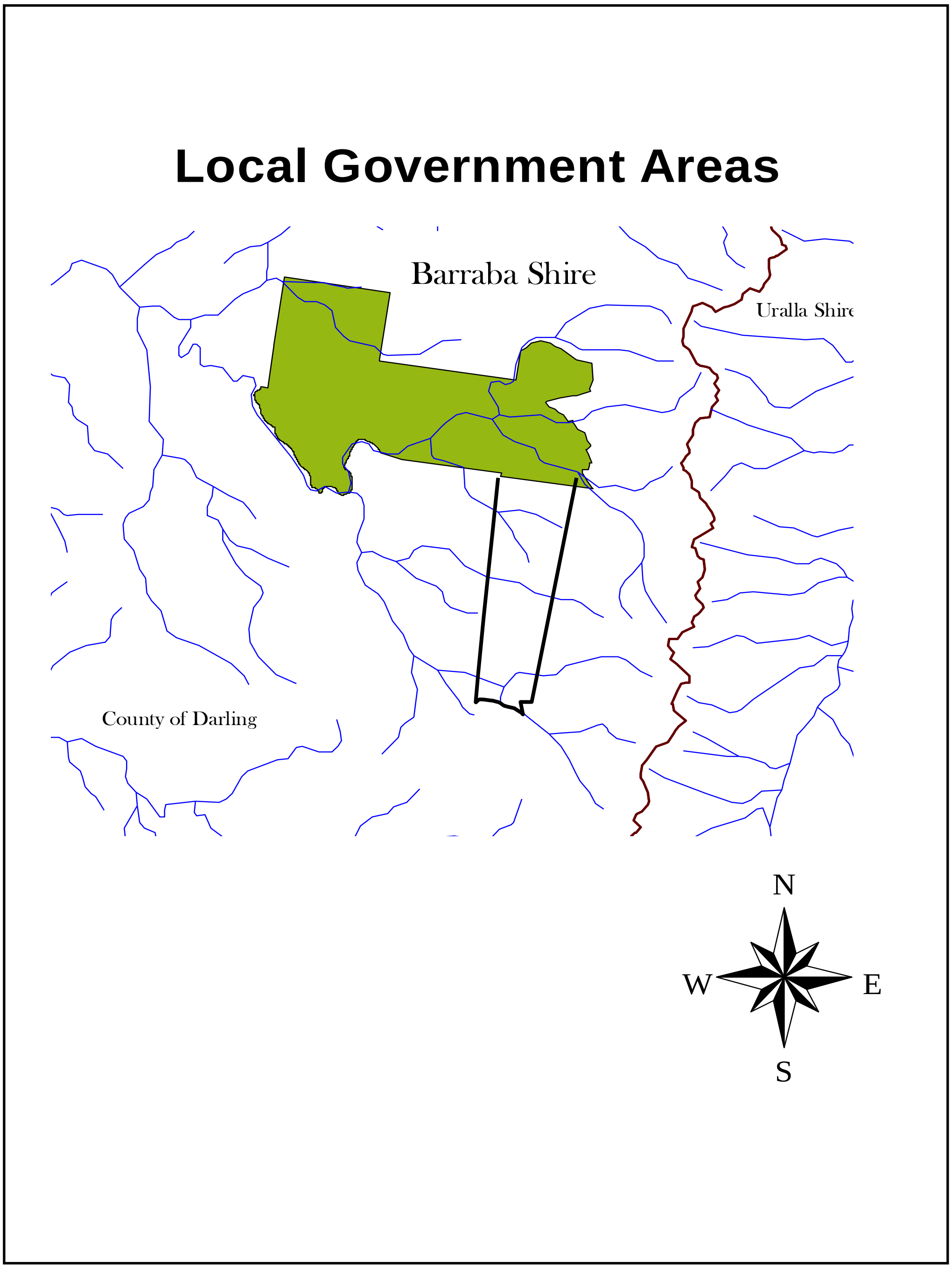


Figure 2: Location of Ironbark Nature Reserve and *Bornhardtia* Voluntary Conservation Area.

1.4 Climate

The median rainfall is 773 mm per annum (Table 1) but fluctuates greatly as records for the last 30 yrs (Figure 3) with yearly rainfall as little as 473 mm and as high as 1108 mm. Seasonal peaks on average between October and January, with January being the highest rainfall month (Figure 4). Seasonal snowfalls occur but are uncommon, frosts are common in the winter months. Average annual temperature varies from 14.6-17.7°C, with an average maximum of 32°C and minimum of –2.2°C. The climate varies greatly over the study area due to the rugged topography and changes in elevation.

1.5 Landform

The study area is a rugged landscape located on an eastern arm of the Nandewar Range. The topology of the landscape is dominated by exposed rock platforms, outcrops, kopjies (boulder piles), nubbins (large boulders), boulder fields and fugitive outcrops (subsurface rock sheets) (Plates 1-4). Areas of low relief are uncommon though some sections occur along deeply incised sections of Long Swamp Creek and some in upper catchments. Drainage flows to the west from both conservation areas.

The majority of water flows from *Bornhardtia* into Bald Rock Swamp Creek which later joins to Long Swamp Creek on the southern boundary of Ironbark NR (Figure 5). All water catchments within both conservation areas drain into Long Swamp Creek which joins Ironbark Creek to the west. Ironbark Creek then heads south to join the Namoi River; this flows into Lake Keepit.

Elevation ranges from 640 m at the point where Long Swamp Creek leaves the Nature Reserve to 1010 m at the top of Little Bald Rock within *Bornhardtia* (Figures 6-8).

Table 1: Raw rainfall data from Granite Heights which borders Ironbark NR and the *Bornhardtia* VCA.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1965		5.5	8.4	51.8	11.9	20.8	21.3	22.8	36.6	63.2	55.4	133.7	
1966	14.5	52.6	63	22.7	16.7	55.2	25	124.7	24.4	91.4	137.9	94.6	722.7
1967	34.7	40.7	48.2	1.3	44.5	78.7	17.2	50	19.6	111	12.5	41.6	500
1968	220.6	39.4	82.1	11.2	95	5.8	58.9	126.2	61.8	31.2	43.1	61	839.3
1969	85.2	49.5	17.3	44	79.6	31.1	16	51.1	65.8	127.2	110	76.5	753.3
1970	196	57.7	6.1	44.4	25.7	20	0.5	31.8	119.3	49.8	54.9	264.6	870.6
1971	137.7	162.3	0	8.7	9.7	3.8	89.9	121.7	70.4	27.4	84.8	23.1	739.5
1972	124.8	55.6	34.5	54.4	31.2	20.3	5.1	49.9	44.2	159.8	100.9	56.1	736.8
1973	150.7	98.9	22.5	4.3	36.4	47.2	58.9	51.8	85.8	168	131.7	85.2	919.2
1974	184.8	21.6	49.2	61.4	70	39.6	37.6	53.6	21.4	94	95.5	32.4	741.1
1975	60.2	180	108.6	28.6	15.2	53	37.4	54.8	39.8	92	118.8	107.8	896.8
1976	153.4	184.4	48.8	10.4	20	65.8	38.2	12.4	38.9	87.2	72	29.4	740.9
1977	138.4	127.8	93	34	165.8	36	14	26	38	27.2	43.2	44.7	788.1
1978	221.4	59.8	65.7	24	100	95.2	60.5	20.6	122.6	31	115	93.4	1009.2
1979	41.2	23.2	80	43	90	51	19.2	28.8	76	46.2	74.8	11.7	584.8
1980	104.8	22.2	16	3.2	89.8	13.6	42	17	1	48.4	19	95.7	472.7
1981	10	92.9	0	26.5	111	58.5	99.2	15.4	44	85	85.2	96.5	751.2
1982	47.5	62.5	191	15	26	14	20.6	10	31.4	47	15	105.2	585.2
1983	72.2	51.8	75.4	124	172.9	48	76	52.4	78.8	128.6	88	64	1032.1
1984	221.8	106.8	50.4	61	5.2	8	195.2	41.2	53.4	51.4	80	33.6	888
1985	85.8	63.6	45.4	87.4	20.1	33.6	26.6	96.2	52	86.6	31	137	785.3
1986	47.2	16.8	24.6	1	68.8	0	138	38.4	82.6	75.2	88	39.4	620
1987	172.6	27.8	112	17.2	96.2	41	26.6	116.6	23	83.8	82	99.2	898
1988	101.2	43	13	178.8	41.2	35	84.4	80.8	96	28.2	48.1	129.4	879.1
1989	66.8	21.8	81	64.4	54	108.8	118	20.5	10.2	19.2	131	149.2	875.1
1990	107.8	96	7.8	153.8	1.1	53.2	102.8	60.4	52.6	32.4	26.2	54.6	848.6
1991	155.7	111.8	67.2	0	90.8	70.2	72.3	1.6	19.8	32.4	53.8	97.4	773
1992	81.1	163	24.6	41.6	25.2	25.8	53.6	78	32.2	112.8	116.8	128	882.7
1993	95.3	68	9	1	46	73.4	91.6	38.4	89.2	81.8	53	111.2	757.9
1994	26.2	123.6	105	34	6.4	31.4	11	46.8	26	30.8	80.6	101.2	603
1995	141	78.2	26.8	7.6	64.2	91.2	25.6	2.2	111.8	70.1	181.4	148.2	948.1
1996	242.4	87.8	6.8	15.8	85	82.2	81.8	94.9	71.6	43.6	144.2	152	1107.9
1997	151.9	156.6	34.1	0	89.8	33							

Summary of Total Monthly Precipitation using available data from 1965 to 1997

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Mean	114.8	77.4	49	38.7	60.8	45	55.1	51.1	53.7	70.1	79.2	90.6	791.3
Median	106.3	62.5	45.4	26.5	54	40.3	40.1	48.4	48.1	65.2	78.4	95.2	773
Highest	242.4	184.4	191	178.8	172.9	108.8	195.2	126.2	122.6	168	181.4	264.6	1107.9
Lowest	10	5.5	0	0	5.2	0	0.5	1.6	1	19.2	12.5	11.4	472.7
Number	32	33	33	33	33	32	32	32	32	32	32	32	31

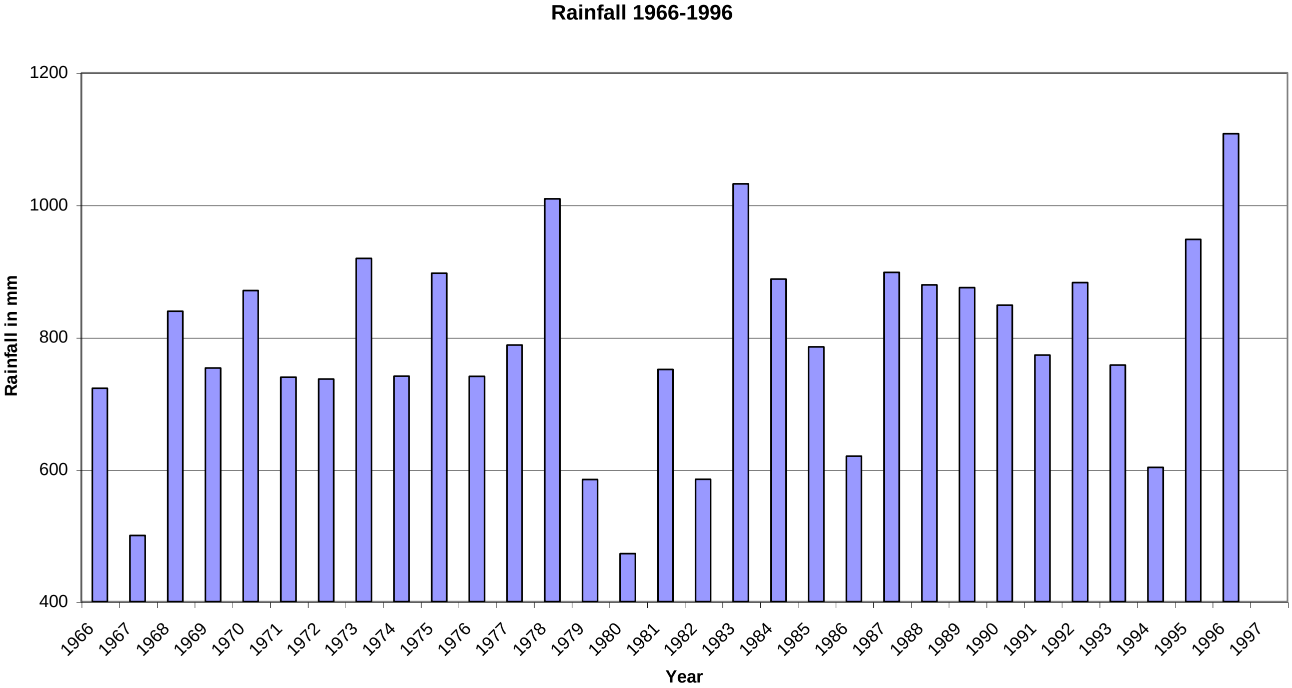


Figure 3: Total rainfall from 1966 to 1996.

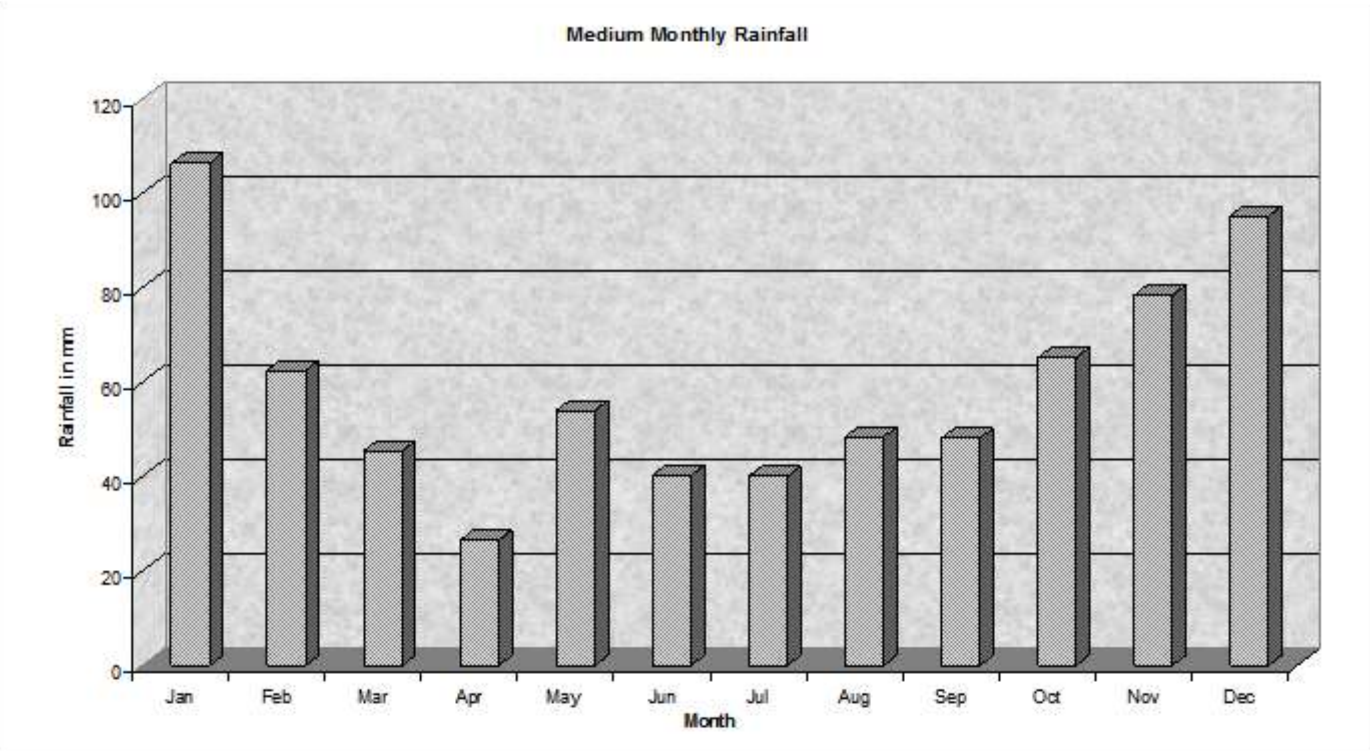


Figure 4: Medium monthly rainfall for each month from 1966 to 1996.

Plate 1: Aerial photograph of areas contained within Ironbark Nature Reserve (left and top half) and *Bornhardtia* VCA (bottom right). Long Swamp Creek is the main drainage feature in this photograph. Note the abundance of exposed granite sheeting and outcrops. (Cobbadah 1: 25 000; Run 9 71; 21-10-91; NSW4051).

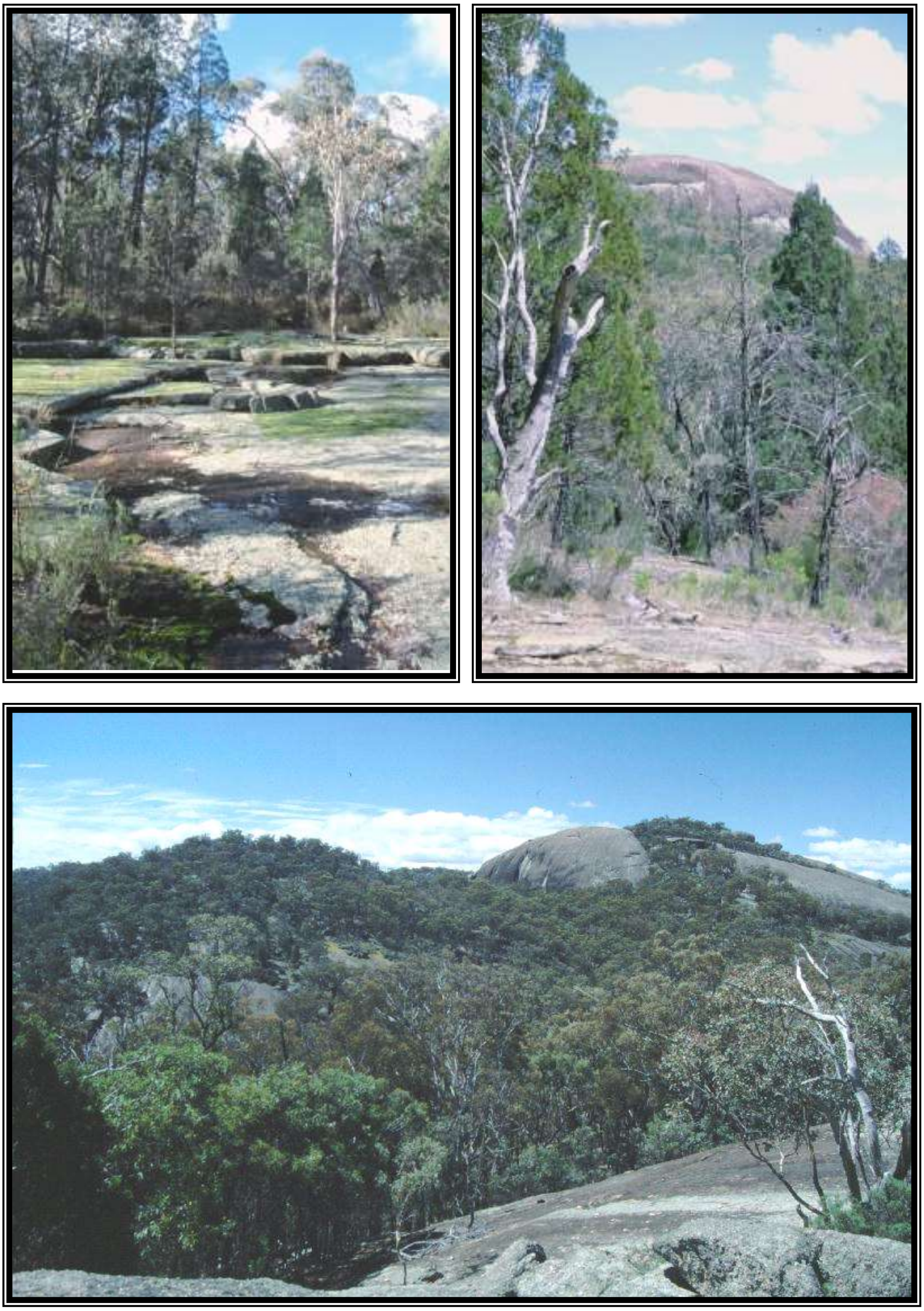


Plate 2: Landscape features of Ironbark NR and the *Bornhardtia* VCA. Included here are views of Bald Rock a named cadastral feature within the VCA.

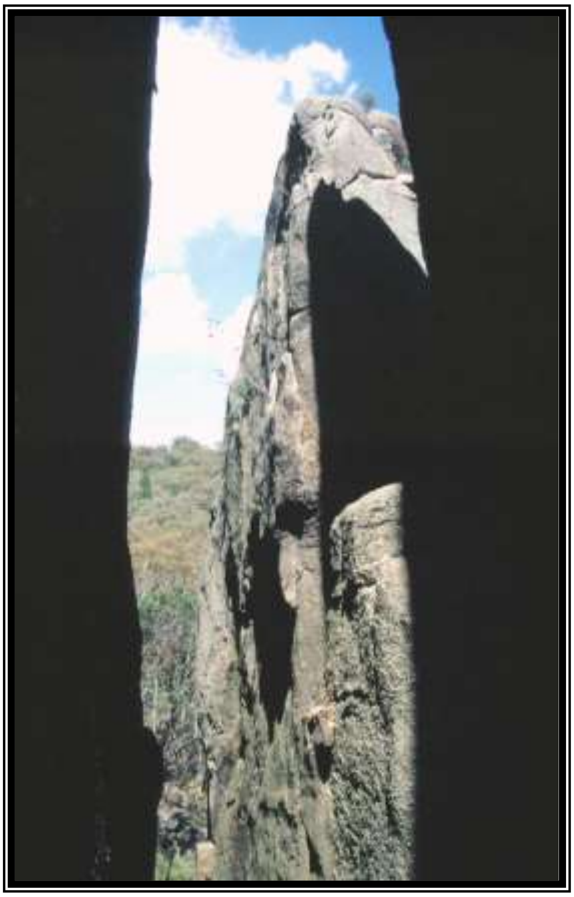
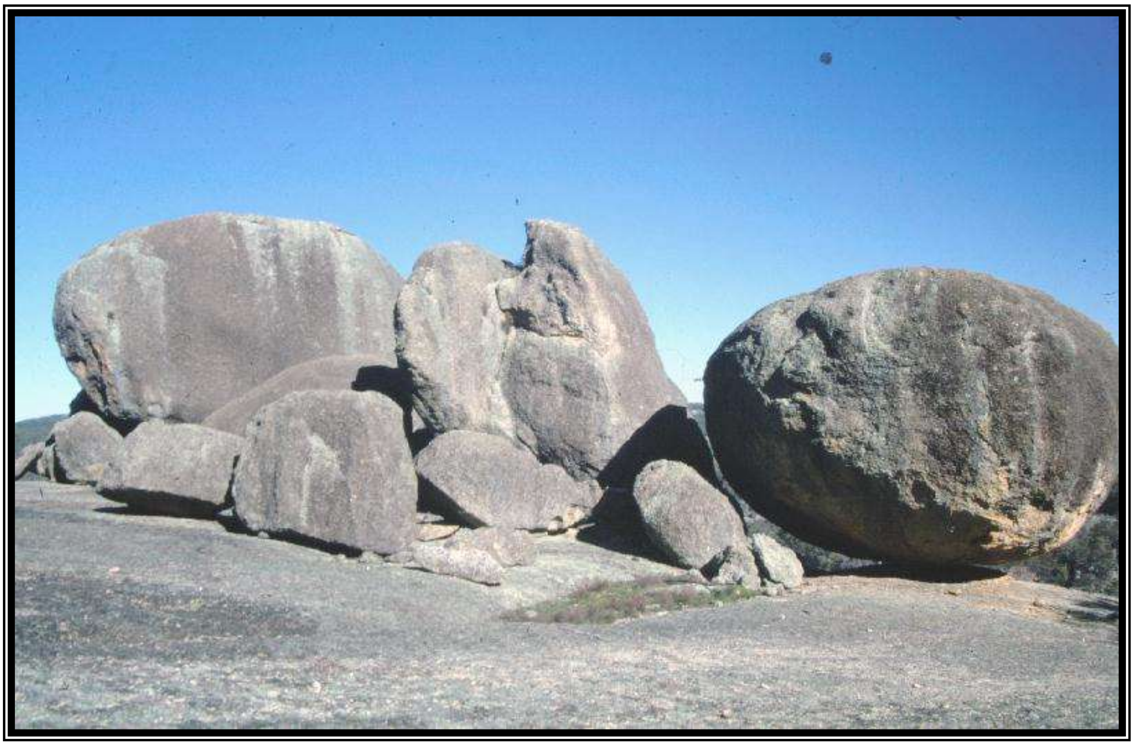


Plate 3: Landscape features of Ironbark NR and the *Bornhardtia* VCA.



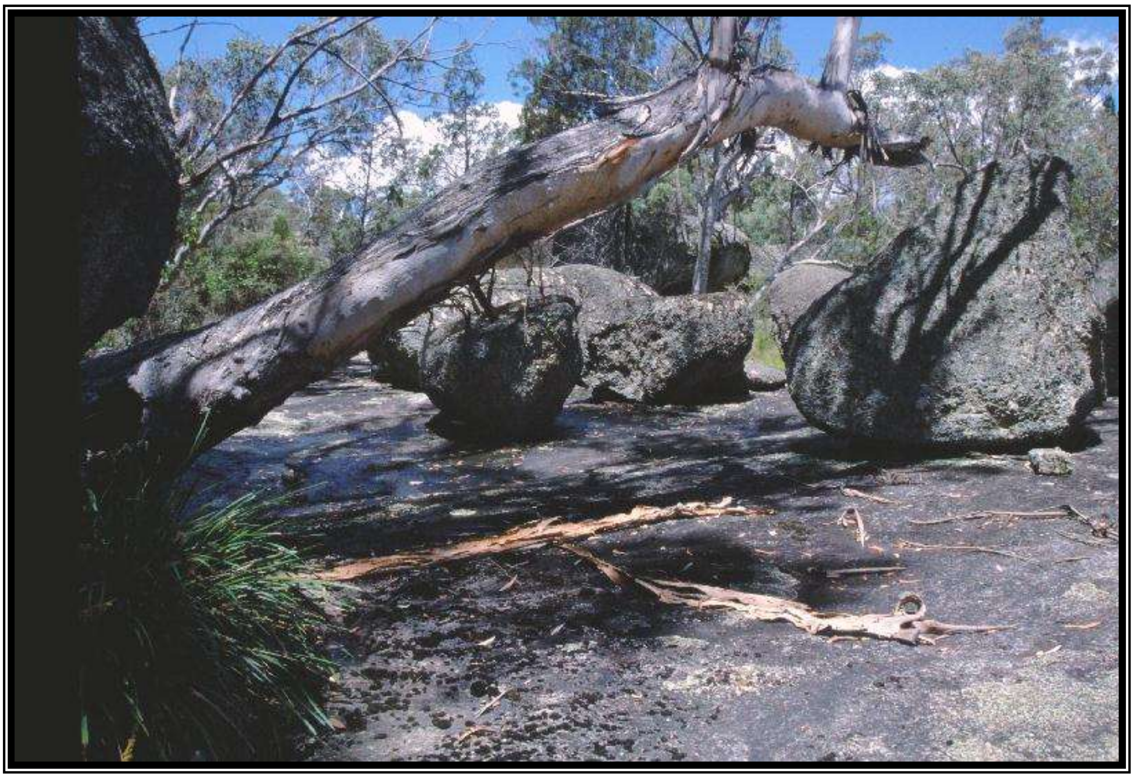


Plate 4: Landscape features of Ironbark NR and the *Bornhardtia* VCA.

Plate 5: View east from Townsend's Mountain above and view of Townsend's Mountain from the east.

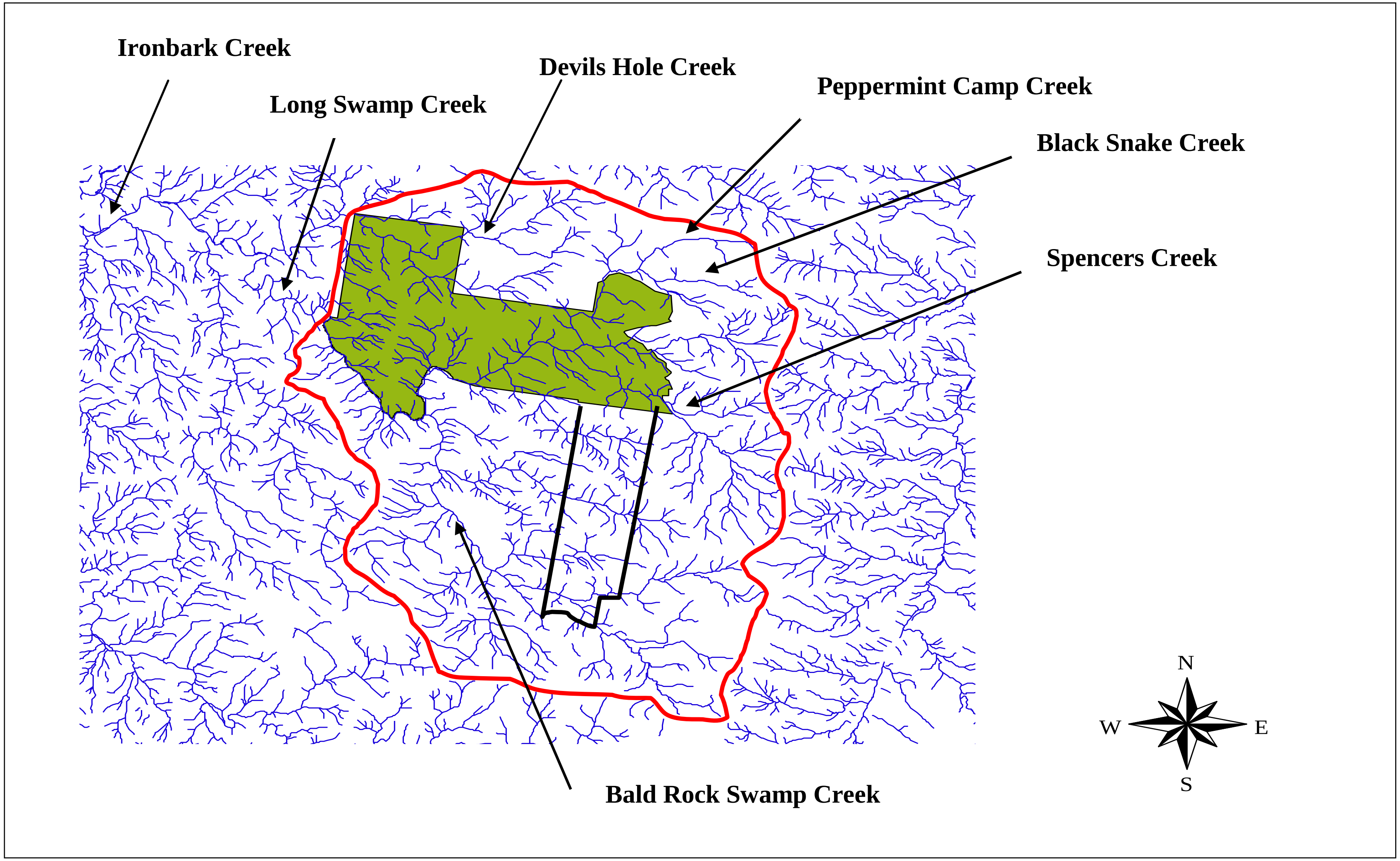


Figure 5: Catchment of Ironbark NR and *Bornhardtia* VCA.

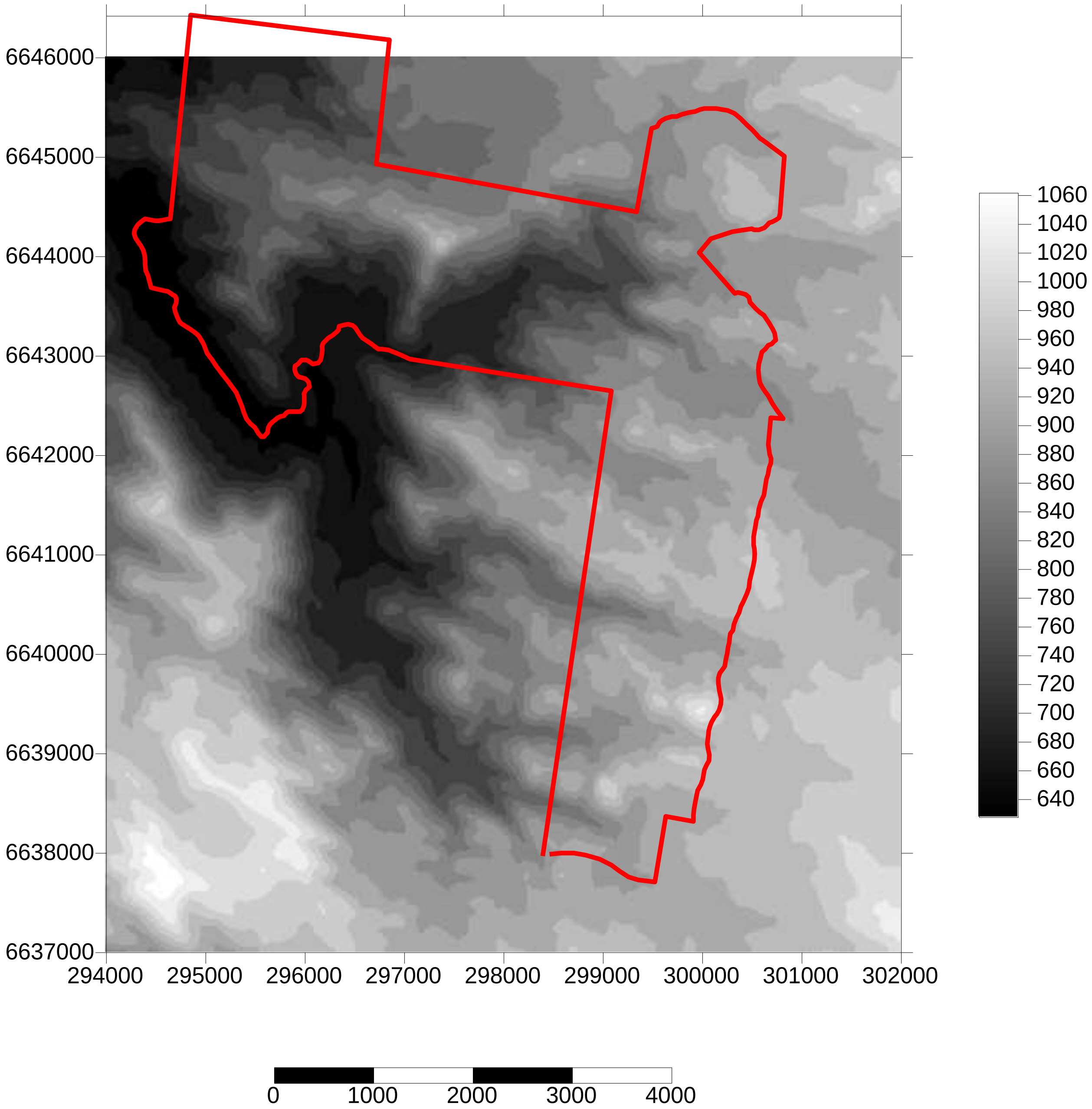


Figure 6: Topographic patterns in Ironbark NR and *Bornhardtia* VCA. Drainage patterns run primarily west Axes are in AMG Co-ordinates and scale bars are in meters.

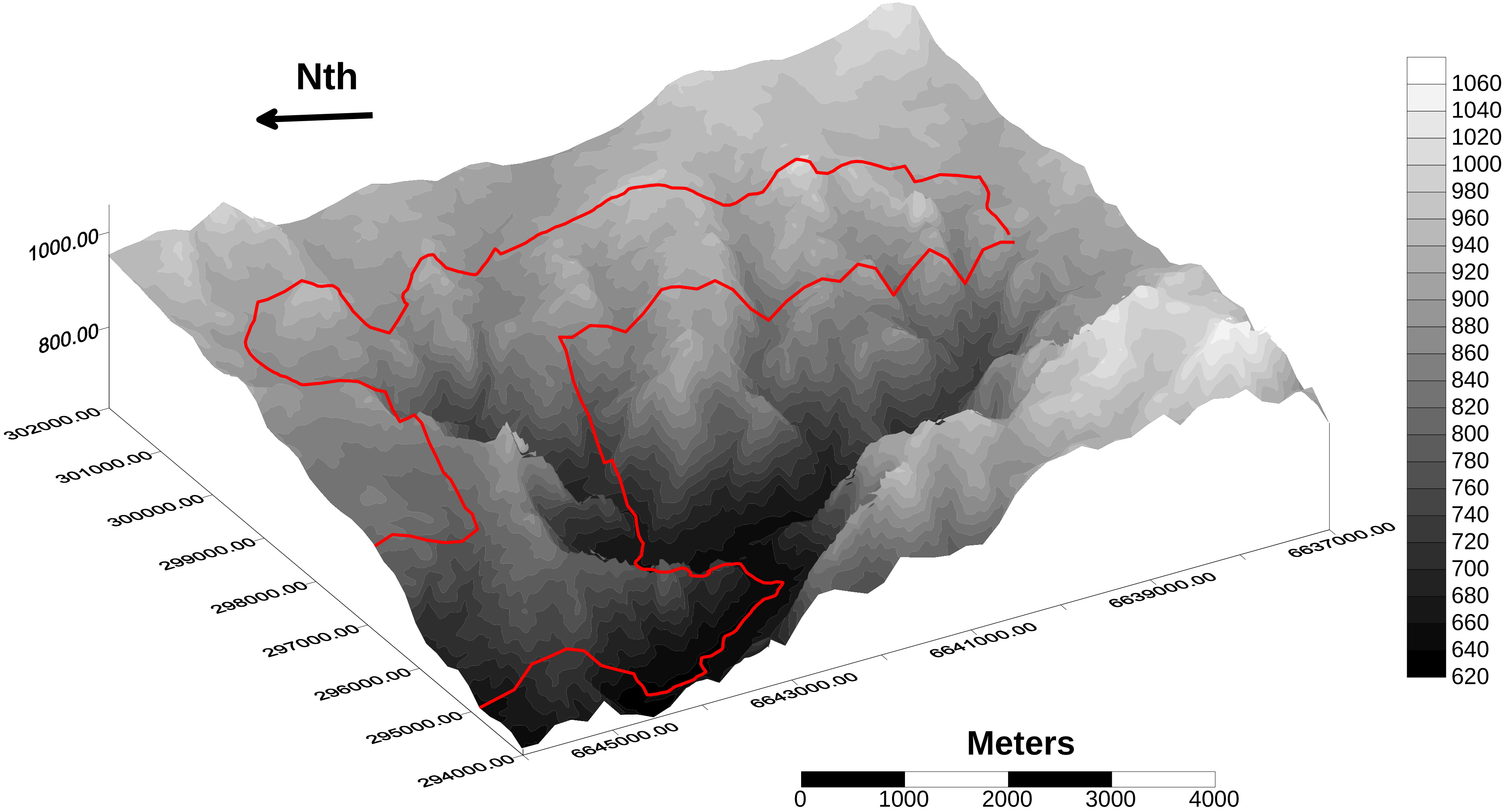


Figure 7: 3-D landscape projection and altitudinal variation within Ironbark NR, the *Bornhardtia* VCA and neighboring areas.

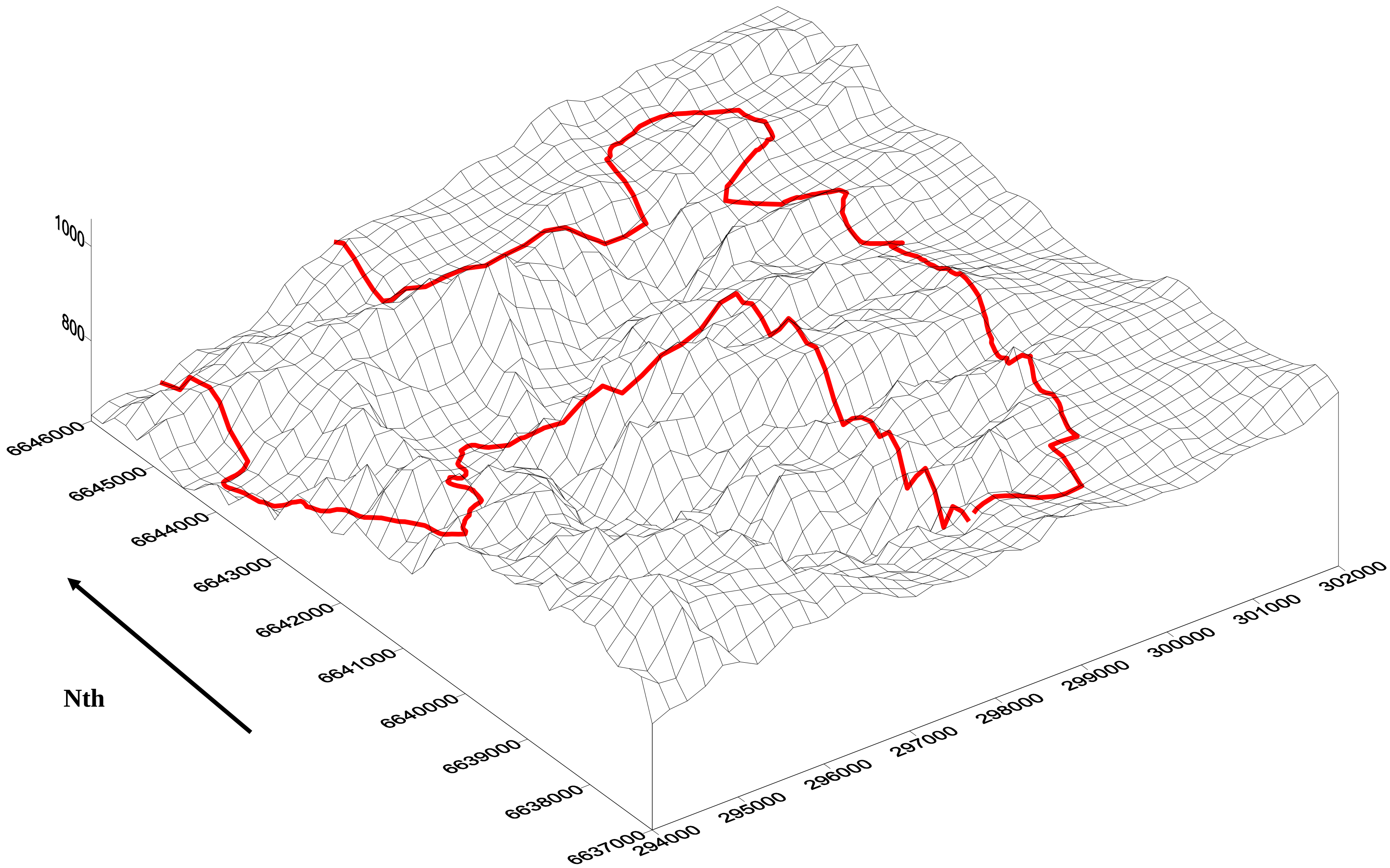


Figure 8: 3-D surface plot of landforms and altitudinal changes in Ironbark NR and *Bornhardtia* VCA.

1.6 Geology of Ironbark NR and the Bornhardtia VCA

The conservation areas are situated within the Central Block (Gilligan & Brownlow 1987) of the southern New England Orogen, east of the Tamworth Belt and the Peel Fault System. The majority of the study area is within the Bundarra Plutonic Suite (Pbg) that is an S-type post-tectonic unstressed granitoid belt of about 290 million years old that runs from Howell (Copeton Dam) south of Inverell south to Bendemeer north of Tamworth (Ashley & Flood 1997). The western boundary of Ironbark NR at the point that Long Swamp Creek leaves the reserve is a small area of the Whitlow Formation (Cws) that includes low-grade regionally metamorphosed and multiply deformed lithic wacke. Minor inclusions of the Cara Formation (DCcf) that includes low grade regionally metamorphosed and multiply deformed metabasalt also occurs here and on Townsend's Mountain (High Knob).

1.7 European history and landuse

The initial settlement of this region of New South Wales probably occurred around 1839 and 1850. Early interests were mainly in cattle grazing (Gilmour & Helman 1993). It was not until the 1860's that extensive clearing began after the introduction of the Robertson Selection Acts (Pearson 1992; RACAC 1996b). By 1890 *c.* 10% of the Northern Tablelands had been ring barked or cleared (Benson & Ashby 1996). Pasture improvement with a range of exotic species commenced in the 1920's and by the 1970's 19% of the region was sown to improved pastures (Benson & Ashby 2000).

Portion 3 of the Shire of Barraba and Paris and County of Darling which forms the majority of the current Ironbark Nature Reserved was resumed on the 4th of August 1897. At that time the more open areas with deeper soil along Long Swamp Creek on both sides of Townsend's Mountain (High Knob) had been cleared with some areas showing regrowth. Prickly Pear was noted to be infesting at least a quarter of the portion. By 1911 areas of the land to the north of Townsend's Mountain (High Knob) had be ring-barked with suckers mattocked twice while the rest had been ring-barked but had thick regeneration occurring. The areas within the reserved were grazed up until they were taken over by the NPWS with sections along Long Swamp Creek being regularly burnt for green pick. Areas in the south-eastern corner of the reserve also appear to have been selectively cleared in the past.

Much of the *Bornhardtia* VCA appears to have been unmodified over much of its history. It originally formed part of *Stoney Batter* which was gazetted as a pastoral holding in 1851 and included 204 800 acres, of which 66 560 was considered mountains and scrub (Harris 2000). Areas in the northern third of the property appear to have been partially cleared in the past, particularly in the north-eastern corner which also corresponds to are adjoining areas within the Nature Reserve. A small area of approximately 20 ha was being selectively cleared and ring-barked by the previous owner in the mid-1990's. Creeklines, particularly the larger ones appear to have been burnt seasonally for green pick. The top third of the property was occasionally used for winter grazing from 1985. This practice stopped in 1997 after purchase by the current owners.

1.8 Aboriginal history

It is believed that prior to European arrival, the tablelands and the western slopes provided resources for year-round occupation, with groups undertaking a series of short journeys, principally within the tablelands, coupled with seasonal long journeys between the tablelands and western slopes (NSW NPWS 2002). The study areas lie within the territory of the Gamilaroi people. There is evidence of Aboriginal occupation within the Reserve; this includes an extensive stone arrangement. An archaeological survey has been conducted and this report should be consulted for further information (Stone & Martin 2002).

1.9 Fauna

At least two systematic fauna surveys have been conducted within the region. The first of which was conducted between the 10-16th of February 1997 within Ironbark Nature Reserve in wet conditions. The second systematic survey was conducted in May of 2000 and was conducted in fine weather. In total 13 frogs, 22 reptiles, 20 mammals and 116 bird species were recorded over both surveys. 23 species of significance were found.

Table 2: Fauna species of significance.

Name	Common Name	Significance
1: Xanthomyza phrygia	Regent Honeyeater	Endangered
2: Miniopterus australis	Little Bent Wing Bat	Vulnerable
3: Mormopterus beccarii	Beccari's Free-tail Bat	Vulnerable
4: Neohema pulchella	Turquoise Parrot	Vulnerable
5: Ninox connivens	Barking Owl	Vulnerable
6: Petaurus norfolcensis	Squirrel Glider	Vulnerable
7: Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	Vulnerable
8: Scoteanax rueppellii	Greater Broad-nose Bat	Vulnerable
9: Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	Vulnerable
10: Vespadelus troughtoni	Eastern Cave Bat	Vulnerable
11: Anomalopus leuckartii	Skink	Regionally Significant
12: Anomalopus verreauxii	Verreaux's Skink	Regionally Significant
13: Chrysococcyx ascularis	Black-eared Cuckoo	Regionally Significant
14: Chthonicola sagittata	Speckled Warbler	Regionally Significant
15: Cinclosoma punctatum	Spotted Quail-thrush	Regionally Significant
16: Falcunculus frontatus	Crested Shrike-tit	Regionally Significant
17: Lichenostomus melanops	Yellow-tufted Honeyeater	Regionally Significant
18: Melanodryas cucullata	Hooded Robin	Regionally Significant
19: Plectorhyncha lanceolata	Striped Honeyeater	Regionally Significant
20: Pseudophryne bibronii	Brown Toadlet	Regionally Significant
21: Sericornis pyrrhopygius	Chestnut-rumped Heathwren	Regionally Significant
22: Underwoodisaurus millii	Thick-tailed Gecko	Regionally Significant
23: Vespedelus sp. nov.	Snail	New Species

1.10 Botanical exploration

The original exploration of the region was undertaken by the Botanist and explorer Allan Cunningham. Cunningham in April to May of 1827 walked over the Nandewar Range north of the Manilla River but considered the area disappointing and inferior, being of deep stony gullies and ridges covered with stunted ironbark and *Callitris* and monotonous sclerophyll forest (McMinn 1970).

Some of the earliest publications on the vegetation and flora of the north east of New South Wales are those of Turner (1903; 1906). Botanists made several collecting trips from the Botanic Gardens in Sydney over many decades, in particular Maiden and Boorman. Many local professional and amateur botanists were also active on the New England namely, Rupp, Blakely, McKie and Youman to name a few. It was not until the late 1950s and early 1960s that any concerted effort was made in surveying the vegetation and flora of the New England. Unfortunately, due to arguments amongst those carrying out the surveys, all site data was destroyed and the only record remaining of this work is the annotated checklist published by Gray (1961). Williams (1963) described the major changes in vegetation across the eastern scarp to the western slopes. Only in the last decade has a concerted effort to survey communities and flora of the New England and the escarpment occurred.

Greg Roberts, local ranger and naturalist visited the Nature Reserve on its dedication and provided a brief synopsis of the major floristic patterns and some of the more unusual species (Roberts, *unpublished*). Roberts completed a masters preliminary thesis on the vegetation on granite in the Northern Tablelands and North Western Slopes, but no sites were placed in the study area (Roberts 1983). Roberts (1992) mapped the vegetation of the region using LANDSAT TM images. Hunter (1996, *unpublished*) conducted a preliminary investigation in 1996 of Granite Heights as part of the owner’s application for NPWS purchase. A checklist of 120 species was made on a half-day visit of the property around Bald Rock. Hunter returned later in 1996 and placed 30 x 0.1 ha full floristic survey sites between Bald Rock and Little Bald Rock (Hunter & Clarke 1998; Hunter 1999). Hunter described a new species of *Eucalyptus* (Hunter & Bruhl 1999) and a new species of *Homoranthus* (Hunter 1998) from what was to become *Bornhardtia*.

Methodology

2.1 Survey design

The survey was carried out in a stratified random way in order to sample and replicate the major environmental changes. One hundred and ten sites were surveyed and information from an additional 30 sites were compiled, providing a base of 140 sites for use in subsequent analysis and mapping. The survey sites were divided between combinations of three major environmental variables (Table 3). Specialised communities are often missed in stratified sampling strategies, thus sites were placed in specialised communities that were not included in the *a priori* sampling strategy or to stratified classes that were not replicated in the sampling design.

Table 3: Environmental attributes and the classes within them used for stratifying sample sites. 21 environmental sub-classes were sampled.

Environmental Attribute	Class	Subclass	Number of Samples
600-800 m	North	Crest-Upper Slope	2
		Mid-Lower Slope	4
		Flat-Open Depression	1
	South	Crest-Upper Slope	1
		Mid-Lower Slope	6
		Flat-Open Depression	3
	East	Crest-Upper Slope	-
		Mid-Lower Slope	2
		Flat-Open Depression	-
	West	Crest-Upper Slope	-
		Mid-Lower Slope	9
		Flat-Open Depression	3
801-1000 m	North	Crest-Upper Slope	17
	+5	Mid-Lower Slope	6
		Flat-Open Depression	4
	South	Crest-Upper Slope	7
	+9	Mid-Lower Slope	9
		Flat-Open Depression	4
	East	Crest-Upper Slope	6
	+5	Mid-Lower Slope	4
		Flat-Open Depression	1
	West	Crest-Upper Slope	9
	+4	Mid-Lower Slope	3
		Flat-Open Depression	15
Total		**24**	**140**

2.2 Site and species information

Topological information was also collected along with measurements of altitude, slope, aspect and horizontal elevation. Altitude was taken directly from topographic maps. Slope and horizontal elevation were measured using a 'SUUNTO Optical Reading Clinometer'. Horizontal elevation was measured at eight equidistant compass bearings. Aspect was measured using a compass with reference to magnetic north. Information on soil, fires and other disturbances was also collected in a form amenable to the site survey data sheets supplied by the Glen Innes Area of the National Parks and Wildlife Service (Appendix A). Site location was derived from a Magellan Trailblazer XL GPS with reference to topographic maps.

Vegetation structure was derived using the system developed by Walker and Hopkins (1990). This method uses growth form, height and crown cover of the dominant taxa in each of the strata layers that are identifiable. Individual taxon data for each quadrat was recorded using the species data forms supplied by the Glen Innes Area of the National Parks and Wildlife Service (Appendix A). Species were scored in accordance with a modified Braun-Blanquet (1982) cover abundance six ranking scale. Cover codes are as follows:

Cover Code	**Projected Canopy Cover**
1	<5% few individuals
2	<5% any number of individuals
3	6-25%
4	26-50%
5	51-75%
6	>75%

These methods will enable cross comparison of species records with other major vegetation surveys carried out by the New South Wales National Parks and Wildlife Service.

2.3 Vouchering

The importance of vouchering is discussed by Hosking *et al.* (1996) who conclude that without vouchers one may as well not publish results. As Hosking *et al.* (1996) state, current taxonomic knowledge is continually changing, and what was once one species may be split into ten or vise-versa. Vouchers can be checked with up to date descriptions and nomenclature changes as they are published.

It is unreasonable and impossible to collect all taxa from all sites. During this survey where possible at least one sample of each taxon was collected. All taxa that could not be identified accurately without doubt in the field were sampled from each site and labled according to the site they were taken. Opportunistic sitings of taxa were also collected if they were not found in any of the previous survey sites.

A complete as practical set of taxa was prepared on field cards and retained by the owners of *Bornhardtia*. Additional good quality material of many taxa were also retained as vouchers and sent to the Coffs Harbour Botanic Gardens Regional Herbarium (CFSHB) then to the National Herbarium of New South Wales (NSW) as a second choice and further duplicates were sent to NCW Beadle Herbarium (NE) and other recognised herbaria if available.

2.4 Data management

'Paradox 7 for Windows' (Borland 1995) a relational database, was used for data management, validation, storage and retrieval. 'Parent' tables were created with verified information that was used for data entry in 'Child' tables allowing consistency in data entry (for example the spelling of species names (Campbell 1984; McKenzie 1991; McKenzie *et al.* 1991)). Three 'parent' tables were created to store information with six 'child' tables used for referential integrity, validation and data entry. The three primary tables stored information relating to the taxa found and the quadrats placed. The region number and site number were the relational fields used to link the three main tables. These three record values are unique and duplicate values were not accepted by the database. The system was designed to minimise the number of keystrokes, and allow for subsequent specimen determinations and results of analyses to be incorporated later without disruption. Field data collected during a single field trip were added either at night in the field on a 'note book' computer or immediately on the days after returning from the field on the main computer. Thus, discrepancies could be sorted out while the relevant survey sites were fresh in the mind.

Sorted data was exported to EXCEL spreadsheets prior to analysis. All site and species attributes are presented in EXCEL spreadsheets and included in the electronic form of this document that is held with the Armidale office of the New South Wales National Parks and Wildlife Service.

2.5 Analysis of regional diversity

Regional diversity is calculated by assuming an exponential species-area curve relationship exists. The regional diversity index is calculated by D=S/logA, where S is the number of taxa in a region of A hectares.

2.6 Multivariate Analysis

Initial exploratory analysis of sites was conducted using classification and ordination techniques available in PATN: Pattern Analysis Package (Belbin 1995ab). PATN was developed for manipulation, analysis and display of patterns in multivariate biological data (Belbin 1995a). Both classification and ordination were performed on data as each technique is complimentary and the use of both highlights anomalies produced by the other (Gauch 1982). Ordination will detect natural clusters if they are present and highlight overall trends clarifying relationships alluded to with classification (Belbin 1991; Belbin 1995a). However, strong discontinuities in survey data can affect the way ordination techniques display continuous variation (Faith 1991). Classification techniques will impose groups on continuous data even if they are not present (Belbin 1991; Faith 1991; Belbin 1995a). In such situations 'chaining' may occur whereby samples grow by accretion one by one rather than by fusion with other clusters (Goodall 1980). Even in such situations utility can be found in imposed divisions (Gauch 1982). Classification is useful in detecting outliers that may affect ordination procedures (strong discontinuity). This technique also aids in the detection of smaller groupings or trends within the data that may be difficult to see from an ordination where groupings may be less obvious (Faith 1991).

Site classification was achieved using the Kulczynski association measure that has proven to be a superior measure of association with ecological data (Faith *et al.* 1987; Belbin 1995b). Agglomerative hierarchical clustering using flexible UPGMA (Unweighted Pair Group arithMetic Averaging) was used for group joining, this optimises the hierarchy and not the groups. UPGMA gives equal weight to objects not groups in the fusion process thereby groups are weighted proportionally to the number of objects contained (Belbin 1995b). This method has been widely tested and is the most frequently used classification technique (Gauch 1982; Belbin 1995b) and it provides the best fit between the association measure and the distances implied from the dendrogram (Belbin 1991). Flexible UPGMA enables the value of β, which ranges from –0.1 to 1.0 to be changed, this controls the amount of space dilation during the fusion process (Belbin 1991; Belbin 1995b). A β value of –0.1 was used to enable slight dilation to occur; this has been shown to better recover known partitions (Belbin 1995b).

Semi- Strong- Hybrid Multidimensional Scaling (SSH) was used as the ordination technique. Multidimensional scaling (MDS) moves objects around in a space defined by the number of dimensions chosen and the dissimilarities among sites in terms of their composition (Faith 1991; Belbin 1991). SSH calculates the level of stress, which is the miss-match between distances between points and the best estimate of the same values (Belbin 1995b). Subsequently all points in the initial ordination are moved slightly to reduce stress, this process is iterated a specified number of times or until a minimum stress is achieved (Orl✱ci 1978; Belbin 1995b). MDS has been shown to be a robust method (Minchin 1987; Faith 1991). SSH has the advantage of being designed to cope with unimodal responses of taxa replacing the assumption of linearity used by many other ordination procedures (see e.g. Noy-Meir & Whittaker 1978; Orl✱ci 1978; ter Braak & Prentice 1988; Faith 1991; Belbin 1995a).

The number of groups to be recognised can be based on a number of a priori methods. The point at which a leveling of a scree plot of dissimilarity and number of fusion points occurs can be an indication of the optimal cut off point. At such a point, many clusters are formed at essentially the same linkage distance.

'Canonical Correspondence Analysis' (CCA) via CANOCO (ter Braak 1987-1992) was used for exploration of site attributes and their affects on site ordination. CCA is a multivariate direct gradient analysis technique for the analysis of patterns of variation in community composition that can be explained by environmental variables. The technique is based on the reciprocal averaging algorithm of Correspondence Analysis (CA). In CCA the axis of the ordination is constrained to be linear combinations of the environmental variables (i.e. direct gradient analysis), which enables the analysis to handle complex environmental gradients. A major advantage of this type of analysis is it assumes a unimodal Gaussian response of taxa which is more ecologically realistic (see e.g. Gauch 1982, ter Braak 1986; Sparrow 1990; Austin 1991; Faith 1991), but it is also robust to significant departures from this (Gauch 1982; ter Braak 1986; Palmer 1993).

Forward selection of variables was used for data reduction, ranking of variable importance and significance testing (ter Braak & Verdonschot 1995). This was achieved by using the forward selection module on CANOCO. Here the variation explained by each variable is partitioned and a model of significant variables is constructed, i.e. all environmental variables are ranked based on the fit of each variable separately. The significance of the effect of each variable is tested by a Monte Carlo permutation test (in this case 999 iterations). A variable was added if its significance was at the 5% level or less. As each variable is selected, the remaining variables are reassessed based on the fit that each variable gives in conjunction with the variables already selected (ter Braak & Verdonschot 1995). Forward selection ceases when the significance based on the Monte Carlo tests is greater than 5%. The overall significance of the CCA ordinations was tested by Monte Carlo permutation (99 iterations) of residuals of the taxa after fitting co-variables and environmental variables (ter Braak 1992).

A total of 21 environmental variables collected at each site were chosen for analysis. These variables included: Slope, Easting, Northing, Fire, Clearing, Pollution, Grazing, Horizontal Elevation N, NE, E, SE, S, SW, W, NW, Altitude, Aspect, Geology, Soil

Depth, Drainage, and Physiography. Aspect was coded into four 90° groups for use in analyses thereby avoiding the problem that north is both 0° and 360°. 1 = NNW to NNE; 2 = W to NNW, E to NNE; 3 = W to SSW, E to SSE; 4 = SSE to SSW. This assumes that the greatest differences are between North and South (S★derstr★m 1981).

2.7 Coleman curves

Coleman curves represent the means of repeated sampling of all pooled samples. The smoothed Colman curves thus represent the statistical expectation for the corresponding acummunaltion curve. Coleman curves are different from accumulation curves which record the total number of species found with addition sampling (species area curves) as they are produced by repeated resampling of the species pool at random. Sampling is done without replacement within each resampling. This repeated randomised sampling produces a smooth rarefaction curve. Here the algorithym of Incidence-Based Coverage Estimator of species richness was used (ICE) to generate the data for estimating the potential total species richness (Lee and Chao 1994). During these simulations 200 random samplings were used.

2.8 Significant vascular plant taxa within the conservation areas

Three main sources of information were used initially to assess the significance, in terms of rarity, of any taxa found within the reserve. The national list of rare or threatened Australian plants (ROTAP) (Briggs & Leigh 1996) along with the New South Wales *Threatened Species Conservation* Act 1995 (TSC Act) was used as a primary indicator of national and state significance. The regional significance of taxa was assessed with reference to other flora survey publications. Finally, local botanical knowledge as expressed in unpublished survey reports and the personal experience of the author and other botanists was used as a final source of information.

2.9 Range distribution analyses

Information on the geographic range of Australian vascular plant species is summarised by Hnatiuk (1990). This information has been updated by a number of

State and regional census and floras. The regions adopted are those recognized by the herbaria of each State and Territory within Australia, and are generally defined as capturing important ecological differences between regions (Oakwood *et al.* 1993). The availability of this information enables investigations into the relationships of geographic range (occupancy). Most analyses of geographic range do not differentiate between the limits of geographic range and the areas used within the range. Gaston (1991) referred to the former as the extent of occurrence and the latter as the area of occupancy. Occupancy within each of the 97 'ecological regions' has been chosen as the measure of geographic range size in this investigation. Occupancy is used as the questions asked are framed in terms of species ecology (Gaston 1991; Maurer 1994), and the environmental gradients across Australia are largely discordant. Quinn *et al* (1996) investigated various means of measuring geographic range size and concluded that in most instances the methods where largely interchangeable.

2.10 Mapping

Photo patterns were initially delineated from 1:25 000 scale aerial photographs based on statistical analysis of sites. The images were interpreted stereoscopically for patterns of vegetation and geomorphology, to provide a spatial resolution of the vegetation communities derived from numerical analysis. A detailed program of ground truthing and field traverse was used to investigate unusual sites and to confirm polygons labels and resolve vegetation boundaries. The final vegetation polygons were then transferred and corrected to the 1:25 000 topographic map sheet and coded, ready for digitising into a geographic information system.

Results

3.1 Site stratification

The basic stratification as outlined in the methods was completed. In total, the 110 stratified sites were sampled over a period of 14 days during September of 2001 and April of 2002 (Figure 9).

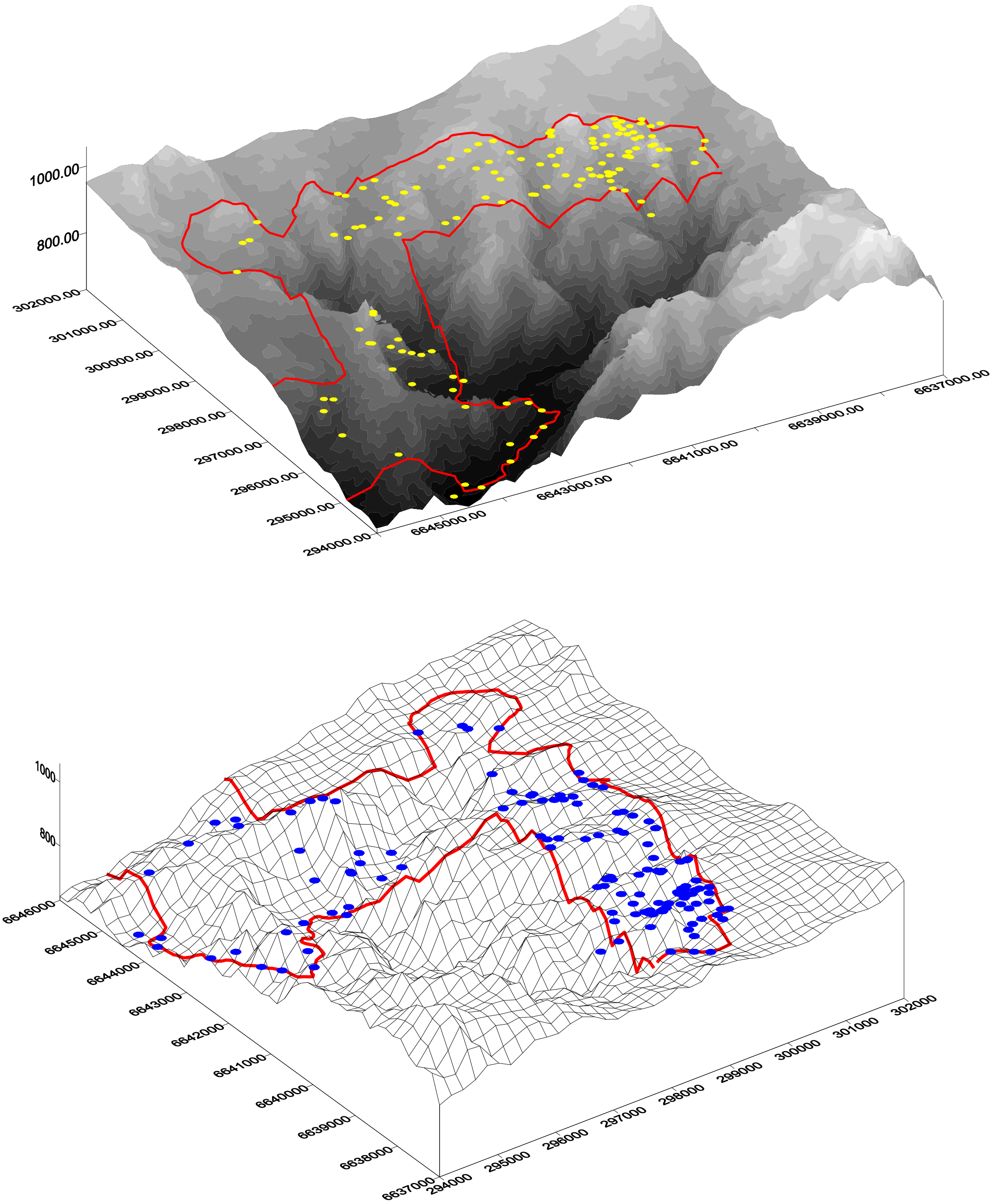


Figure 9: Topographic placement of all sites within the conservation reserves.

3.2 Floristics

A total of 477 vascular plant taxa were recorded during the collation of existing site data and subsequent extra sampling. From the 110 new sites 402 taxa were recorded. A further 75 taxa were recorded opportunistically and from previous surveys. In total data from 140 sites was collated. The number of taxa captured represents *c*. 7% of the total New South Wales flora and *c*. 22% of the flora of the Northern Tablelands.

The 477 taxa occurred in 93 families and 269 genera. The families with the greatest number of taxa are: Asteraceae (55), Poaceae (53), Fabaceae (49), Myrtaceae (24), Cyperaceae (22), Orchidaceae (20), Juncus (11), Caryophyllaceae (11), Rubiaceae (10), Apiaceae (10), Epacridaceae (9) and Proteaceae (9). The richest genera are: *Acacia* (14), *Eucalyptus* (11), *Juncus* (10), *Cyperus* (8), *Hibbertia* (6), *Leptospermum* (6), *Pterostylis* (6), *Brachyscome* (5), *Goodenia* (5), *Leucopogon* (5), *Lomandra* (5), *Olearia* (5), *Pultenaea* (5), *Senecio* (5), *Wahlenbergia* (5).

The most dominant species in terms of summed cover/abundance scores are given in Table 4. The most dominant species is *Cymbopogon refractus* a common grass. Half of the most dominant taxa were herbs, seven of which were grasses. Based on this table the understorey, in terms of grasses, are characterised by being dominated by *Cymbopogon refractus*, *Joycea pallida*, *Aristida vagans* and *Dichelachne micrantha.* The second most dominant species was *Callitris endlicheri*. Six tree species in total were apparent in the 28 most dominant taxa. Thus the overstorey thus can be characterised by a dominance of *Callitris endlicheri* with a subordinate mix of *Eucalyptus macrorhyncha, Eucalyptus prava, Angophora floribunda* and *Eucalyptus caleyi*. Eight shrubs were also in the dominant 28 species. *Cassinia quinquefaria* was the third most dominant species overall. The shrub layer of the study area is characterised by the presence of *Cassinia quinquefaria, Leucopogon muticus, Hibbertia obtusifolia* and *Pultenaea* sp. G.

In comparison to 29 other surveys listed in Table 5, the study area is medial to slightly above average in terms of species richness. Based on raw richness the study area is 12th highest, and in terms of regional diversity 11th.

Table 4: List of the most dominant native species, in terms of summed cover, based on the 110 sampled sites.

Taxa	Summed Cover
1: Cymbopogon refractus (Herb)	241
2: Callitris endlicheri (Tree)	184
3: Cassinia quinquefaria (Shrub)	156
4: Leucopogon muticus (Shrub)	130
5: Joycea pallida (Herb)	128
6: Aristida vagans (Herb)	124
7: Hibbertia obtusifolia (Shrub)	115
8: Pultenaea sp. G (Shrub)	114
9: Eucalyptus macrorhyncha (Tree)	112
10: Dichelachne micrantha (Herb)	112
11: Lepidosperma laterale (Herb)	107
12: Eucalyptus prava (Tree)	104
13: Cheilanthes sieberi subsp. *sieberi* (Herb)	103
14: Aristida calycina var. *calycina* (Herb)	101
15: Lomandra multiflora var. *multiflora* (Herb)	100
16: Geranium solanderi subsp. *solanderi* (Herb)	97
17: Angophora floribunda (Tree)	94
18: Olearia elliptica (Shrub)	84
19: Luzula flaccida (Herb)	84
20: Dianella caerulea var. *caerulea* (Herb)	78
21: Olearia viscidula (Shrub)	76
22: Brachyloma daphnoides subsp. *daphnoides* (Shrub)	76
23: Eucalyptus caleyi subsp. *caleyi* (Tree)	75
24: Echinopogon caespitosus var. *caespitosus* (Herb)	75
25: Eucalyptus andrewsii (Tree)	74
26: Acacia neriifolia (Tall Shrub)	74
27: Melichrus urceolatus (Shrub)	73
28: Imperata cylindrica var. *major* (Herb)	72

Table 5: Comparison of species richness for other recently surveyed areas in the NSW NPWS New England Tablelands Region.

Number of Taxa	Introduced Species	Number of Sites	Mean Richness	Regional Diversity Index	Area Covered by Survey
926	6%	264	42/0.1 ha	214	Capoompeta & Washpool Additions NPs (Hunter 2001a).
878	2%	120	36/0.1 ha	198	Gibraltar Range & part of Washpool NP (Sheringham & Hunter 2002). 20 x 50 m sites.
840	5%	88	50/0.1 ha	205	Bald Rock & Boonoo Boonoo NP (Hunter 2003) 20 x 50 m sites.
826	9%	180		184	Nymboida NP (Benwell 2000). 20 x 50 m sites.
752	5%	201	60/0.1 ha	168	Torrington SRA (Clarke *et al.* 1998). 0.1 ha sites. 152 species from previous records.
666	5%	101	40/0.1 ha	158	Part of Guy Fawkes National Park (Hunter & Alexander 1999b). 20 x 50 m sites
507	31%	87	38/0.04	143	Warrabah NP (Hosking & James 1998). Also 20 x 20 m sites Meanders over many seasons and years.
503	10%	105	37/0.04 ha	53	1:100 000 Ashford Map Sheet (Le Brocque & Benson 1995). 20 x 20 m sites (290 taxa) and all additional records (213 extra taxa).
502	11%	69	40/0.04 ha	155	Bolivia Hill Nature Reserve (Hunter 2002d). 20 x 20 m sites.
495	9%	71	41/0.04 ha	150	Warra NP (Hunter 2001b). 20 x 20 m sites, and additional 32 x 32 m nested quadrats.
657	8%	170	36/0.04 ha	144	Mt Kaputar NP (Hunter & Alexander 2000a). 20 x 20 m sites.
477	**9%**	**140**	**35/0.04 ha**	**142**	**Ironbark NR & *Bornhardtia* VCA (*Ibid.*)**
460	9%	48	38/0.04 ha	130	Severn River NR (Hunter 2000f) 20 x 20 m sites.
441	10%	75	51/0.04 ha	112	Kings Plains NP (Hunter 2000h). 20 x 20 m sites.
434	21%	50	36/0.04 ha	123	Arakoola NR (Hunter 2000d). 20 x 20 m sites.
424	11%	40	?	124	Single NP (Clarke *et al.* 2000). 20 x 20 m sites. Lachlan Copeland *pers. comm.*
417	4%	40	38/0.1	120	Basket Swamp (Hunter 2002b).
410	35%	None	NA	140	Attunga State Forest (Hosking & James 1998). Meanders over many seasons and years.
407	17%	101	40/0.04 ha	116	Kwiambal National Park (Hunter 1998d). 20 x 20 m sites.

Number of Taxa	Introduced Species	Number of Sites	Mean Richness	Regional Diversity Index	Area Covered by Survey
367	8%	48	41/0.04 ha	113	Bluff River NR (Hunter 2002d). 20 x 20 m sites
365	2%	40	52/0.1 ha	124	Demon Nature Reserve (Hunter *et al.* 1999). 32 x 32 m nested quadrats.
345	4%	38	?/0/04 ha	103	The Basin Nature Reserve. (Hunter & Copeland 2002, *unpublished*). 20 x 20 m plots.
342	4%	28	33/0.1 ha	135	Burnt Down Scrub Nature Reserve (Hunter 2000). 20 x 20 m sites.
341	8%	28	?/0.04 ha	110	Watson's Creek Nature Reserve (Copeland 2002, *unpublished*). 20 x 20 m sites.
309	9%	23	?/0.04 ha	112	Stoney Batter Nature Reserve (Copeland 2002, *unpublished*). 20 x 20 m sites.
211	13%	15	37/0.04 ha	90	Curry's Gap NR (Hunter 2002). 20 x 20 m sites
170	3%	15	30/0.04 ha	79	Mt McKenzie NR (Hunter 2002). 20 x 20 m sites.
112	4%	15	26/0.04 ha	51	Gibraltar NR (Hunter 2002). 20 x 20 m sites.
90	2%	7	?	25	Derra Derra Ridge, Bingara (Benson *et al.* 1996). 20 x 20 m sites.

3.3 Community definition

The scree plot analysis indicates that the point of inflection lies near the 0.8 dissimilarity level, thereby eleven groups of species assemblages are recognised (Figure 10). This level of inference for community definition is similar to that used by investigators within the same bioregion (Hunter 1999a; Hunter 2000f&h: Hunter 2001b; Hunter 2002d). The eleven communities recognised are displayed in a summary dendrogram (Figure 11) and an ordination (Figure 12). Four major divisions are displayed on the dendrogram and these largely correspond to landscape features from crests and ridges at one extreme to wetlands at the other. The ordination (Figure 12) implies a greater overlap between the major disjunctions on the dendrogram with the exception of Community 11, which is highly discordant in the ordination. A similar gradient can be implied and overlaid on the ordination (Figure 12) based on landscape features as was implied by the dendrogram.

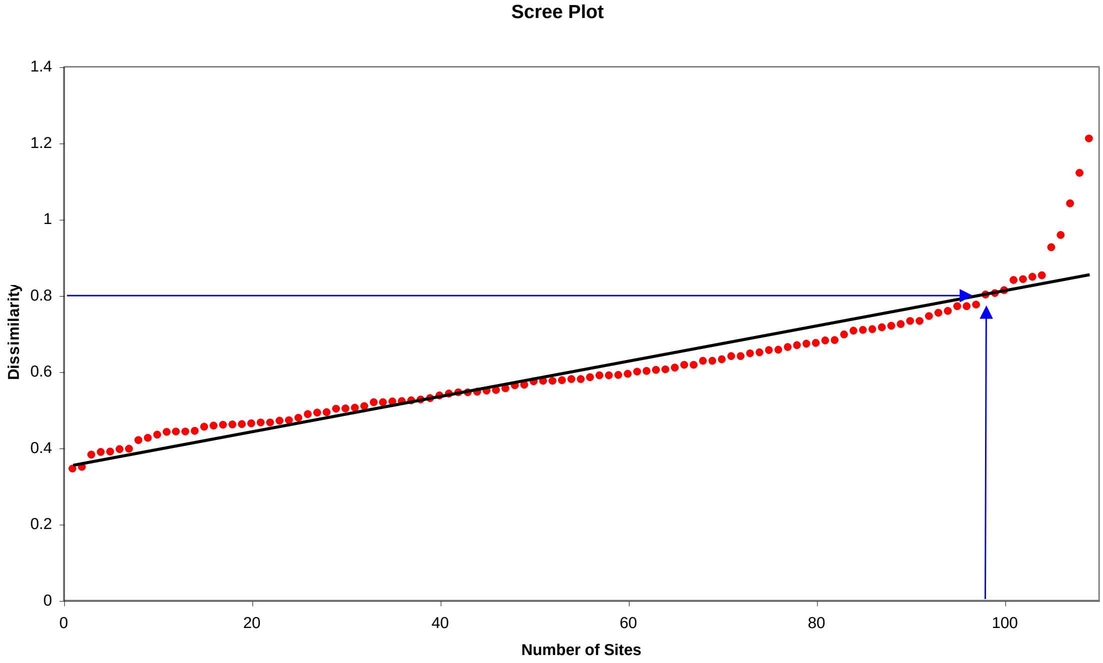


Figure 10: Scree-plot analysis of flexible UPGMA fusion strategy results. The line of demarcation represents the cut off point for recognition of floristic groups. Note that groups are recognised near the point of inflection. Y axis = dissimilarity; X axis = number of linkages in the dendrogram.

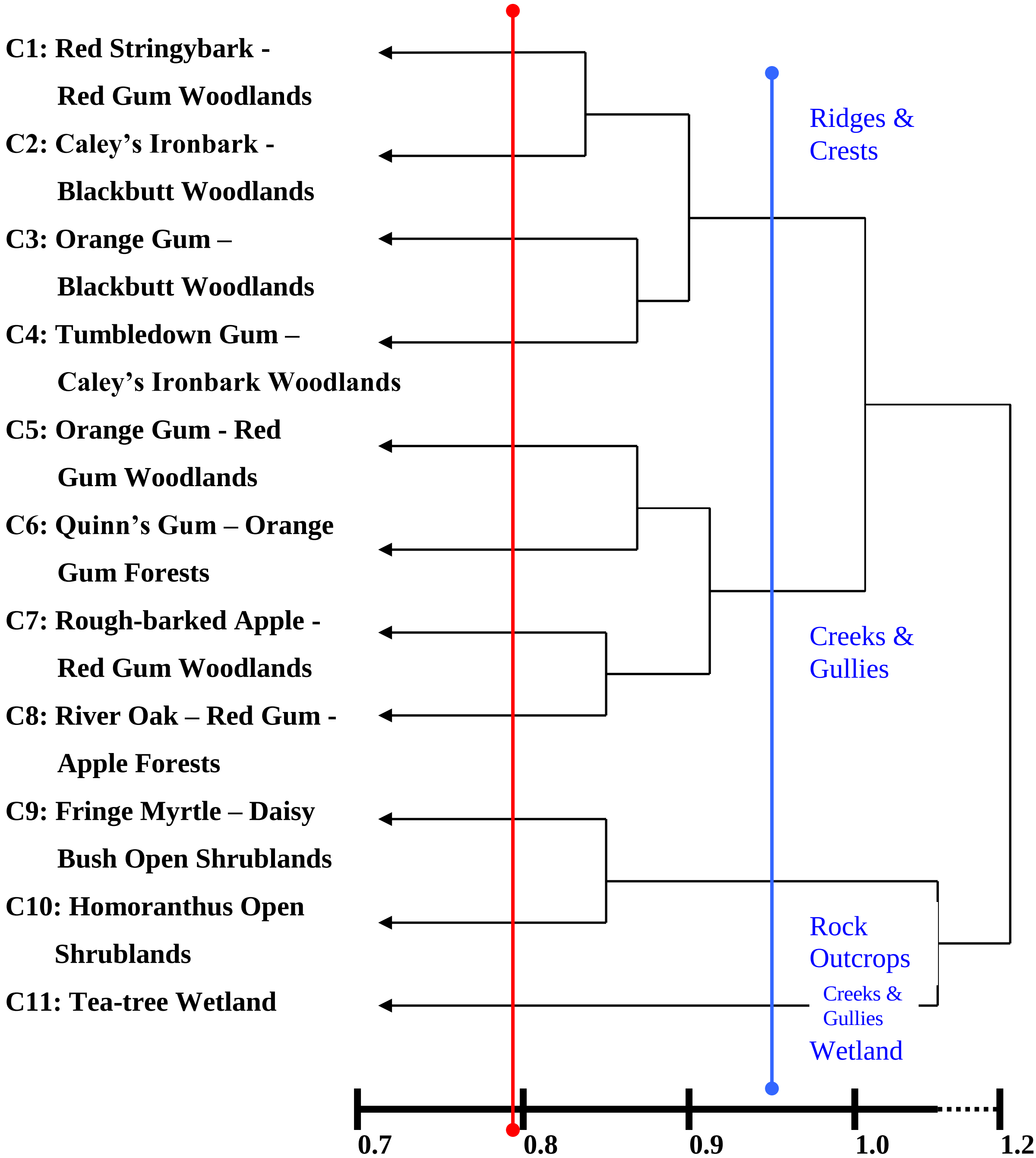


Figure 11: Summary dendrogram of dataset of sites surveyed during this investigation using Kulczynski association and flexible UPGMA fusion strategy. Communities are defined at a dissociation of *c.* 0.8.

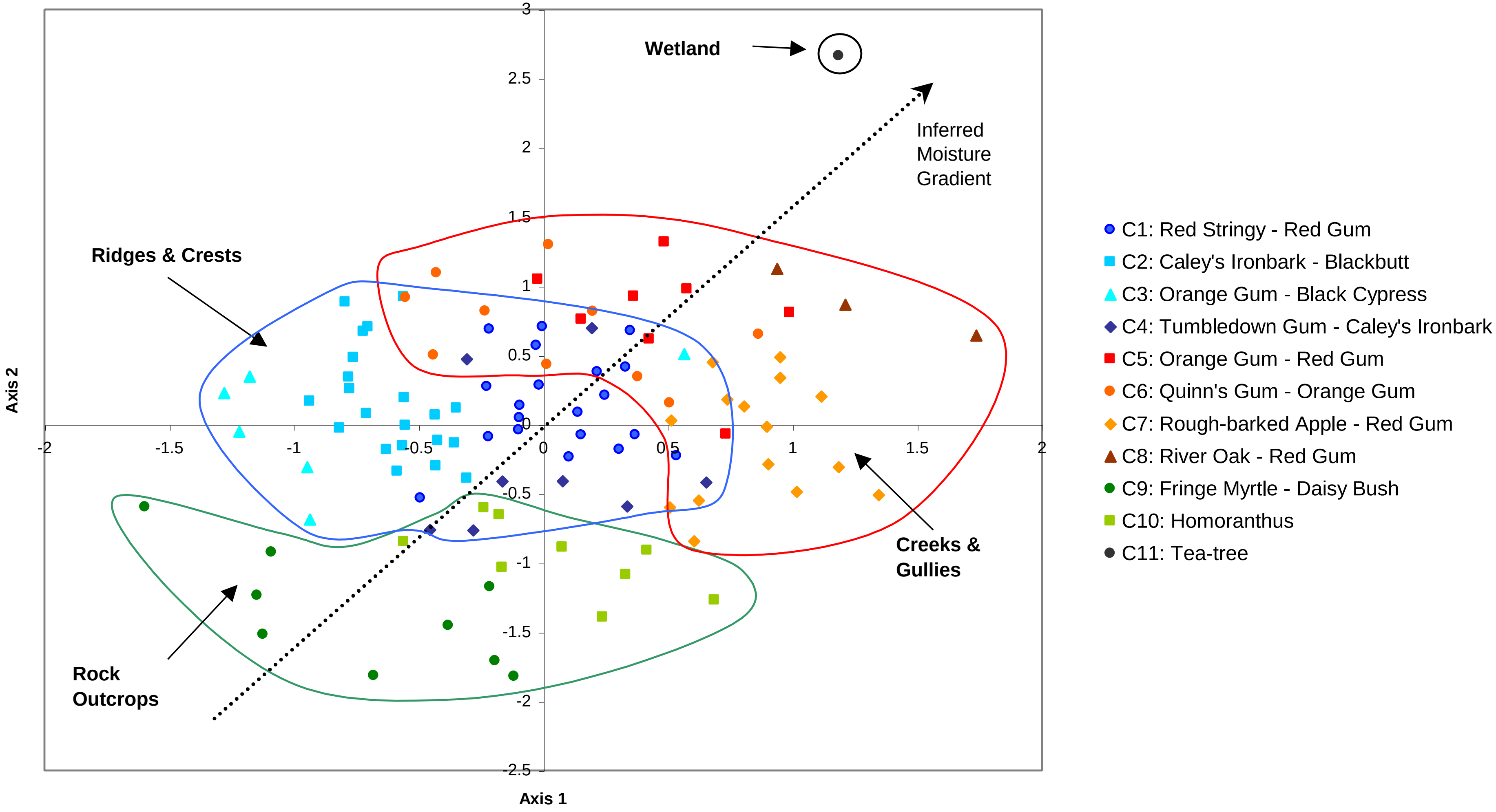


Figure 12: Ordination scattergram of all sites sampled based on full floristics and analysis by Kulzynski association measure and Semi-Strong-Hybrid Multi-Dimensional Scaling (stress = 0.223). 11 communities have been defined by classification (Figure 11).

3.4 Canonical correspondence analysis (CCA)

A CCA plot of the significant environmental variables on the distribution of sites is shown in Figure 13. Monte Carlo permutations on the first constrained axis and the overall model are significant at 0.001%. Axis 1 explains 36.8% of the variance with Axis 2 explaining 27.1% of the variance (80.1% in total). Simple rules are associated with the interpretation of CCA biplots and these include:

- Sites with similar distributions will be close and those with divergent distributions will be distant.
- Arrows point in the direction of maximal change in that variable.
- The longer the arrow the more important the variable.
- The order of perpendicular projected points on the variable arrows gives an inferred ranking.
- Points and arrows on the same side are positively correlated.
- Those on the opposite side are negatively correlated.
- Those that are perpendicular are not correlated at all.
- Sites at the centroid are uncorrelated with any variable.

Of the 20 variables tested only seven were found to be significant at the 5% level. The significant variables included:

1. Drainage. From waterlogged to well drained.
2. Easting. From west to east.
3. Soil depth. From deep to skeletal.
4. Physiography. From Crests to open depressions.
5. Nth protection. From fully exposed to the north to heavily protected.
6. Northing. From south to north.
7. Rock type. From granitic to metabasaltic.

The variables with greatest statistical significance includes Drainage, Easting, Soil Depth, Physiography and Protection from the North, all of which were significant at 0.001%. Northing was significant at the 0.01% level and rock type at 0.05% level. The importance of each variable is measured by arrow length, with Drainage being the longest arrow, followed by Easting, Soil Depth, Northing, Physiography, Rock Type and Nth Protection. Drainage and Soil Depth are strongly correlated with each other, however they were statistically distinct enough to both be significant at the 0.001% level, indicating that they both are acting independently on species and site placement despite their obvious association. The ordination indicates that the most well drained and shallower soil localities are more common on higher topographic positions and are slightly associated with a southern distribution.

3.4.1 Communities

Communities 1 to 4 primarily occur on better drained shallower soils that are more exposed in the landscape, usually protected from the north and in the south and east of the study area (Figure 13). Community 1 appears to be the least affected by the variables tested, however this assemblage does tend to occur in southern eastern localities and more commonly in areas protected from the north. Community 2 is more strongly associated with areas to the south and east but in higher positions in the landscape with soils that are slightly shallower and poorly drained than Community 1. Community 3 is far more scattered in the ordination and sites are correlated to a number of the variables. Community 4 on the other hand is strongly associated with a richer substrate and a north and western locality.

Communities 5 to 8 overall occur on lower topographic localities in the north on poorer drained and deeper soils (Figure 13). Communities 1 and 2 are associated with greater protection from the north and a generally more eastern distribution. Conversely Communities 7 and 8 are usually exposed to the north and in western localities. Community 8 in particular is strongly correlated with a northwest distribution in lower topographic positions with soils that are deep and poorly drained.

Communities 9 and 10 are strongly correlated with shallow and well drained soils at higher more exposed topographic positions (Figure 13). Community 9 in particular is strongly correlated with the shallowest most well drained soils but is weakly correlated also with more southern localities. Community 10 can occur on slightly less well drained and shallow soils and many sites are found in the north and west and sometimes on other rock types.

Community 11 is the most divergent in the ordination and its placement is strongly correlated with lower topography in poorly drained and deep soils in the north and east with protection from the north.

3.4.2 Trees

The species least affected by all variables measured are *Eucalyptus macrorhyncha* and *E. andrewsii* both of which however are correlated with slightly more south eastern localities that are slightly protected from the north.

In general much of the variation in tree distribution is explained by the CCA ordination (Figure 14), with some of the variance explained as high as 95%. At least 10% of all variance is explained for all tree species. Some groups of taxa are strongly associated with similar environmental conditions. In particular, *Eucalyptus quinniorum, E. bridgesiana, E. subtilior, Angophora floribunda* and *Pittosporum undulatum* are all strongly correlated with protection from the north and lower topographic positions that have deeper and more poorly drained soils and also slightly more northern localities. *Eucalyptus melliodora* is correlated with a more northern and western distribution and is less affected by topographic position and soil depth and drainage than *Eucalyptus blakelyi*.

Eucalyptus caleyi, *E. prava* and *E. dealbata* distributions are correlated with well drained shallow soil localities on higher topographic positions. *E. caleyi* and *E. prava* are also slightly associated with south eastern areas. *Eucalyptus prava* however is less strongly associated than the other two species to soil depth, drainage and physiography. *Eucalyptus dealbata* is associated with sites fully exposed to the north and slightly associated with western positions.

Brachychiton populneus is more common in north and western localities exposed to the north as is *Eucalyptus albens* which is even more strongly associated with these gradients. *Casuarina cunninghamii* is strongly associated with lower topographic positions which are poorly drained, deep and in the north.

3.4.3 Rare and threatened species

The variance explained by the ordination is generally low. Most of the significant species are correlated with well drained and shallow soil sites that are in higher topographic positions (Figure 15). *Eucalyptus quinniorum* and in particular, *Callistemon pungens* are on the opposite side of the ordination correlated with lower topographic placement on deeper less well drained soils. *Homoranthus bornhardtiensis* then *Thelionema grande* are the most strongly correlated with well drained shallow soils. *Goodenia macbarroni*, *Pultenaea campbellii* and *Eucalyptus quinniorum* are associated with eastern localities protection from the north, with the first two also correlated with a more southern distribution.

3.4.4 Introduced species

In contrast to the rare and threatened species (Section 3.4.3) the majority of introduced species are associated with lower topographic sites on deeper less well drained soils (Figure 16). Most of the introduced species are divided in the constrained ordination between those that are correlated with a north and western distribution and those with an eastern occurrence.

A number of introduced species are also correlated with areas protected from the north and were more common in the north. A small number of species were weakly associated with any of the variables in particular *Hypochaeris radicata* was the most ubiquitous species in terms of the variables tested, although it was slightly correlated with east in sites protected from the north. *Arenaria leptoclados* and less so *Hypochaeris glabra* were unusual in being correlated with better drained and shallower soils in higher topographic positions. *Opuntia stricta* had a large amount of variance explained by its correlations with north western localities exposed to the north.

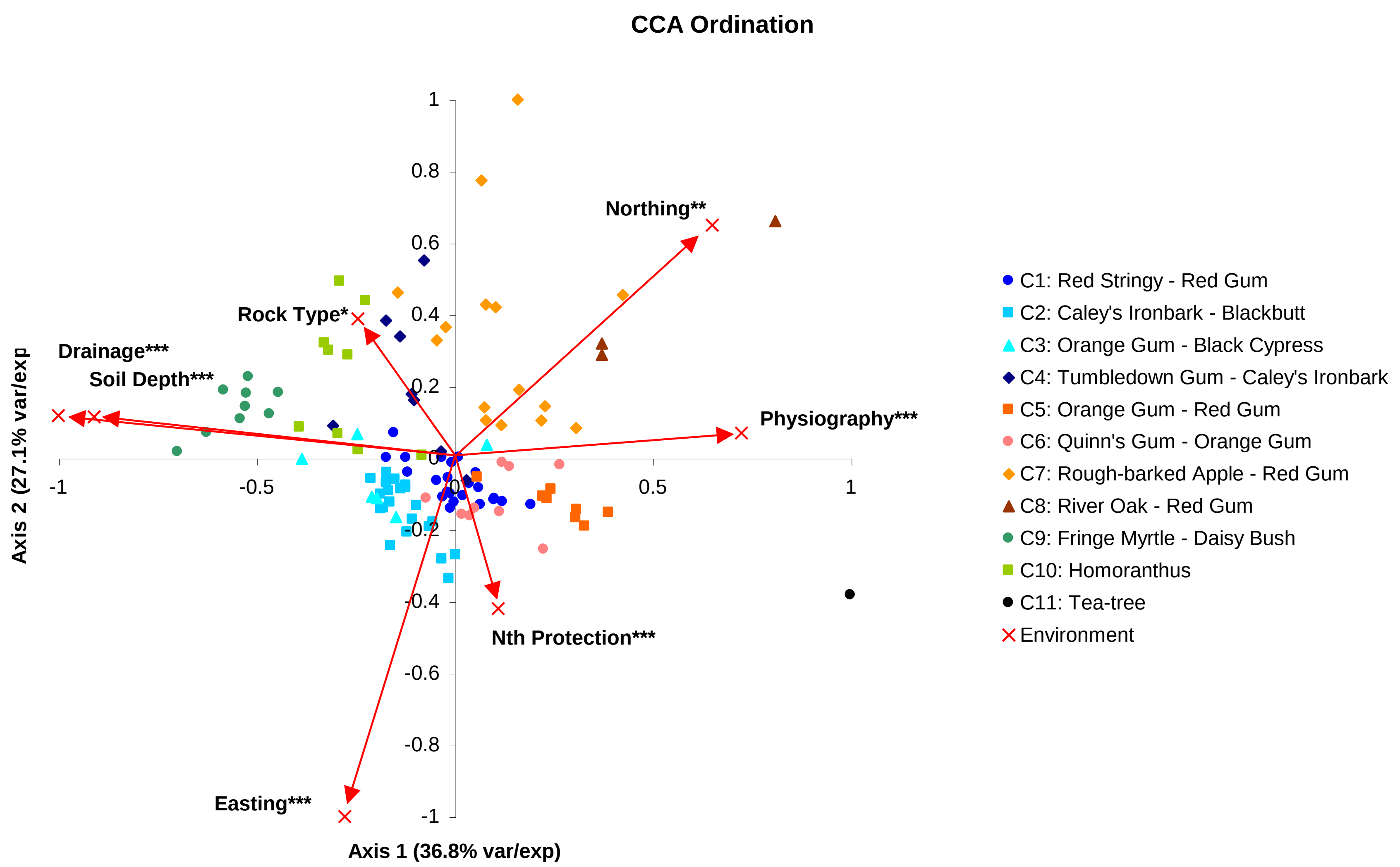


Figure 13: Biplot of canonical correspondence analysis on sites. Red arrows = environmental variables. *** P < 0.001; ** P < 0.01; * P < 0.05.

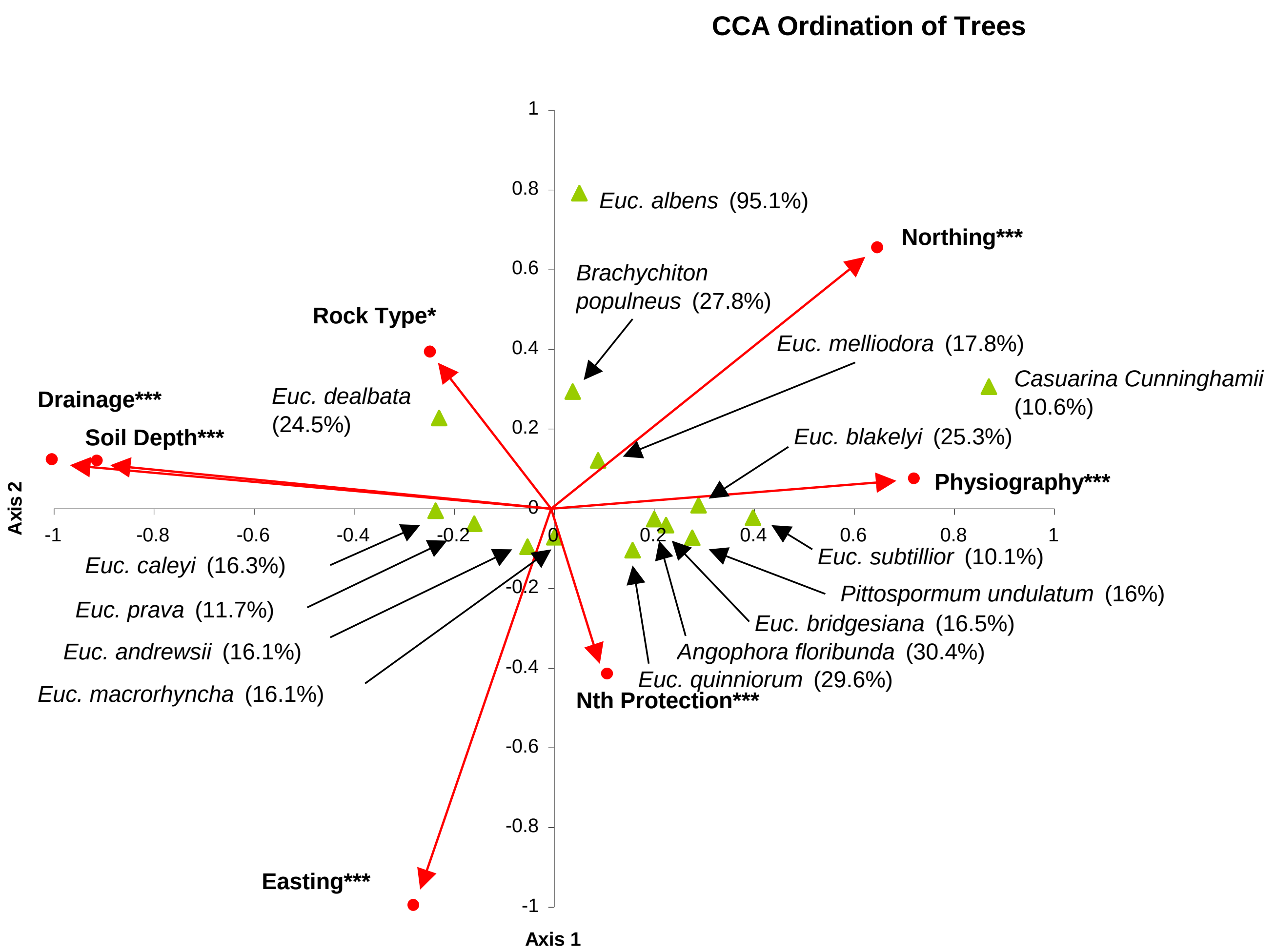


Figure 14: Biplot of canonical correspondence analysis on Tree species (variance explained in brackets). Red arrows = environmental variables.

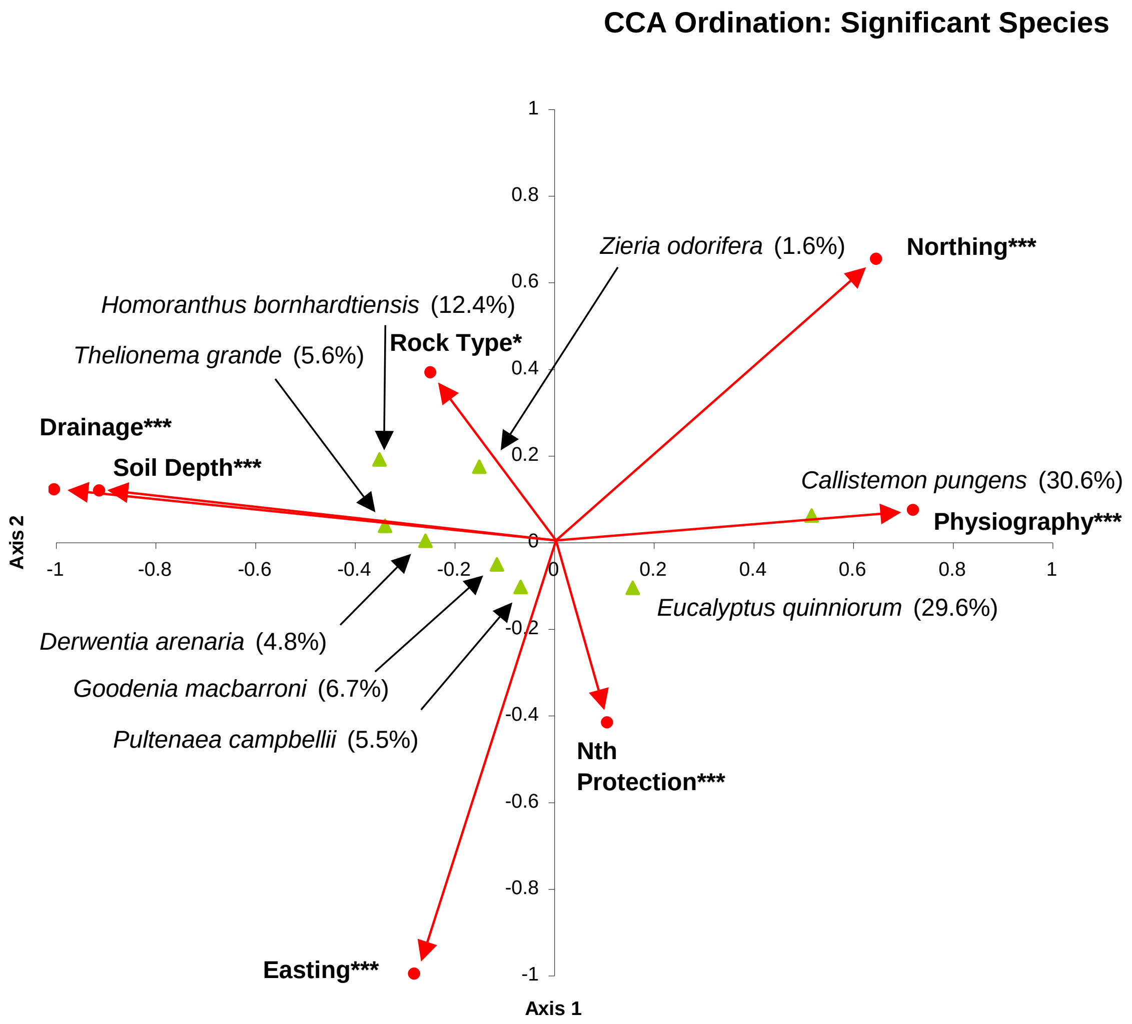


Figure 15: Biplot of canonical correspondence analysis on rare or threatened plant species (variance explained in brackets). Red arrows = environmental variables.

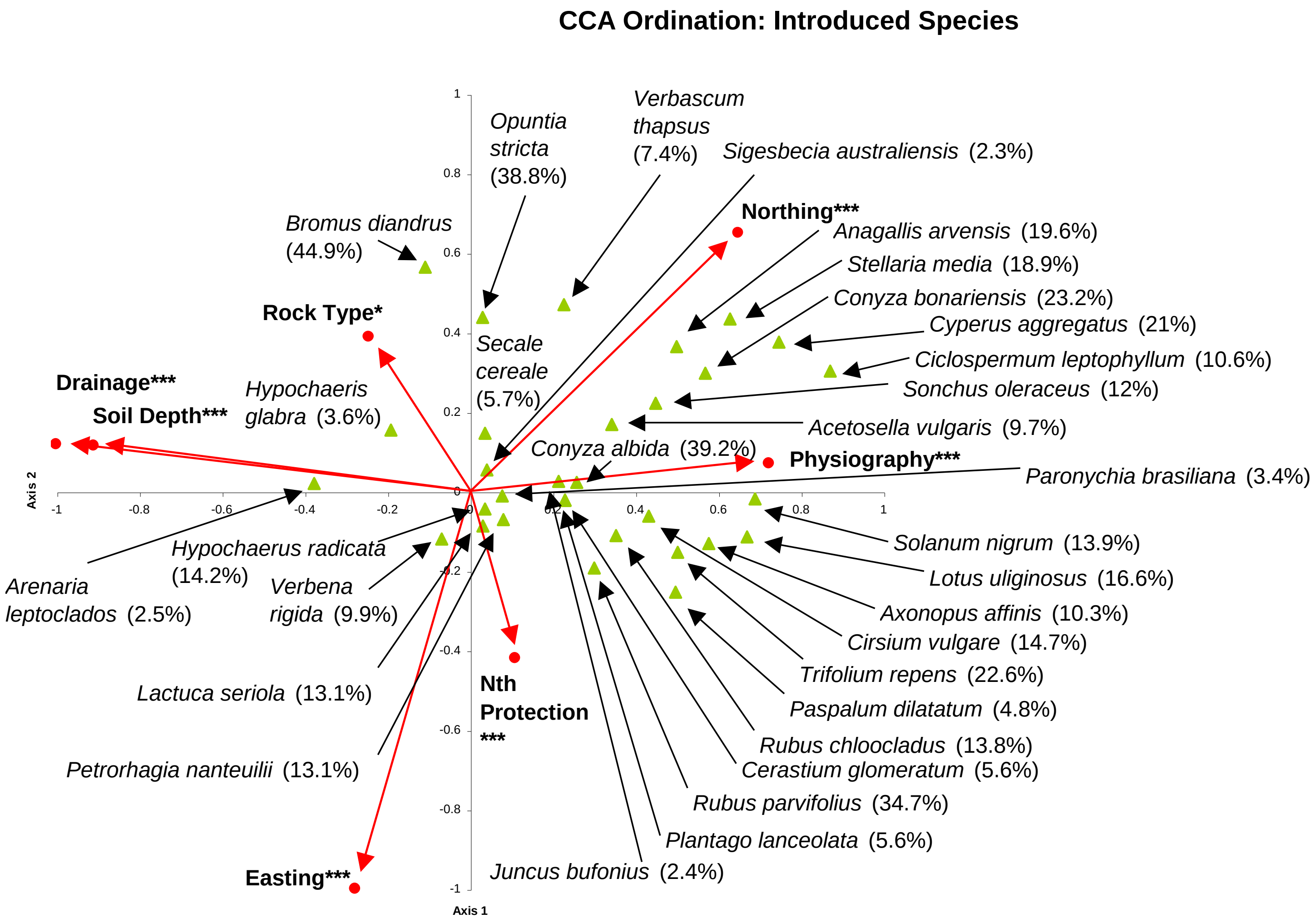


Figure 16: Biplot of canonical correspondence analysis on weed taxa (variance explained in brackets). Red arrows = environmental variables.

3.5 Coleman curves and richness estimation

Over 90% of species observed were found within sites. Based on the expected number of species for the region (Figure 17) the number of species observed accounts for all predicted to occur indicating that sampling may be at saturation.

Based on the predicted richness for each community all communities have been inadequately surveyed (Figure 18). In particular Community 8 and 10 have 50% or less of the predicted species captured in sites. Communities 3 and 5 are also poorly sampled. Communities 1, 2, 4, 6 and 7 probably have a substantial amount of the potential species captured in sites during this investigation. Community 5 is predicted to contain the greatest number of species, followed by Community 1 and then Community 7. The poorest community is predicted to be Community 9 followed by Community 4 and Community 3.

Coleman curves for individual communities are given in Figure 19. There is a large difference between the beta diversity variation in communities. Community 5 is the richness and most variable between sites being nearly two and a half times as rich as Community 9 at the nine site sampling level. Based on the inferred moisture gradient given on Figures 11 and 12, Communities 5-7 from primarily creeks and gullies on deeper less well drained soils of the north (Figure 13) are the richest with more inter-site variation. Communities 1-4 from ridges and crests primarily to the east and south and often protected from the north are intermediate in terms of community richness and inter-site variation in species composition (Figures 11-13). Communities 9 and 10 are the poorest with the least inter-site variation in composition and number and these were associated with well drained shallow soils in higher topographic positions to the south (Figures 11-13).

Using Coleman curves (Figure 20) the study area is intermediate in terms of richness. Based on the surveys analysed 13 have greater Coleman curves and 13 have lower Coleman curves (Figure 20). The study area is closest to Severn River NR in terms of richness and lies between Warra NP (higher) and Kwiambal (lower) in terms of curve shape and richness.

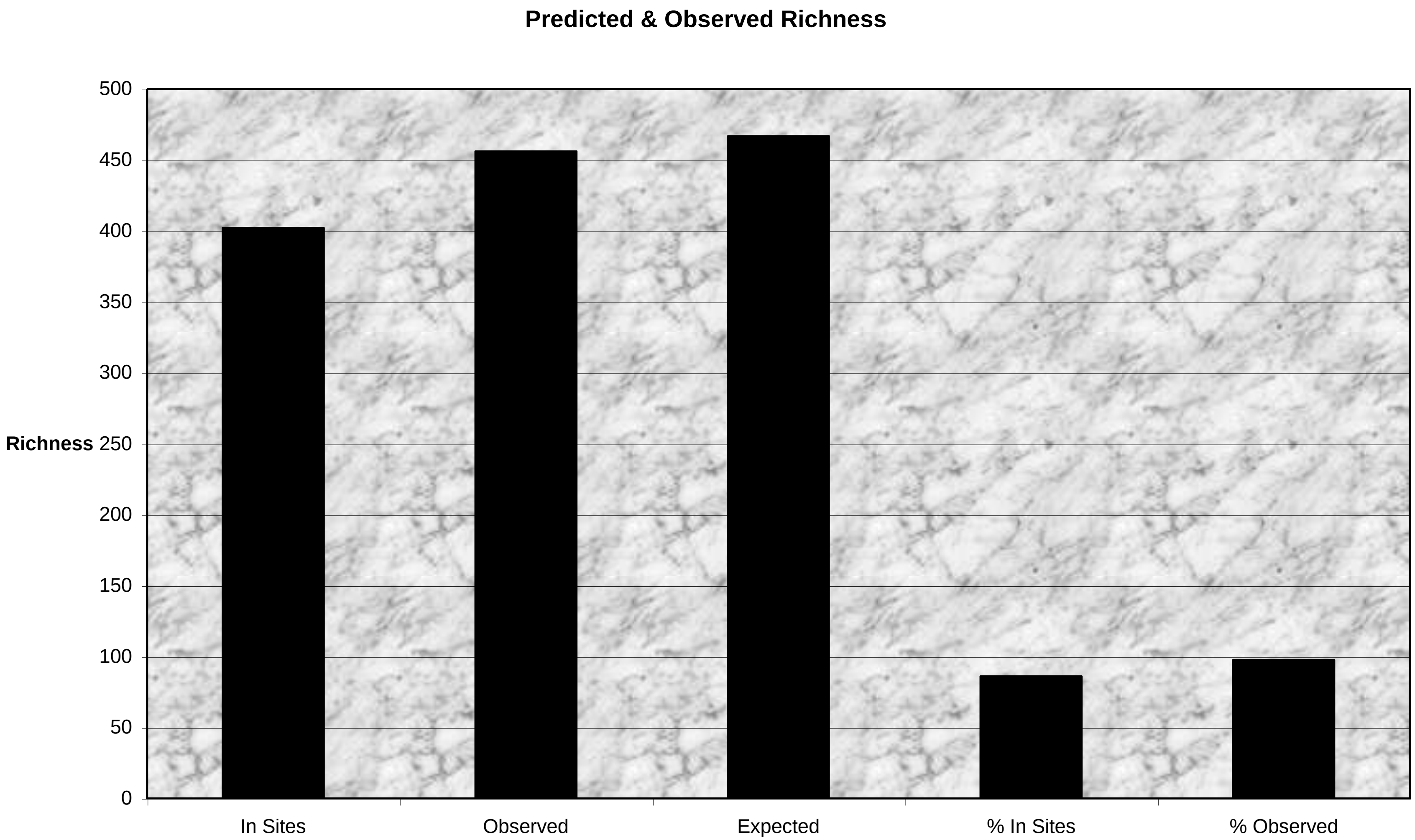


Figure 17: Comparison of richness found in sites, observed and the number predicted based on Incident Coverage Estimator of species richness (ICE).

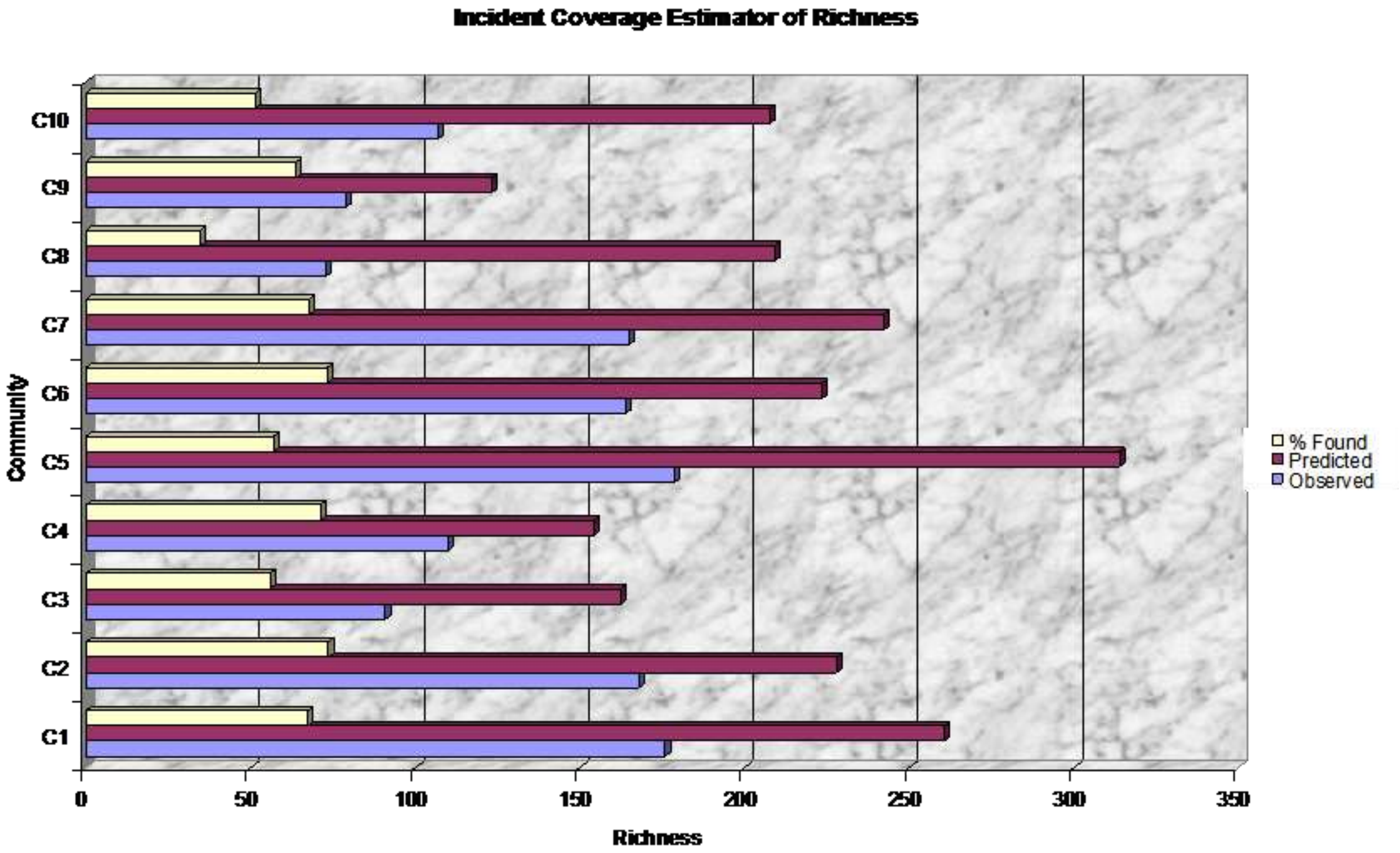


Figure 18: Incident based Coverage Estimator of species richness (ICE) for communities with more than three sites, the actual observed richness based on species captured in sites and the percent comparison of both. Note all communities are predicted to contain many more species than was actually captured.

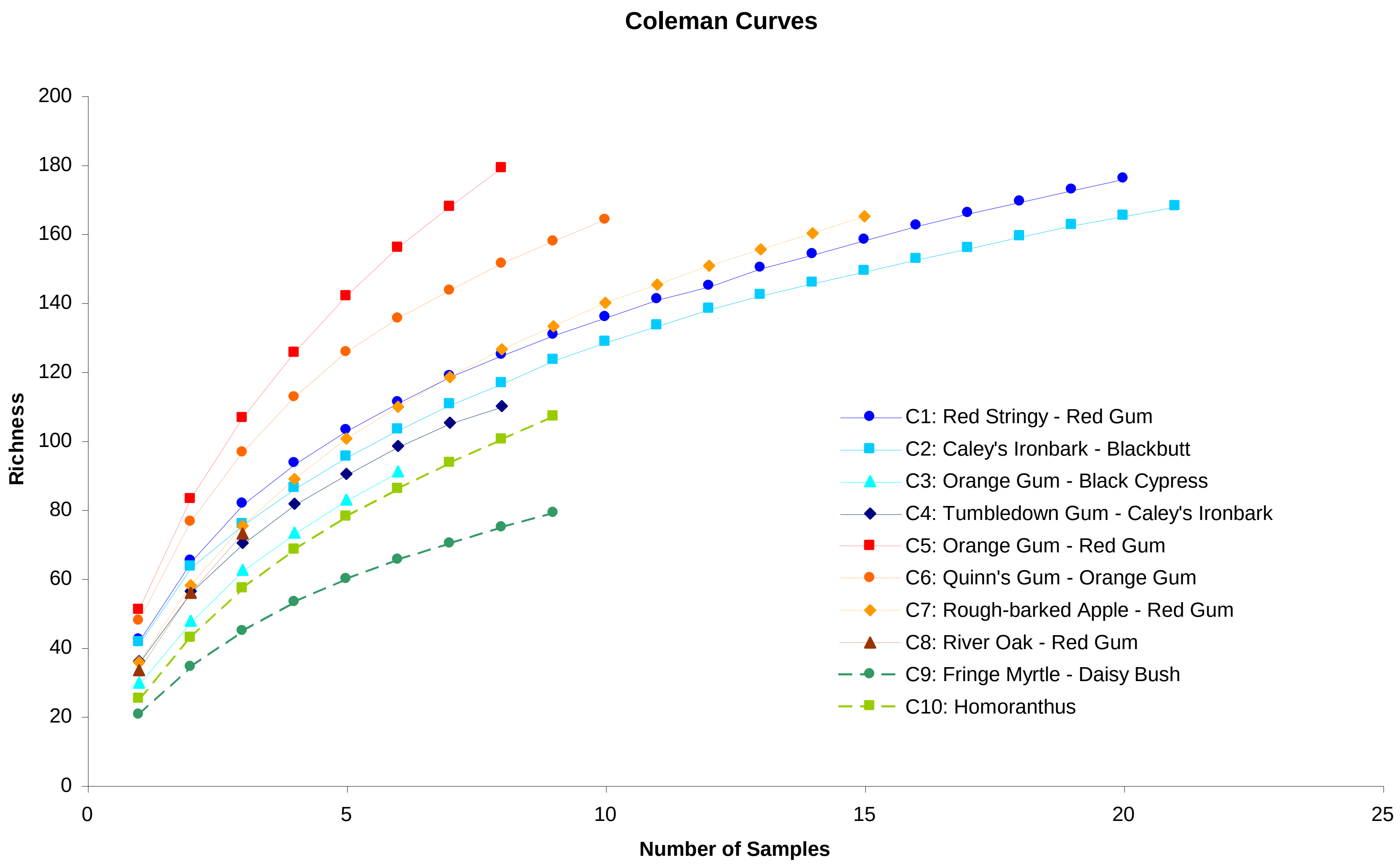


Figure 19: Coleman curves for defined communities with more than three sampled sites.

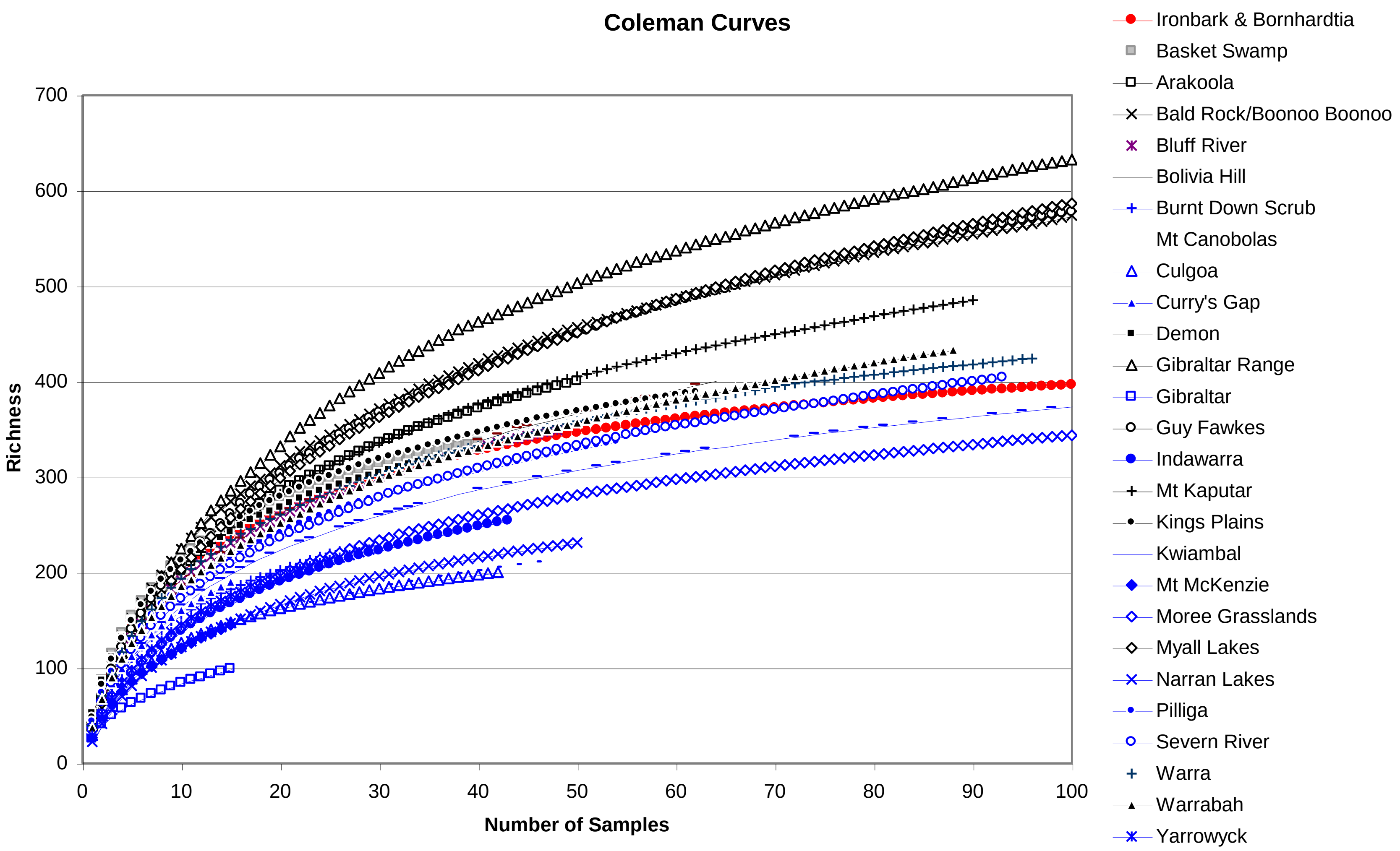


Figure 20: Comparison of Rarefaction curves for recent surveys conducted in New South Wales.

3.6 Range distribution

Table 6 presents a representation of the average range size, in terms of New South Wales botanical districts, for the component flora of each community. As each the study area is within the Northern Tablelands of New South Wales, 100% of the flora of all communities is distributed within this district. On average all communities are commonly share their component flora with the North Western Slopes, as this is the closest adjoining Botanical Division this is not surprising. The coastal districts of New South Wales are however, where most other taxa are shared, both the Central Coast and the North Coast, the Central Tablelands and the Central Western Slopes then follow. These communities have affinities with the central and north coasts more so than other tablelands or slopes areas. Lesser affinities are shared with the South Far Western Plains and the North Far Western Plains.

The mean on the right hand side of the table gives an indication of the cosmopolitan nature of the component floras. The average spread of each community is 63%, hence communities with a score above this are more cosmopolitan than average and below this are more restricted. Communities 1, 5 and 7 have the most cosmopolitan component floras. Community 11 is comparatively the most endemic flora followed by Community 9 and Community 3.

Table 6: Table showing the percentage occupation of the NSW botanical divisions of the component flora of each of the eleven communities found within Ironbark Nature Reserve and *Bornhardtia* VCA (excluding the informal Community 11). The average score for occupation of a botanical division gives an inferred ranking of floristic affinity. The median score gives an inferred ranking of the cosmopolitan nature of the flora. NT = Northern Tablelands; NC = North Coast; CT = Central Tablelands; CC= Central Coast; SC = South Coast; ST = Southern Tablelands; NWS = North Western Slopes; CWS = Central Western Slopes; SWS = South Western Slopes; NWP = North Western Plains; SWP = South Western Plains; SFWP = South Far Western Plains; NFWP = North Far Western Plains.

	NT	NWS	CC	NC	CT	CWS	ST	SC	SWS	NWP	SWP	NFWP	SFWP	Mean
C1	100	91	84	82	82	81	70	67	57	53	43	17	15	65
C2	100	88	83	79	83	79	74	68	53	48	40	16	13	63
C3	100	100	75	78	73	76	69	65	45	51	35	13	12	61
C4	100	96	82	80	81	82	63	65	49	53	38	15	13	63
C5	100	90	84	82	82	80	75	72	56	49	45	15	14	65
C6	100	88	83	78	84	79	76	70	54	49	40	16	11	64
C7	100	93	83	77	81	83	69	67	55	55	47	19	16	65
C8	100	87	86	83	77	76	70	70	56	54	39	13	14	63
C9	100	88	74	79	75	70	61	63	43	51	42	18	12	60
C10	100	90	79	81	76	79	63	63	51	66	49	24	17	64
C11	100	79	79	79	74	47	84	74	63	37	37	11	5	59
Mean	100	90	81	80	79	76	70	68	53	51	41	16	13	**63**

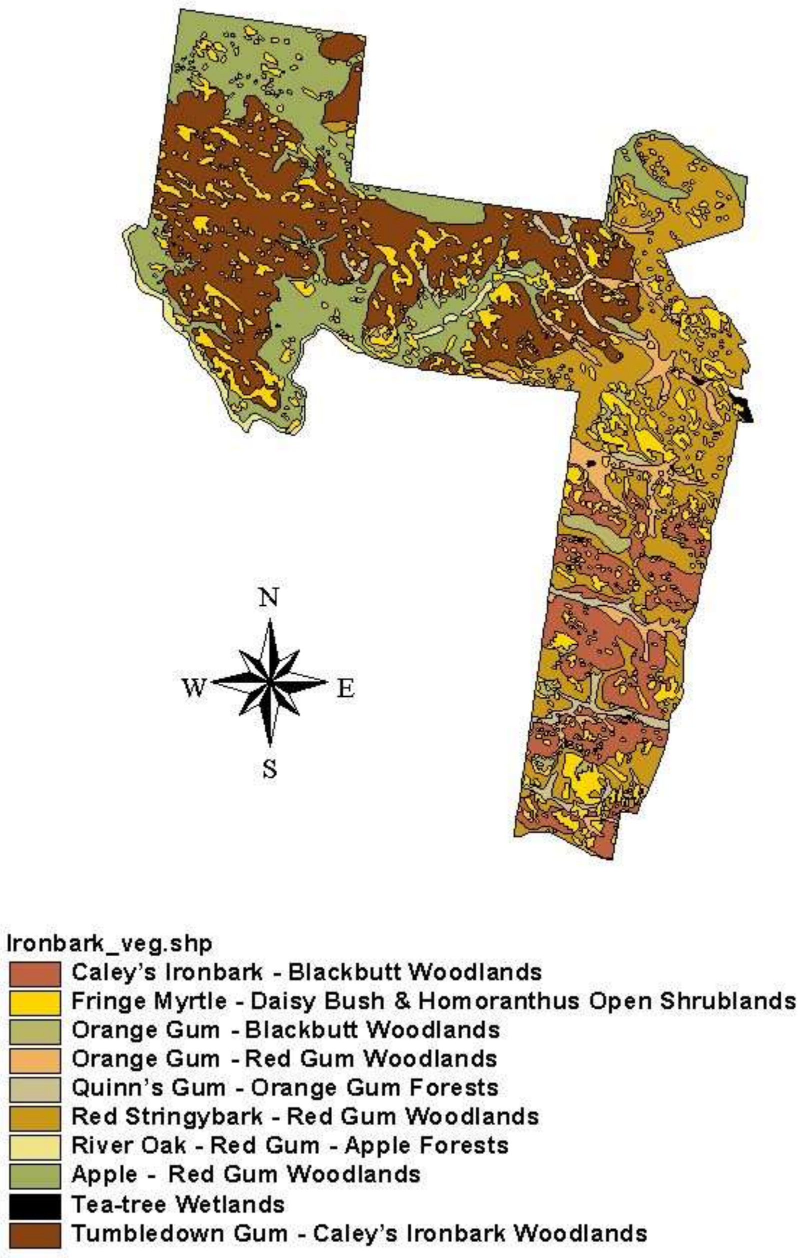


Figure 21: Distribution of all communities within Ironbark Nature Reserve and *Bornhardtia* Voluntary Conservation Area.

3.7 Description of plant communities

Most of the vegetation communities within Ironbark Nature Reserve and the *Bornhardtia* Voluntary Conservation Area are Woodlands with either a predominantly shrubby or grassy understorey. Shrublands and herbfields do occur but are of restricted distribution primarily on shallow skeletal soils. Grasslands, except for those of a derived nature were not found. Sedgelands were also missing, apart from minor occurrences directly associated with creek banks. Forests are found, but these are infrequent and usually associated with protected sites with deeper soil development. *Callitris endlicheri* is the most prominent tree species in the area and has often been subsumed in the community names to enable greater differentiation of floristic units. Other overstorey dominant trees are also ubiquitous or at least subdominant in several assemblages. The general fidelity of associated understorey species changes considerably allowing the recognition of communities despite many overstorey similarities. Overall, communities within the study area are Cypress Pine, Red Gum and Ironbark dominant with occurrences of Stringybark and Box on better and deeper soils. Eleven communities in total are described below.

3.7.1 Community 1: Red Stringybark – Red Gum Woodlands

Eucalyptus macrorhyncha (Red Stringybark) – *Callitris endlicheri* (Black Cypress Pine) – *Eucalyptus blakelyi* (Blakely's Red Gum) Forests & Woodlands.

Sample sites (20): 1, 2, 4, 7, 9, 10, 18, 36, 37, 42, 44, 48, 53, 57, 60, 61, 98, 106, 108, 110.

Number of hectares: 549 **Proportion of reserve:** 20.3%

Environmental relationships: usually on mid to upper slopes but sometimes also on lower slopes and flats. Soils are usually sandy loam, loam or rarely loamy sand, are deep or shallow and are usually dark to light brown or grey brown.

Distribution within conservation areas: primarily restricted to the eastern sections of both conservation areas and to sites protected from the north.

Structure: primarily grassy woodlands but also shrubby woodlands and open forests.

- Tree layer: (12-) 20-25 (-30) m tall; 20-30 (-40)% cover.

- Tall shrub layer: absent.
- Low shrub layer: 1-3 (-4) m tall; (5-) 20-30 (40)% cover.
- Understorey layer: > 1 m tall; (30-) 50-90% cover.

No. of taxa: 179 **No. of taxa per plot:** 35-**44.8**-54.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Eucalyptus macrorhyncha, Callitris endlicheri, Angophora floribunda, Eucalyptus blakelyi, Eucalyptus bridgesiana, Eucalyptus melliodora, Eucalyptus prava, Eucalyptus andrewsii, Eucalyptus caleyi*.

Shrubs: *Cassinia quinquefaria, Leucopogon muticus, Hibbertia obtusifolia, Melichrus urceolatus, Pultenaea* sp. G, *Brachyloma daphnoides* ssp. *glabrum, Lissanthe strigosa, Olearia elliptica, Olearia viscidula, Hibbertia riparia, Dodonaea viscosa* var. *angustifolia, Acacia neriifolia, Acacia leiocalyx, Pultenaea* sp. C, *Indigofera adesmiifolia.*

Climbers & trailers: *Desmodium varians, Glycine clandestina, Hardenbergia violacea, Clematis glycinoides.*

Ground cover: *Cymbopogon refractus, Aristida vagans, Geranium solanderi* var. *solanderi, Dichelachne micrantha, Lomandra multiflora, Echinopogon caespitosus* var. *caespitosus, Luzula flaccida, Dichondra repens, Dianella caerulea, Senecio diaschides, Caladenia fuscata, Aristida calycina, Themeda triandra, Cheilanthes sieberi, Hydrocotyle peduncularis, Dianella revoluta, Wahlenbergia planifolia* ssp. *pilosa, Oxalis chnoodes, Joycea pallida, Acaena novae-zelandiae, Viola betonicifolia, Veronica calycina, Goodenia macbarroni, Plantago varia, Lepidosperma laterale, Imperata cylindrica, Ranunculus lappaceus, Chrysocephalum apiculatum, Austrodanthonia laevis, Vittadinia cuneata, Scleranthus biflorus, Poa sieberiana, Microlaena stipoides, Goodenia hederacea, Hypericum gramineum, Euchiton sphaericus, Wahlenbergia gracilis, Sorghum leiocladum, Haloragis heterophylla, Galium migrans, Sigesbeckia australiensis, Pomax umbellata, Opercularia diphylla, Galium gaudichaudii, Fimbristylis dichotoma, Dichondra* sp. A, *Carex breviculmis, Scutellaria humilis, Poranthera microphylla, Lomandra longifolia, Goodenia bellidifolia, Echinopogon ovatus.*

Introduced taxa: *Hypochaeris radicata, Conyza albida, Centaurium erythraea, Trifolium repens, Lactuca serriola, Verbena rigida, Verbena bonariensis, Secale cereale, Rubus chloocladus, Petrorhagia nanteuilii, Cirsium vulgare.*

Percent of species introduced: 6%

Variability: this is a predominantly grassy and herbaceous assemblage with often a minor shrub component. However, in a few sites, particularly on more exposed positions or where soils are shallower shrubs can become more prominent and be up to 40% cover, reducing the ground layer percent cover.

Condition: generally very good. Some areas are old growth condition with other areas having been selectively cleared or ring-barked in the past. Some sections, particularly along watercourses have been burnt regularly for green pick in the past. However, overall this is a relatively unmodified unit within the two conservation areas. The density and age of *Callitris* stands are one of the more visible differences within this unit.

Taxa of conservation importance: *Goodenia macbarroni, Thelionema grande, Pultenaea* sp. G.

Notes: no direct correlates can be found within the literature. This assemblage is likely to occur from south of Inverell in the Goonoowiggal area and Howell extending south to the eastern and higher altitude areas of Warrabah. Unlike some other assemblages described herein *Olearia* species do not dominate, and unlike Community 2 *Pultenaea* sp. G is usually absent or rare in the shrub layer.

Conservation status: although likely to extend from at least Goonoowiggal to Warrabah this assemblage is only reserved locally, here and in Warrabah NP and potentially Stoney Batter NR. Thus this community is not represented formally in conservation areas across its range. In addition, the number of combined hectares in reserve are likely to be between one to two thousand hectares at the most. Thus this assemblage should be considered poorly conserved both locally in terms of area and also inadequately in terms of representation within the reserve network. Parts of this community are dominated by Yellow Box – Blakely's Red Gum and as such would be considered Endangered on the *TSC* Act and the *EPB&C* Act.

Threats: as this assemblage is primarily grassy in the understorey it is potentially threatened by the invasion of exotic grass species. It is also threatened by inappropriate fire regimes.

Management considerations: appropriate fire regimes should be researched and followed through. Pigs are causing noticeable damage to some large areas and need to be controlled. Stray cattle have also been noted within this community and these will need to be controlled. Care should be taken not to introduced some of the more highly invasive exotic grasses which are within close proximity to these conservation areas, such as Coolatai Grass (*Hyparrhenia hirta*). Blackberry is also of concern in a few minor localities.

Plate 6: Photographs of Community 1. Above left Site 44 and right 61.

Plate 7: Photographs of Community 1. Above left Site 60 and right 57; below Site 53

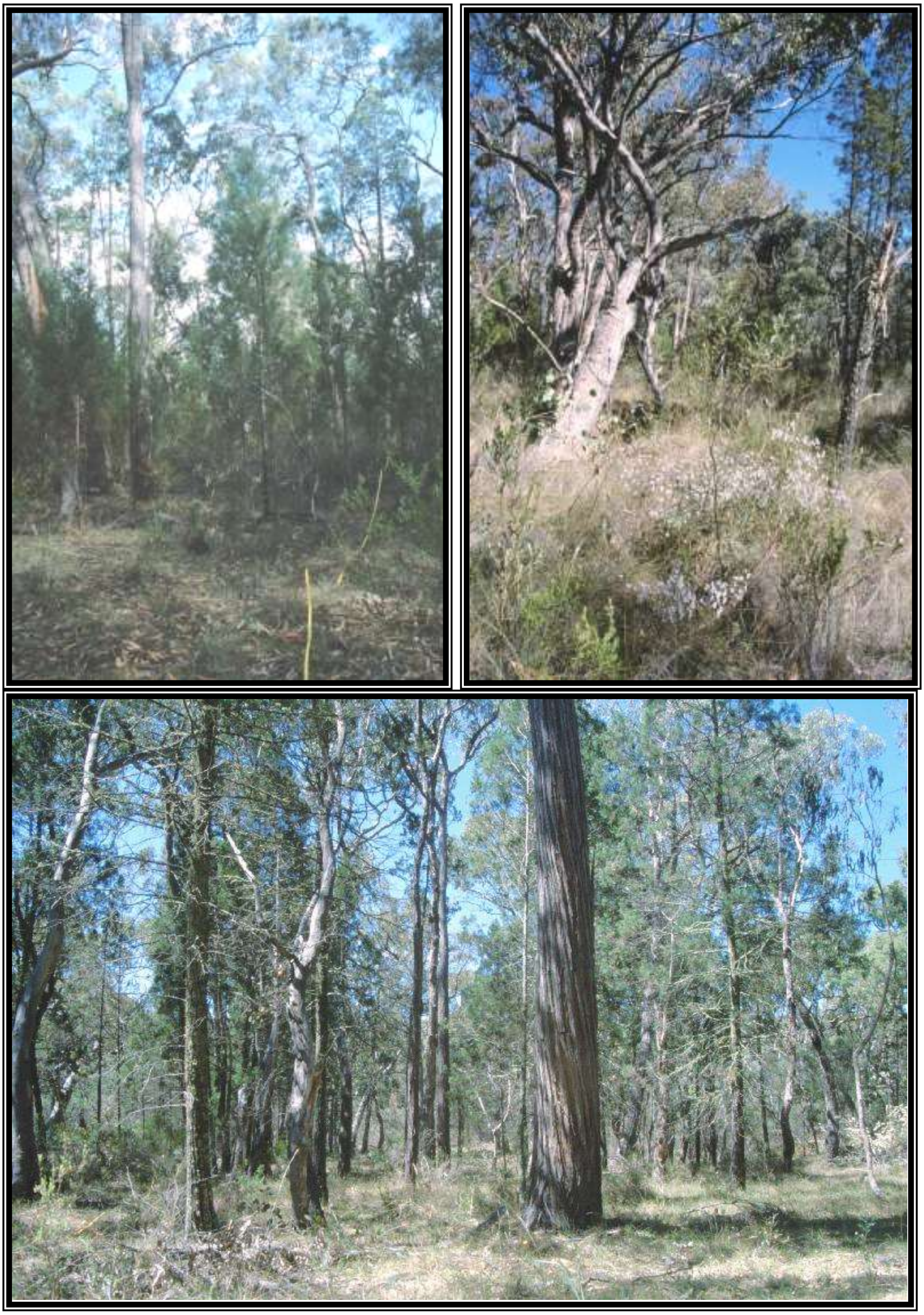


Plate 8: Photographs of Community 1. Above left Site 18.

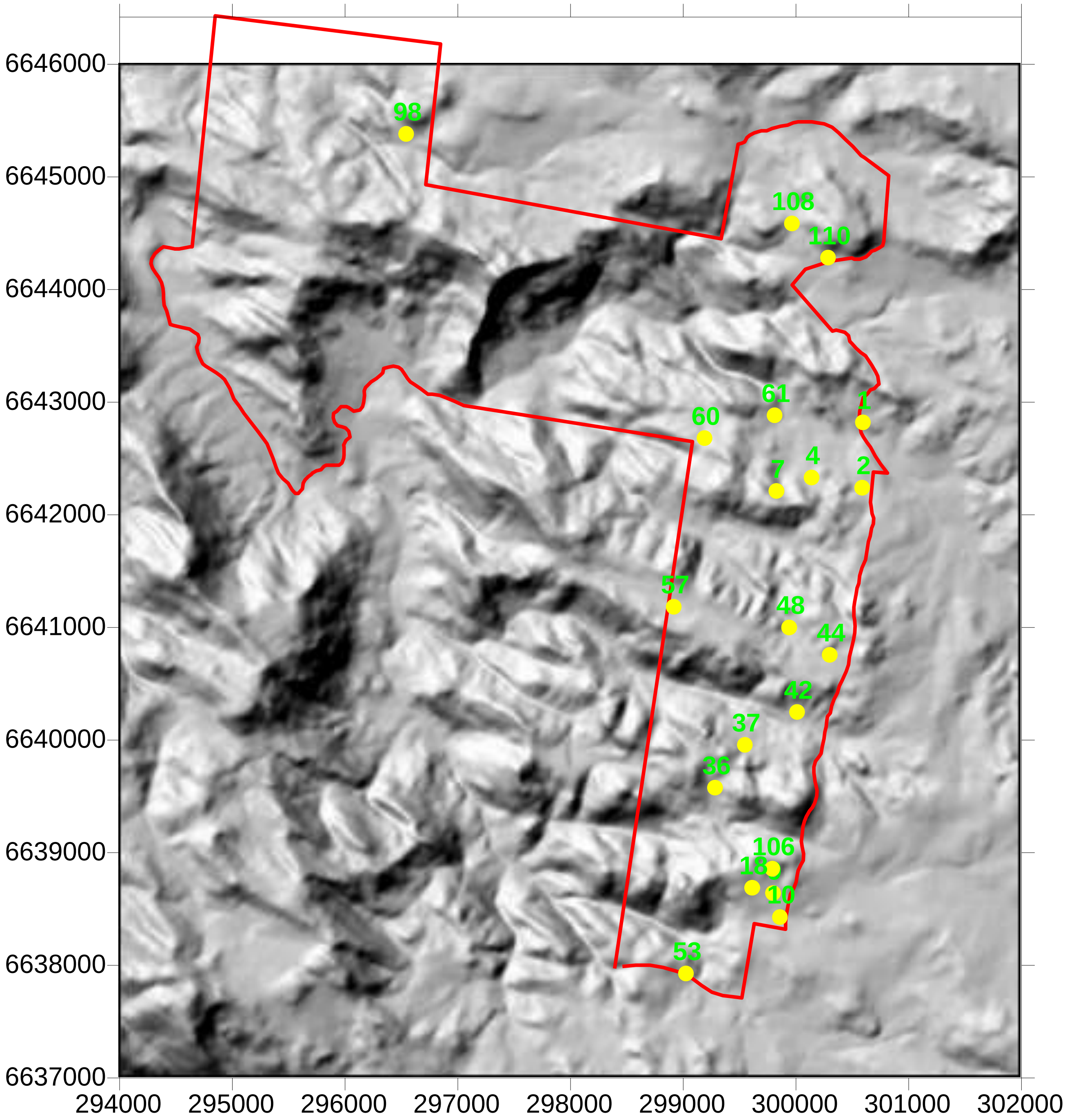


Figure 22: Placement of sites within Community 1.

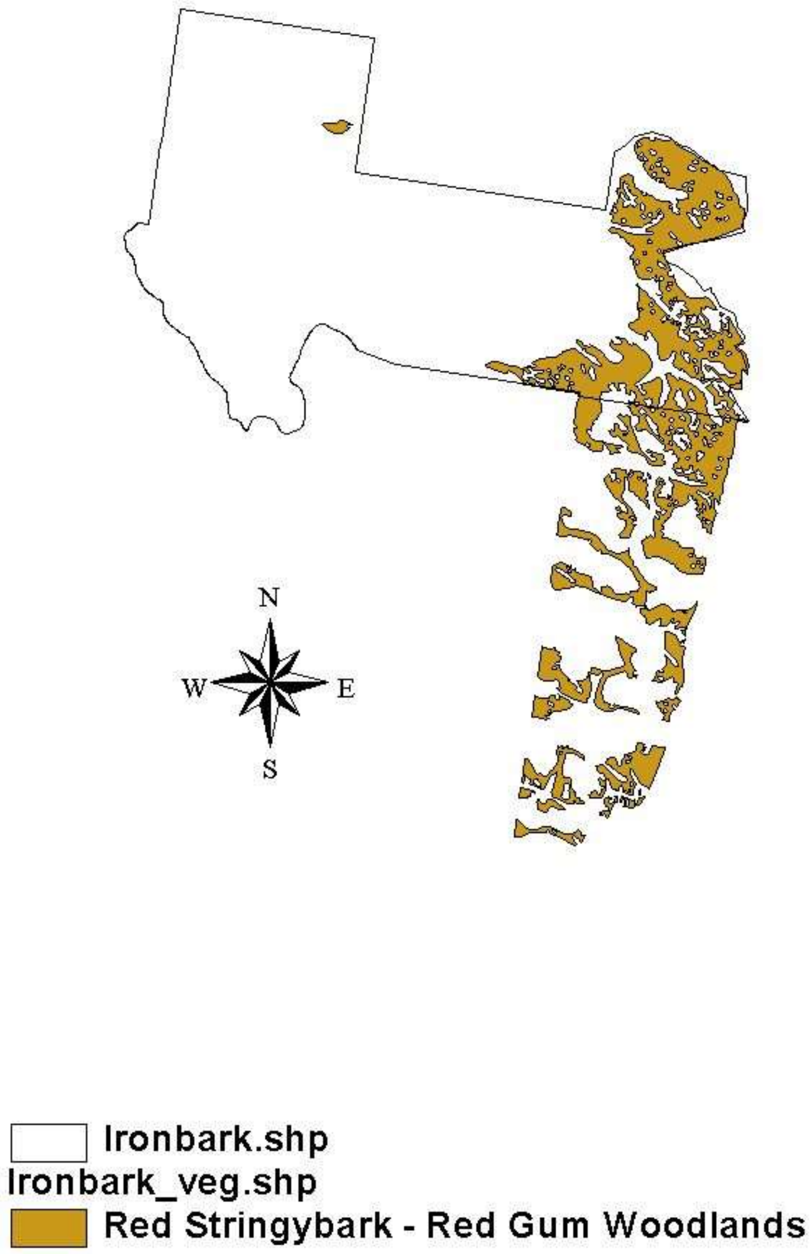


Figure 23: Mapped distribution of Community 1.

3.7.2 Community 2: Caley's Ironbark – Western New England Blackbutt Woodlands

Callitris endlicheri (Black Cypress Pine) – *Eucalyptus caleyi* subsp. *caleyi* (Caley's Ironbark) – *Eucalyptus andrewsii* (Western New England Blackbutt) Woodlands

Sample sites (21): 14, 16, 17, 22, 23, 24, 27, 31, 32, 35, 38, 40, 41, 43, 45, 46, 49, 51, 54, 103, 105.

Number of hectares: 255.2 **Proportion of reserve:** 9.5%

Environmental relationships: primarily on crests and upper slopes, but also on other physiographic positions. Soils are well drained or occasionally moist. Soil colour is usually brown, from light to grey brown or occasionally red brown and are sandy loam in texture or rarely loamy sand or loam.

Distribution within conservation areas: entirely restricted to the VCA area, this community is commonly found on exposed ridges facing north.

Structure: primarily shrubby woodlands or open forests.

- Tree layer: (8-) 15-20 (-30) m tall; 20-30 (-40)% cover.
- Tall shrub layer: 3-10 (-12) m tall; 10-20 (-40)% cover. Usually absent.
- Low shrub layer: 1-3 m tall; (10-) 20-30 (-40)% cover.
- Understorey layer: > 1 m tall; (10-) 30-60 (-80)% cover.

No. of taxa: 168 **No. of taxa per plot:** 29-**41.6**-52.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Callitris endlicheri, Eucalyptus caleyi, Eucalyptus prava, Eucalyptus andrewsii, Eucalyptus macrorhyncha, Eucalyptus quinniorum, Angophora floribunda, Eucalyptus melliodora, Eucalyptus bridgesiana*.

Shrubs: *Pultenaea* sp. G, *Cassinia quinquefaria, Leucopogon muticus, Hibbertia obtusifolia, Brachyloma daphnoides* ssp. *glabrum, Acacia neriifolia, Olearia elliptica, Lissanthe strigosa, Melichrus urceolatus, Leucopogon lanceolatus, Dodonaea viscosa* ssp. *angustifolia, Acacia penninervis, Correa reflexa, Persoonia sericea, Indigofera australis, Pultenaea spinosa, Olearia rosmarinifolia, Acacia buxifolia.*

Climbers & trailers: *Hardenbergia violacea, Glycine clandestina, Glycine tabacina, Clematis glycinoides, Billardiera scandens, Desmodium varians.*

Ground cover: *Joycea pallida, Lepidosperma laterale, Dichelachne micrantha, Lomandra multiflora, Cymbopogon refractus, Goodenia hederacea, Luzula flaccida, Macrozamia heteromera, Caladenia fuscata, Pomax umbellata, Dianella caerulea, Senecio diaschides, Wahlenbergia planiflora* ssp. *pilosa, Geranium solanderi* var. *solanderi, Patersonia sericea, Gonocarpus tetragynus, Plantago varia, Oxalis chnoodes, Dianella revoluta, Cheilanthes sieberi, Derwentia arcuata, Vittadinia cuneata, Lomandra longifolia, Carex breviculmis, Aristida vagans, Euchiton sphaericus, Themeda triandra, Ranunculus lappaceus, Opercularia diphylla, Goodenia macbarroni, Derwentia arenaria, Arthropodium milleflorum, Aristida calycina, Brachyscome microcarpa, Wahlenbergia gracilis, Lomandra filiformis, Hypericum gramineum, Hydrocotyle peduncularis, Galium gaudichaudii, Dichondra repens, Crassula sieberiana, Viola betonicifolia, Veronica calycina, Poa sieberiana.*

Introduced taxa: *Hypochaeris radicata, Conyza albida, Opuntia stricta, Centaurium erythraea, Paronychia brasiliana, Arenaria leptoclados, Aira cupaniana.*

Percent of species introduced: 4%

Variability: two fairly distinctive sub-assemblages are readily recognised on the full dendrogram and in the field. In areas slightly less exposed, such as on the southern side of dry shallow ridges or sites amongst a large collection of boulders a sub-assemblage dominated by *Eucalyptus andrewsii* (Western New England Blackbutt), *Euc. quinniorum* (Quinn's Gum), *Euc. macrorhyncha* (Red Stringybark) occurs. The understorey is primarily dominated by *Pultenaea* sp. G in the shrub layer and *Joycea pallida* and *Austrodanthonia* spp. being more common in the ground layer. In more exposed ridges or northern slopes a second sub-assemblage occurs which is dominated by *Euc. caleyi*, *Euc. prava* and *Euc. macrorhyncha* with an understorey of with *Cassinia quinquefaria* and *Leucopogon muticus* being most common in the shrub layer and a dominance of *Cymbopogon refractus* and *Joycea pallida* in the ground layer.

Condition: generally in excellent condition. Many areas are in old growth condition. Some areas in the north may have been selectively cleared in the distant past. Almost all areas have only been minimally winter grazed.

Taxa of conservation importance: *Goodenia macbarroni, Derwentia arenaria, Eucalyptus quinniorum, Thelionema grande, Pultenaea campbellii, Cyperus secubans, Olearia erubescens, Psilotum nudum, Pultenaea* sp. G.

Notes: in broad circumscription this assemblage is likely to occur from the Sundown area of Queensland as far south as Warrabah, but is likely to be more common from south of Goonoowiggal to Warrabah and as far east as Single NP and the Basin NR. In the strictest sense, this community only occurs from the study area south to the high altitude eastern parts of Warrabah National Park and surrounds. This community naturally has a very distinct shrub layer that is characterised by *Pultenaea*, *Cassinia* and *Leucopogon* with only a moderately dense grassy understorey, both in contrast to Community 1.

Conservation status: Wall (2000) considered a similar broad assemblage to be 64% cleared with only 2.4% of its reservation target met. This is likely to represent an overestimate of the area cleared as this type of assemblage is usually of poor agricultural quality and is often what is left in remnants. Similarly in broad terms this assemblage may occur in as many as nine reserves within New South Wales. Despite these reservations, the area under conservation (in the broad sense) may be as little as 8000 ha and in the strict sense less than 1000 ha. This community can be said to be reserved across its range of occurrence, but representation is probably inadequate in terms of the area conserved. In general this assemblage is poorly conserved.

Threats: inappropriate fire regimes. Within the central parts of *Bornhardtia* this community may have been burnt too frequently. Incursions from invasive exotic grasses are also a considerable threat. Browsing by goats and stray cattle may threaten parts of this assemblage.

Management considerations: research and implementation of appropriate fire regimes is a priority. Care should be taken not to introduce the more invasive introduced grasses which are within nearby properties. Control of goats and stray cattle may also be an ongoing management problem.

Plate 9: Photographs of Community 2. Above left Site 24 and right Site 35; below Site 54.

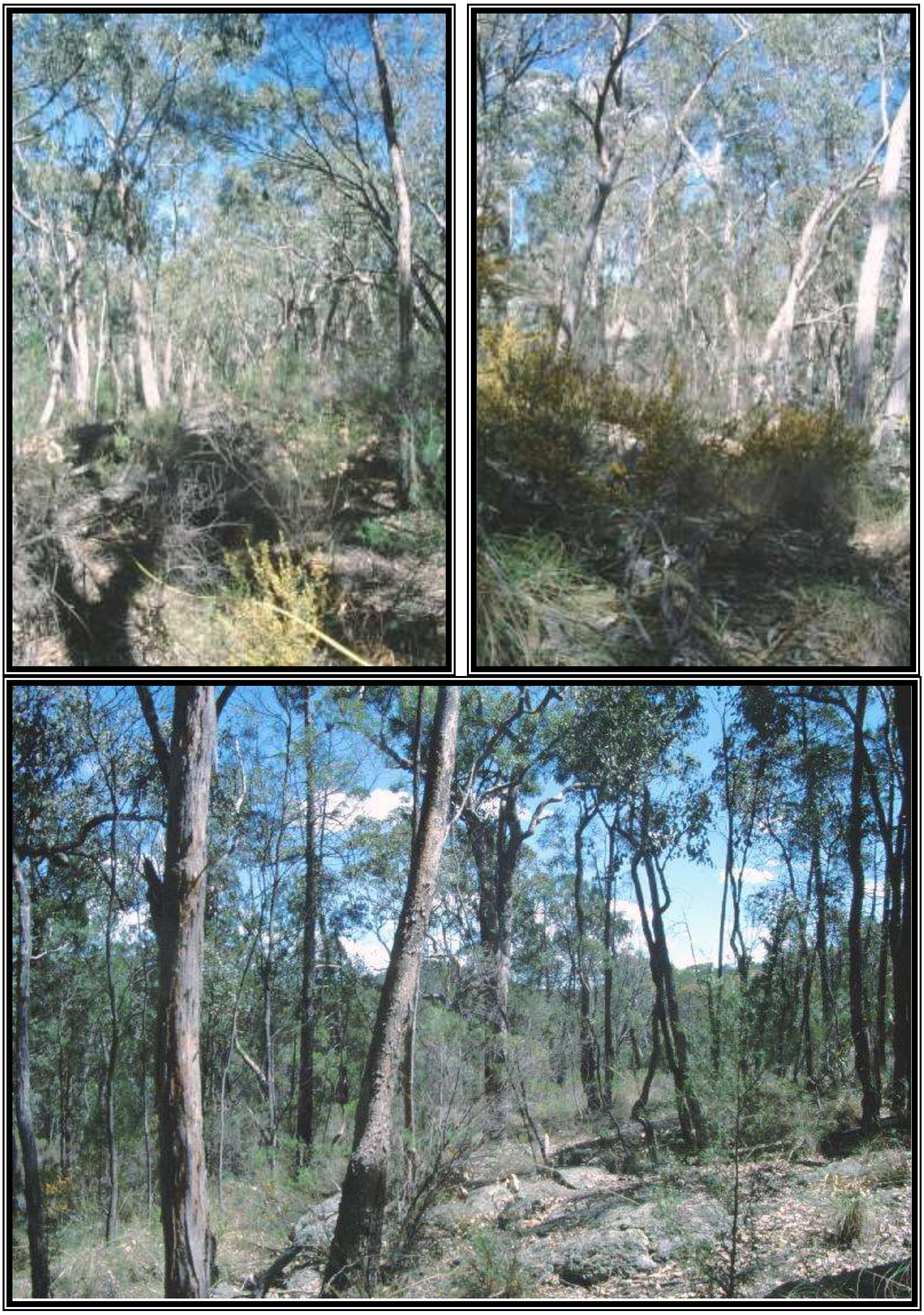


Plate 10: Photographs of Community 2. Above left Site 46 and right Site 32; below Site 40.

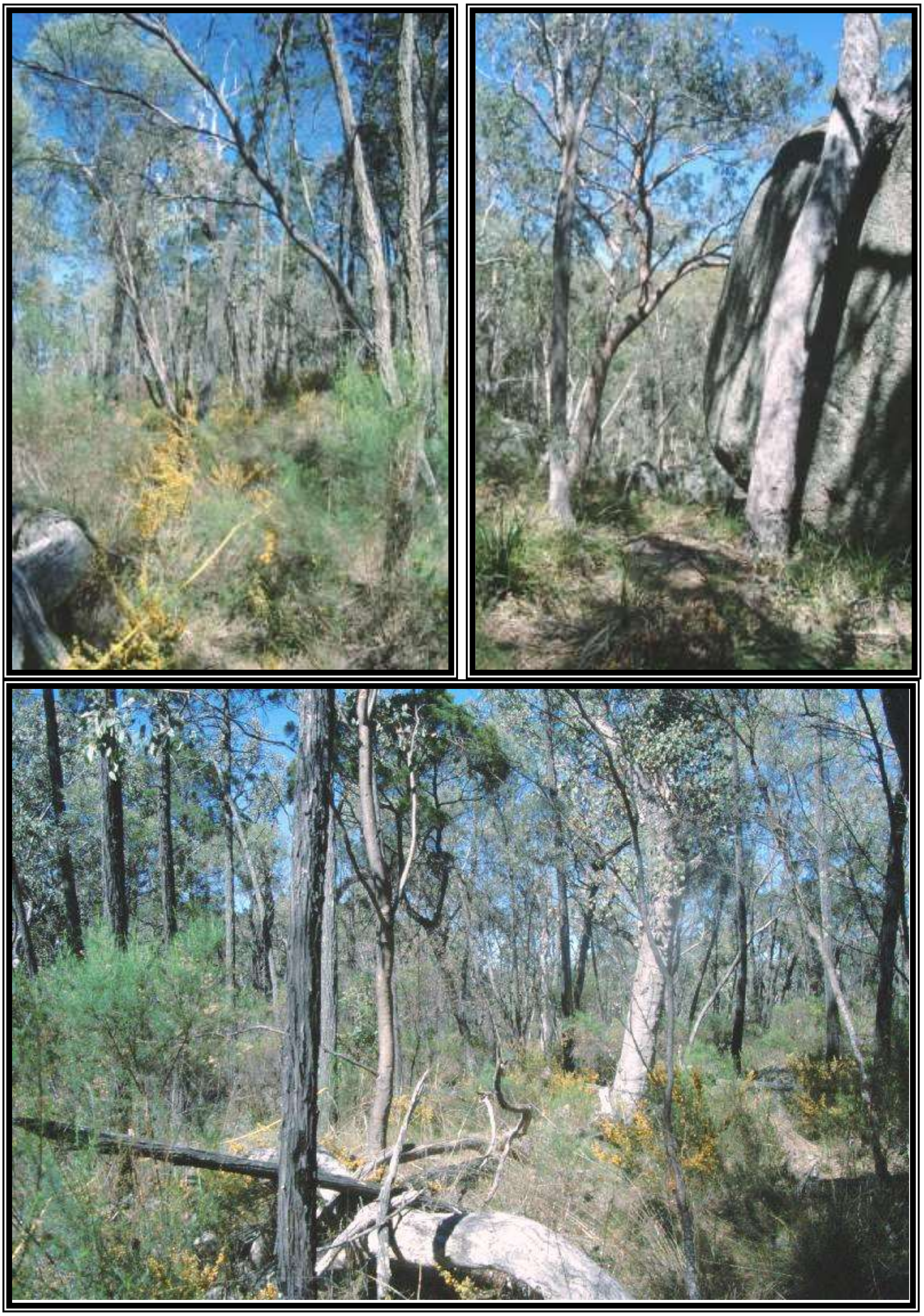


Plate 10: Photographs of Community 2. Above right Site 31 and left Site 22; below Site 16.

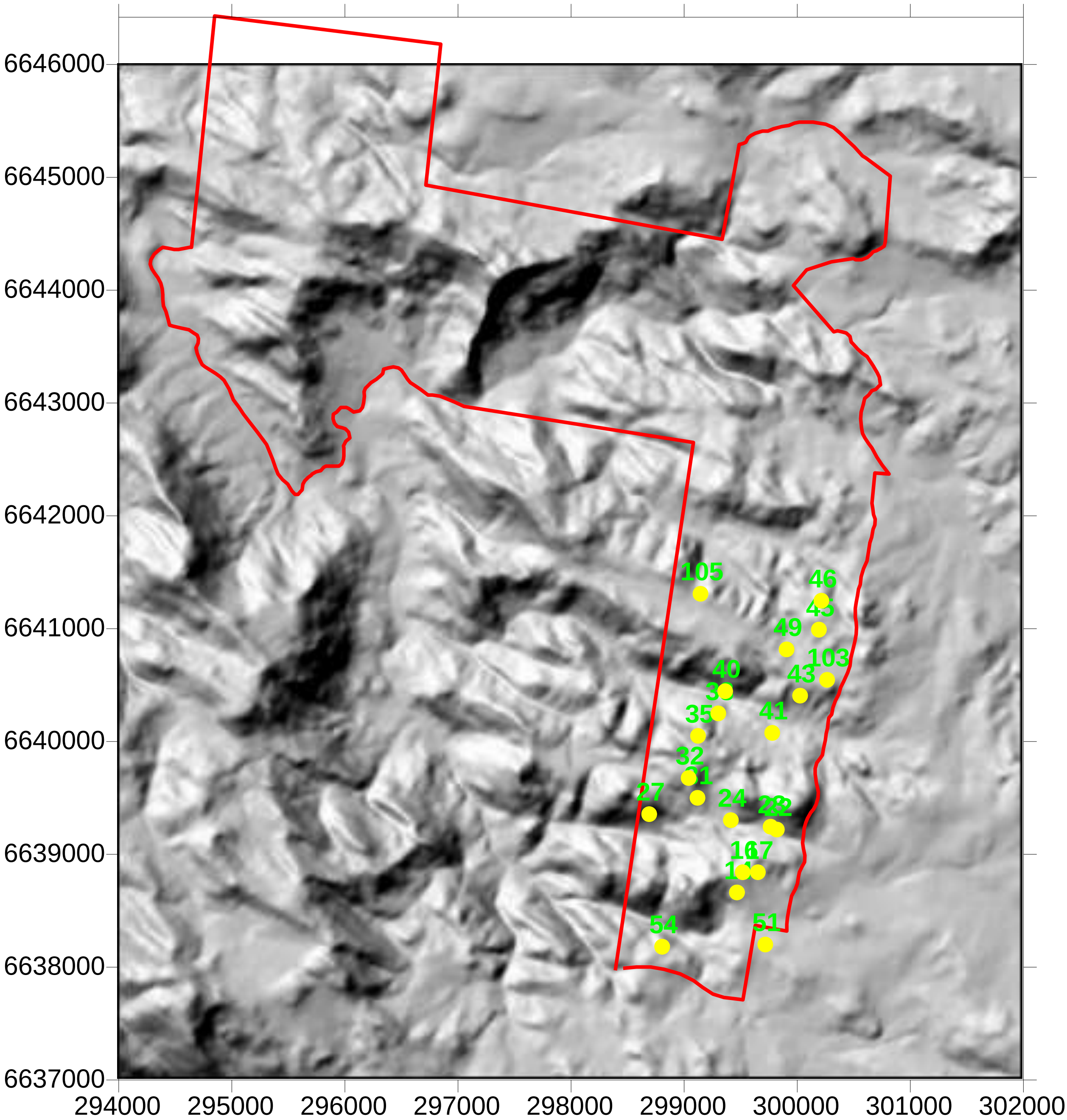


Figure 24: Placement of sites within Community 2.

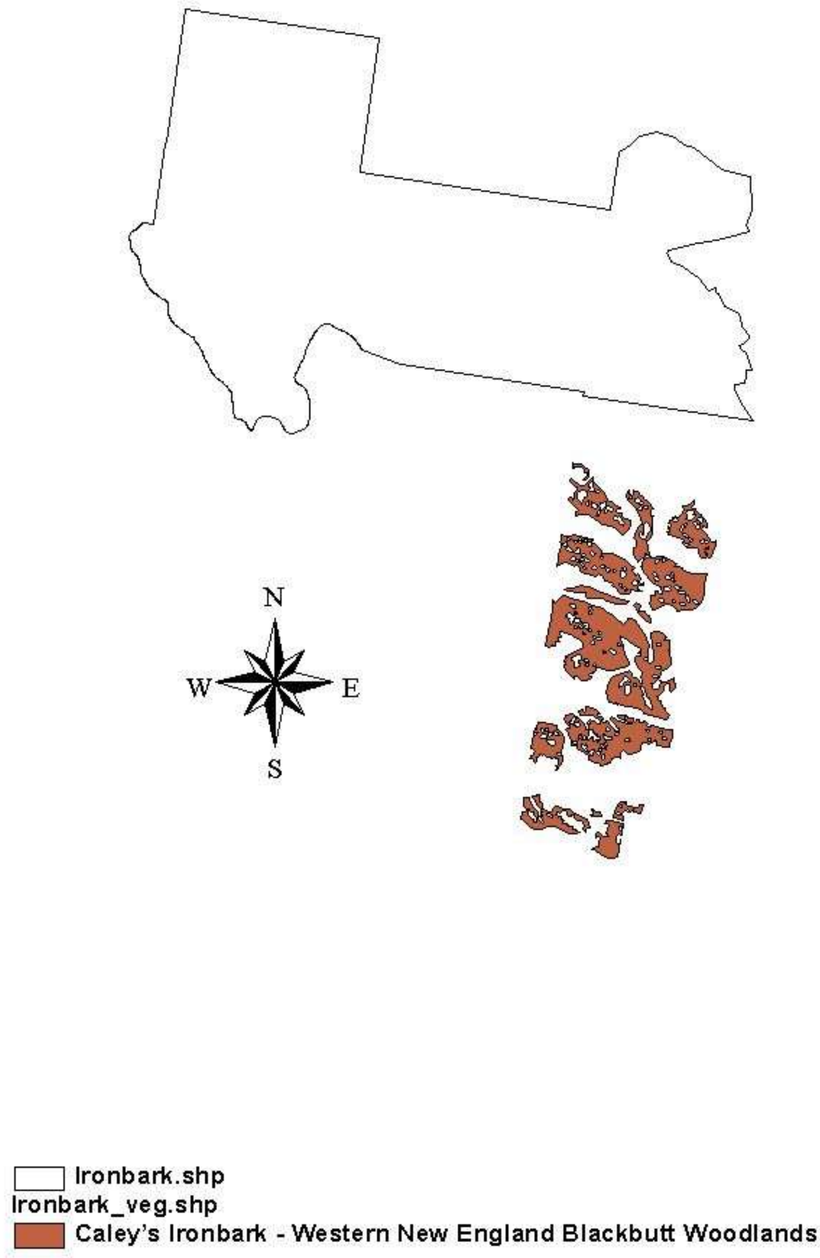


Figure 25: Mapped distribution of Community 2.

3.7.3 Community 3: Orange Gum – Blackbutt Woodlands

Eucalyptus prava (Orange Gum) – *Callitris endlicheri* (Black Cypress Pine) – *Eucalyptus andrewsii* (Western New England Blackbutt) Open Woodlands.

Sample sites (6): 33, 50, 56, 63, 85, 86.

Number of hectares: 32 **Proportion of reserve:** 1.2%

Environmental relationships: commonly on slopes, particularly mid slopes, but also on crests. On well drained or rarely moist soils, which are sandy loam or loamy sand in texture. Soils are dark brown or dark grey brown in colour.

Distribution within conservation areas: scattered throughout both conservation areas, but primarily occurring in western exposed sites at lower to mid altitudes on shallow rocky soils.

Structure: usually low woodlands or low open woodlands verging on shrublands.

- Tree layer: 8-18 (-25) m tall ; 10-30% cover.
- Tall shrub layer: absent.
- Low shrub layer: 1-3 m tall; (5-) 10-20% cover.
- Understorey layer: > 1 m tall; 20-60 (-80)% cover.

No. of taxa: 92 **No. of taxa per plot:** 16-**28.7**-45 .

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Eucalyptus prava, Callitris endlicheri, Eucalyptus andrewsii, Eucalyptus quinniorum, Eucalyptus macrorhyncha, Eucalyptus caleyi, Eucalyptus melliodora, Angophora floribunda*.

Shrubs: *Leucopogon muticus, Pultenaea* sp. C, *Cassinia quinquefaria, Acacia penninervis, Hibbertia acicularis, Pultenaea foliolosa, Notelaea microcarpa, Monotoca scoparia, Lissanthe strigosa, Hibbertia obtusifolia, Acacia neriifolia, Ozothamnus obcordatus, Olearia viscidula, Melichrus urceolatus, Leucopogon virgatus, Hibbertia* sp. ‘grandiflora’, *Grevillea triternata, Brachyloma daphnoides* ssp. *daphnoides.*

Climbers & trailers: *Hardenbergia violacea.*

Ground cover: *Joycea pallida, Pomax umbellata, Lomandra multiflora, Gonocarpus tetragynus, Dichelachne micrantha, Imperata cylindrica, Wahlenbergia communis,* *Patersonia sericea, Opercularia diphylla, Goodenia macbarroni, Dianella revoluta, Dianella caerulea, Stylidium graminifolium, Poa sieberiana, Lomandra longifolia, Lomandra filiformis, Lepidosperma laterale, Entolasia stricta, Dichelachne sieberiana.*

Introduced taxa: none apparent.

Percent of species introduced: 0%

Variability: this assemblage is highly variable in structure but is generally of a low open grassy woodland. It occurs in a variety of situations, but usually in exposed situations with shallow to almost skeletal soils on the margins of rock outcrops or areas with a great deal of loose rock. Tall shrub layers are absent always and only a sparse shrub layer is present. Despite this the ground layer is also often sparse. The greatest overall variability is due to how low and open the canopy is and the cover of the ground layer.

Condition: generally in very good condition, most areas are of old growth, with some interference with low impact grazing. Goats do frequent some sites but currently they haven't caused any great damage.

Taxa of conservation importance: *Goodenia macbarroni, Eucalyptus quinniorum, Zieria odorifera, Jasminum suavissimum*.

Notes: in the broad sense this assemblage is likely to occur from the Sundown region of Queensland south to Warrabah. In the strict sense this community probably occurs from south of Inverell to Warrabah.

Conservation status: Wall (2000) considered that 58.6% of this type of assemblage has been cleared and that only 6.8% of the reservation target has been met. DeVries (2000) considered that 40% of this type of assemblage has been cleared in the Nandewar Bioregion. It is possible that the estimated amount of clearance of this type of community is overestimated, but the amount in reservation would still be minimal. In the strict sense this assemblage may occur in as many as four formal conservation reserves and in the broad sense within seven in New South Wales. However, the number of hectares is minimal. Thus, it may be that this assemblage is represented and sampled across its range but that it is under represented in terms of the area contained in each. Overall this assemblage is inadequately represented in the conservation network in terms of area.

Threats: this community is threatened by the invasion of introduced grasses such as Coolatai Grass (*Hyparrhenia hirta*). Goats frequent many of these areas. Inappropriate fire regimes may also be of concern.

Management considerations: care should be taken to reduce the likelihood of invasive grasses entering these areas. Goats will need continual control and appropriate fire regimes will need to be investigated.

Plate 11: Photographs of Community 3. Above Site 33; below Site 50.

Plate 12: Photographs of Community 3. Above Site 56; below Site 63.

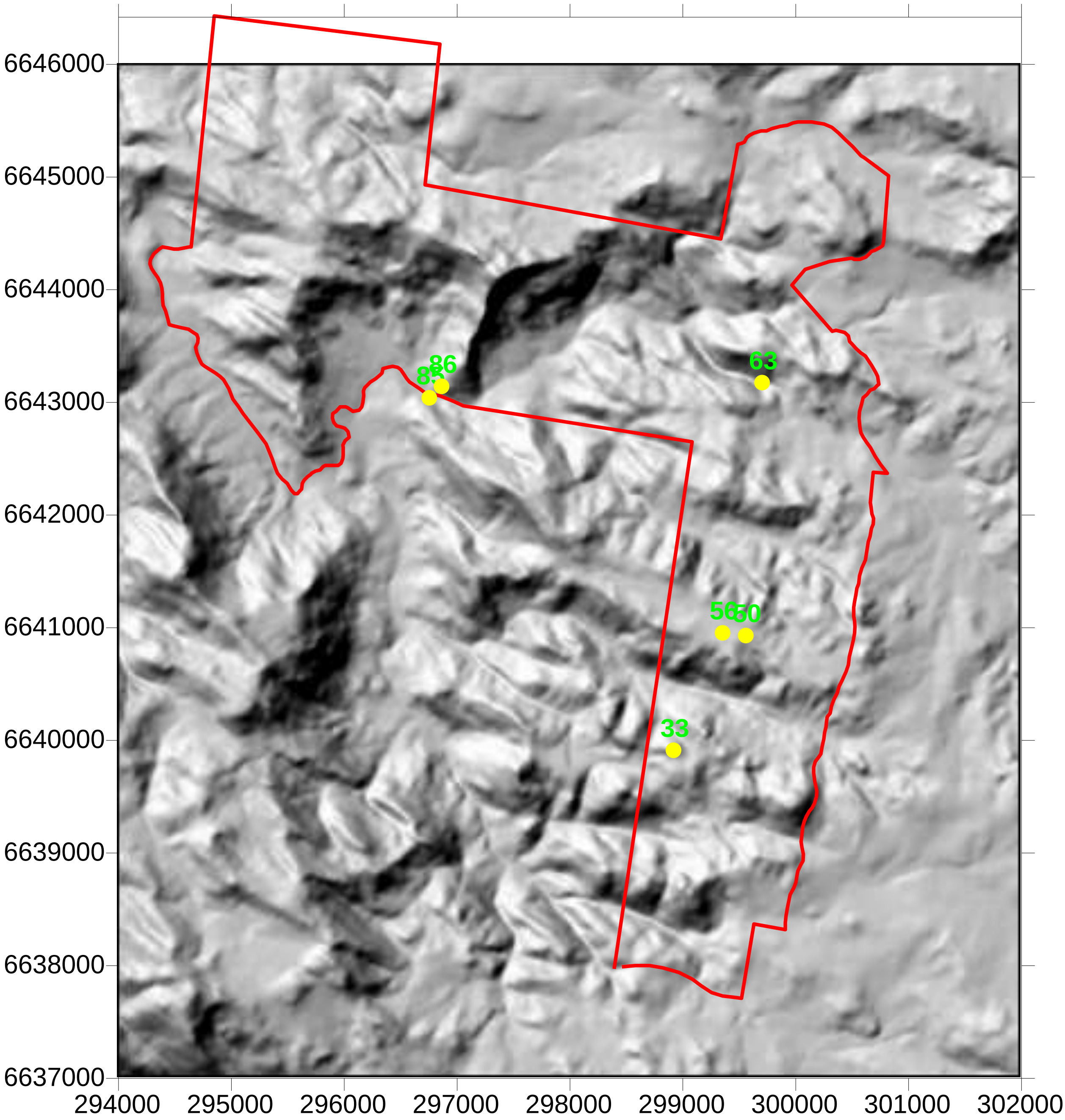


Figure 26: Placement of sites within Community 3.

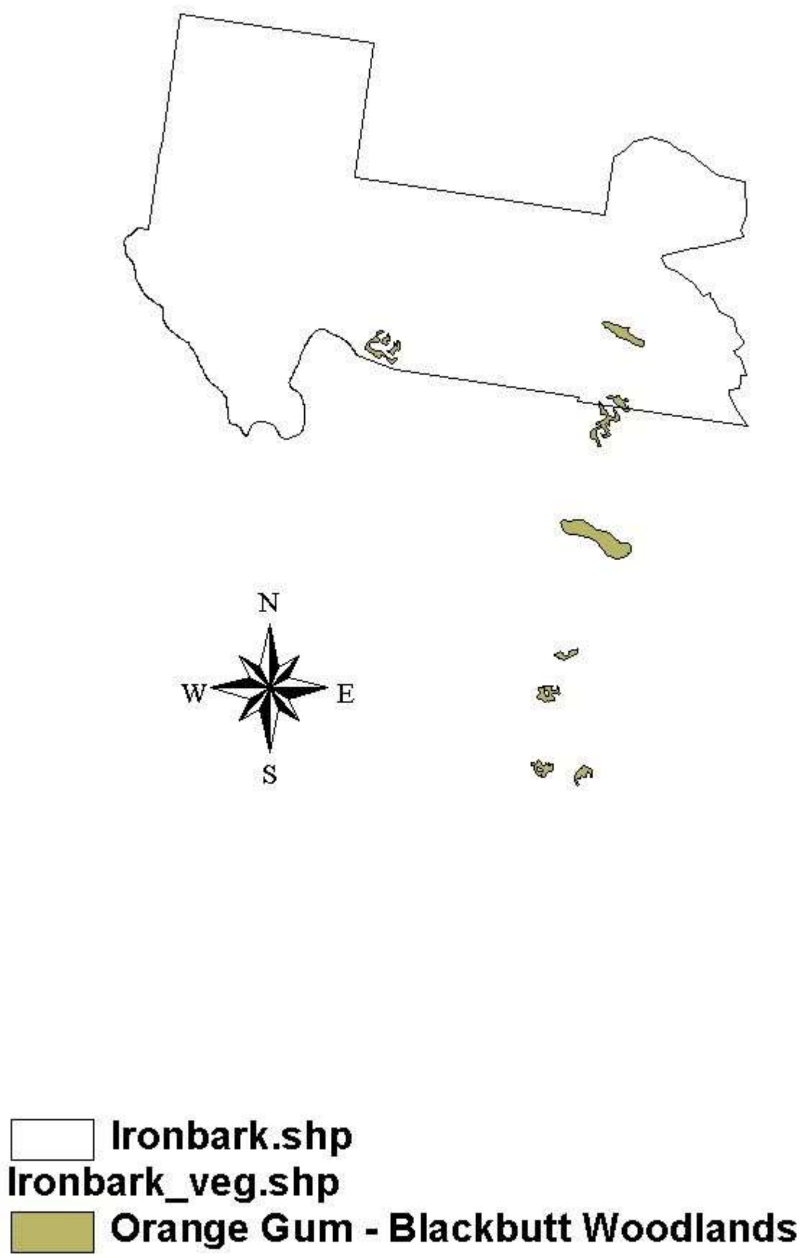


Figure 27: Mapped distribution of Community 3.

3.7.4 Community 4: Tumbledown Gum – Caley's Ironbark Woodlands

Eucalyptus dealbata (Tumbledown Gum) – *Callitris endlicheri* (Black Cypress Pine) – *Eucalyptus caleyi* subsp. *caleyi* (Caley's Ironbark) Woodlands.

Sample sites (8): 64, 76, 77, 78, 79, 87, 88, 89.

Number of hectares: 778.5 **Proportion of reserve:** 28.8%

Environmental relationships: found usually on crests and upper slopes on well drained soils. Soils are generally sandy loam, or loamy sand or rarely loamy in texture and are grey brown to dark brown in colour. Shallow soils are most common with deep or skeletal soils being rare.

Distribution within conservation areas: restricted to Ironbark Nature Reserve, particularly in western areas at lower to mid altitudes, but also other western exposed areas. Particularly associated with Townsend's Mountain.

Structure: usually low open woodlands to woodlands.

- Tree layer: 8-15 (-25) m tall ; 10-30% cover.
- Tall shrub layer: absent.
- Low shrub layer: 1-3 m tall; 20-30 (-50)% cover.
- Understorey layer: > 1 m tall; 20-70% cover.

No. of taxa: 110 **No. of taxa per plot:** 24-**36.3**-46 .

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Eucalyptus dealbata, Callitris endlicheri, Eucalyptus caleyi* ssp. *caleyi, Eucalyptus prava, Eucalyptus quinniorum, Eucalyptus macrorhyncha, Eucalyptus andrewsii, Eucalyptus albens, Brachychiton populneus, Angophora floribunda, Eucalyptus melliodora*.

Shrubs: *Cassinia quinquefaria, Olearia elliptica, Hibbertia obtusifolia, Correa reflexa*, *Leucopogon muticus*, *Acacia neriifolia*, *Pultenaea* sp. G, *Maytenus silvestris, Bursaria spinosa, Pultenaea* sp. C, *Notelaea microcarpa, Indigofera adesmiifolia, Melichrus urceolatus, Acacia penninervis.*

Climbers & trailers: *Desmodium varians, Glycine tabacina, Parsonsia eucalyptophylla, Clematis glycinoides.*

Ground cover: *Aristida vagans, Joycea pallida, Cymbopogon refractus, Lepidosperma laterale, Dichelachne micrantha, Lomandra multiflora, Cheilanthes distans, Aristida calycina, Wahlenbergia communis, Scleranthus biflorus, Dichondra* sp. A, *Dianella revoluta, Cheilanthes sieberi, Arthropodium milleflorum, Scleria mackaviensis, Pomax umbellata, Poa sieberiana, Austrodanthonia racemosa* ssp. *obtusata, Lomandra filiformis, Themeda triandra, Lomandra longifolia, Echinopogon caespitosus, Trachymene incisa, Scutellaria humilis, Plantago varia, Panicum effusum, Oxalis chnoodes, Opercularia aspera, Luzula flaccida, Goodenia hederacea, Geranium solanderi* var. *solanderi, Desmodium brachypodum, Derwentia arenaria, Cyperus fulvus, Commelina cyanea, Carex appressa.*

Introduced taxa: *Opuntia stricta, Secale cereale, Bromus diandrus.*

Percent of species introduced: 2.7%

Variability: few canopy species have fidelity in this assemblage. *Eucalyptus dealbata* (Tumbledown Gum) is most common associate with *Euc. caleyi* (Caley's Ironbark), *Euc. prava* (Orange Gum) and *Euc. macrorhyncha* (Red Stringybark) in one sub-assemblage on more exposed sites with *Aristida* spp., *Joycea pallida* and *Cymbopogon refractus* common in the ground layer. A second sub-assemblage. In slightly more protected sites a variety of other eucalypt taxa are found with very little fidelity, but which may include *Euc. andrewsii* (Western New England Blackbutt) and *Euc. caleyi* (Caley's Ironbark) along with other species and an ground layer commonly dominated by *Joycea pallida*, *Lomandra* spp. and *Cymbopogon refractus*. Both sub-assemblages have a dominance of *Olearia elliptica* (Daisy) and *Cassinia quinquefaria*.

Condition: in moderate condition in most areas, some areas are likely to be of old growth. This community has been extensively cleared in the past and is of multi-stemmed regrowth, particularly in the on the northern slopes and west of Townsend's Mountain.

Taxa of conservation importance: *Derwentia arenaria, Eucalyptus quinniorum, Acacia cheelii, Parsonsia eucalyptophylla, Pittosporum undulatum, Pultenaea* sp. G.

Notes: this assemblage includes areas dominated by White Box – Yellow Box – Red Gum. This dominant mix is very limit in distribution in the reserve and is known only from small intrusion of differing lithology along the western boundary. Though this area appears to be largely regrowth it is of sufficient age to be in reasonable condition. In general, this assemblage in the broad sense is likely to occur from west of

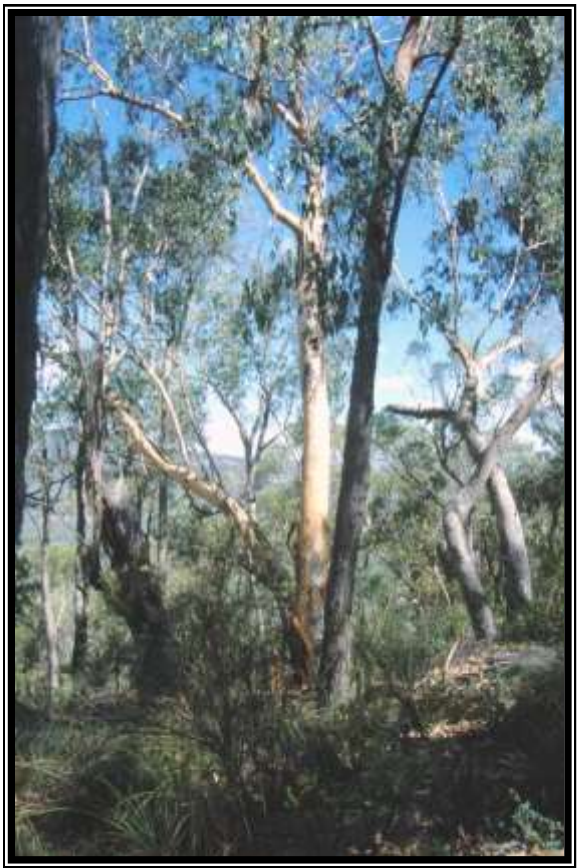
Tenterfield to Warrabah, but in the strict sense only in more western areas of Copeton Dam to western areas of Warrabah.

Conservation status: according to DeVries (2000) between 55-58% of similar assemblages have been cleared in the past in the Nandewar Bioregion. This assemblage potentially occurs within four reserves within New South Wales, but in a stricter sense it is likely to only occur within Ironbark NR and Warrabah NP. In both areas the distribution is limited and thus this assemblage should be considered poorly reserved both locally and across its range. The areas that include White Box – Yellow Box are considered Endangered on the *TSC* Act and the *EPB&C* Act.

Threats: introduced invasive grasses are a threat along with inappropriate fire regimes. Goats are known to frequent some of these areas as well as occasional stray cattle. There appears to be boundary issues with adjoining properties. This assemblage is currently being cleared extensively in adjoining areas.

Management considerations: to ensure reduction in clearing and grazing of this assemblage boundaries will need to be clearly defined. Much of this community is along the northern boundary of the reserve where clearing and other activities are likely to increase the likelihood and spread of highly invasive exotic grasses. Thus control of these grasses will need to occur with surrounding landholders to reduce the potential of their encroachment into the reserve. Goats and stray cattle need to be controlled.

Plate 13: Photographs of Community 4. Above Site 64; below Site 76.



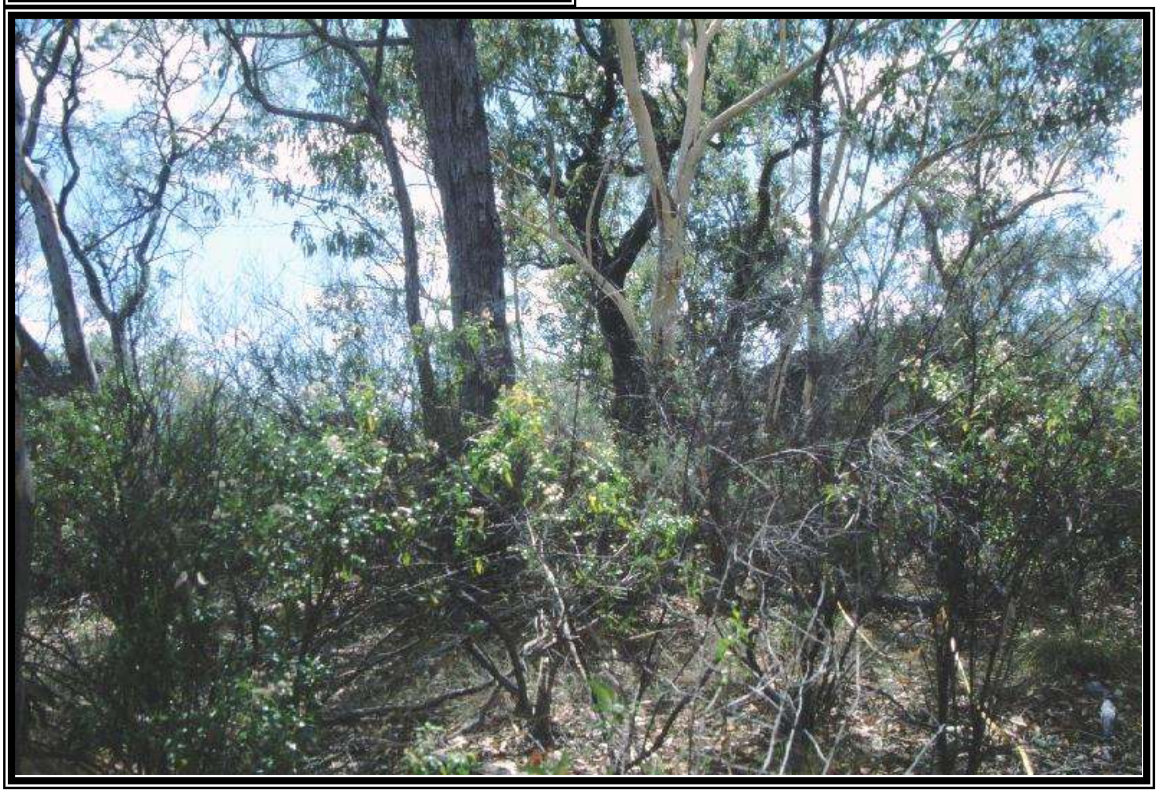


Plate 14: Photographs of Community 4. Above Site 78; below Site 77.

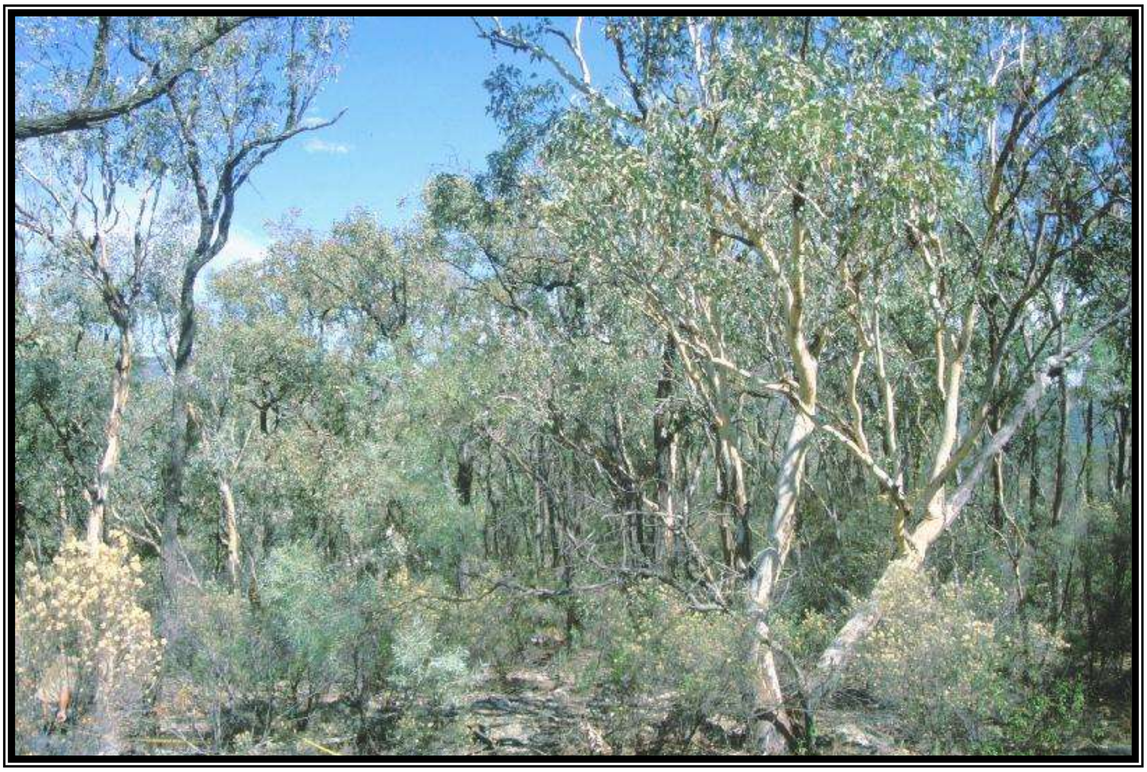


Plate 15: Photographs of Community 4. Above Site 79; below Site 88.

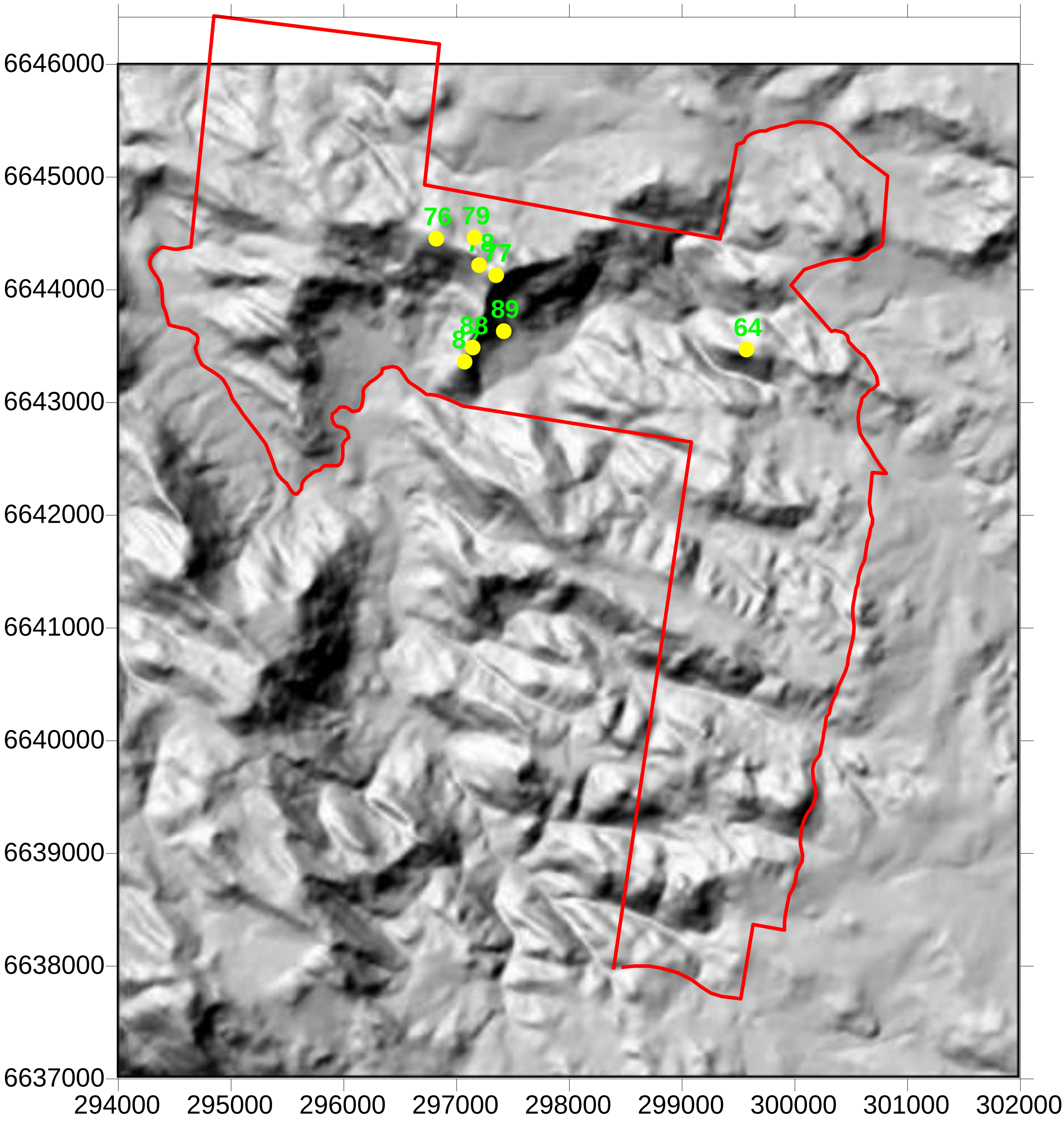


Figure 28: Placement of sites within Community 4.

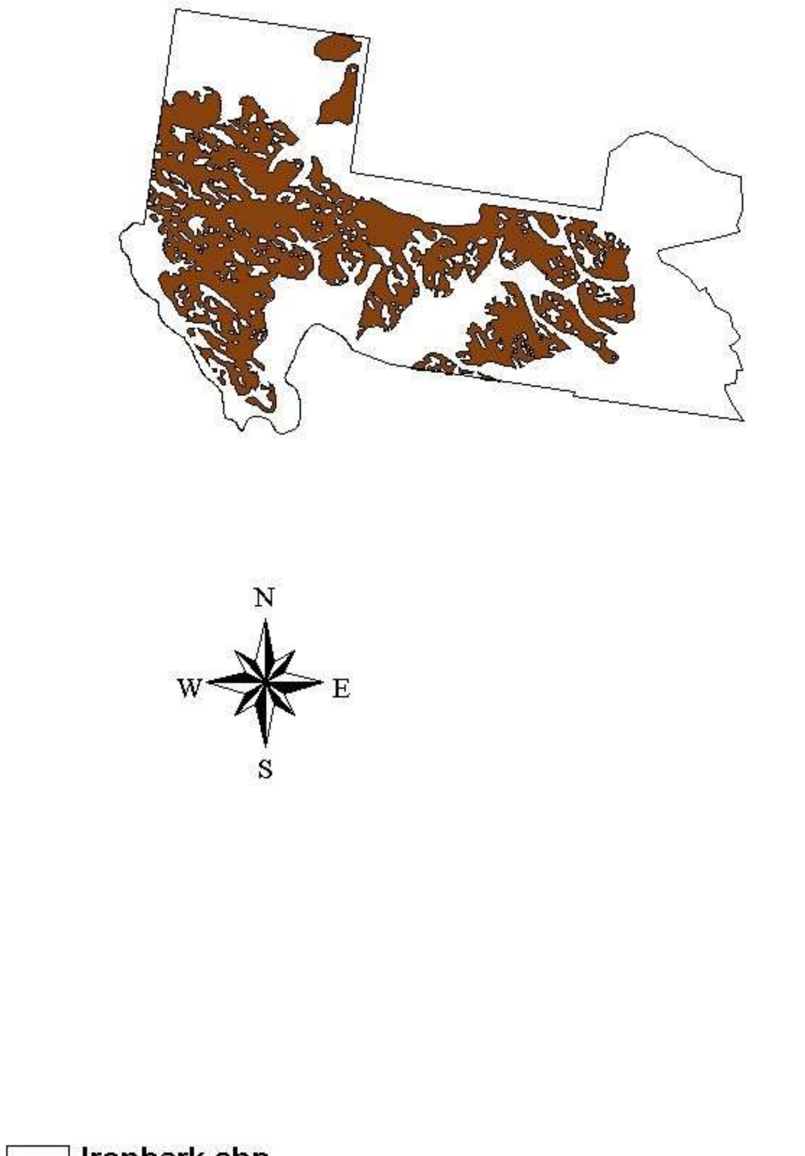


Figure 29: Mapped distribution of Community 4.

3.7.5 Community 5: Orange Gum – Red Gum Woodlands

Callitris endlicheri (Black Cypress Pine) – *Eucalyptus prava* (Orange Gum) – *Eucalyptus blakelyi* (Blakely's Red Gum) Woodlands.

Sample sites (8): 3, 13, 29, 52, 58, 62, 101, 104.

Number of hectares: 100.8 **Proportion of reserve:** 3.7%

Environmental relationships: found almost exclusively in open depressions but also rarely on lower slopes. Soils are usually moist but also rarely well drained or water logged. Soil texture is loamy or sandy loam or rarely loamy sand or clay loam and is distinctly brown in colour.

Distribution within conservation areas: restricted to high altitude areas primarily within *Bornhardtia* but also eastern sections of Ironbark.

Structure: woodlands.

- Tree layer: 10-25 m tall; 20-30% cover.
- Tall shrub layer: absent.
- Low shrub layer: 1-3 (-6) m tall; 10-60% cover.
- Understorey layer: > 1 m tall; 40-100% cover.

No. of taxa: 179 **No. of taxa per plot:** 33-**49.5**-65.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Callitris endlicheri, Eucalyptus prava, Angophora floribunda, Eucalyptus blakelyi, Eucalyptus bridgesiana, Eucalyptus macrorhyncha, Eucalyptus quinniorum, Eucalyptus caleyi* ssp. *caleyi, Eucalyptus andrewsii*.

Shrubs: *Leptospermum polygalifolium, Callistemon pungens, Cassinia quinquefaria, Dodonaea viscosa* ssp. *angustifolia, Acacia neriifolia, Olearia viscidula, Olearia elliptica, Leucopogon muticus, Correa reflexa, Calytrix tetragona.*

Climbers & trailers: *Glycine clandestina, Desmodium varians, Clematis glycinoides, Rubus parvifolius.*

Ground cover: *Imperata cylindrica, Hydrocotyle peduncularis, Arthropodium milleflorum, Echinopogon caespitosus, Cymbopogon refractus, Carex gaudichaudiana, Lomandra longifolia, Dianella caerulea, Juncus subsecundus, Euchiton sphaericus, Haloragis heterophylla, Epilobium billardierianum, Juncus* *vaginatus, Entolasia stricta, Gonocarpus micranthus, Aristida calycina, Stellaria angustifolia, Microlaena stipoides, Luzula flaccida, Galium migrans, Dichondra repens, Carex appressa, Schoenus apogon, Geranium solanderi* var. *solanderi, Viola betonicifolia, Themeda triandra, Senecio diaschides, Hypericum gramineum, Gratiola peruviana, Centipeda minima, Carex breviculmis, Wahlenbergia communis, Rumex brownii, Rhodanthe anthemoides, Ranunculus lappaceus, Lepidosperma laterale, Fimbristylis dichotoma, Dichelachne micrantha, Dianella revoluta, Acaena novae-zelandiae, Wahlenbergia gracilis, Viola hederacea, Scleranthus biflorus, Poranthera microphylla, Panicum simile, Lotus cruentus, Lotus australis, Juncus bufonius, Isolepis hookeriana, Hypericum japonicum, Arundinella nepalensis, Aristida vagans..*

Introduced taxa: *Hypochaeris radicata, Conyza albida, Trifolium repens, Rubus chloocladus, Paronychia brasiliana, Lotus uliginosus, Cirsium vulgare, Acetosella vulgaris, Vicia villosa, Verbena bonariensis, Cerastium glomeratum, Centaurium erythraea, Taraxacum officinale, Sonchus oleraceus, Plantago lanceolata, Petrorhagia nanteuilii, Paspalum dilatatum, Lactuca serriola, Axonopus affinis, Anagallis arvensis, Aira cupaniana.*

Percent of species introduced: 11.3%

Variability: structure varies considerably in the understorey. This assemblage often occurs along drainage lines, some of which are ephemeral creeks and others have permanent running water. The presence and density of Tea-tree can change the character of this assemblage greatly. Areas with more permanent water or that are damper can have a reasonably dense stand of Tea-tree whereas other areas have little or no Tea-tree but a dense understorey of *Carex*. Some areas have been extensively burned for green pick and are dominated by *Imperata* (Blady Grass) in the understorey. In more protected localities the overstorey is taller and may have a prominence of *Euc. quinniorum* and *E. bridgesiana* (Apple Box) compared to more open situations where *Euc. blakelyi* (Blakely's Red Gum) and *E. prava* (Orange Gum) occur. In general the occurrences of this assemblage are in slightly more exposed situations and sometimes shallower soils than the following Community 6.

Condition: generally good to very good. However, some sections have had some tree removal and subsequent regeneration has occur both within Ironbark and *Bornhardtia*. In addition these areas have been grazed more heavily than other areas within the VCA. Fires have also been more frequent for green pick in both the VCA and

Reserve. Pigs have caused extensive damage to many areas, particularly along the margins of creeklines where Tea-tree occurs.

Taxa of conservation importance: *Goodenia macbarroni, Callistemon pungens, Derwentia arenaria, Eucalyptus quinniorum, Baloskion stenocoleum, Pultenaea* sp. G, *Viola caleyana*.

Notes: no directly synonymous assemblages are described in the literature. This assemblage is probably included within much more widespread assemblages such as Blakely's Red Gum Associations in broad scale mapping or generally under Grassy Box-Red Gum Alliances. In this broad sense this type of assemblage is common along the western side of the tablelands and along the slopes from over the Queensland border south to northern Victoria. However, in the stricter sense this community type is likely to be largely restricted to the region with small occurrences as far north as west of Tenterfield and as far south as Warrabah.

Conservation status: similar associations are described by Wall (2000) as being nearly 60% cleared with only 1.6% of their reservation target met. These type of Grassy Box-Gum woodlands are usually the most intensively used in this type of granite country and elsewhere as well and parts of this community would conform to the Endangered Red Gum – Yellow Box Woodlands on the *TSC* Act. This assemblage should be considered poorly conserved across its range and vulnerable.

Threats: fires may have been at too high a frequency in some areas. Pigs are a serious problem in this assemblage, not only causing structural damage to the vegetation and soil but also in terms of weed spread. Introduced invasive grasses are likely to easily take a strong hold in these areas if they are facilitated. Blackberry is a problem in some areas and this needs to be controlled.

Management considerations: continual control of pigs is important along with control of Blackberry. Stray cattle often congregate in this assemblage. Appropriate fire regimes need to be implemented along with care to reduce the introduction of exotic temperate grasses.

Plate 16: Photographs of Community 5. Above right Site 3; below Site 58.

Plate 17: Photographs of Community 5. Above left Site 29; below Site 13.

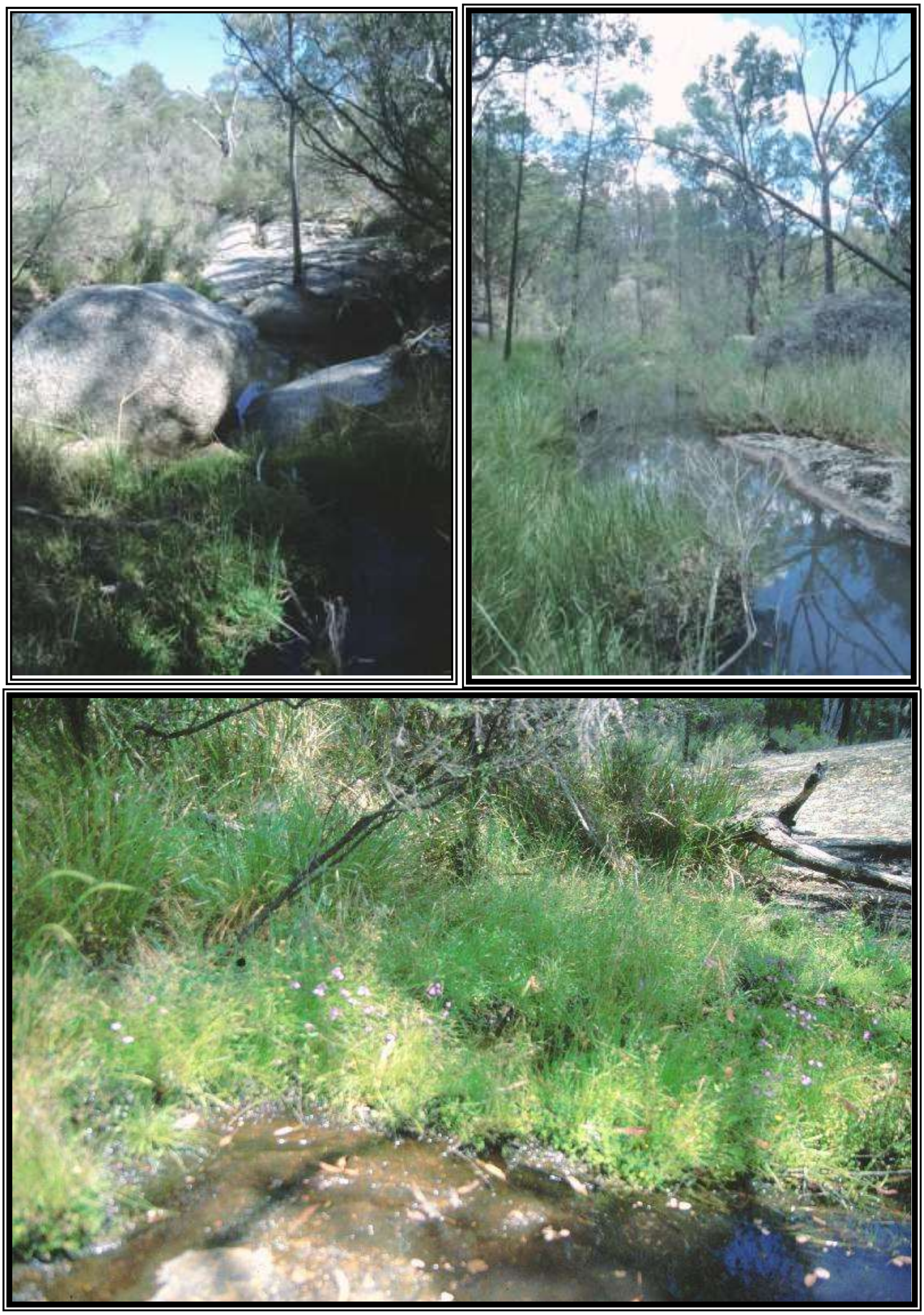


Plate 17: Photographs of Community 5. Above left Site 52 and left Site 62.

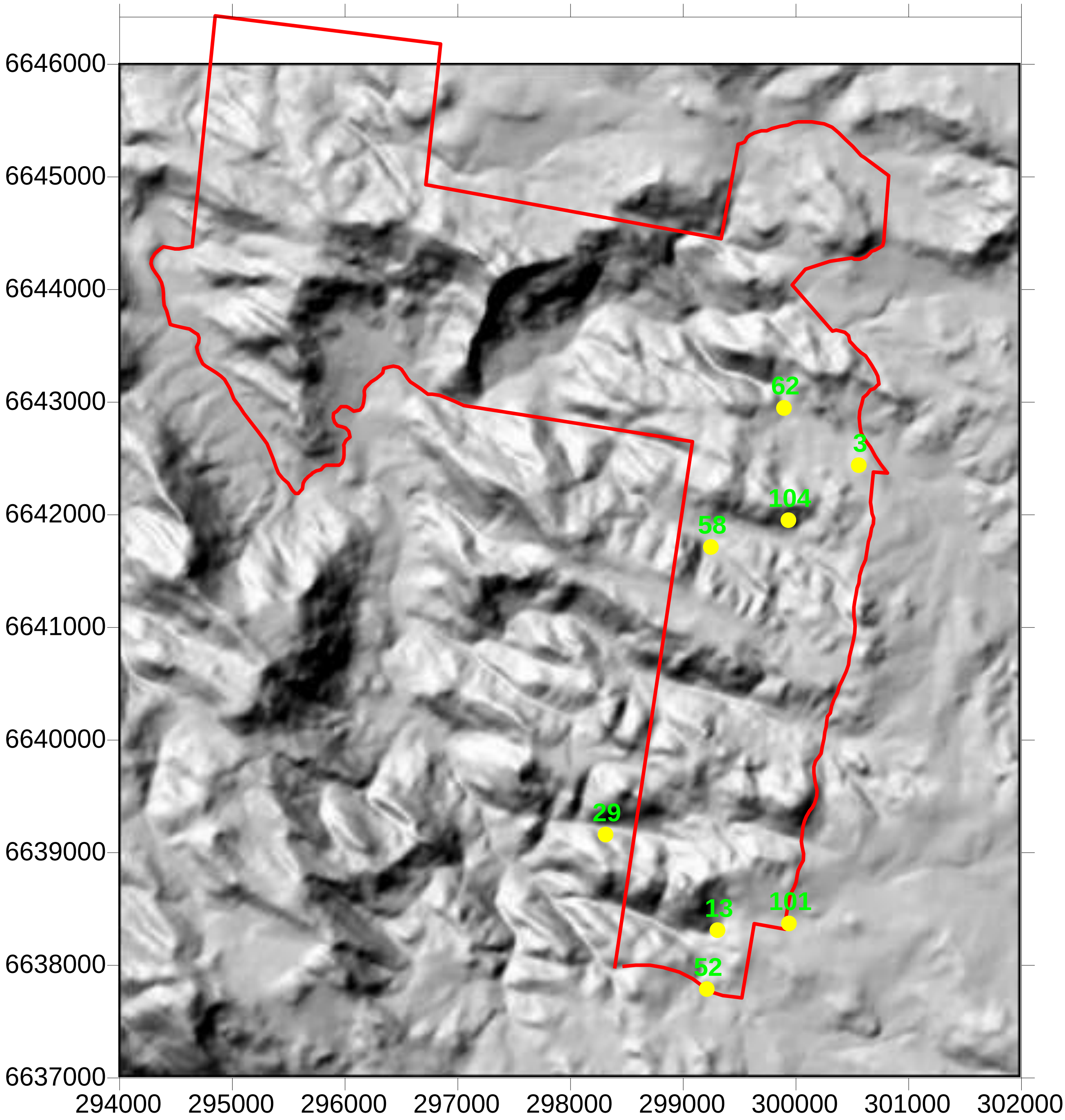


Figure 30: Placement of sites within Community 5.

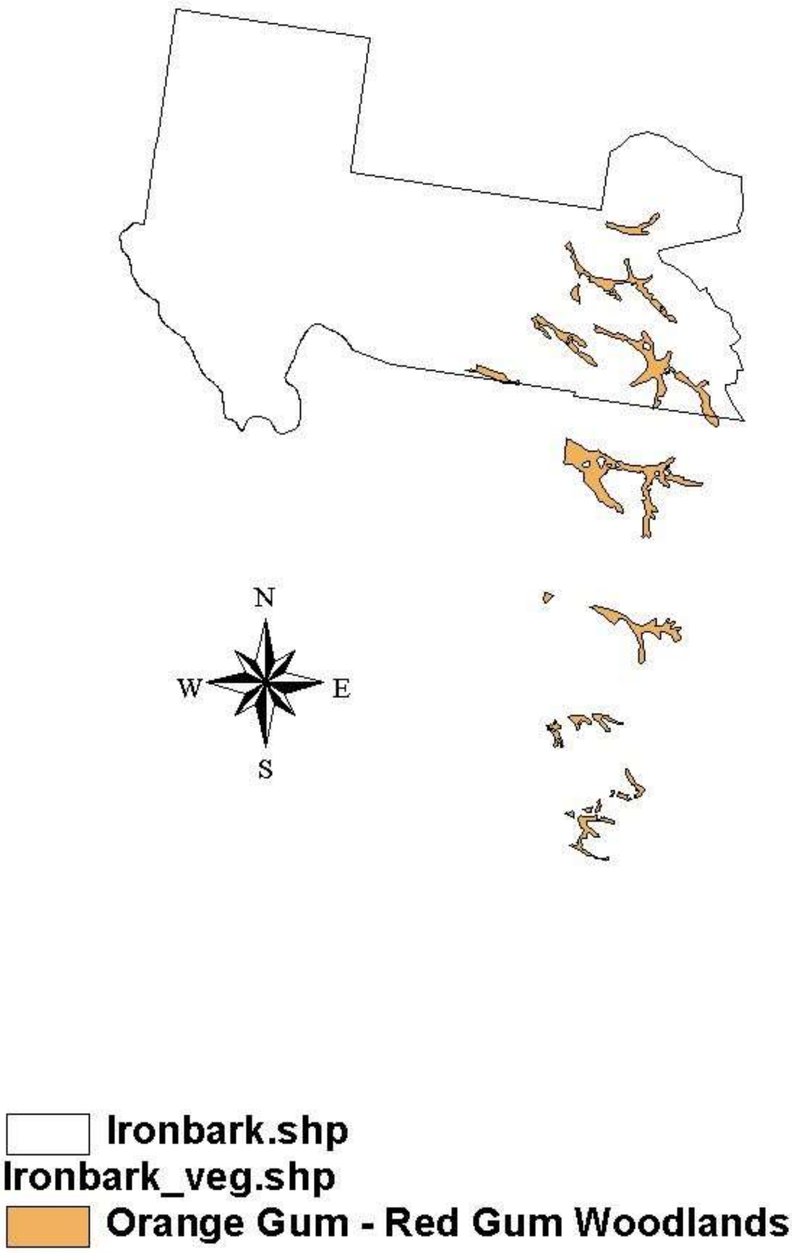


Figure 31: Mapped distribution of Community 5.

3.7.6 Community 6: Quinn's Gum – Orange Gum Forests

Eucalyptus quinniorum (Quinn's Gum) – *Angophora floribunda* (Rough-barked Apple) Forests and Woodlands.

Sample sites (10): 11, 12, 21, 25, 28, 30, 39, 80, 90, 102.

Number of hectares: 43.6 **Proportion of reserve:** 1.6%

Environmental relationships: usually in open depressions but also on lower and sometimes mid slopes. Soils are sandy loam to loam in texture and are usually deep or sometimes shallow. Soil colour is usually a dark brown, either grey or reddish.

Distribution within conservation areas: primarily restricted to gullies and protected drainage positions in the southern half of the *Bornhardtia* VCA, but also in very protected gullies associated with Townsend's Mountain within Ironbark NR.

Structure: mostly open forests but also woodlands.

- Tree layer: (10-) 20-30 (-40) m tall; 20-40% cover.
- Tall shrub layer: 5-12 m tall; 20% cover. Usually absent.
- Low shrub layer: 1-3 m tall; 10-30 (-90)% cover. Rarely absent.
- Understorey layer: > 1 m tall; 40-90% cover.

No. of taxa: 164 **No. of taxa per plot:** 32-**49.6**-67.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Eucalyptus quinniorum, Angophora floribunda, Eucalyptus prava, Eucalyptus macrorhyncha, Eucalyptus andrewsii, Eucalyptus bridgesiana, Pittosporum undulatum, Eucalyptus blakelyi, Callitris endlicheri, Eucalyptus subtilior, Eucalyptus caleyi* ssp. *caleyi, Eucalyptus melliodora*.

Shrubs: *Olearia viscidula, Pultenaea* sp. G*, Leptospermum polygalifolium, Acacia neriifolia, Olearia elliptica, Leucopogon muticus, Hibbertia obtusifolia, Brachyloma daphnoides* ssp. *glabrum, Cassinia quinquefaria, Correa reflexa, Pultenaea campbellii, Notelaea microcarpa, Leptospermum brevipes, Persoonia sericea.*

Climbers & trailers: *Clematis glycinoides, Desmodium varians, Hardenbergia violacea, Rubus parvifolius, Glycine clandestina, Glycine tabacina, Cassytha pubescens.*

Ground cover: *Scleranthus biflorus, Luzula flaccida, Geranium solanderi* var. *solanderi, Lomandra longifolia, Lepidosperma laterale, Imperata cylindrica, Joycea pallida, Dichondra repens, Cymbopogon refractus, Carex breviculmis, Galium migrans, Aristida vagans, Cheilanthes sieberi, Themeda triandra, Senecio diaschides, Microlaena stipoides, Dianella revoluta, Cassinia quinquefaria, Veronica calycina, Scutellaria humilis, Oxalis chnoodes, Entolasia stricta, Echinopogon caespitosus, Carex appressa, Arthropodium milleflorum, Adiantum aethiopicum, Lomandra multiflora, Dichelachne micrantha, Dianella caerulea, Caladenia fuscata, Aristida calycina, Acaena novae-zelandiae, Plantago varia, Pellaea nana, Macrozamia heteromera, Euchiton sphaericus, Ajuga australis, Wahlenbergia planiflora, Wahlenbergia gracilis, Viola betonicifolia, Solanum elegans, Pterostylis curta, Pteridium esculentum, Hydrocotyle peduncularis, Derwentia arenaria, Craspedia variabilis.*

Introduced taxa: *Hypochaeris radicata, Conyza albida, Cirsium vulgare, Rubus chloocladus, Trifolium repens, Solanum nigrum, Bidens pilosa.*

Percent of species introduced: 4.3%

Variability: two distinct sub-assemblages are recognisable. In more exposed situations usually on shallower soils which may be better drained *Euc. prava* (Orange Gum) more frequently dominates with an assortment of other species such as *Euc. macrorhyncha* (Red Stringybark), *Euc. quinniorum* (Quinn's Gum) and *Euc. caleyi* (Caley's Ironbark). The understorey is often of *Leptospermum brevipes* and *Leucopogon muticus* with a ground layer of *Joycea pallida* and *Lomandra longifolia* (Long-leaved Mattrush). The second sub-assemblage is in more protected localities and is dominated by *Euc. quinniorum* (Quinn's Gum) and *Angophora floribunda* (Rough-barked Apple) with *Euc. andrewsii* (Western New England Blackbutt) and *Euc. macrorhyncha* (Red Stringybark). The understorey often has a prominent layer of *Olearia elliptica* and *O. viscidula* (Sticky Daisy) and an understorey of *Imperata cylindrica* (Blady Grass) and *Cymbopogon refractus* (Barbed-wire Grass). The two sampled localities within Ironbark also are slightly different in that they contained *Pittosporum undulatum* and an ground layer including ferns.

Condition: generally good to very good and of old growth condition. Some sections are heavily damaged by pigs and some have been burnt frequently in the past for green pick.

Taxa of conservation importance: *Callistemon pungens, Derwentia arenaria, Eucalyptus quinniorum, Pultenaea campbellii, Haloragis serra, Pittosporum undulatum, Pultenaea* sp. G.

Notes: no direct correlates are described in the literature. The most prominent tree in this assemblage is the rare *Euc. quinniorum* which has a very restricted distribution from Ironbark to Warrabah with some isolated stands within the Bendemeer and Moonbi areas. A broadly similar assemblage occurs in the eastern fall of Mt Kaputar where similar communities are dominated by *Euc. volcanica* which is a one of the closest relatives of *E. quinniorum*. This assemblage in the broad sense is thus likely to occur from the eastern fall of Mt Kaputar east to Ironbark and Stoney Batter and as far south as Warrabah, with potential extension as far south as Bendemeer and higher altitude parts of the Moonbis'. The two sampled sites within Ironbark Nature Reserve are likely to change structure and much of the flora may change if fires are kept from this area in the longer term. These steep and protected areas flanking Townsend's Mountain, approach that of dry gully rainforests similar to those found in steep gullies on the eastern higher altitude sections of Mt Kaputar.

Conservation status: no directly synonymous assemblages are described so the extent of this community in other reserves is hard to establish. However, it is very likely that much less than 500 ha is reserved across its range, even if described in the broader sense. Thus, this assemblage is highly restricted in distribution and inadequately represented in the reserve network and should be considered poorly conserved.

Threats: pigs are a serious threat to understorey components of this assemblage. Stray cattle and pigs have caused damage to many herbfields and non-grass components of the understorey. Pigs and Cattle have also aided the introduction of weeds along creeklines and in this assemblage. Blackberry is a problem in a number of situations. The introduction of invasive exotic grasses would cause serious problems.

Management considerations: pigs need to be controlled if further degradation of this assemblage is not to occur. Stray cattle also need control. Blackberry control needs to be continual and appropriate fire regimes will need instigation. Care must be taken to reduce the risk of introducing seriously invasive exotic grasses.

Plate 19: Photographs of Community 6. Above left Site 28 and right Site 39; below Site 25.

Plate 20: Photographs of Community 6. Above Site 21; below Site 30.

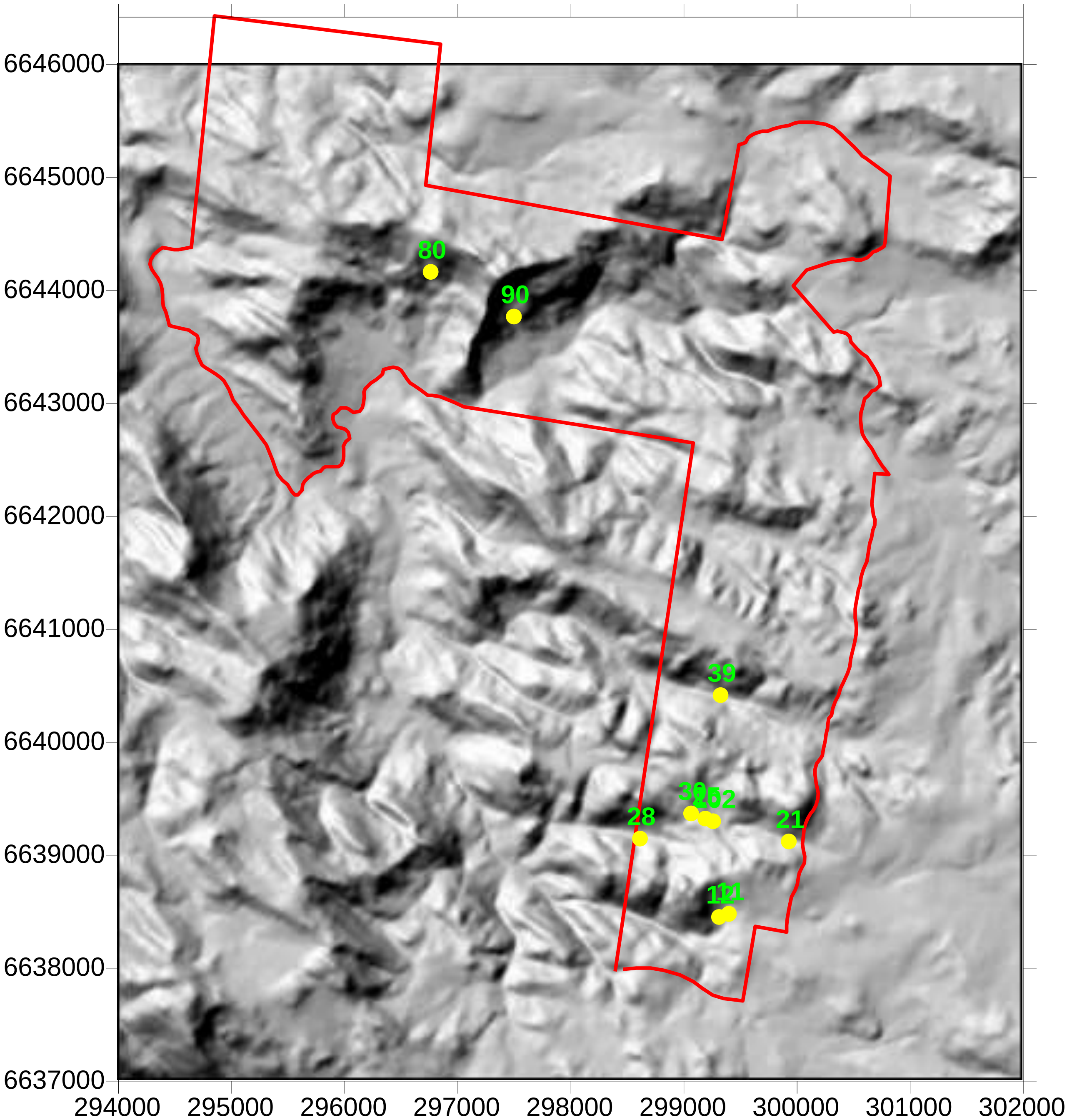


Figure 32: Placement of sites within Community 6.

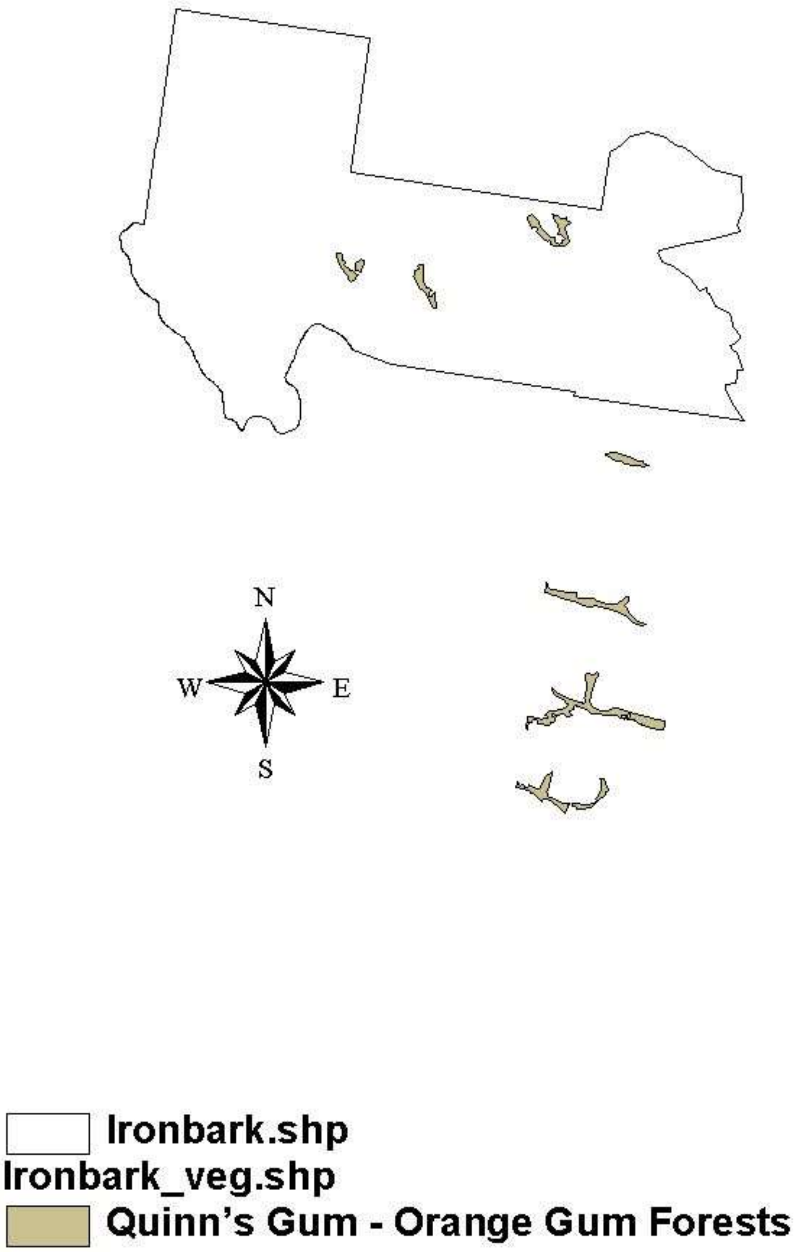


Figure 33: Mapped distribution of Community 6.

3.7.7 Community 7: Rough-barked Apple – Red Gum Woodlands

Angophora floribunda (Rough-barked Apple) – *Eucalyptus dealbata* (Tumbledown Gum) – *Eucalyptus blakelyi* (Blakely's Red Gum) Woodlands.

Sample sites (15): 67, 68, 69, 74, 81, 82, 84, 92, 93, 95, 96, 97, 99, 100, 107.

Number of hectares: 490.1 **Proportion of reserve:** 18.1%

Environmental relationships: usually on lower slopes, but also mid slopes or rarely upper slopes or open depressions. Soils are usually sandy loam in texture but also may be loamy sand or clay loam. Soils are usually moist and deep and are light brown to dark brown in colour.

Distribution within conservation areas: entirely restricted to Ironbark Nature Reserve and primarily in the lower altitude western half of the reserve.

Structure: woodlands and open forests.

- Tree layer: 10-20 (-40) m tall; (10-) 20-40% cover.
- Tall shrub layer: 4-8 m tall; 20% cover. Usually absent.
- Low shrub layer: 1-3 (-6) m tall; 10-30 (-70)% cover.
- Understorey layer: > 1 m tall; (20-) 70-90% cover.

No. of taxa: 165 **No. of taxa per plot:** 22-**37.1**-60.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Angophora floribunda, Eucalyptus dealbata, Eucalyptus blakelyi, Eucalyptus melliodora, Callitris endlicheri, Eucalyptus macrorhyncha, Eucalyptus albens, Eucalyptus bridgesiana, Brachychiton populneus, Eucalyptus caleyi* ssp. *caleyi, Eucalyptus andrewsii*.

Shrubs: *Hibbertia obtusifolia, Notelaea microcarpa, Olearia viscidula, Melichrus urceolatus, Cassinia quinquefaria, Olearia elliptica, Leptospermum polygalifolium, Leptospermum brevipes, Brachyloma daphnoides* ssp. *glabrum, Acacia neriifolia, Phyllanthus subcrenulatus, Callistemon pungens, Xanthorrhoea johnsonii, Sida cunninghamii, Maytenus silvestris, Dodonaea viscosa* var. *angustifolia, Acacia implexa.*

Climbers & trailers: *Desmodium varians, Glycine tabacina, Glycine clandestina, Clematis glycinoides, Hardenbergia violacea, Glycine stenophita.*

Ground cover: *Cymbopogon refractus, Aristida calycina, Dichondra* sp. A, *Echinopogon caespitosus, Cheilanthes sieberi, Aristida vagans, Scleranthus biflorus, Geranium solanderi* var. *solanderi, Eragrostis leptostachya, Imperata cylindrica, Wahlenbergia communis, Austrodanthonia racemosa* ssp. *obtusata, Arundinella nepalensis, Microlaena stipoides, Lomandra multiflora, Chrysocephalum apiculatum, Aristida ramosa, Juncus pauciflorus, Carex appressa, Acaena novae-zelandiae, Scutellaria humilis, Rumex brownii, Oxalis chnoodes, Desmodium brachypodum, Dichelachne micrantha, Poa sieberiana, Plantago varia, Panicum effusum, Dichondra repens, Tripogon loliiformis, Lomandra longifolia, Dianella revoluta, Cyperus gracilis, Arthropodium milleflorum, Vittadinia muelleri, Sigesbeckia australiensis, Senecio diaschides, Lepidosperma laterale, Epilobium billardierianum, Commelina cyanea, Oxalis perennans, Lespedeza juncea, Joycea pallida, Hypericum gramineum, Hydrocotyle laxiflora, Gonocarpus tetragynus, Galium migrans, Fimbristylis dichotoma, Eragrostis elongata, Echinopogon ovatus, Dianella caerulea, Centipeda cunninghamii, Carex breviculmis.*

Introduced taxa: *Conyza albida, Hypochaeris radicata, Opuntia stricta, Hypochaeris glabra, Conyza bonariensis, Cyperus aggregatus, Acetosella vulgaris, Tradescantia fluminensis, Stellaria media, Sonchus oleraceus, Bidens pilosa, Verbascum thapsus, Secale cereale, Rubus chloocladus, Cirsium vulgare, Centaurium erythraea, Anagallis arvensis.*

Percent of species introduced: 10.2%

Variability: this is a highly variable assemblage with up to three sub-assemblages each with a highly diverse set of dominant trees with relatively low fidelity. The first sub-assemblage is found in more open and exposed sites and *Euc. albens* (White Box) and *Euc. dealbata* (Tumbledown Gum) being more common with *Euc. melliodora* (Yellow Box) and *Euc. blakelyi* (Blakely's Red Gum) also associated. The understorey is of scattered *Cassinia quinquefaria* and *Notelaea microcarpa* and *Olearia viscidula*. The ground layer is often dominated by *Cymbopogon refractus*. Sites are usually on lower slopes with soils that are usually moist to well drained and are usually loamy in texture (clay to sandy or just plain loam) and are light to yellow brown. The second sub-assemblage is mainly dominated by *Euc. blakelyi* (Blakely's Red Gum) and *Angophora floribunda* (Rough-barked Apple) with other species such as *Euc. melliodora* (Yellow Box), *Euc. bridgesiana* (Apple Box) and *Euc. andrewsii* (Western New England Blackbutt). The understorey often contains *Leptospermum* *polygalifolium* (Tea-tree) and possibly *Notelaea microcarpa* and *Callistemon pungens*. The ground layer often contains *Imperata cylindrica* (Blady Grass), *Lomandra longifolia* (Long-leaved Mattrush) and *Arundinella nepalensis* (Reed Grass). Soils are usually moist and sandy loam in texture, with a light to dark brown colour. The third sub-assemblage is commonly dominated by *Euc. melliodora* (Yellow Box) and *Angophora floribunda* (Rough-barked Apple) with subdominant *Euc. blakelyi* (Blakely's Red Gum) and *Euc. macrorhyncha* (Red Stringybark). Understorey shrubs commonly include *Notelaea microcarpa*, *Olearia viscidula* (Sticky Daisy Bush) and *Leptospermum brevipes* (Grey Tea-tree). The ground cover is usually of *Cymbopogon refractus* (Barbed-wire Grass) and *Aristida* spp. Usually found on mid and lower slopes on well drained soils which are sandy loam in texture and dark to grey brown in colour.

Condition: in reasonable to good condition. This community type has been the most highly modified in the past in comparison to all others. Historical notes show that much of this community type had been ring-barked and cleared extensively, or at least selectively cleared. This community was favoured for cattle grazing, particularly in the lower topographic areas along Long Swamp Creek for much of the last 120 years. Much of this assemblage is mature but little if any may be classified as old growth. Some areas along Long Swamp Creek have been burnt in high frequency for green pick and are potentially over dominated by *Imperata cylindrica* (Blady Grass). Some of the more low lying areas (particularly with herbfields) have been extensively damaged by pigs. Stray cattle have also damaged some of these areas. Blackberry is also occasional, particularly along the margins of creeks.

Taxa of conservation importance: *Callistemon pungens, Derwentia arenaria, Haloragis serra, Sida cunninghamii*.

Notes: the community as circumscribed here most closely resembles the widespread Yellow Box – Red Gum alliance that is found from over the Queensland border to the northern parts of Victoria along the western margin of the tablelands and along the western slopes. This variant as described here is likely to be more or less restricted to the areas west of Glen Innes to the Tamworth region.

Conservation status: DeVries (2000) considered that 94% of similar assemblages within the Nandewar Bioregion have been cleared. This community type would correspond to the Endangered White Box – Yellow Box – Blakely's Red Gum listed on the *TSC* Act in most areas and potentially also with the Grassy White Box

Woodlands on the *EBP&C* Act. This community type is represented in a number of reserves but is usually highly modified, as has occurred here in the past, and of limited extent. Thus this community should be considered Endangered and Poorly Conserved both locally and across its range.

Threats: pigs are a significant threat to this assemblage along with stray cattle. Inappropriate fire regimes are a threat as is Blackberry. Exotic invasive grasses are also a threat.

Management considerations: pigs will need constant control within this community along with stray cattle. Appropriate fire regimes will need instigation and this may include the reduction of fire frequency along some parts of Long Swamp Creek. Blackberry will need continual control. The main fire trail impacts most significantly on this assemblage. It is likely that if highly invasive introduced grasses such as Coolatai Grass is brought into the reserve it may be along this fire trail and within this assemblage in the first instance. Care must be taken to not inadvertently bring seed material from surrounding properties into the reserve along this fire trail. This fire trail on some occasions has been diverted and new side trails made due to boggy conditions or tree falls. This braiding of the fire trail must be avoided and entry into the reserve after high rainfall events should be avoided. Reduction of vehicle traffic would be beneficial and should include reduced access by neighbouring landholders, who may increase the likelihood of braiding of the trails and introduction of weedy species.

Plate 21: Photographs of Community 7. Above Site 74; below Site 81.

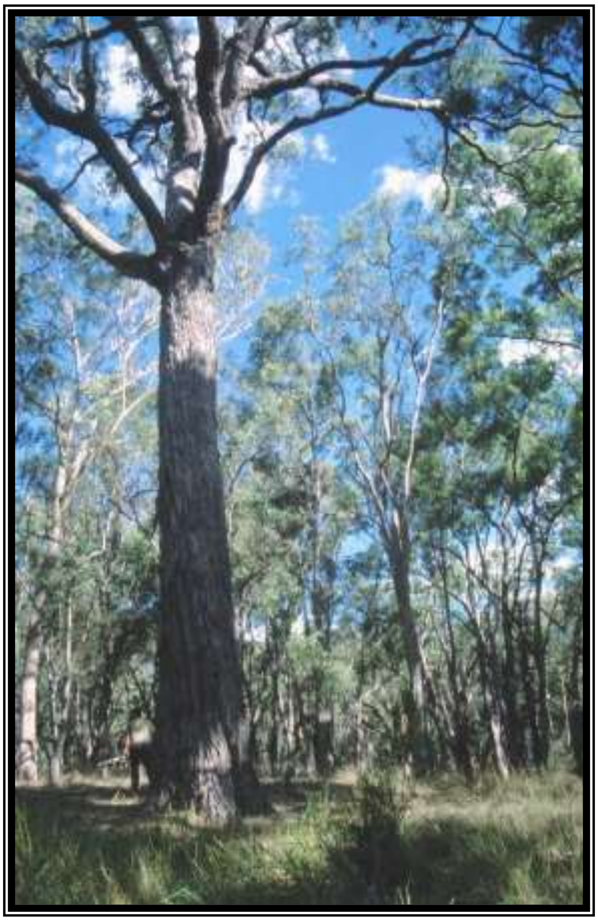


Plate 22: Photographs of Community 7. Above Site 82; below Site 84.

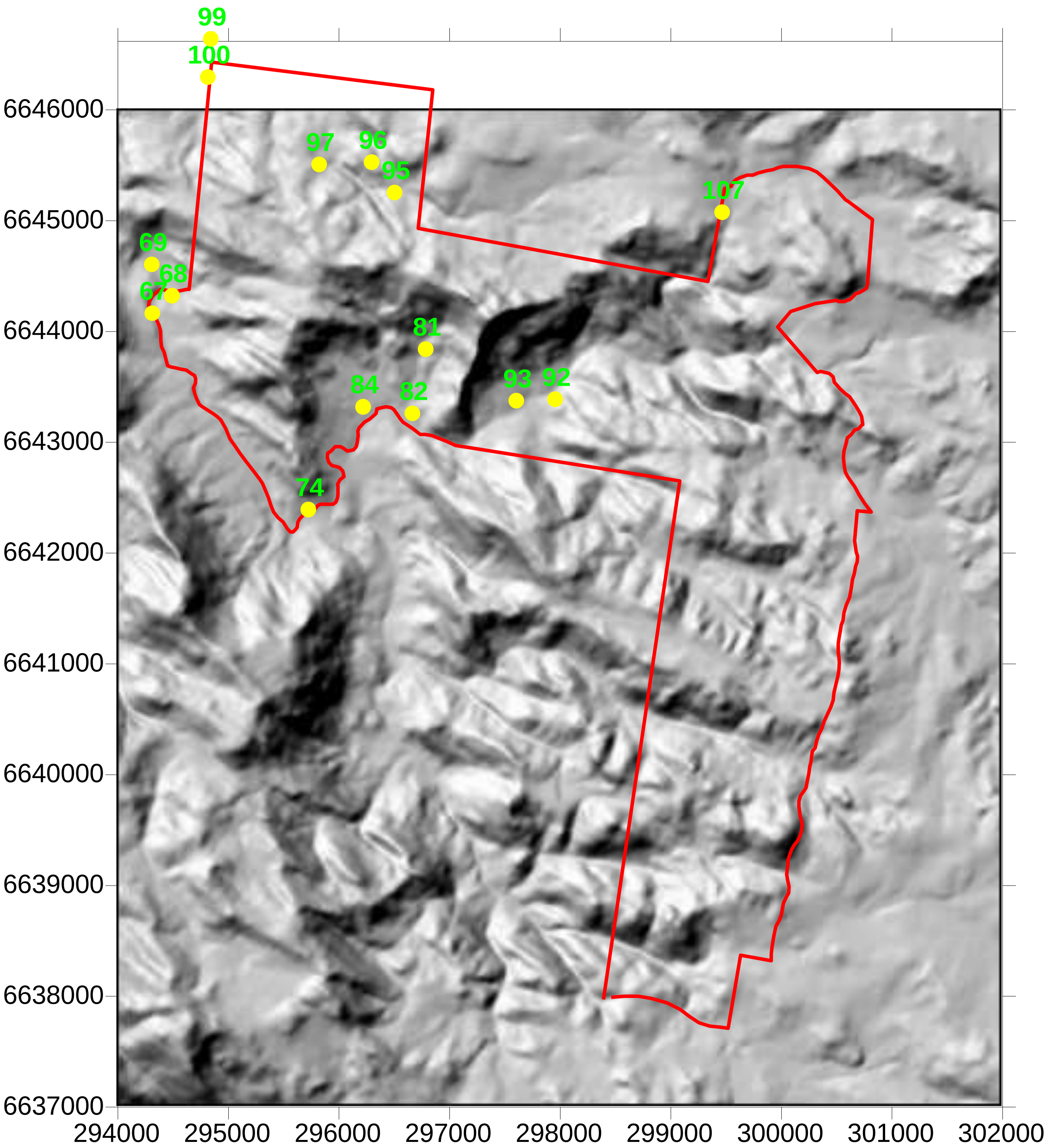


Figure 34: Placement of sites within Community 7.

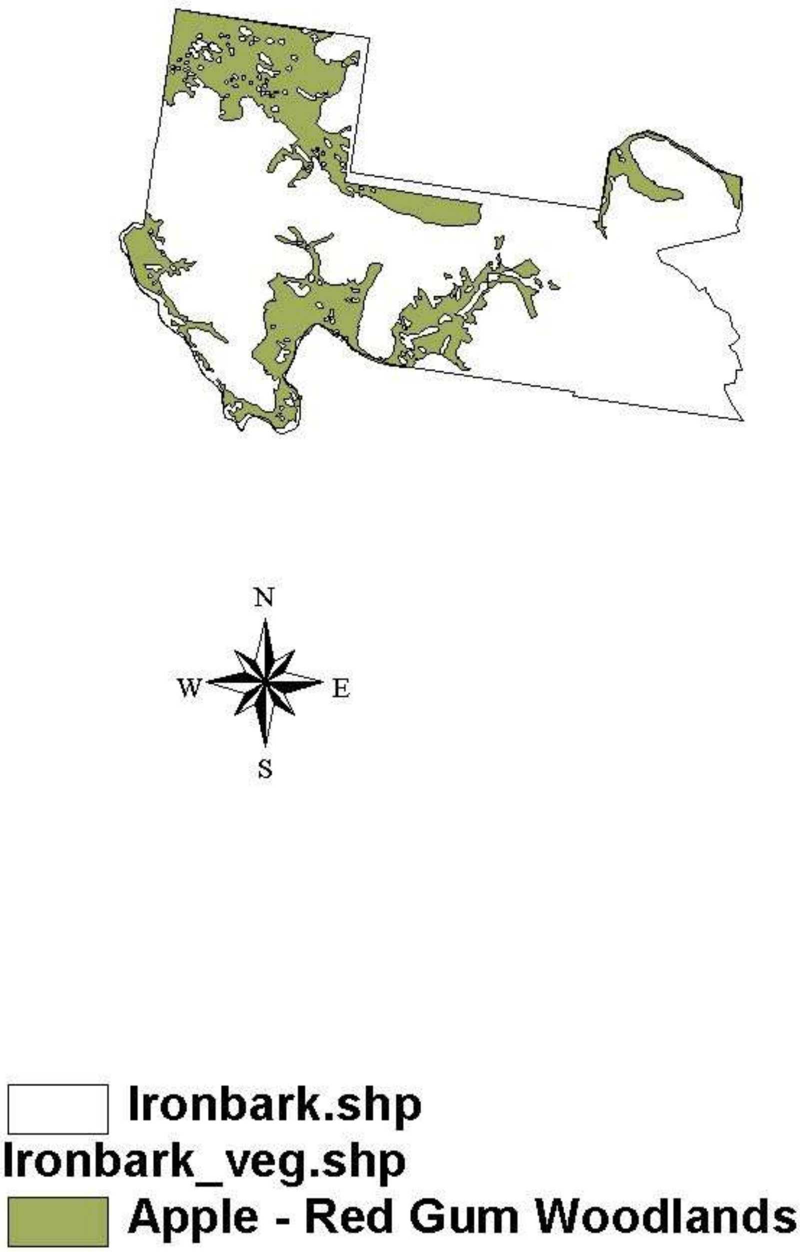


Figure 35: Mapped distribution of Community 7.

3.7.8 Community 8: River Oak – Red Gum – Apple Forests

Eucalyptus blakelyi (Blakely's Red Gum) – *Casuarina cunninghamiana* (River Oak) – *Angophora floribunda* (Rough-barked Apple) Forests.

Sample sites (3): 70, 72, 73.

Number of hectares: 37.2 **Proportion of reserve:** 1.4%

Environmental relationships: restricted to open depressions or flats associated with major creeks. Soils are moist to damp, sandy loam, clay loam or loamy sand in texture and are dark or yellow brown in colour and are deep.

Distribution within conservation areas: restricted to deeper soil in protected localities along Long Swamp Creek within Ironbark Nature Reserve.

Structure: open forests.

- Tree layer: 20-40 m tall; 30-60% cover.
- Tall shrub layer: 5-12 m tall; 10% cover. Usually absent.
- Low shrub layer: 2-8 m tall; 20-30% cover.
- Understorey layer: > 1 m tall; 70-90% cover.

No. of taxa: 73 **No. of taxa per plot:** 30-**33.7**-39.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Eucalyptus blakelyi, Casuarina cunninghamiana, Angophora floribunda, Eucalyptus bridgesiana, Eucalyptus macrorhyncha, Eucalyptus prava, Brachychiton populneus*.

Shrubs: *Notelaea microcarpa, Olearia viscidula, Maytenus silvestris, Callistemon pungens.*

Climbers & trailers: *Desmodium varians, Glycine clandestina.*

Ground cover: *Microlaena stipoides, Juncus pauciflorus, Imperata cylindrica, Dichondra repens, Cyperus lucidus, Cymbopogon refractus, Commelina cyanea, Arundinella nepalensis, Rumex brownii, Lomandra longifolia, Juncus vaginatus, Hydrocotyle peduncularis, Echinopogon caespitosus, Aristida ramosa, Viola hederacea, Viola caleyana, Vernonia cinerea, Urtica incisa, Scutellaria humilis, Scirpus polystachyus, Pteridium esculentum, Persicaria hydropiper, Oplismenus imbecillis, Isotoma fluviatilis, Isolepis hookeriana, Geranium solanderi* var.

solanderi, Einadia trigonos, Dichondra sp. A, *Chenopodium pumilio, Carex appressa, Adiantum aethiopicum.*

Introduced taxa: *Conyza albida, Cyperus aggregatus, Modiola caroliniana, Hypochaeris radicata, Conyza bonariensis, Stellaria media, Solanum nigrum, Rubus chloocladus, Ciclospermum leptophyllum, Bidens pilosa, Anagallis arvensis.*

Percent of species introduced: 15.1%

Variability: only three sites were placed within this assemblage thus only minimal variation can be described. The most obvious difference between sites is the occurrence or not of *Casuarina cunninghamiana* (River Oak). This species is the most readily recognisable member of this assemblage, however the fringing 'floodplain' or areas of previous stream bank flow are also included within this assemblage and this often does not include River Oak. Within the main creek channel many species occur, particularly wetland taxa such as *Carex* etc, that do not occur in the fringing vegetation, which often is dominated by *Imperata cylindrica* (Blady Grass).

Condition: generally reasonable to good. Much of the area fringing Long Swamp Creek was cleared and grazed extensively in the past. This community was favoured for cattle grazing, particularly in the lower topographic areas along Long Swamp Creek for much of the last 120 years. Much of this assemblage is mature but little if any may be classified as old growth. Some areas along Long Swamp Creek have been burnt in high frequency for green pick and are potentially over dominated by *Imperata cylindrica* (Blady Grass). Some of the more low lying areas (particularly with herbfields) have been extensively damaged by pigs. Stray cattle have also damaged some of these areas. Blackberry is also occasional, particularly along the margins of creeks.

Taxa of conservation importance: *Callistemon pungens, Viola caleyana*.

Notes: *Casuarina cunninghamiana* communities are widespread in New South Wales. Beadle (1981) states that *Casuarina cunninghamiana* communities fringing rivers are common from southern New South Wales to Cape Yorke and even to Arnhem Land. However, there are no regularly associated species. It appears that although riverine communities similar to this assemblage occur throughout this part of the state they have been rarely sampled or described.

Conservation status: DeVries (2000) considered that 79% of similar assemblages have been cleared in the Nandewar Bioregion. This community probably occurs through out the North Western Slopes and into western south east Queensland. Areas within the current reserve network are very small and is in most situations highly disturbed or invaded by exotic species. This community should be considered as poorly reserved across its range and much that is reserved being of poor quality. These systems if in good condition should be a priority for further inclusion into the reserve network.

Threats: pigs are a significant threat to this assemblage along with stray cattle. Inappropriate fire regimes are a threat as is Blackberry. Exotic invasive grasses are also a threat. This assemblage currently has the highest number of introduced species of any described herein. Altered stream flows or water contamination may affect this assemblage.

Management considerations: similar issues exist within this community as did for the previous community. Pigs will need constant control within this community along with stray cattle. Appropriate fire regimes will need instigation and this may include the reduction of fire frequency along some parts of Long Swamp Creek. Blackberry will need continual control. The main fire trail impacts most significantly on this assemblage. It is likely that if highly invasive introduced grasses, such as Coolatai Grass, is brought into the reserve it may be along this fire trail and within this assemblage in the first instance. Care must be taken to not inadvertently bring seed material from surrounding properties into the reserve along this fire trail. This fire trail on some occasions has been diverted and new side trails made due to boggy conditions or tree falls. This braiding of the fire trail must be avoided and entry into the reserve after high rainfall events should be avoided. Reduction of vehicle traffic would be beneficial and should include reduced access by neighbouring landholders, who may increase the likelihood of braiding of the trails and introduction of weedy species. This community is linear with a large edge to area ratio. Any works along the creek bank will require an associated weed eradication program that should include several return visits as weeds will constantly germinate after works until native vegetation is established. As with many other areas, creek lines are often used as property boundaries, which affectively means that this assemblage is usually shared with the neighbouring landholdings. Management of this assemblage would be much improved if both high banks Long Swamp Creek were included within the reserve.

Plate 23: Photographs of Community 8. Above right Site 70; below Site 72.

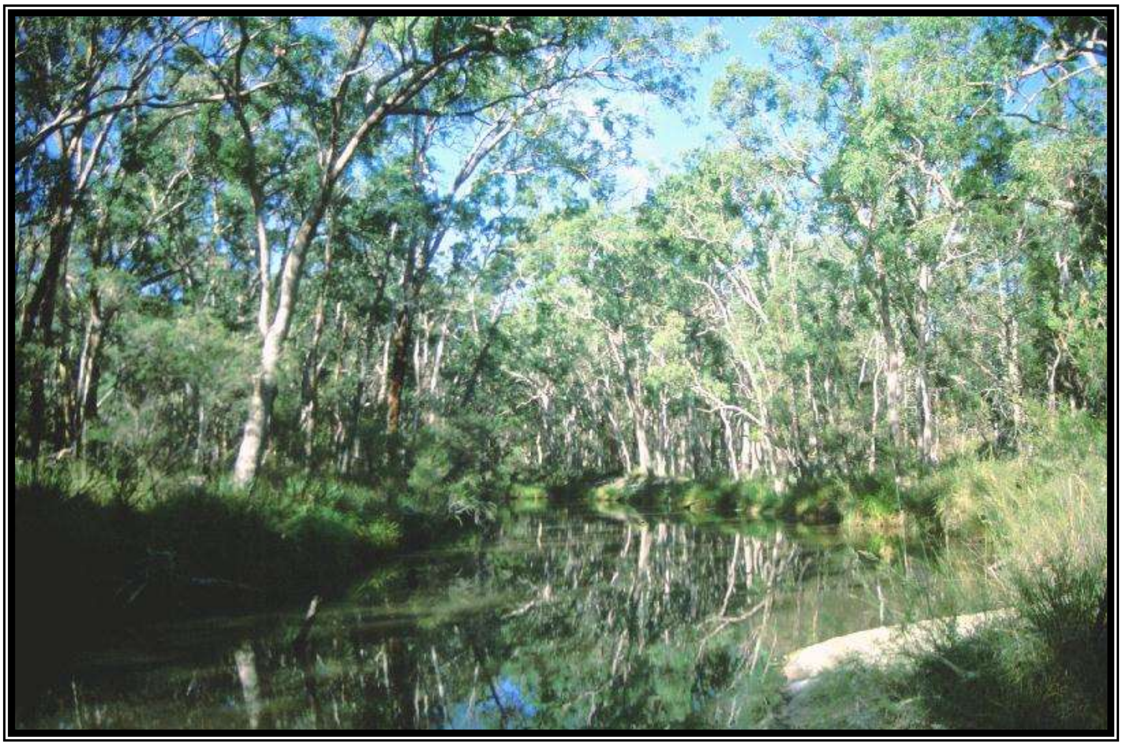


Plate 24: Photographs of Community 8. All taken on Long Swamp Creek.

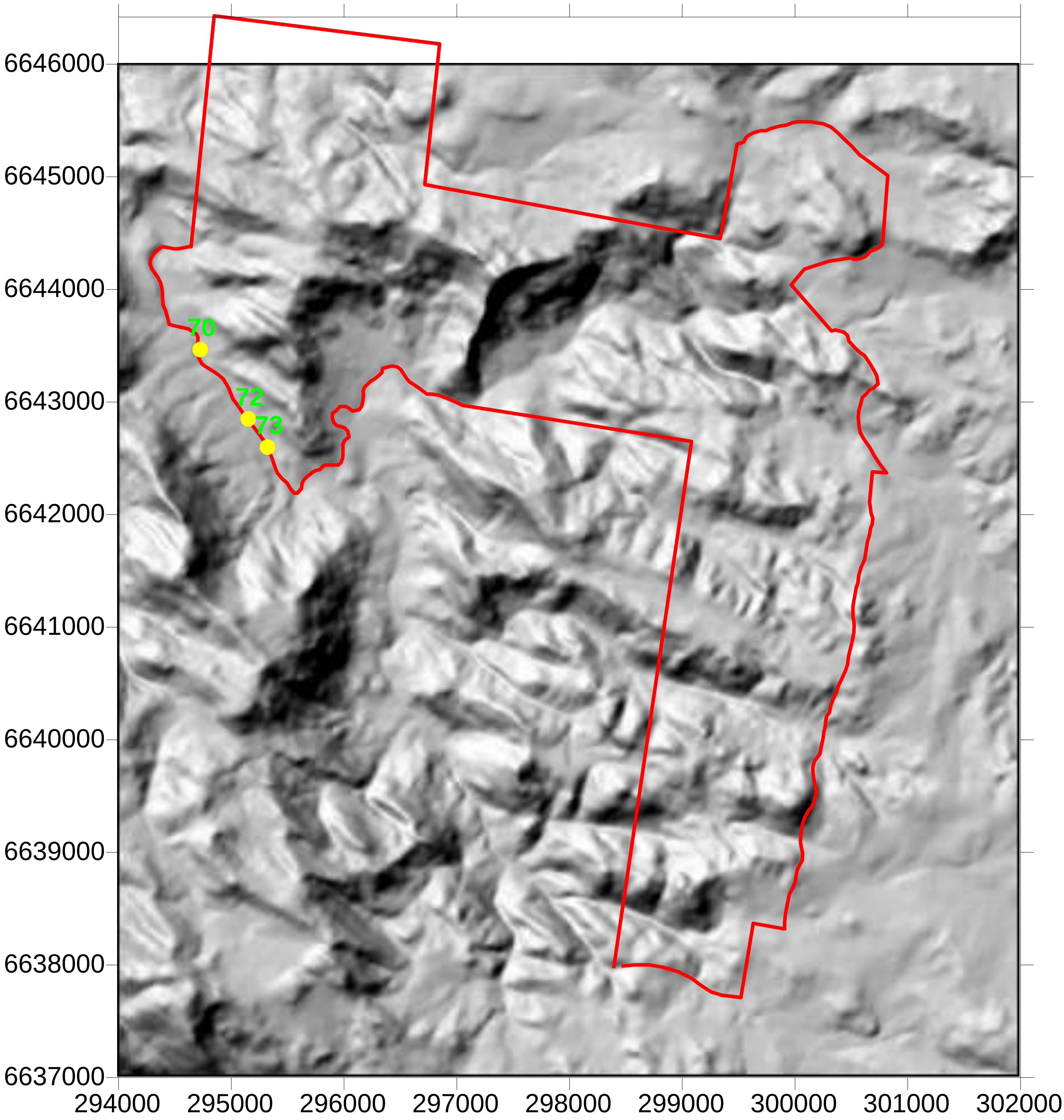


Figure 36: Placement of sites within Community 8.

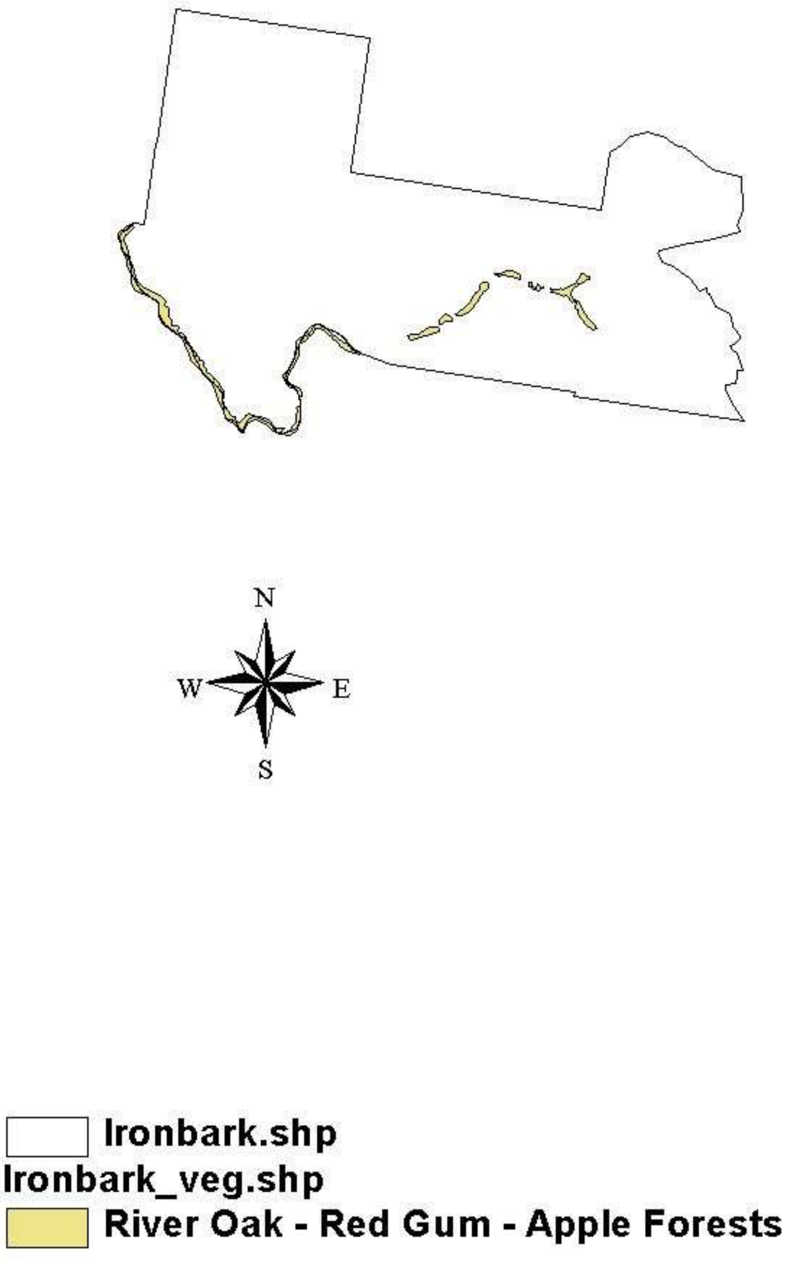


Figure 37: Mapped distribution of Community 8.

3.7.9 Community 9: Fringe Myrtle-Daisy Bush Open Shrublands

Calytrix tetragona (Fringe Myrtle) – *Ozothamnus obcordatus* (Daisy Bush) Open Shrublands.

Sample sites (9): 5, 8, 15, 19, 34, 47, 55, 65, 94.

Number of hectares: ?206 **Proportion of reserve:** ?7.6%

Environmental relationships: restricted to rock platforms and outcrops. Soils are well drained, sandy peat to sandy loam or loam. They are black to brown or red brown in colour and skeletal in texture.

Distribution within conservation areas: restricted primarily to *Bornhardtia* and the southeastern section of Ironbark but common in these areas.

Structure: usually open shrublands but also, woodlands, herbfields or grasslands.

- Tree layer: 5-12 m tall ; 10 (-30)% cover. Usually absent.
- Tall shrub layer: 2-4 m tall; 10% cover. Rarely present.
- Low shrub layer: 1-3 m tall; 10 (-30)% cover.
- Understorey layer: > 1 m tall; (10-) 20 (-30)% cover.

No. of taxa: 79 **No. of taxa per plot:** 19-**20.2**-24.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Callitris endlicheri, Eucalyptus prava, Eucalyptus dealbata*.

Shrubs: *Calytrix tetragona, Ozothamnus obcordatus, Homoranthus bornhardtiensis, Prostanthera nivea, Leptospermum novae-angliae, Leucopogon muticus, Acacia neriifolia, Boronia anethifolia, Acacia triptera, Cyphanthera albicans, Acacia viscidula, Kunzea parvifolia, Hibbertia* sp. 'grandiflora', *Cryptandra amara, Acacia cheelii, Mirbelia pungens, Leptospermum brevipes, Hibbertia cistoidea.*

Climbers & trailers: *Cassytha pubescens.*

Ground cover: *Tripogon loliiformis, Lepidosperma laterale, Stypandra glauca, Gonocarpus tetragynus, Cheilanthes sieberi, Cyperus secubans, Thelionema grande, Brachyscome stuartii, Isotoma anethifolia, Crassula sieberiana, Trachymene incisa, Pomax umbellata, Austrodanthonia laevis, Aristida calycina, Cymbopogon refractus, Gonocarpus teucrioides, Fimbristylis dichotoma, Lobelia gracilis, Gonocarpus oreophilus, Entolasia stricta, Digitaria ramularis, Aristida vagans, Vittadinia* *muelleri, Ophioglossum lusitanicum, Laxmannia gracilis, Joycea pallida, Isotoma axillaris, Drosera burmannii, Dichelachne micrantha, Cheilanthes distans, Calandrinia eremaea, Brachyscome nova-anglica, Austrodanthonia monticola, Aristida ramosa, Actinotus helianthi.*

Introduced taxa: *Hypochaeris radicata, Hypochaeris glabra.*

Percent of species introduced: 2.5%

Variability: structurally highly variable. Two distinct sub-assemblages occur on the dendrogram but these are difficult to conceptualize in the field as they are largely based on herbaceous vegetation, however one sub-assemblage appears to be restricted to peaty black soils which are associated with colder wetter and more protected localities and the other has sandy loam to loamy brown to red brown soils. The latter are usually in more exposed drier localities. Overall, outcrop communities are highly structured by stochastic distributions and frequent sporadic colonisation and extinction and hence they can appear structurally very dissimilar even when in close proximity to each other. The occasional tree can be present giving a low open woodland appearance. Shrubs can be prominent and dense in some localities such as, *Leptospermum brevipes* or *L. novae-angliae* giving a dense tall heath appearance. However, overall a large enough number of shared species occur including many outcrop endemics that enable delineation of the assemblage purely on floristics.

Condition: generally very good. Some areas have been severely impacted upon by goats. Rabbits, are also a feature of some rocky locations and have degraded the grassier parts. Pigs have also caused a deal of damage on a number of outcrops, causing extensive modification of herbfields and pushing and moving of exfoliated rocks.

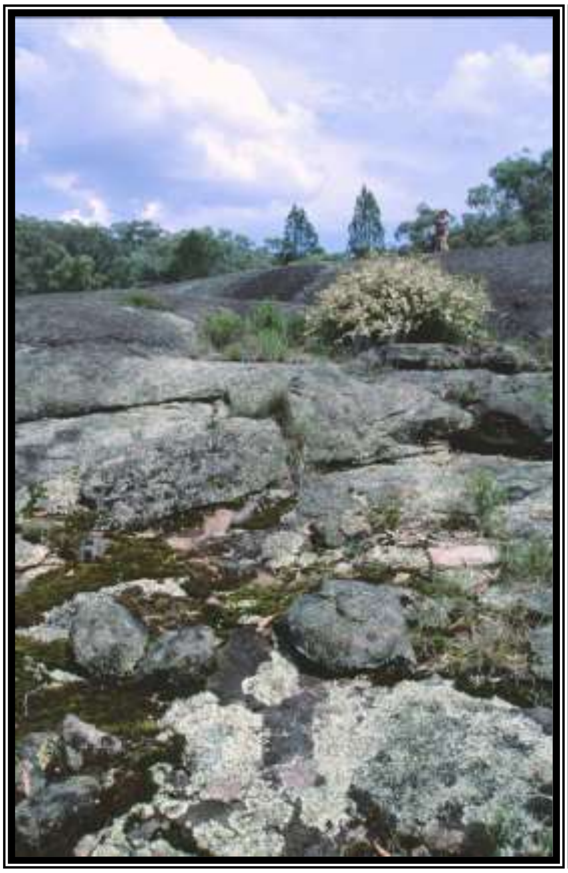
Taxa of importance: *Homoranthus bornhardtiensis, Thelionema grande, Acacia cheelii, Cyperus secubans, Cyphanthera albicans, Ophioglossum latiusculum.*

Notes: this assemblage is in general shrubbier than Community 10 and primarily occurs at higher altitudes and positions less exposed to the north west. Hunter and Clarke (1998) placed this assemblage within Element 7: Western New England Shrublands and Herbfields in the batholith wide analysis of rock outcrop communities. This assemblage in broad circumscription occurs from Sundown in Queensland to Bendemeer in New South Wales and potentially west to Mt Kaputar but excludes the Howell-Copeton Dam area.

Conservation status: Hunter and Clarke (1999) considered Element 7 to be under-represented within the reserve network as a whole. Community 7f within Element 7 is directly synonymous with this assemblage. This community is restricted to *Bornhardtia* and Ironbark and is one of three communities out of a total of eight within this Element to be reserved at all. Despite the Element as a whole be under-represented, the extensive outcrop areas within Ironbark and *Bornhardtia* mean that locally this community is adequately reserved. This does not mean that further inclusions of this assemblage would not be important as Hunter (2000) has shown the nature of naturally fragmented ecosystems means that any addition to the reserve network would significantly increase species richness and resilience of this assemblage.

Threats: threats are largely due to direct damage caused by pigs, rabbits, goats and humans. This includes rutting of soil and rocks by pigs, browsing of shrubs and herbs by goats and rabbits. Trampling by pigs, stray cattle and humans are also threats. Inappropriate fire regimes also threaten this assemblage.

Management considerations: communities on outcrops are fragile and may be severely impacted upon by walking traffic or nutrient addition. Plants are known to die due to soil compaction and an increase in nutrients due to organic rubbish. Trails should not be constructed or maintained in this community. Appropriate fire regimes for this community are likely to be of great importance as most of the primarily outcrop restricted species are obligate seeders that are potentially frequent fire avoiders (Hunter 2003). Research into the dynamics of this community in terms of fire and general recruitment is necessary. Some ‘fire ephemeral’ species are known to occur after major fires or lightning strikes. These communities may have long-term climate driven processes that aid in the reshuffling of dominant species. Casual monitoring of such changes and a written record may give insight in years to come of such processes and their implications. Pigs, rabbits and goats will need to be controlled.



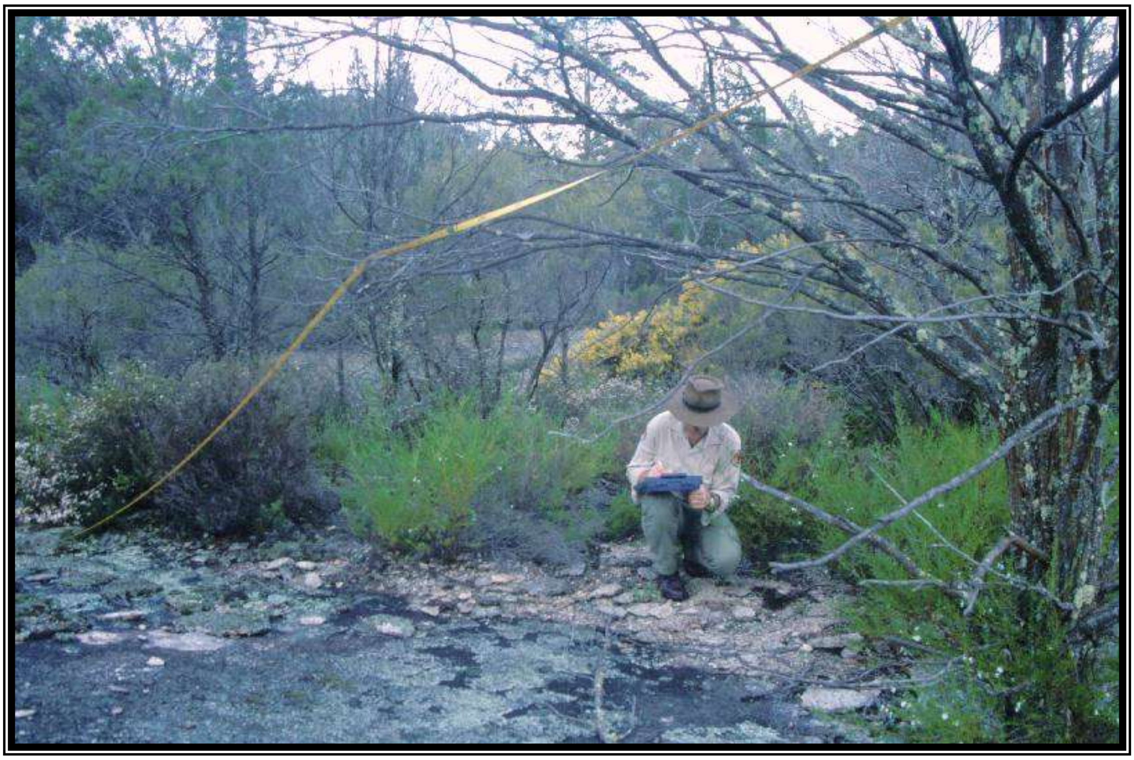


Plate 25: Photographs of Community 9. Above left Site 5 and right Site 34; below Site 14. Note *Homoranthus bornhardtiensis* in flower in the top right.

Plate 26: Photographs of Community 9. Above Site 47 and below Site 65.

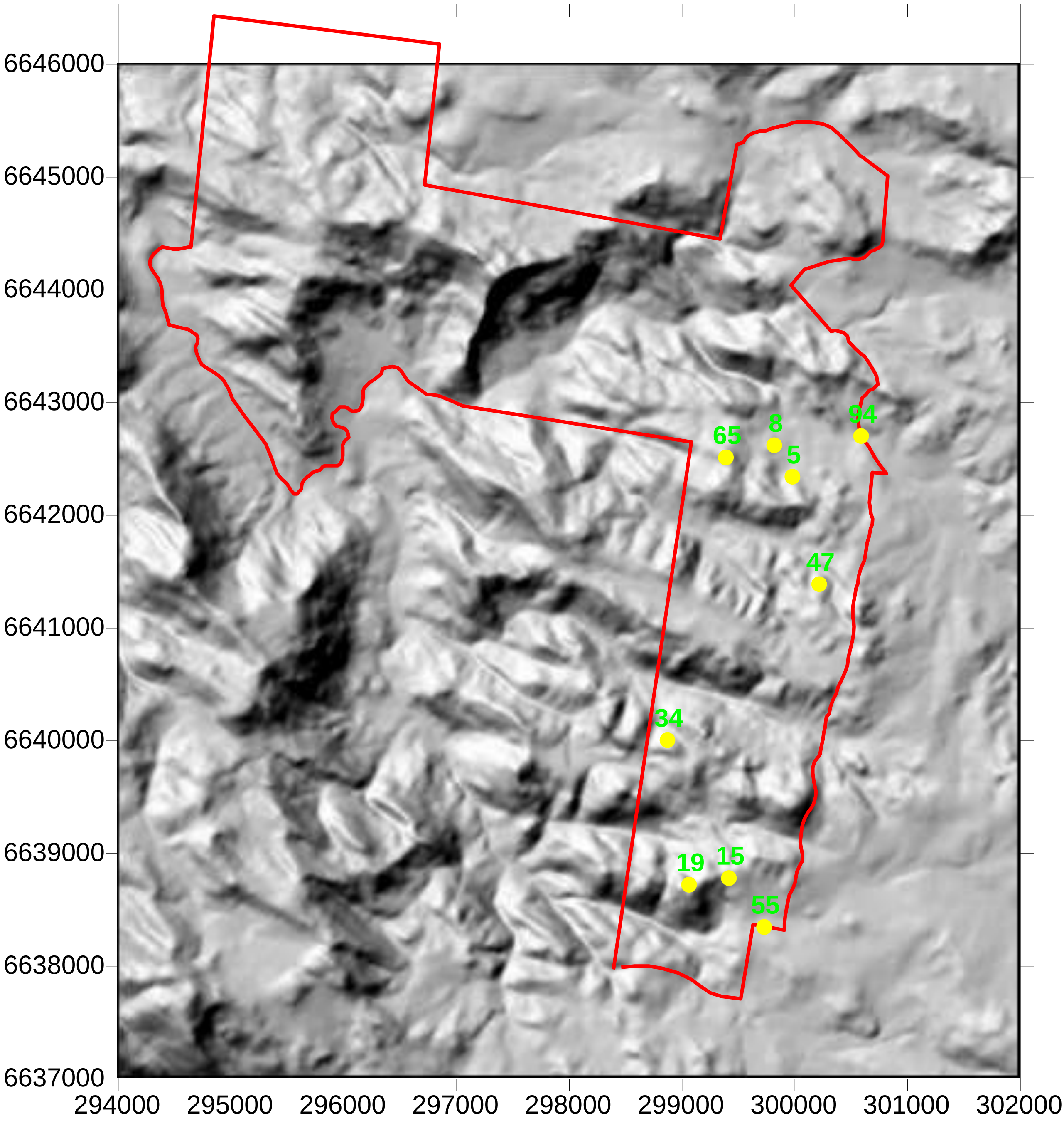


Figure 38: Placement of sites within Community 9.

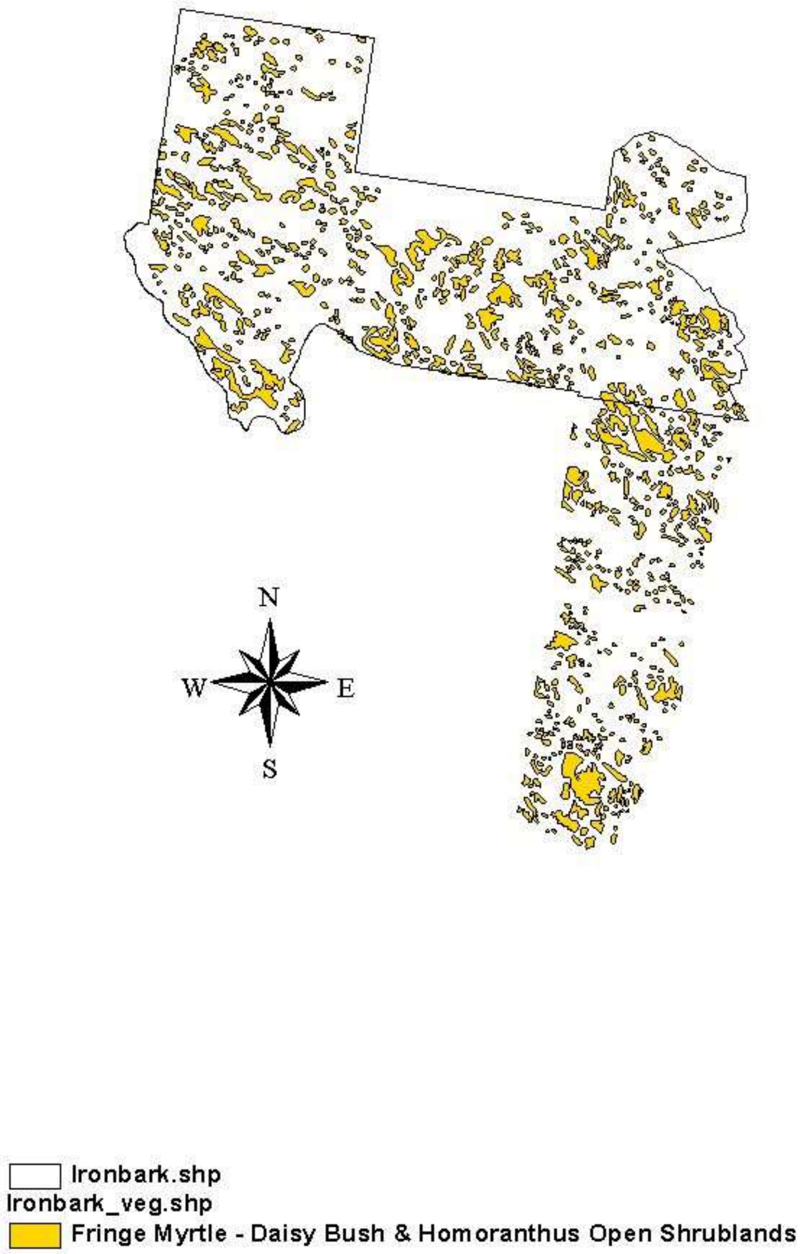


Figure 39: Mapped distribution of Community 9 & 10.

3.7.10 Community 10: Homoranthus Open Shrublands

Homoranthus bornhardtiensis (Homoranthus) Open Shrublands.

Sample sites (9): 6, 20, 26, 66, 71, 75, 83, 91, 109.

Number of hectares: ?206 **Proportion of reserve:** ?7.6%

Environmental relationships: restricted entirely to skeletal soils on rock outcrops in gravel basins and within the cracks and fissures on the outcrops. Sometimes associated the immediate fringe of flat rocks or close to the surface fugitive outcrops.

Distribution within conservation areas: found throughout both conservation areas more common in more exposed localities compared to the Community 9.

Structure: primarily shrublands but occasionally grasslands, herbfields or low open woodlands.

- Tree layer: 6-15 m tall; 10% cover. Usually absent.
- Tall shrub layer: 3-10 m tall; 10-20% cover. Usually absent.
- Low shrub layer: 1-3 m tall; 5-20% cover.
- Understorey layer: > 1 m tall; 20-40 (-80)% cover.

No. of taxa: 107 **No. of taxa per plot:** 17-**25.6**-38.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: *Callitris endlicheri, Eucalyptus prava, Eucalyptus dealbata, Eucalyptus caleyi* ssp. *caleyi, Eucalyptus blakelyi*.

Shrubs: *Homoranthus bornhardtiensis, Cassinia quinquefaria, Leucopogon muticus, Calytrix tetragona, Melichrus urceolatus, Hibbertia obtusifolia, Acacia neriifolia, Ozothamnus obcordatus, Pultenaea* sp. G., *Olearia elliptica, Notelaea microcarpa, Leptospermum brevipes, Grevillea triternata, Mirbelia pungens, Brachyloma daphnoides* ssp. *glabrum.*

Climbers & trailers: *Glycine tabacina, Desmodium varians.*

Ground cover: *Tripogon loliiformis, Cymbopogon refractus, Cheilanthes sieberi, Aristida calycina, Fimbristylis dichotoma, Pomax umbellata, Dichelachne micrantha, Arthropodium milleflorum, Thelionema grande, Chrysocephalum apiculatum, Cheilanthes distans, Trachymene incisa, Joycea pallida, Hypericum gramineum, Eragrostis elongata, Dianella caerulea, Aristida vagans, Aristida ramosa, Wurmbea* *biglandulosa, Lepidosperma laterale, Goodenia macbarroni, Cyperus fulvus, Chrysocephalum semipapposum, Austrodanthonia racemosa* ssp. *obtusata, Vittadinia cuneata, Triptilodiscus pygmaeus, Plantago varia, Goodenia hederacea, Gonocarpus teucrioides, Drosera peltata, Cyperus secubans, Crassula sieberiana, Commelina cyanea, Brachyscome multifida, Wahlenbergia planiflora* ssp. *pilosa, Vittadinia muelleri, Senecio lautus, Poa sieberiana, Panicum effusum, Murdannia graminea, Luzula flaccida, Laxmannia compacta, Hydrocotyle peduncularis, Haloragis heterophylla, Gonocarpus tetragynus, Galium migrans, Eragrostis leptostachya, Entolasia stricta, Digitaria breviglumis, Cymbopogon obtectus, Brachyscome nova0anglica, Actinotus helianthi.*

Introduced taxa: *Hypochaeris radicata, Opuntia stricta, Aira cupaniana.*

Percent of species introduced: 2.8%

Variability: highly variable in structure. *Homoranthus bornhardtiensis* though highly abundant in many sites is not ubiquitous, for example two sub-assemblages are apparent in the dendrogram, the first of which usually don't have this species as a component, or at least not as a dominant. This first sub-assemblage occurs on loam or sandy loam soils that are usually yellow brown in colour. The second sub-assemblage is usually dominated by *Homoranthus bornhardtiensis* and occurs on sandy loam or loamy sand soils that are chocolate to orange brown in colour. Overall, outcrop communities are highly structured by stochastic distributions and frequent sporadic colonisation and extinction and hence they can appear structurally very dissimilar even when in close proximity to each other. The occasional tree can be present giving a low open woodland appearance. Shrubs can be prominent and dense in some localities such as, *Leptospermum brevipes* or *L. novae-angliae* giving a dense tall heath appearance. In some situations, grasses predominate giving the structure of a small grassland, or herbfield if grasses are absent. However, overall a large enough number of shared species occur including many outcrop endemics that enable delineation of the assemblage purely on floristics.

Condition: generally very good. Some areas have been severely impacted upon by goats. Rabbits, are also a feature of some rocky locations and have degraded the grassier parts. Pigs have also caused a deal of damage on a number of outcrops, causing extensive modification of herbfields and pushing and moving of exfoliated rocks.

Taxa of conservation importance: *Homoranthus bornhardtiensis, Goodenia macbarroni, Thelionema grande, Cyperus secubans, Hibbertia* sp. 'grandiflora', *Pultenaea* sp. G.

Notes: Hunter and Clarke (1998) placed this assemblage within Element 7: Western New England Shrublands and Herbfields in the batholith wide analysis of rock outcrop communities. This assemblage in broad circumscription occurs from Sundown in Queensland to Bendemeer in New South Wales and potentially west to Mt Kaputar but excludes the Howell-Copeton Dam area.

Conservation status: Hunter and Clarke (1999) considered Element 7 to be under-represented within the reserve network as a whole. Community 7f within Element 7 is directly synonymous with this assemblage. This community is restricted to *Bornhardtia* and Ironbark and is one of three communities out of a total of eight within this Element to be reserved at all. Despite the Element as a whole be under-represented, the extensive outcrop areas within Ironbark and *Bornhardtia* mean that locally this community is adequately reserved. This does not mean that further inclusions of this assemblage would not be important as Hunter (2000) has shown the nature of naturally fragmented ecosystems means that any addition to the reserve network would significantly increase species richness and resilience of this assemblage.

Threats: threats are largely due to direct damage caused by pigs, rabbits, goats and humans. This includes rutting of soil and rocks by pigs, browsing of shrubs and herbs by goats and rabbits. Trampling by pigs, stray cattle and humans are also threats. Inappropriate fire regimes also threaten this assemblage.

Management considerations: communities on outcrops are fragile and may be severely impacted upon by walking traffic or nutrient addition. Plants are known to die due to soil compaction and an increase in nutrients due to organic rubbish. Trails should not be constructed or maintained in this community. Appropriate fire regimes for this community are likely to be of great importance as most of the species primarily restricted to outcrops are obligate seeders that are potentially frequent fire avoiders (Hunter 2003). Research into the dynamics of this community in terms of fire and general recruitment is necessary. Some 'fire ephemeral' species are known to occur after major fires or lightning strikes. These communities may have long-term climate driven processes that aid in the reshuffling of dominant species. Casual monitoring of such changes and a written record may give insight in years to come of such processes and their implications. Pigs will and goats will need to be controlled.

Plate 27: Photographs of Community 10. Above Site 6; below Site 20.

Plate 28: Photographs of Community 10. Above Site 83; below Site 26.

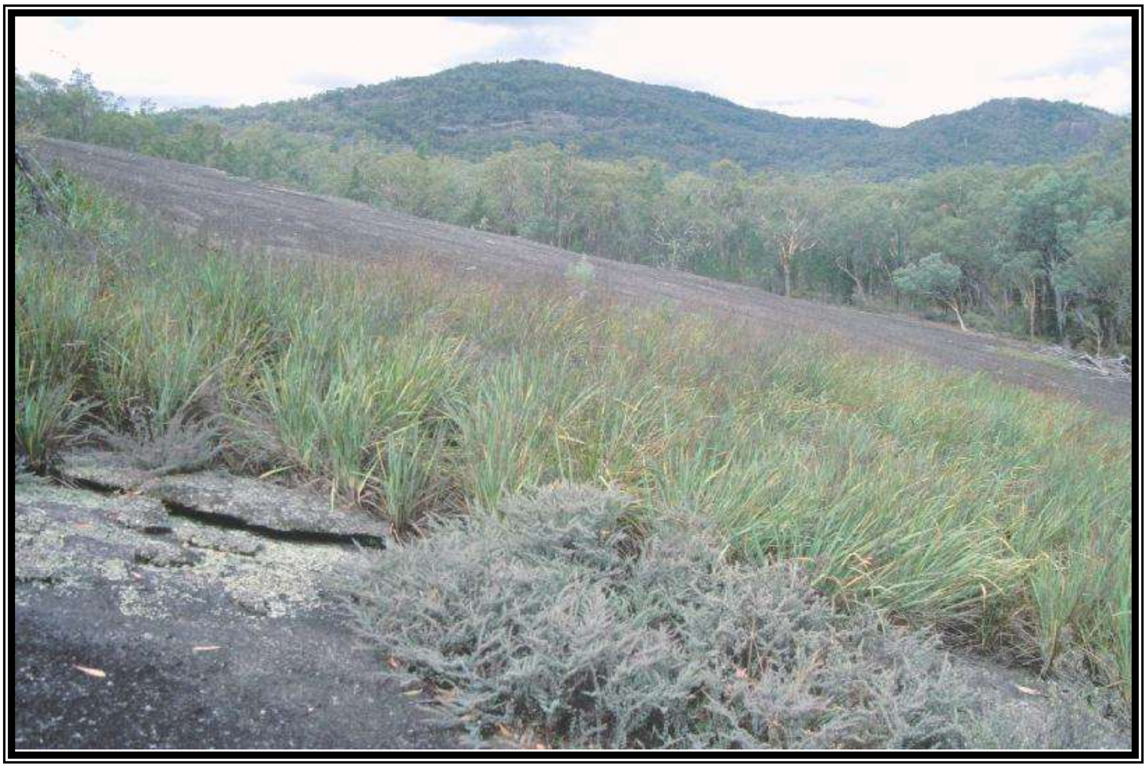


Plate 29: Photographs of Community 10. Above Site 66; below Site 75. Note *Homoranthus bornhardtiensis* in both localities and *Thelionema grande* in the bottom photograph.

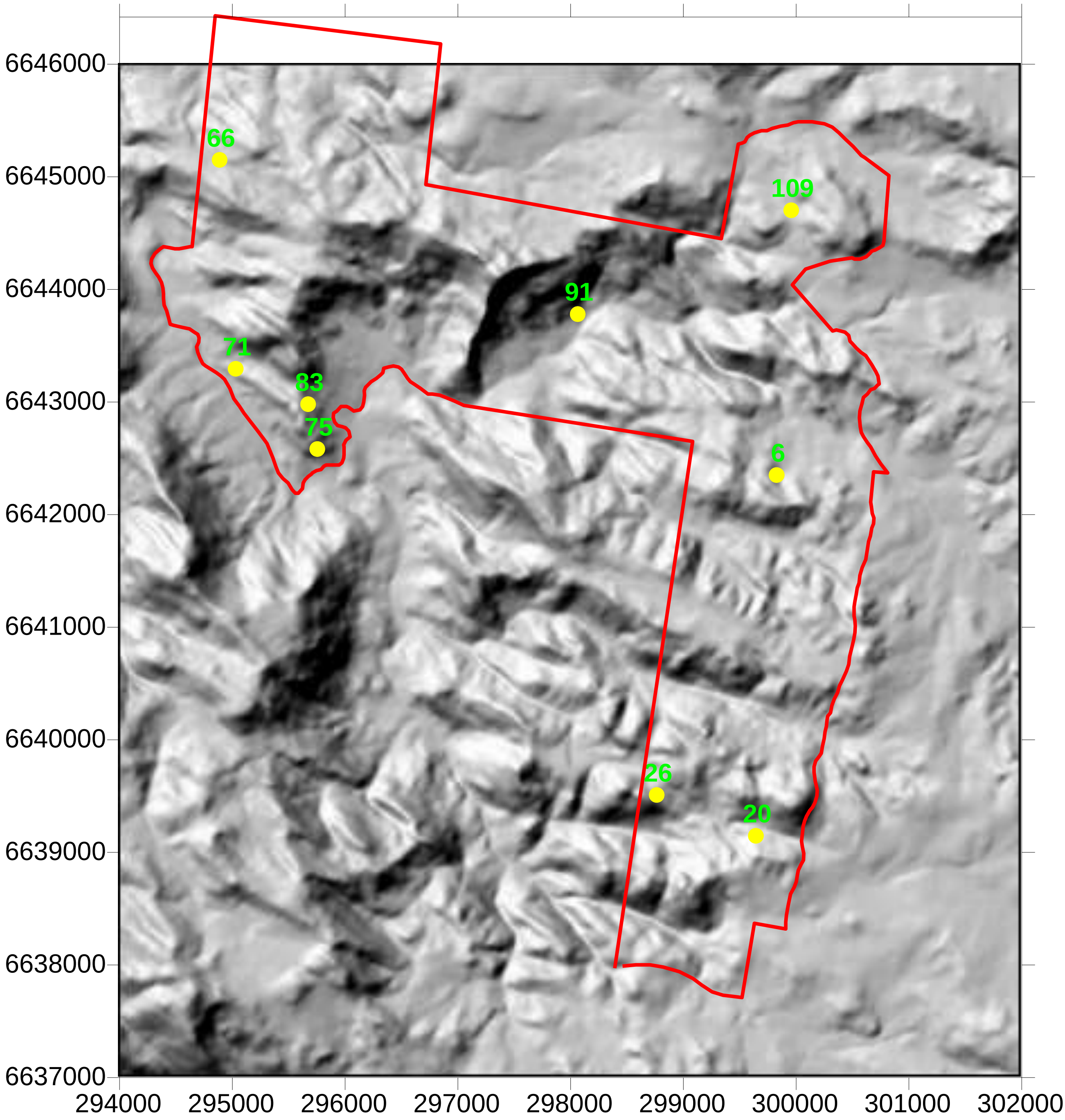


Figure 40: Placement of sites within Community 10.

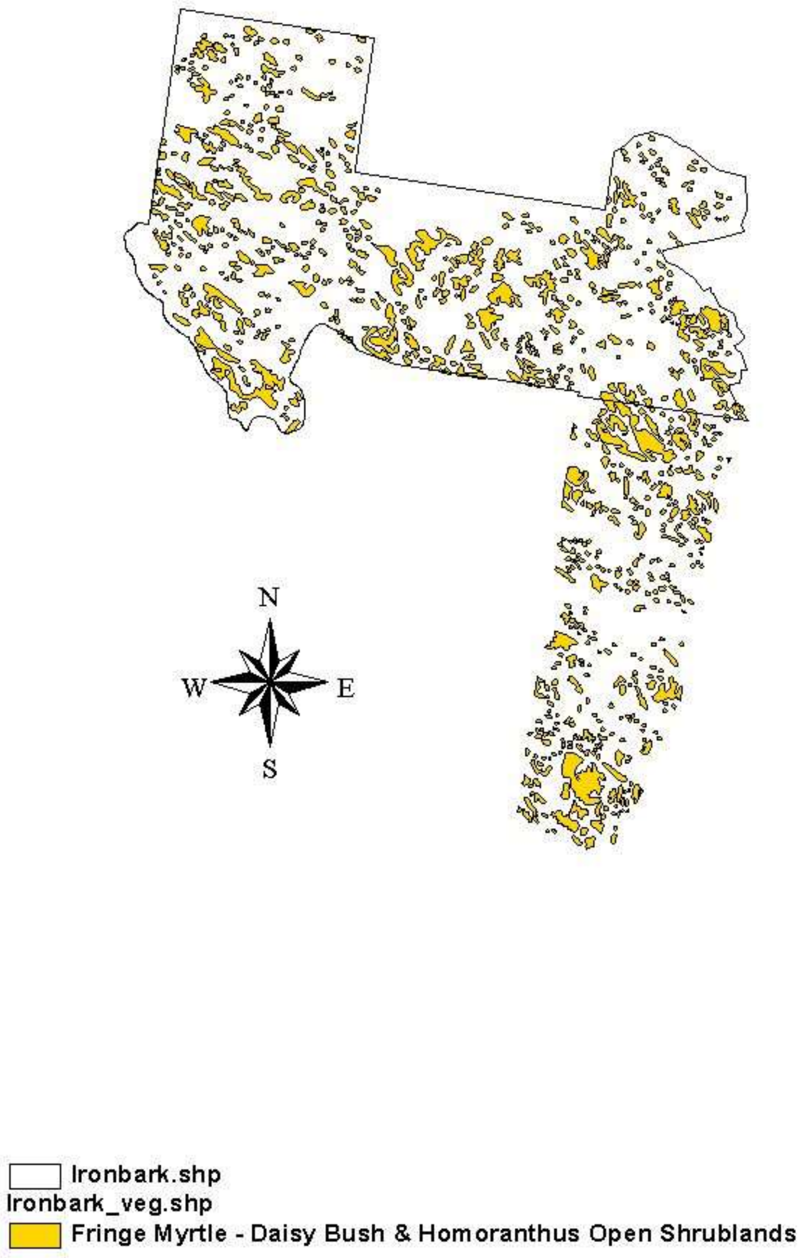


Figure 41: Mapped distribution of Community 9 & 10.

3.7.11 Community 11: Tea-tree Wetlands

Leptospermum polygalifolium ssp. *transmontanum* (Creek Tea-tree) – *Callistemon pungens* (Bottlebrush) Wetland.

Sample sites (1): 59.

Number of hectares: 3.4 **Proportion of reserve:** 0.1%

Environmental relationships: restricted to permanently waterlogged sites.

Distribution within conservation areas: found only in a few very small localities mostly associated with Long Swamp.

Structure: woodlands to herbfields.

- Tree layer: 12-18 m tall; 10% cover.
- Tall shrub layer: 2-5 m tall; 40% cover.
- Low shrub layer: 1-2 m tall; 10% cover.
- Understorey layer: > 1 m tall; 100% cover.

No. of taxa: 21 **No. of taxa per plot:** **21**.

Most common natives: listed in order of decreasing summed cover scores (fidelity x cover).

Trees: none apparent.

Shrubs: *Leptospermum polygalifolium, Hakea microcarpa, Callistemon pungens.*

Climbers & trailers: none apparent.

Ground cover: *Stellaria angustifolia, Ranunculus* sp. A, *Phragmites australis, Gonocarpus micranthus, Geranium solanderi* var. *grande, Epilobium billardierianum, Baloskion stenocoleum, Schoenus apogon, Eryngium vesciculosum, Juncus vaginatus, Juncus fockei, Hydrocotyle peduncularis, Carex gaudichaudiana, Arthropodium milleflorum, Rhynchospora brownii.*

Introduced taxa: *Trifolium repens, Lotus uliginosus, Axonopus affinis.*

Percent of species introduced: 14.3%

Variability: only one formal site sampled this assemblage therefore, community variability cannot be adequately discussed. However, the assemblage is likely to be very stochastic both in temporal and spatial terms. Differences in extent of water-logging and duration will significantly affect what species are present the long term and also how extensive the community is. Some areas have extensive and dense

Phragmites (Reed Grass) stands and *Leptospermum polygalifolium* may or may not be present as a significant feature.

Condition: generally good, however some Blackberry and other weeds are prominent in some localities. Pigs and cattle also frequent these areas and as such all patches are also degraded to some extent.

Taxa of conservation importance: *Callistemon pungens, Baloskion stenocoleum*.

Notes: as described here there appear to be few if any true counterparts. The most synonymous described assemblage occurs in Single National Park in similar situations. The distribution of this type of assemblage is likely to be very small and highly scattered, with stands usually less than 1 ha in size.

Conservation status: this assemblage only ever will occur in small areas of less than one hectare and in a sporadic and isolated distribution. It is under significant threat from various land uses and by feral animals and weeds. This type of assemblage should be considered vulnerable and poorly conserved, both across its range, if it is synonymous with more widespread associations, and locally.

Threats: feral pigs and stray cattle are significant threats to this mainly herbaceous and small community. Exotic plants are prominent and serous problem in this assemblage. Changes in water flow, water quality and climate are likely to impact on this community. Inappropriate fires regimes are also a threat. Similar areas are often drained or dammed on private lands.

Management considerations: water flow and quality needs to be maintained. Pigs, stray cattle and exotic weeds need to be controlled in order to assure the continuance of this assemblage. Such areas are likely to be used for fire fighting purposes as they usually occur where permanent water exists, damage from such activities needs to be minimised, or better such activities should occur in other places.

Plate 30: Photograph of Community 11. Site 59.

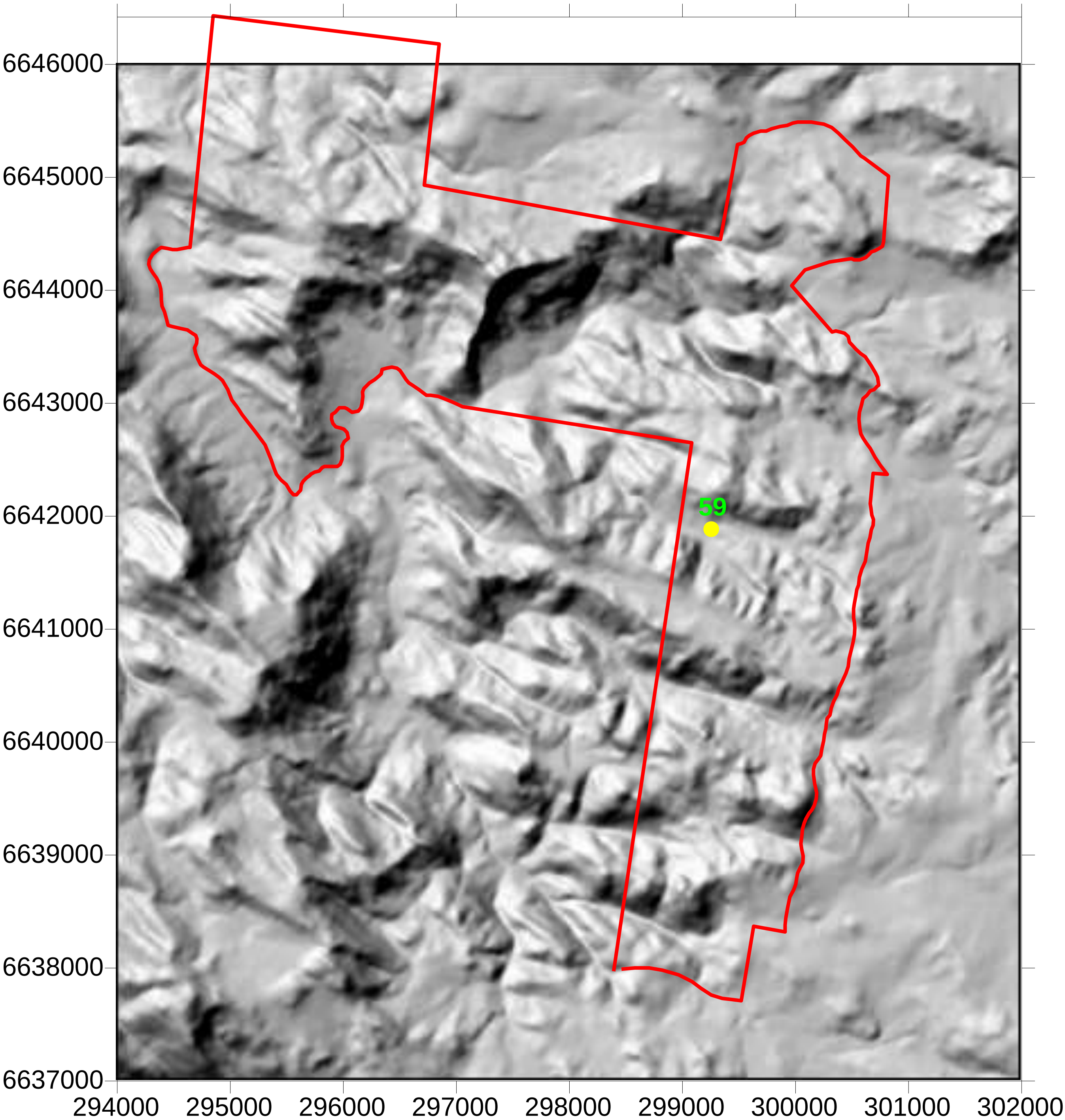


Figure 42: Placement of site within Community 11.

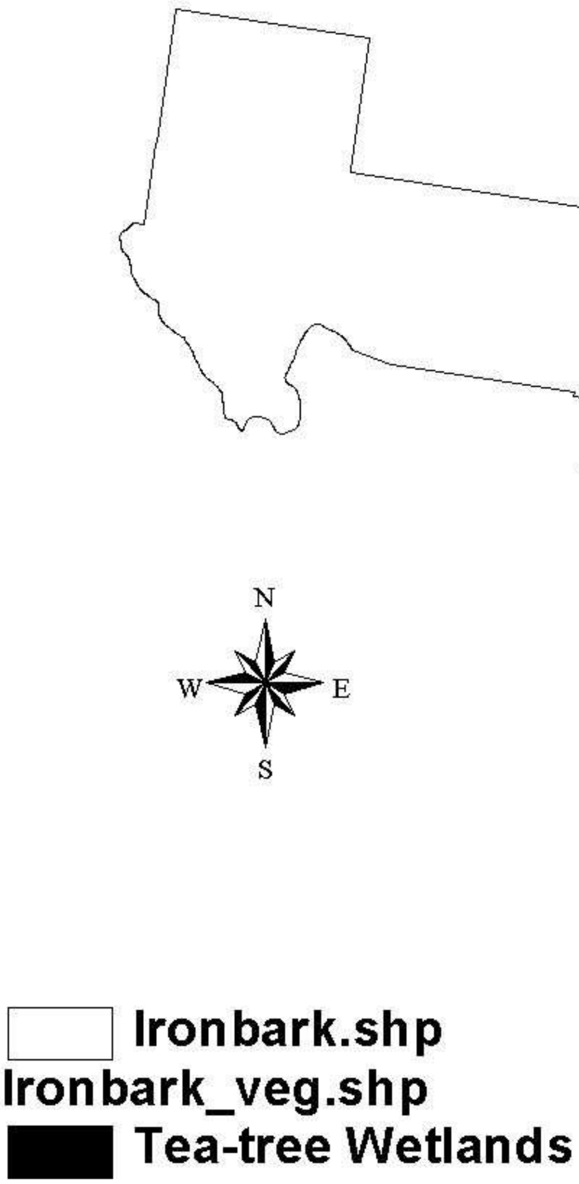


Figure 43: Mapped distribution of Community 11.

3.8 Reservation status of communities and comparison with other studies

The following represents a review of the current literature on communities considered synonymous with those described within Ironbark Nature Reserve and the *Bornhardtia* Voluntary Conservation Area, the reservation status of these are given. The region in which the study area is included has few comprehensive vegetation surveys that are published or reports, thus it is difficult to directly compare the assemblages found with others in the local and regional areas and also their comprehensive reservation status and threats.

Table 7: Comparative table of Ironbark and *Bornhardtia* vegetation communities with other communities defined in the north-east of New South Wales and their reservation status. Communities listed following = are exactly or very closely matching assemblages, those following ≈ are loosely related assemblages at least with some major correlating taxa.

Floristic Community	Similar Floristic Classifications	Reservation Status	Reserved
C1: Euc. macrorhyncha – Callitris endlicheri - E. blakelyi	= s115p Red Stringybark Yellow Box Blakely's Red Gum (DeVries 2000) ≈ s11rp Red Stringybark Orange Gum (DeVries 2000)	56% cleared in the Nandewar Bioregion (DeVries 2000). Few to no direct correlates in the literature. This community in the strict sense is likely to be restricted to a band south of Inverell, through the western side of Bundarra and south to Warrabah and potentially Watson's Creek. Should be considered restricted in distribution and **Poorly Conserved**.	= Ironbark & Bornhardtia (549 ha) = Warrabah NP = Stoney Batter NR
C2: Callitris endlicheri – Euc. caleyi – E. andrewsii	= Ecosystem 176 Orange Gum – Ironbark (Wall 2000) ≈ s112p Orange Gum Caleys Ironbark (DeVries 2000) ≈ C9: *Euc. caleyi – E. prava* (Clarke *et al.* 2000) ≈ C1: *Euc. caleyi – Callitris endlicheri – E. prava* (Hunter 2000f) ≈ *Euc. prava – E. caleyi – E. laevopinea* (Hunter 2002b)	Considered 64.9% cleared with 2.4% of reservation target met by Wall (2000). 52% considered cleared in the Nandewar Bioregion (DeVries 2000). In the broad sense this assemblage occurs from the Severn River (Kings Plains) south to Watson's Creek. In the strict sense likely to be restricted	= Ironbark & Bornhardtia (255 ha) = Warrabah NP = Stoney Batter ≈ Bluff River NR (775 ha) ≈ Bolivia Hill NR (118 ha) ≈ Kings Plains NP (4970 ha) ≈ Single NP (2 ha) ≈ The Basin NR

	≈ *Euc. caliginosa – E. prava – E. caleyi* (Hunter 2002b).	to south of Inverell to the higher altitude eastern parts of Warrabah NP. Should be considered **Poorly Conserved** to potentially **Adequately Represented** across its broader range..	≈ Watson's Creek NR
Floristic Community	**Similar Floristic Classifications**	**Reservation Status**	**Reserved**
C3: Euc. prava – Callitris endlicheri – E. andrewsii	= Ecosystem 175 Orange Gum – New England Blackbutt – Tumbledown Gum (Wall 2000) = S11p Orange Gum (DeVries 2000) ≈ C7: *Euc. crebra – E. prava – E. andrewsii* (Hunter 2000h) ≈ C5: *Euc. prava – E. caleyi – E. macrorhyncha* (Hunter 2000f) ≈ C3c: *Euc. andrewsii – E. prava – Callitris endlicheri* (Clarke *et al.* 1997)	Considered 58.6% cleared with only 6.8% of reservation target met by Wall (2000). 40% considered cleared in the Nandewar Bioregion (DeVries 2000). In the broad sense this assemblage occurs from west of Tenterfield south to Warrabah NP. Should be considered **Poorly Conserved** across its range and **Reasonably** conserved locally.	= Ironbark & Bornhardtia (32 ha) = Stoney Batter NR = The Basin NR = Warrabah NP ≈ Kings Plains NP (672 ha) ≈ Severn River (112 ha) ≈ Torrington SRA
C4: Euc. dealbata – Callitris endlicheri – Euc. caleyi	=S102p Caley's Ironbark Tumbledown Gum (DeVries 2000) = s129p White Box White Cypress Pine Rough-barked Apple (DeVries 2000) = Type 10b *Euc. dealbata – E. caleyi – Callitris endlicheri* (Clarke *et al.* 1995). ≈ C4: *Callitris endlicheri – Euc. dealbata – E. caleyi* (Hunter 2000h) ≈ C8: *Euc. dealbata – E. dwyeri* (Porteners 1998) ≈ C5: *Euc. dealbata – E. caleyi – Callitris endlicheri* (Clarke *et al.* 1997) ≈ Type 7a *Euc. dealbata – Callitris endlicheri* (Clarke *et al.* 1995)	55-58% considered cleared in the Nandewar Bioregion (DeVries 2000). Likely to be a more widespread assemblage. This community in the broad sense occurs from west of Tenterfield south to Warrabah. Should be considered **Poorly Conserved** to **Vulnerable.**	= Ironbark & Bornhardtia (779 ha) = Warrabah NP ≈ Severn River NR (2732 ha) ≈ Torrington SRA
C5: Callitris endlicheri – Euc. prava – E. blakelyi	≈ Ecosystem 174: Orange Gum – Tumbledown Gum - Apple (Wall 1999)	In the broad sense Ecosystem 174 is considered to be 57.8% cleared with only 1.6% of reservation target met (Wall 2000). No direct correlates are in the literature. This community type however is likely to be similar to those	= Ironbark & Bornhardtia (101 ha) = Warrabah NP

		occurring from west of Tenterfield to Warrabah and in the strict sense from Inverell to Warrabah. Should be considered **Poorly Conserved.**	
Floristic Community	**Similar Floristic Classifications**	**Reservation Status**	**Reserved**
C6: Euc. quinniorum – Angophora floribunda	≈ C5: *Euc. andrewsii – E. volcanica – E. laevopinea – E. macrorhyncha* (Hunter & Alexander 2000a)	No direct correlates in the literature exist. Similar however to areas described for Mt Kaputar to the west. Likely highly restricted to the Nandewars from the eastern fall of Mt Kaputar to the local region including Warrabah. **Highly restricted** and **Poorly Conserved.**	= Ironbark & Bornhardtia (44 ha) = Stoney Batter NR = Warrabah NP ≈ Watsons Creek NR ≈ Mt Kaputar NP (?4000? ha)
C7: Angophora floribunda – Euc. dealbata – E. blakelyi	= s130p Yellow Box Blakely's Red Gum Rough-barked Apple (DeVries 2000) = C2: *Euc. albens – Angophora floribunda* (Hunter & Alexander 2000a) ≈ C6: *Euc. melliodora – Angophora floribunda – E. blakelyi* (Hunter 2000h) ≈ C2: *Euc. blakelyi – Callitris endlicheri – E. melliodora* (Hunter 2000f) ≈ C10: *Casuarina cunninghamiana* (Porteners 1998)	94% cleared in the Nandewar Bioregion (DeVries 2000). In the broad sense this is a very widespread assemblage on the western fall of the tablelands from over the Queensland border to the central west of New South Wales. However, likely most similar to areas west of Glen Innes south to Tamworth. **Endangered** and **Poorly Conserved.**	= Ironbark & Bornhardtia (490 ha) = Mt Kaputar NP (?500? ha) = Warrabah NP ≈ Severn River NR (21 ha) ≈ Kings Plains NP (268 ha)
C8: Euc. blakelyi – Casuarina cunninghamiana – Angophora floribunda	= s116p River She Oak River Red Gum (DeVries 2000) ≈ C6: *Angophora floribunda – E. banksii – Casuarina cunninghamiana* (Hunter 2000h) ≈ C7: *Casuarina cunninghamiana* (Hunter 2000f) ≈ C4b: *Angophora floribunda – Casuarina cunninghamiana – Euc. blakelyi* (Clarke *et al.* 1997) ≈ Ecosystem 163: Yellow Box – Blakely's Red Gum (Wall 2000)	79% considered cleared in the Nandewar Bioregion (DeVries 2000). Considered poor to very poor conservation status (DeVries 2000). In the broad sense occurring throughout the western parts of the Tablelands. In the strict sense probably occurring from west of Glen Innes to Tamworth. **Vulnerable** and **Poorly Conserved**.	= Ironbark & Bornhardtia (37 ha) = Warrabah NP ≈ Kings Plains NP (120 ha) ≈ Severn River NR (3 ha) ≈ Torrington SRA
C9: Calytrix tetragona – Ozothamnus obcordatus	= 7f *Calytrix tetragona – Ozothamnus obcordatus* Shrubland (Hunter & Clarke 1998). = Element 7. Western New England Shrublands &	In the broad sense similar to many assemblages in the literature on the western side of the tablelands from	= Ironbark & Bornhardtia (?206 ha) = Stoney Batter NR = Warrabah NP

	Herbfields (Hunter & Clarke 1998). ≈ Element 8. Kwiambal Grasslands *Aristida vagans – Tripogon loliiformis* Grassland (Hunter & Clarke 1998) ≈ Element 9: Howell Shrublands (Hunter & Clarke 1998) ≈ C3: *Acacia pycnostachya – Leptospermum arachnoides – L. novae- angliae* (Hunter 2002d) ≈ C15: *Leucopogon neo-anglicus – Micromyrtus sessilis – Kunzea bracteolata* (Hunter 2002d) ≈ C9: *Kunzea* sp. D – *Calytrix tetragona – Homoranthus flavescens* (Hunter & Alexander 2000h) ≈ C10: *Kunzea* sp. D – *Ozothamnus obcordatus* (Hunter & Alexander 2000a) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae* (Hunter 2000) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae* (Hunter 2000f) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae – Leucopogon neoanglicus* (Hunter 2000h) ≈ C10: *Acacia granitica – Leptospermum novae-angliae* (Clarke *et al.* 2000) ≈ C6: *Euc. prava – Callitris endlicheri – E. andrewsii* (Clarke *et al.* 1997) ≈ C5: *Kunzea* sp. D, *Leptospermum brevipes – Calytrix tetragona* (Porteners 1997) ≈ Type 10a *Eucalyptus prava* (Clarke *et al.* 1995)	Sundown to Bendemeer and west to Mt Kaputar NP. Should be considered **Adequately Conserved locally** but **Poorly Conserved** and represented across its range and locally.	≈ Bluff River NR (24 ha) ≈ Bolivia Hill NR (198 ha) ≈ Kings Plains NP (250 ha) ≈ Mt Kaputar NP (?400? ha) ≈ Severn River NR (220 ha) ≈ Single NP (2 ha) ≈ The Basin NR ≈ Torrington SRA ≈ Yarrowyck NR
Floristic Community	**Similar Floristic Classifications**	**Reservation Status**	**Reserved**
C10: Homoranthus bornhardtiensis	= 7f *Calytrix tetragona – Ozothamnus obcordatus* Shrubland (Hunter & Clarke 1998). = Element 7. Western New England Shrublands & Herbfields (Hunter & Clarke 1998). ≈ Element 8. Kwiambal Grasslands *Aristida vagans – Tripogon loliiformis* Grassland (Hunter & Clarke	Similar to above, but probably with greater affinities to areas west of Bundarra south to Attunga and Bendemeer. **Adequately Reserved Locally** but probably inadequately represented across its range.	= Ironbark & Bornhardtia (?206 ha) ≈ Bluff River NR (24 ha) ≈ Bolivia Hill NR (198 ha) ≈ Kings Plains NP (250 ha) ≈ Mt Kaputar NP (?400? ha) ≈ Severn River NR (220 ha)

	1998). ≈ Element 9: Howell Shrublands (Hunter & Clarke 1998). ≈ C3: *Acacia pycnostachya – Leptospermum arachnoides – L. novae- angliae* (Hunter 2002d) ≈ C15: *Leucopogon neo-anglicus – Micromyrtus sessilis – Kunzea bracteolata* (Hunter 2002d) ≈ C9: *Kunzea* sp. D – *Calytrix tetragona – Homoranthus flavescens* (Hunter & Alexander 2000a) ≈ C10: *Kunzea* sp. D – *Ozothamnus obcordatus* (Hunter & Alexander 2000a) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae* (Hunter 2000h) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae* (Hunter 2000f) ≈ C8: *Calytrix tetragona – Leptospermum novae-angliae – Leucopogon neoanglicus* (Hunter 2000a) ≈ C7: Western Rocky Outcrops (Clarke *et al.* 1997)		≈ Stoney Batter NR ≈ The Basin NR ≈ Torrington SRA ≈ Warrabah NP ≈ Yarrowyck NR
Floristic Community	**Similar Floristic Classifications**	**Reservation Status**	**Reserved**
C11: Leptospermum polygalifolium – Callistemon pungens	= C1: *Leptospermum polygalifolium* (Clarke *et al.* 2000) ≈ Type 4h *Leptospermum gregarium – Leptospermum arachnoides* (Clarke *et al* 1995)	Apparently a fairly unique assemblage that has no direct correlates in the literature. Potentially occurring in Single NP in the broad sense. Should be considered **Locally Restricted** and **Vulnerable** and **Poorly Conserverd**.	= Ironbark & Bornhardtia (3 ha) = Single NP (2 ha)

3.9 Description of taxa of conservation significance

A total of nine rare or threatened taxa have been recorded from Ironbark Nature Reserve or the *Bornhardtia* Voluntary Conservation Area. Two of these are currently listed on the *Threatened Species Conservation* Act and nine have been listed as Rare or Threatened Australian Plants by Briggs & Leigh (1996) or by subsequent authors using their criteria. A further 30 species were found to be regionally significant. In total 39 taxa (9%) were found to be of significance within the conservation areas. Discussions of rare or threatened taxa follow.

Table 8: Summary of rare, threatened and regionally uncommon species. Codes in red within brackets are those suggested by subsequent publications but are yet to be ratified, see following profiles for citation of newer codes.

Taxon	*TSC* Act Listing	RoTAP Code	Regionally or Locally Significant
1: Homoranthus bornhardtiensis	Endangered	[2EC-]	Type Locality in VCA
2: Goodenia macbarronii	Vulnerable	3VC-	
3: Callistemon pungens		3R [3RCa]	
4: Derwentia arenaria		3RC [3RCa]	
5: Eucalyptus quinniorum		[3RCa]	Type Locality in VCA
6: Thelionema grande		3RC [3RCa]	Southern Limit of Distribution in VCA
7: Pultenaea campbellii (currently subsumed)		3K	Locally Rare
8: Zieria odorifera		3RCi	Locally Rare
9: Acacia cheelii			Eastern Occurrence. Disjunct.
10: Acacia montana			Regionally Uncommon
11: Alectryon subdentatus			Locally Rare and Regionally Disjunct
12: Baloskion stenocoleum			Western Limit, Locally Rare

Taxon	*TSC* Act Listing	RoTAP Code	
14: Cassine australis var. *angustifolia*			New Distributional Limit, Locally Rare
15: Centrolepis strigosa subsp. *strigosa*			Uncommon, Locally Rare
16: Cymbidium canaliculatum			Locally Rare, Uncommon on Tablelands
17: Cyperus secubans			New Distribution Limit, New Rock Type
18: Cyphanthera albicans subsp. *albicans*			Regionally Uncommon, Locally Rare
19: Geranium solanderi subsp. *grande*			Regionally Uncommon, Locally Rare
20: Haloragis serra			New Distributional Limit, Locally Rare
21: Hibbertia spp.			Potential new Taxon, Locally and Regionally Rare
22: Jasminum sauvissimum			Uncommon on Tablelands, Locally Rare
23: Lilaeopsis polyantha			Western Limit, Locally Rare
24: Lomandra sp. aff. cylindrica		[3RCa] (Clarke *et al.* 2000)	Potential New Taxon, Locally and Regionally Rare, Southern Limit
25: Lyperanthus suaveolens			Regionally and Locally Rare
26: Mirbelia speciosa subsp. *speciosa*			Locally Rare
28: Olearia erubescens			Disjunct, Regionally Rare
29: Ophioglossum latiusculum			Regionally Uncommon, Locally Rare
31: Parsonsia eucalyptophylla			New Distribution, Regionally and Locally Rare
32: Pelargonium australe			Regionally Uncommon
33: Pittosporum undulatum			Near Western Limit, Locally Uncommon
34: Portulaca bicolor			New Distribution, Regionally and Locally Rare
35: Psydrax odoratum			New Distributional Extent (NT), Locally Rare
36: Psilotum nudum			Regionally and Locally Rare

Taxon	*TSC* Act Listing	RoTAP Code	
37: Pultenaea sp. G			Regionally Rare
38: Sida cunninghamii			New Distribution, Regionally and Locally Rare
39: Viola caleyana			Western Limit, Locally Rare

3.9.1 *Callistemon pungens* Lumley & Spencer (3RCa)

Taxonomy

Type: New South Wales, Northern Tablelands, *c.* 3 km along road to Armidale from junction with road from Armidale/Dorrigo Road to Hillgrove, (*c.* 4 km from Highway), 30°33'S, 151°54'E, 21.xi.1983, *P.F.Lumley 1150* (*holo*: MEL; *iso*: NSW).

Reference: *Muelleria* 7: 253 (1991).

Family: Myrtaceae.

Affinities: close to *Callistemon citrinus* but characterized by purple stamens and pungent leaf tips.

Synonymy: known in cultivation for a number of years as *C. 'Lana'* and *C. 'gilesii'*.

Derivation of name: in reference to the pungent leaves.

Common name: none.

Published conservation status: Lumley and Spencer (1991) considered the species was vulnerable. Given a 3R by Briggs & Leigh (1996). Copeland and Hunter (1999) have given this species a 3RCa coding.

Life history

Growth form: shrub or small tree to 5 m tall with rigid branches.

Vegetative spread: none.

Longevity: unknown but apparently long-lived.

Primary juvenile period: unknown.

Flowers: Spring to Summer.

Fruit/seed: Autumn.

Dispersal, establishment & growth: seed.

Fire response: potentially a resprouter (Clarke & Fulloon 1999).

Interactions with other organisms: none apparent.

Distribution

Botanical sub-regions: Northern Tablelands, North Western Slopes and the Darling Downs.

General distribution: from Armidale to Stanthorpe.

Habitat

Habitat: restricted to shallow soils associated with creeks and rivers on granite or rhyolitic soils.

Altitude: 500-1100 m.

Annual Rainfall: 600-1000 mm.

Abundance: common and abundant along creek lines throughout the western margin of the tablelands.

Substrate: found on granite or rhyolite.

Exposure: fully exposed to partially protected.

Management

Population size: common along all major creek banks, often forming a dominant understorey.

Reserved: Ironbark NR, The Basin NR, Stony Batter NR, Watson's Creek NR, Kings Plains NP, Severn River NR, Mann River NR, Oxley Wild Rivers NP, Torrington SRA, Bolivia Hill NR, Arakoola NP, Warrabah NP, Sundown NP and *Bornhardtia* VCA. Informally reserved at Goonoowiggal FR.

Threats: inappropriate fire regimes and pig rutting.

Plate 31: Photograph of *Callistemon pungens* taken within the *Bornhardtia* VCA.

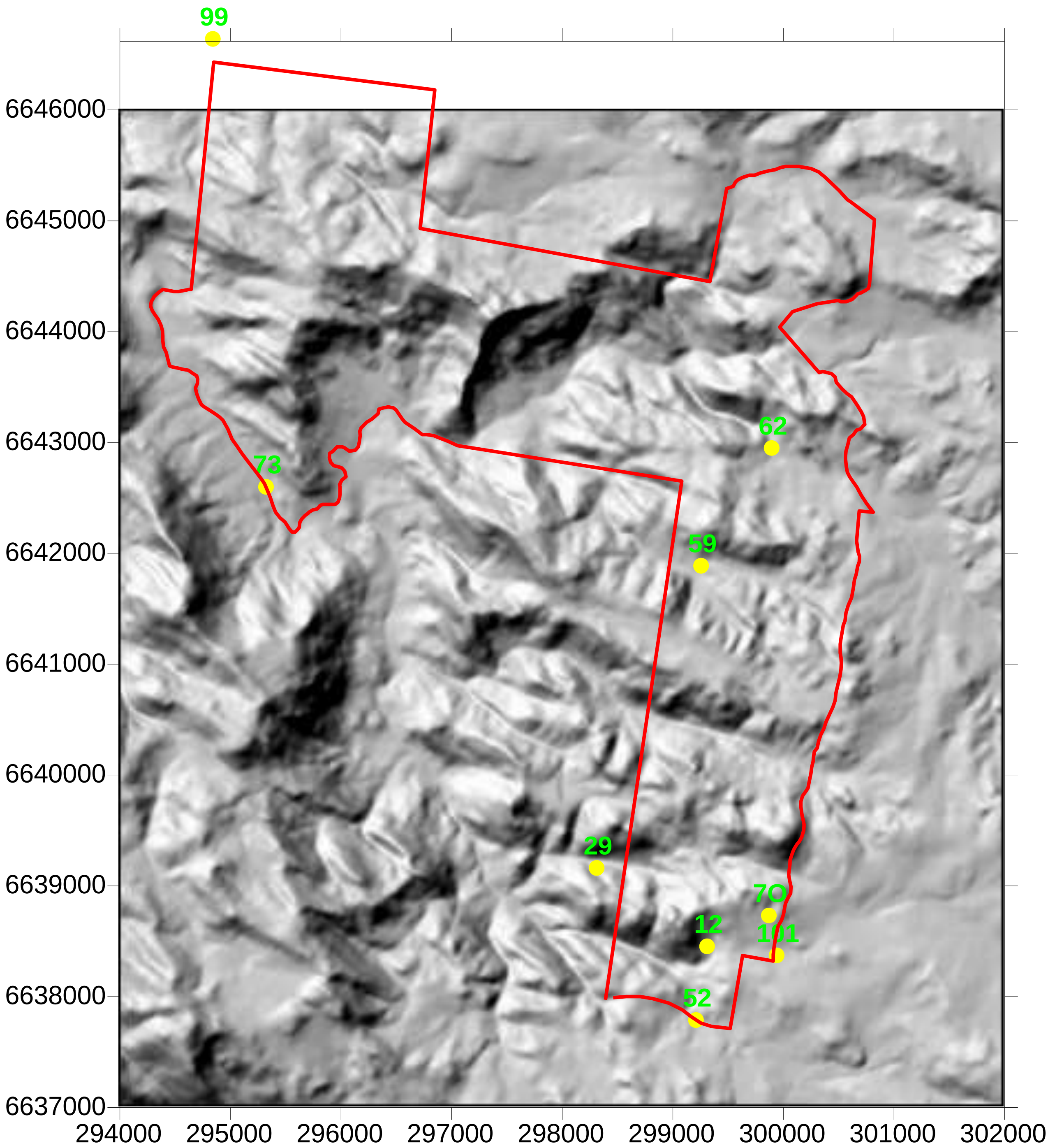


Figure 44: Distribution of sites with *Callistemon pungens.*

3.9.2 *Derwentia arenaria* (A.Cunn. ex Benth.) B.G.Briggs & Ehrend. (3RCa)

Taxonomy

Type: Arid sandy flat on the plain of Daby, Cugeegong River … 50 miles north from Bathurst, *A. Cunningham*, Apr. 1823 (*holo*: K; *iso*: BM, MEL, NSW).

Reference: *Telopea* 5: 264 (1992).

Family: Scrophulariaceae.

Affinities: uncertain.

Synonymy: *Veronica arenaria* A.Cunn. ex Benth.

Derivation of name: *arenaria* meaning sandy, referring to the substrate on which the species is found.

Common name: none.

Published conservation status: 3RC- (Briggs & Leigh 1996). 3RCa proposed by Copeland and Hunter (1999).

Life history

Growth form: herb with a sometimes woody base to 1 m tall.

Vegetative spread: none.

Longevity: unknown but seasonally resprouts from base and above ground shoots die over winter.

Primary juvenile period: unknown but likely to be only 1 yr.

Flowers: Spring to Summer.

Fruit/seed: Summer.

Dispersal, establishment & growth: via seed.

Fire response: unknown but probably resprouts readily in post fire environment.

Interactions with other organisms: unknown.

Distribution

Botanical sub-regions: Northern Tablelands, North Western Slopes, Central Western Slopes and the Darling Downs.

General distribution: from Bathurst to Stanthorpe.

Distribution within conservation areas: found throughout both conservation areas in large numbers, particularly in areas of some disturbance such as the margins of tracks.

Habitat

Habitat: found along side creeks and rivers and rocky slopes.

Altitude: 500-1000 m.

Annual Rainfall: 600-900 mm.

Abundance: infrequent but locally common, likely to be missed as the species is both inconspicuous and annual at least in terms of above ground biomass.

Substrate: granite and rhyolite.

Exposure: fully exposed to partially shaded sites.

Management

Population size: unknown, but likely to be several thousand.

Reserved: Kings Plains NP, Warrabah NP, Ironbark NR, Torrington SRA, Warrumbungle NP and the *Bornhardtia* VCA.

Threats: unknown but likely frequent grazing by cattle and goats will reduce numbers. Invasive grassy species are also a threat. Frequent fires may also be detrimental.

Management considerations: targeted searches in appropriate seasons are needed to establish where this species occurs and what the potential size of the populations are. Basic biological knowledge is also needed before management guidelines can be written for this species.

Plate 32: Scan and Photograph of *Derwentia arenaria* from the *Bornhardtia* VCA.

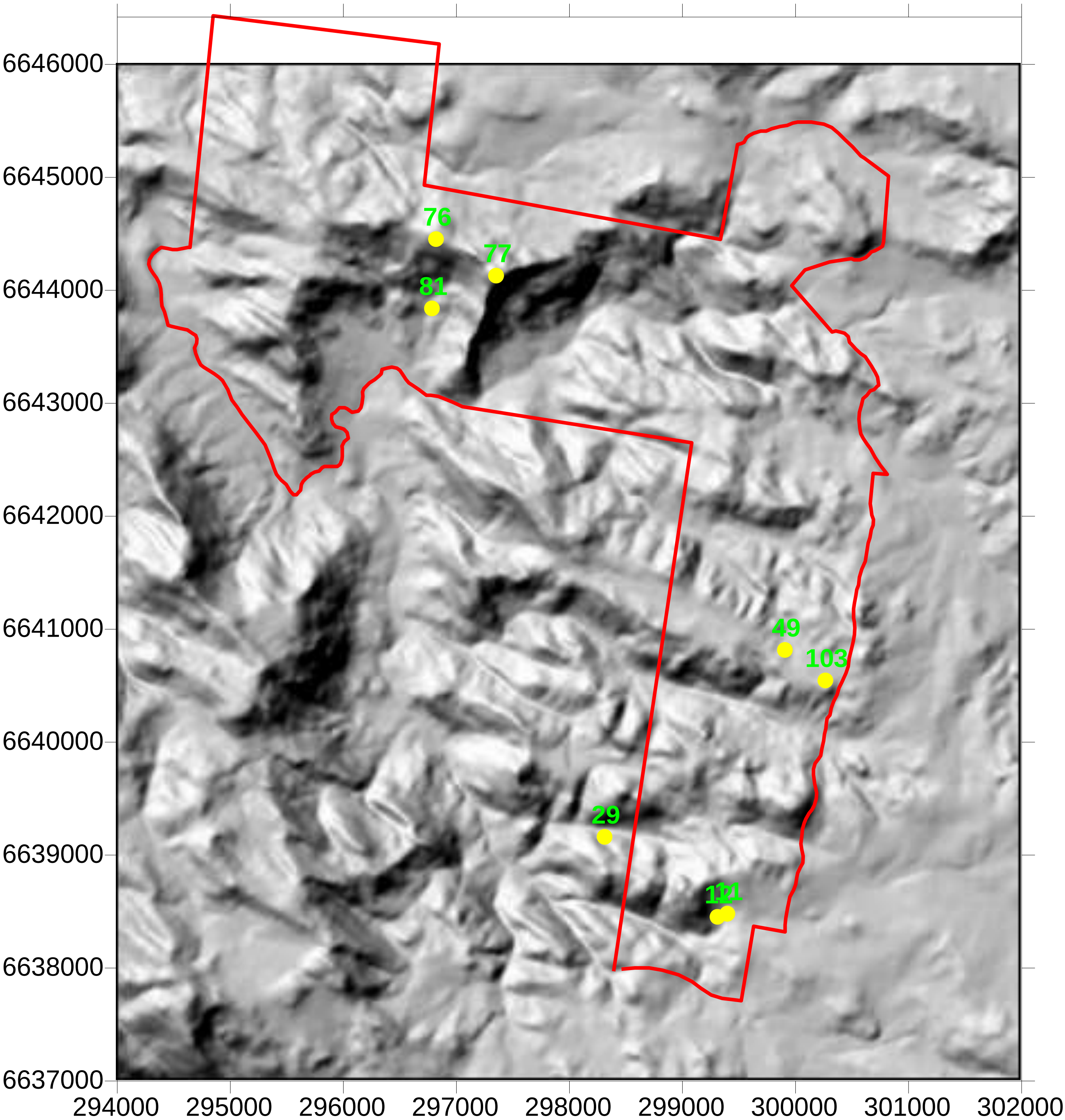


Figure 45: Locations of sites with *Derwentia arenaria*.

3.9.3 *Eucalyptus quinniorum* J.T.Hunter & J.J.Bruhl (2RCa)

Taxonomy

Type: Northern Tablelands: 'Bornhardtia' property east of Barraba, below Bald Rock, 30°21' 150°54', *J.T.Hunter & V.H.Hunter*, 5 July 1998 (holo: NSW; iso: BRI, CANB, CHSB, MEL, NE, PERTH).

Reference: *Telopea* 8: 257 (1992).

Family: Myrtaceae.

Affinities: *E. oresbia*, *E. volcanica*.

Synonymy: *Eucalyptus cypellocarpa* in part.

Derivation of name: named after Francis and Chris Quinn.

Common name: none.

Published conservation status: 2RCa (Hunter & Bruhl 1999).

Life history

Growth form: mallee or tree to 20 m tall.

Vegetative spread: none.

Longevity: likely to be > 100 yrs.

Primary juvenile period: unknown.

Flowers: Spring to Summer.

Fruit/seed: continuous.

Dispersal, establishment & growth: via seed.

Fire response: resprouter.

Interactions with other organisms: unknown.

Distribution

Botanical sub-regions: Northern Tablelands, North Western Slopes.

General distribution: from Ironbark to Moonbi.

Distribution within conservation areas: found throughout both conservation areas in large numbers, particularly in protected sites and in gullies.

Habitat

Habitat: found along side creeks and rivers and rocky slopes.

Altitude: 600-1100 m.

Annual Rainfall: 600-800 mm.

Abundance: infrequent but locally common.

Substrate: granite.

Exposure: fully exposed to partially shaded sites.

Management

Population size: unknown, but likely to be several thousand.

Reserved: Warrabah NP, Ironbark NR, Watson's Creek NR, Stony Batter NR and the *Bornhardtia* VCA.

Threats: unknown, but possibly inappropriate fire regimes.

Management considerations: no immediate management needed.

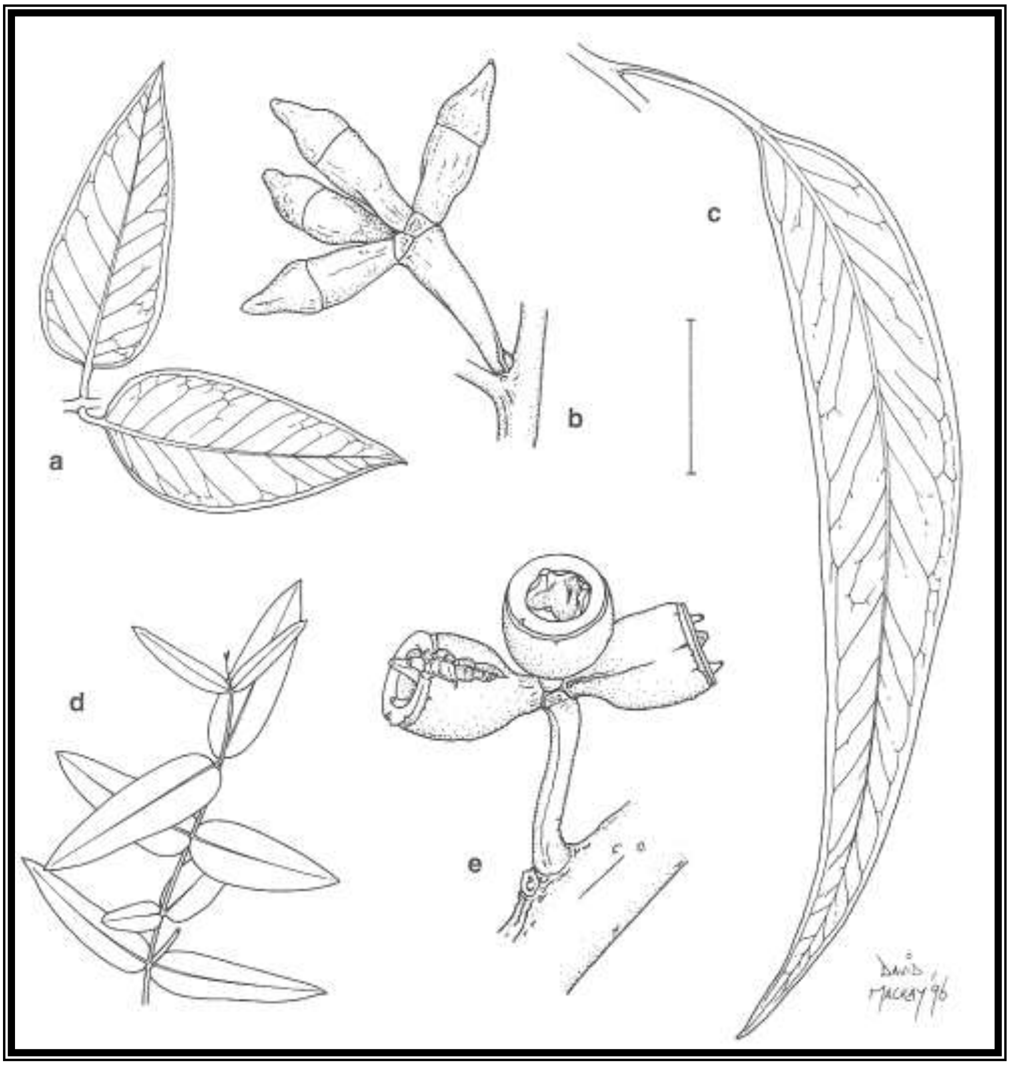


Plate 33: Illustration of *Eucalyptus quinniorum* from type specimen taken from *Bornhardtia*.

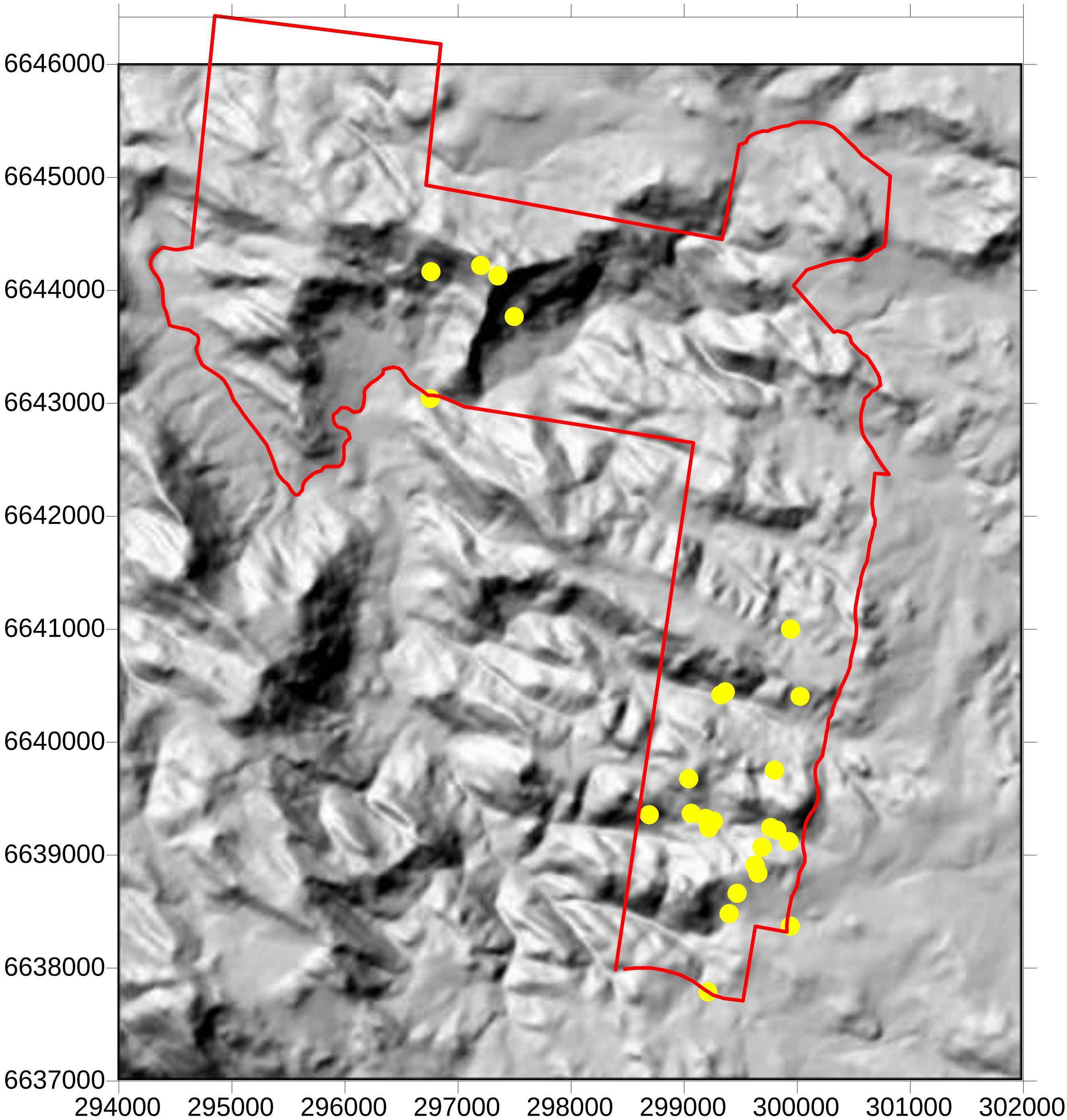


Figure 45: Locations of sites with *Eucalyptus quinniorum*.

3.9.4 *Goodenia macbarroni* Carolin (TSC Act Schedule 2 Vulnerable; ROTAP 3VC-)

Taxonomy

Type: Holbrook, N.S.W., 10 Feb. 1947, *E.J. McBarron 647* (holo: NSW).

Reference: *Telopea* 3: 533 (1990).

Family: Goodeniaceae.

Affinities: similar to *G. gracilis* and *G. paniculata*.

Synonymy: none.

Derivation of name: named after the collector of the type material.

Common name: McBarrons' Goodenia

Published conservation status: the species is not considered vulnerable in Queensland.

Life history

Growth form: rosette herb.

Vegetative spread: none.

Longevity: unknown, but probably only a few years.

Flowers: chiefly October to March

Fruit/seed: November to April.

Dispersal, establishment & growth: via seed.

Fire response: resprouts and germinates readily after fires.

Interactions with other organisms: pollinated by butterflies.

Distribution

Botanical sub-regions: Northern Tablelands, Central Tablelands, North Western Slopes, North Western Plains, Central Western Slopes and the South Western Slopes of New South Wales.

General distribution: from the Darling Downs in Queensland down the Great Dividing Range on the western slopes to north-eastern Victoria.

Distribution within the conservation areas: reasonably widespread but sporadic throughout both conservation areas.

Habitat

Habitat: diverse, including shrublands, herbfields, and open forests and woodlands.

Abundance: scattered, but occasionally abundant locally.

Substrate: red sandy earths and including acid volcanics, granite and basalt.

Exposure: semi-shade or full sun.

Management

Population size: fairly common throughout both reserves, probably many thousands of individuals.

Reserved: Warrabah NP, Warrumbungle NP, Ironbark NR, Severn River NR, Torrington SRA and the *Bornhardtia* VCA.

Threats: grazing, trampling, exotic invasive grasses, pig rutting.

Management considerations: it is likely that it will only appear under favourable conditions. Maintaining the removal cattle from the conservation areas is of primary importance along with monitoring of invasive grass species and control of pigs.

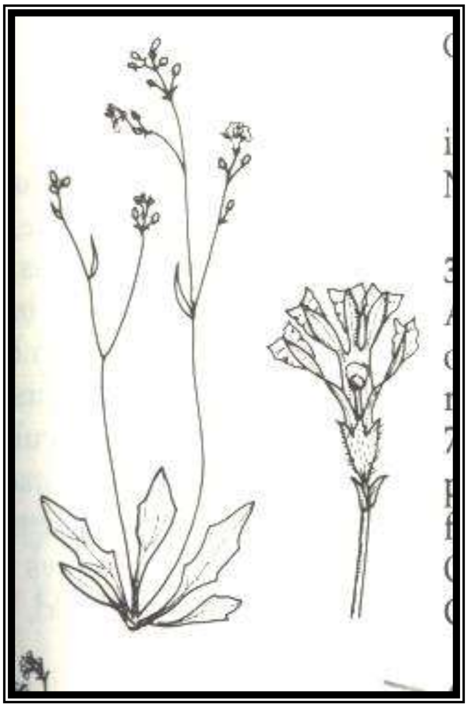


Plate 34: Image of *Goodenia macbarroni* taken from Flora of NSW Vol. 2 Edition 1.

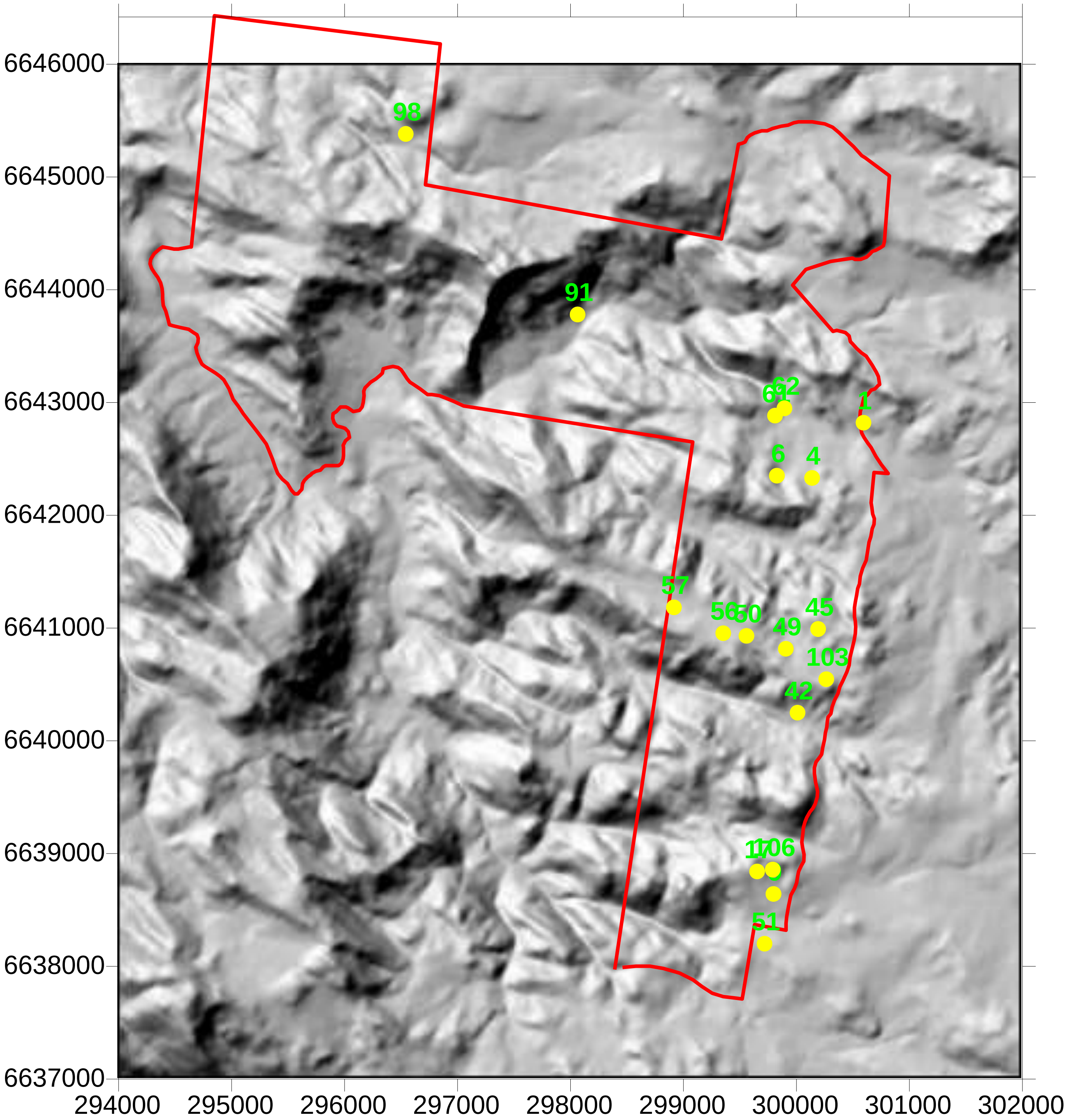


Figure 47: Locations of sites with *Goodenia macbarroni*.

3.9.5 *Homoranthus bornhardtiensis* J.T.Hunter (*TSC* Act Endangered: 2EC-)

Taxonomy

Type: New South Wales, Northern Tablelands, Bald Rock, 'Bornhardtia', adjacent Ironbark Nature Reserve (30°21'58" 150°54'27"), *J.T.Hunter & V.H.Hunter,* 9 Nov 1997 (NSW). Isotypes: BRI, CANB, NE.

Reference: *Telopea*.

Family: Myrtaceae.

Affinities: close to *Homoranthus prolixus* but characterized by ruminate hypanthium as apposed to hairy.

Synonymy: NA.

Derivation of name: in reference type locality from Bornhardtia.

Common name: none.

Published conservation status: Hunter (1998) and Endangered *TSC* Act.

Life history

Growth form: low decumbent shrub to 30 cm tall and 1-2 m diameter.

Vegetative spread: none.

Longevity: unknown but apparently long-lived.

Primary juvenile period: unknown.

Flowers: Spring to Summer.

Fruit/seed: Autumn.

Dispersal, establishment & growth: locally only via hypanthium.

Fire response: probably obligate seeder.

Interactions with other organisms: none apparent.

Distribution

Botanical sub-regions: Northern Tablelands and North Western Slopes.

General distribution: entirely restricted restricted to the local area.

Habitat

Habitat: restricted to shallow soils and crevices associated with granitic rock outcrops.

Altitude: 600-1100 m.

Annual Rainfall: 600-800 mm.

Abundance: common and abundant on many outcrops and flatrocks.

Substrate: found on granite only.

Exposure: fully exposed to partially protected sites.

Management

Population size: estimated to be 20 000 individuals.

Reserved: Ironbark NR and the *Bornhardtia* VCA only.

Threats: inappropriate fire regimes, trampling, goat browsing and pig rutting.

Plate 35: Scan and photograph of *Homoranthus bornhardtiensis*.

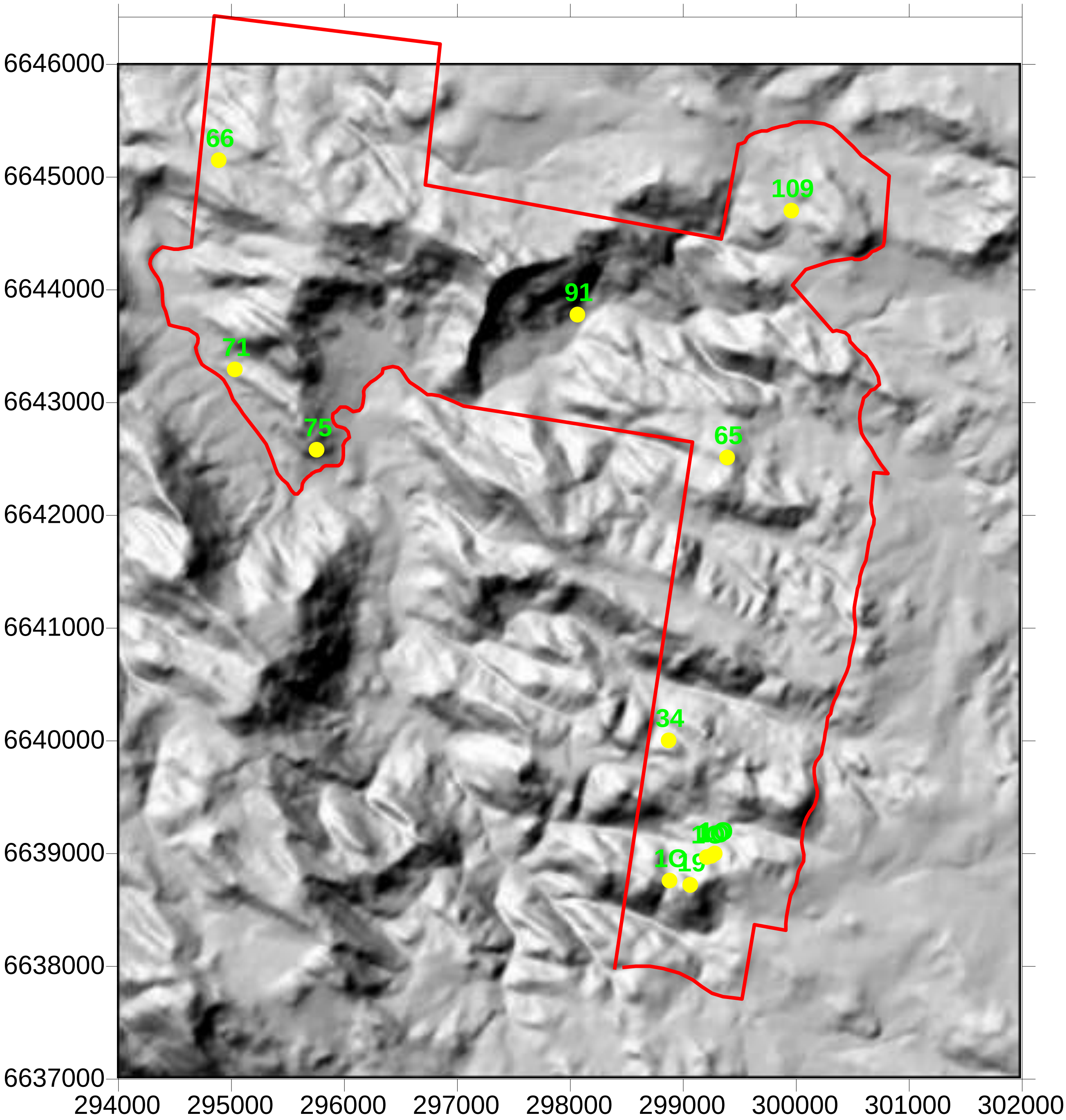


Figure 48: Locations of sites with *Homoranthus bornhardtiensis*.

3.9.6 *Pultenaea campbellii* Maiden & Betche (3K, RoTAP)

Taxonomy

Type: Grave-yard Creek, near Walcha, *J.F.Campbell*, October 1898 (holo: NSW)

Reference: *Proceedings of the Linnean Society of New South Wales* 24: 144 (1899).

Family: Fabaceae.

Affinities: currently included under *Pultenaea setulosa* within the second edition of Volume 2, Flora of New South Wales along with *P. boormanii, P. lapidosa, P* sp. F and *P.* sp. I. Though taxonomic revision is still occurring and the status of this taxon is yet to be confirmed.

Synonymy: *Pultenaea setulosa*.

Derivation of name: named after the collector of the type material.

Common name: Egg & Bacon Pea.

Published conservation status: 3K (Briggs & Leigh 1996), Vulnerable *TSC* Act, but removed subsequently.

Life history

Growth form: shrub to 0.6 m tall.

Vegetative spread: none.

Longevity: unknown but likely at least up to 30 yrs.

Flowers: Spring to Summer.

Fruit/seed: Summer to Autumn.

Dispersal, establishment & growth: via seed.

Fire response: resprouter, but will germinate from seed also.

Interactions with other organisms: none apparent.

Distribution

Botanical sub-regions: Northern Tablelands, North Western Slopes and North Coast.

General distribution: from Glen Innes south to Nundle.

Distribution within the conservation areas: restricted to protected localities in the southern section of *Bornhardtia*.

Habitat

Habitat: in a variety of sclerophyll communities, but restricted to creek banks and gullies within the local area.

Abundance: common throughout the areas that it occurs, usually sporadically distributed but locally very common. *Pultenaea campbellii* is currently listed as a poorly known species by Briggs & Leigh (1996). This species was additionally listed as a vulnerable species on Schedule 2 of the *TSC* Act. However, since that time a number over 30 new localities have been discovered including over 40000 individuals locally within Oxley Wild Rivers National Park. The current estimated population is over 2 million individuals.

Substrate: a variety of substrates from metasediments, granites, acid volcanics and other soil types.

Exposure: usually in partial shade.

Management

Population size: locally rare with potentially only a few hundred individuals.

Reserved: Ironbark NR, Watson's Creek NR, Mann River NR, Single NP, Tomalla NR, Tuggolo Creek NR, Oxley Wild Rivers NP, Boorolong NR, , Stony Batter NR, The Basin NR, *Bornhardtia*, *Paradise* and *Hardacres* VCA.

Threats: inappropriate fire regimes, goat browsing.

Management considerations: none immediate actions necessary.

Plate 36: Scan of *Pultenaea campbellii*.

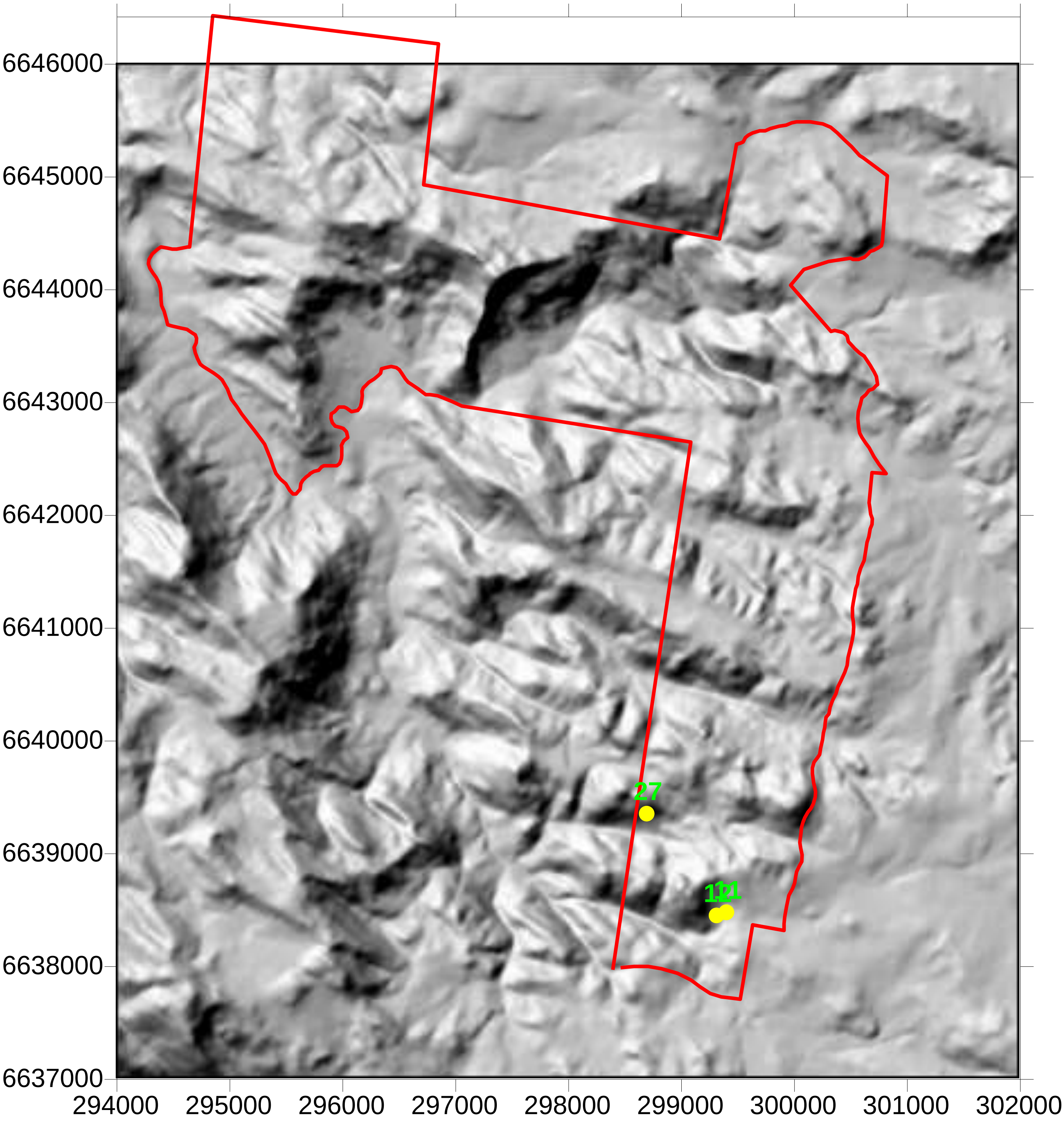


Figure 49: Locations of sites with *Pultenaea campbellii*.

3.9.7 *Thelionema grande* (C.T.White) R.Henderson (3RCa).

Taxonomy

Type: Mt Norman, Queensland, Nov. 1944, *M.S. Clemens* (holo: BRI).

Reference: *Austrobaileya* 2: 110 (1985).

Family: Phormiaceae.

Affinities: *Thelionema caespitosa*.

Synonymy: *Stypandra grandis*.

Derivation of name: in reference to the large size, grand.

Common name: Granite Lily.

Changes in conservation status: 3RC- (Briggs & Leigh 1996). Downgraded to 3RCa by Copeland and Hunter (1999).

Life history

Growth form: herb to 1.3 cm tall.

Vegetative spread: yes.

Longevity: unknown.

Primary juvenile period: unknown.

Flowers: spring to summer.

Fruit/seed: summer.

Dispersal, establishment & growth: via seed and rhizomes.

Fire response: resprouter.

Interactions with other organisms: known to hybridise with *T. caespitosa*.

Distribution

Botanical sub-regions: Darling Downs, Northern Tablelands and North Western Slopes.

General distribution: from *Bornhardtia* to just over the Queensland border.

Habitat

Habitat: two distinct habitats, within sedgeland near creek channels or where soils are waterlogged and on exposed granite outcrops.

Altitude: 600-1300 m.

Annual Rainfall: 600-1400 mm.

Abundance: scattered throughout the western side of the tablelands but often abundant where found.

Substrate: granite and rhyolitic outcrops and quaternary alluvium in waterlogged areas.

Exposure: fully exposed positions.

Management

Population size: probably a few thousand individuals.

Reserved: Girraween NP, Mt Barney NP, Bald Rock NP, Boonoo Boonoo NP, Gibraltar Range NP, Ironbark NR, Werrikimbe NP, Torrington SRA, Bolivia Hill NR, Basket Swamp NP, Warra NP and the *Bornhardtia* VCA.

Threats: unknown, possibly pig damage.

Plate 37: Photographs of *Thelionema grande* from its southern most known location (within the *Bornhardtia* VCA).

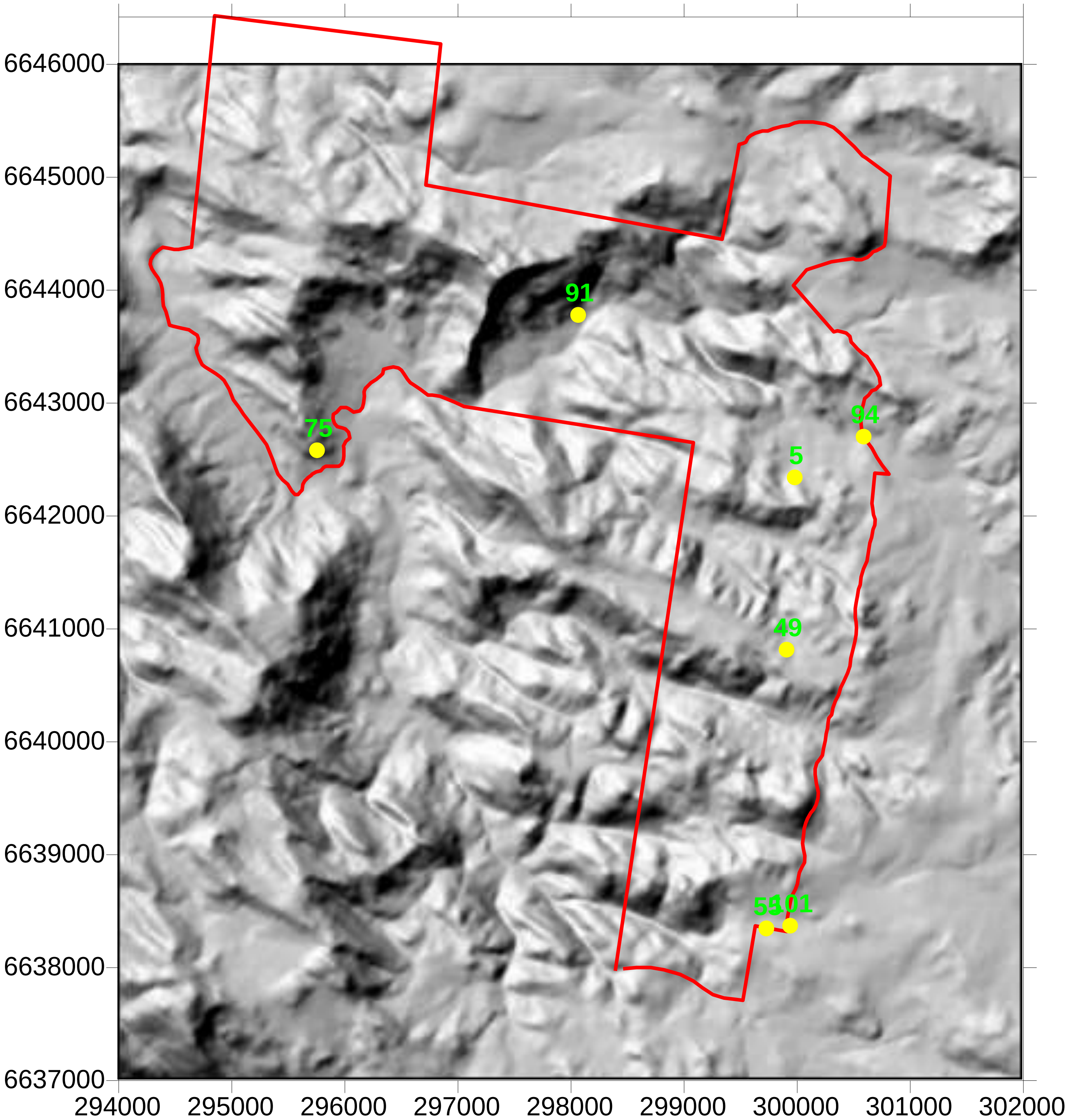


Figure 50: Locations of sites with *Thelionema grande*. Note Site 55 is the southern most known locality for this species.

3.9.8 *Zieria odorifera* J.A.Armstrong (3RCi)

Taxonomy

Type: *M.D.Crisp 3609*, 8.xi.1977. NSW: North West Slopes. Warrumbungle Range, Burrumbuckle Rock 31°20'S, 149°04'E, 1050 m alt. Mountain, summit rock ridge, gentle western slopes. Trachyte crevices. Rare under tall, dense shrubland with *Cassinia* and *Eucalyptus dwyeri*. Spreading shrub, 20cm. (holo: CBG 7707801; iso: NSW).

Reference: *Australian Systematic Botany* 15: 412.

Family: Rutaceae.

Affinities: *Zieria aspalathoides*.

Synonymy: none.

Derivation of name: in reference to the strong smell of the leaves when crushed.

Common name: none apparent.

Published conservation status: 3RCi (Briggs & Leigh 1996), unchanged since.

Life history

Growth form: low shrub to 1 m tall.

Vegetative spread: none.

Longevity: unknown.

Primary juvenile period: unknown but probably within 3 yrs.

Flowers: Spring to Summer.

Fruit/seed: Summer to Autumn.

Dispersal, establishment & growth: via seed.

Fire response: regeneration from subsurface epicormic outgrowths has been reported.

Interactions with other organisms: none apparent.

Distribution

Botanical sub-regions: North Western Slopes and Northern Tablelands.

General distribution: from Warrumbungles to Howell and north to the Severn River.

Distribution within the conservation areas: found on the southern slope of Townsend's Mountain within the Nature Reserve.

Habitat

Habitat: shallow soils associated with rock outcrops, scree slopes and their margins.

Altitude: 600-1100 m.

Annual Rainfall: 600-900 mm.

Abundance: disjunct and in low numbers.

Substrate: rhyolite and granite.

Exposure: fully exposed to partial shade.

Management

Population size: unknown probably less than 100 individuals.

Reserved: Warrumbungle NP, Kings Plains NP, The Basin NR, Mt Kaputar NP, Ironbark NR and the *Bornhardtia* VCA.

Threats: known to be browsed by goats. Inappropriate fire regimes.

Management considerations: a targeted search for this species is warranted. Basic information on the basic biology of this species including responses to fire are required.

Plate 38: Scan of *Zieria odorifera*.

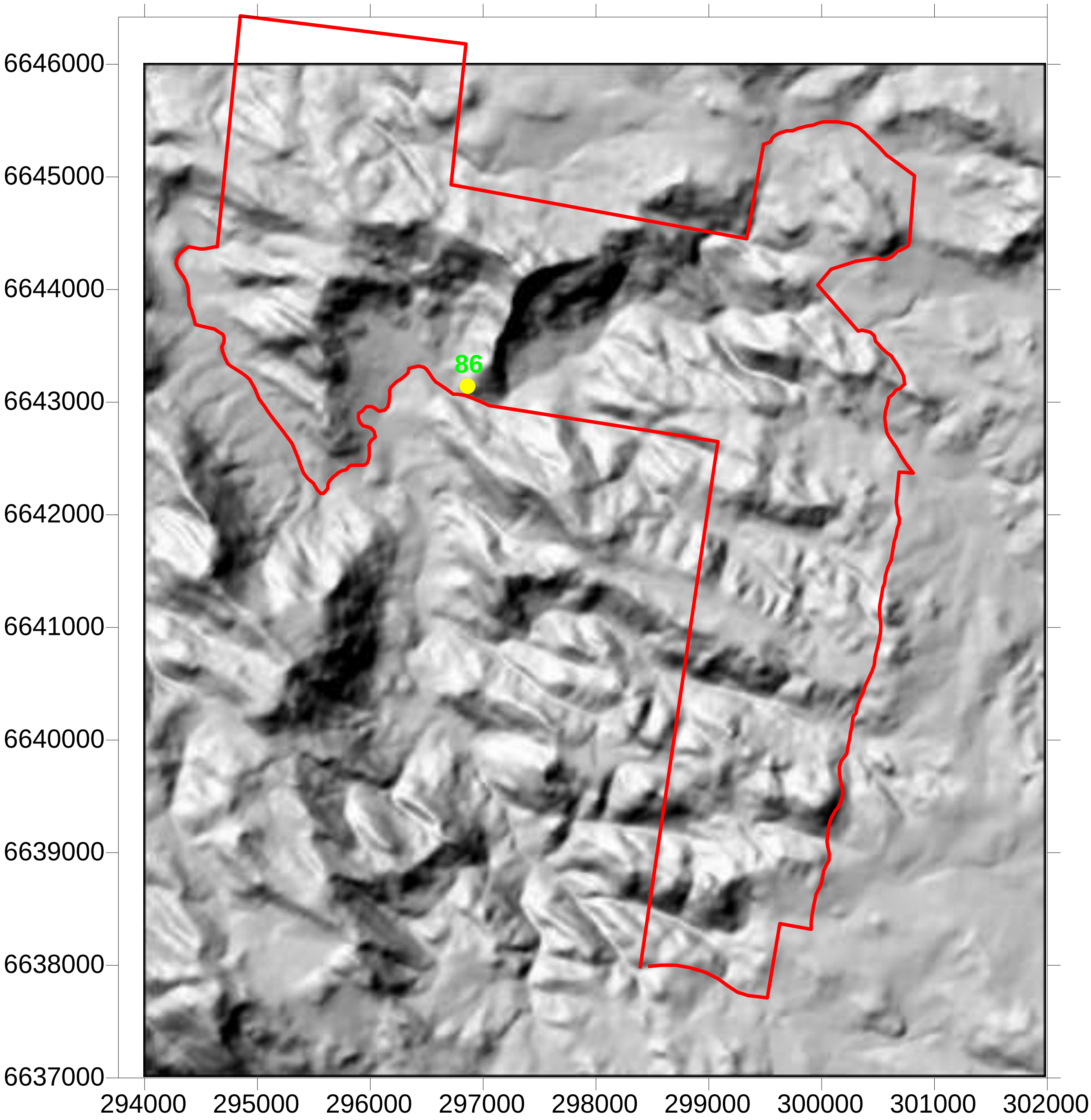


Figure 50: Location of site with *Zieria odorifera*.

3.9.9 Regionally significant species

Acacia cheelii is a tall wattle to 7 m. This species is known to occur from the Glen Davis area north to Torrington. It is very common in parts of the slopes and in some parts of the Northern Tablelands such as Mt Kaputar. The species eastern distributional limit is in the western parts of Torrington SRA and the gorge areas of Warrabah NP. The occurrences on Bald Rock within *Bornhardtia* are at the eastern and altitude range limits occurrence for this taxon.

Plate 39: Scan of *Acacia cheelii*.

Acacia montana is a small shrub from 1-4 m tall that occurs from west of Armidale to Glen Alice, but also occurs within Queensland and Victoria. This species is very uncommon in the northeast. Thus, this species should be considered regionally uncommon.

Alectryon subdentatus forma *subdentatus* is a small tree to 7 m tall that is known from dry rainforest and vine thicket areas on the eastern and western escarpments of the tablelands. Only one locality of this species was found along the far western boundary of the reserve along a creek. This species has a disjunct and sporadic distribution and is more common further west. The occurrence here should be considered of significance due to the its locally restricted distribution.

Baloskion stenocoleum is a tufted herb to 1.5 m tall. The species is restricted to swamps in acid soils on the Northern Tablelands and the Darling Downs of Queensland. It is very common in high altitude swamps on the main part of the range. However, the occurrence here may be a western limit of distribution for this species.

Plate 40: Scan of *Baloskion stenocoleum.*

Cassine australis var. *angustifolia* is a small tree to 8 m tall that grows in dry rainforest areas particularly in drier inland areas. This taxon has not been recorded for the Northern Tablelands previously. It was found in protected gullies within the western portion of the Nature Reserve. It is very rare locally and is a significant taxon.

Centrolepis strigosa subsp. *strigosa* is a widespread herb to 11 cm tall found in most botanical divisions within the state and most states and territories. Occurrences are sporadic and usually infrequent.

Cymbidium canaliculatum is an epiphytic orchid growing in the hollows of trees that is more common in inland areas. The species is very rare on the Tablelands and near its eastern distributional limit.

Cyperus secubans is a small herb to 25 cm tall with sticky leaves. The species was thought to be restricted volcanic rock shelves in Mt Kaputar. The occurrences within the conservation areas are significant as they are a new eastern occurrence on a different rock type. The species was fairly common on rock outcrop sites within both areas.

Plate 41: Scan of *Cyperus secubans*.

Cyphanthera albicans subsp. *albicans* is a disjunctly distributed solanaceous shrub that has only been found a handful of times within the northeast of New South Wales. It has been found in Boonoo Boonoo NP, Torrington SRA and Warra NP. The taxon was found in low numbers in a few localities within *Bornhardtia*. Some of the populations have been severely affected by goat browsing, with one population extinct on Bald Rock due to goats.

Plate 42: Scan of *Cyphanthera albicans*.

Geranium solanderi subsp. *grande* is a perennial herb to 0.5 m tall which is restricted to the Northern Tablelands of New South Wales. It occurs at higher altitudes from Glen Innes to Ebor and west to the higher altitudes of Mt Kaputar. Occurrences are very infrequent on the western parts of the tablelands and thus the occurrence here is of significance.

Haloragis serra has only previously been recorded for the Northern Tablelands at Mt Kaputar and has until now never been recorded for the New England Tablelands Bioregion. It occurs in grassy woodlands more commonly on the slopes. The species was found in the north western section of the Nature Reserve. Local populations are

likely to be under threat by pig rutting.

Plate 43: Scan of *Haloragis serra*.

Hibbertia sp. is an yet to be described species that is possibly restricted to rocky areas between Attunga to Howell. It is likely to be a rare species. It is under threat locally by goat browsing. The taxon was only found in a few localities within *Bornhardtia* on rock outcrops.

Plate 44: Scan of *Hibbertia* sp.

Jasminum sauvissimum is a climbing and scrambling species that is found throughout the north of the state and into Queensland. It has been found within the Northern Tablelands before, but is considered uncommon in this botanical region.

Lilaeopsis polyantha is a small herb to 30 cm long that occurs on the margins of lakes and streams. It is found on the tablelands and coast from Queensland to Tasmania and South Australia. It is more common on the eastern parts of the tablelands and is rare on the western side of the Northern Tablelands and absent from the North Western Slopes. The occurrence within *Bornhardtia* is considered to be at the western limit of the species distribution of a locally rare species.

Lomandra sp. aff. cylindrica is a potential new species which is know to occur from this area north to Boonoo Boonoo NP. The species is suggested to be 3RCa by Clarke *et al.* 2000). However, this species is probably more frequent than collections indicate.

Lyperanthus suaveolens is a widespread orchid that is very uncommon on the Northern Tablelands. Only one individual was found at one site within *Bornhardtia*. The species has been previously recorded at Watson’s Creek Nature Reserve on the Tablelands.

Mirbelia speciosa subsp. *speciosa* is a shrub to 1 m tall found north of Illawarra. It is common on the Tablelands and Slopes, but primarily between Gibraltar Range to Torrington. The species is uncommon in the southern parts of the North Western Slopes and south western parts of the Northern Tablelands. The species is considered to be locally rare and was only found at one locality within Ironbark Nature Reserve.

Olearia erubescens is a species more common south of the Blue Mountains. It has also been recorded from Drake, near Point Lookout and Nundle on the Northern Tablelands. This species was common in very protected localities in gullies throughout Ironbark and *Bornhardtia*. The occurrences here are of a species that is disjunct in the north east, regionally rare and potentially at its western limit in the north of the state.

Plate 45: Scan of *Olearia erubescens*.

Ophioglossum latiusculum is a widespread species found in most botanical districts in the state and in most states and territories. It however is rarely found within the north east and is regionally infrequent. This species was found on a rock outcrop within *Bornhardtia*.

Plate 46: Scan of *Ophioglossum latiusculum*.

Parsonsia eucalyptophylla has not been formally described as occurring on the Northern Tablelands. However, it has recently been found within The Basin Nature Reserve. The occurrences within Ironbark are the second population found on the Northern Tablelands and are of significance.

Pelargonium inodorum is a herb which is regionally uncommon in north east. It appears to be widespread and common in other parts of the state. It has been recorded from Single and Mt Kaputar National Parks within the broader region.

Plate 47: Photograph of *Pelargonium inodorum*.

Pittosporum undulatum is a reasonably common species throughout the tablelands, coast and slopes of New South Wales. Its western limit in the north is in the lower valleys of the Nandewar Range of which Ironbark is part. It is locally infrequent found only in steep protected gullies associated with Townsend's Mountain which may have been frequently burnt in the past.

Portulaca bicolor is a small decumbent annual herb that was previously only known from the North Western Slopes of New South Wales. The species was only found on one occasion.

Psydrax odoratum is a small tree to 8 m tall that is widespread in dry rainforests in coastal areas and in rocky sites in the west. It has not been recorded for the Northern Tablelands. The occurrence within the reserve is a new extension into the Northern

Tablelands and these occurrences are of significance. The species is scattered in low numbers in the western portion of the Nature Reserve.

Psilotum nudum is a widespread terrestrial fern in central and northern coastal areas of New South Wales, . It is rarely found away from coast areas. The species was found within *Bornhardtia* during the survey and is of significance due to its sparse occurrence in the region.

Plate 48: Scan of *Psilotum nudum*.

Pultenaea sp. G is an unnamed species limited to the area between the Liverpool Range and the Nandewar Range. The species is particularly abundant within Ironbark and *Bornhardtia* but is infrequent elsewhere on the Northern Tablelands apart from Mount Kaputar NP. Locally common but regionally rare.

Plate 49: Scan of *Pultenaea* sp. G.

Sida cunninghamii is prostrate species not formally described for the Northern Tablelands. However, the species has been found recently in Bluff River NR (Hunter 2002). The species is common on the slopes and other areas of western New South Wales. As this is one of only two described localities on the Northern Tablelands this species is of significance

Viola caleyana is a herb found in wet situations in woodlands and swamps on the coast and tablelands areas of New South Wales and also in Tasmania. This taxon is more common towards the east and is very uncommon on the western side of the tablelands. The occurrence within *Bornhardtia* as at the western limit of the species distribution.

Species other than those cited above could also be informally considered as locally rare. At least 56 species were only found opportunistically and not within any of the 140 surveyed sites. An additional 55 species only scored a 1 when all cover scores were summed, thus these species were not only sampled in only one site, but were uncommon and covered less than 5% of the area of that single site.

3.10 Introduced species

A total of 41 taxa were found to be exotic in origin within the conservation areas, this accounting for 8.9% of all taxa found. The most troublesome of which is likely to be Blackberry at present. Most other species are ubiquitous across the tablelands even in undisturbed habitats.

Table 9: List of the most important weed species in terms of cover over the 110 sampled sites.

Taxa	Summed Cover
1: Hypochaeris radicta	105
2: Conyza albida	62
3: Trifolium repens	14
4: Rubus chloocladus	12
5: Opuntia stricta	11
6: Centaurium erythraea	9
7: Cirsium vulgare	8
8: Lotus uliginosus	7
9: Hypochaeris glabra	6
10: Cyperus aggregatus	6
11: Conyza bonariensis	6
12: Acetosella vulgaris	6
13: Paronychia brasiliana	4
14: Bidens pilosa	4
15: Verbena bonariensis	3
16: Stellaria media	3
17: Sonchus oleraceus	3
18: Secale cereale	3
19: Lactuca serriola	3
20: Axonopus affinis	3
21: Anagallis arvensis	3
22: Aira cupaniana	3
23: Vicia villosa	2
24: Tradescantia fluminensis	2
25: Solanum nigrum	2
26: Petrorhagia nanteuilii	2
27: Modiola caroliniana	2
28: Cerastium glomeratum	2

Taxa	Summed Cover
29: Verbena rigida	1
30: Verbascum thapsus	1
31: Taraxacum officionale	1
32: Plantago lanceolata	1
33: Paspalum dilatatum	1
34: Ciclospermum leptophyllum	1
35: Bromus diandrus	1
36: Arenaria leptoclados	1
37: Briza minor	Not in Sites
38: Cerastium vulgare	Not in Sites
39: Juncus bufonius	Not in Sites
40: Opuntia aurantiaca	Not in Sites
41: Sigesbeckia orientalis	Not in Sites

3.11 Fire responses of individual taxa

The following represents a review of the current knowledge of the fire responses of selected taxa found within the conservation areas.

Table 10: Known fire responses and traits of taxa found in Ironbark NR and the *Bornhardtia* VCA. NPFR refers to National Fire Register. Fire responses are based on published information, some of which is contradictory. Possible reasons for these contradictions are in the discussion.

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Acacia buxifolia		Diaspore: hard-coated seed.						Regrowth and suckers from rootstocks and lateral roots, seedlings recorded less than 1 yr after fire.	Purdie (1977), Benson & McDougall (1996).
Acacia falciformis	Obligate Seeder	Soil stored seedbank, after medium intensity fire much germination						pers. obs. Perennial. Facultative resprouter.	NPFR
Acacia implexa	Resprouter	Reproduction by sexual means, reproducing by seed propagation between 1-5 years.	Seed	Dispersed by expulsion			5-30	Stems killed, resprout from base or root suckers. Prominent in soil seedbank in gaps. Present throughout gaps in unburnt Rf communities. Root bud suckers. 20-60% stems killed low intesity fire all killed by high. No protected vegetative buds.	Benson & McDougall (1996), Melick & Ashton (1991), Clarke (1989), Morrison & Renwick (2000).
Acacia maidenii	Obligate Seeder	Best germination after 45 days 3-6cm depth. Viable seed at 9-12cm.						Killed. Site unburnt 30yrs had slightly more viable seed than that burnt 14yrs ago. 100% scorch kills.	Benson & McDougall (1996), Floyd (1976), Fox (1988), NPFR.
Acacia obtusifolia	Obligate Seeder	May germinate after fire						Resprouts from base and root suckers. Seedlings may establish on disturbed sites.	NPFR, Benson & McDougall (1996).
Acacia rubida	Resprouter							From root suckers	Benson & McDougall (1996).
Acacia ulicifolia	Variable	No germination at 60 degrees.			<3 yr			Variable. Killed by fire. Resprouts and root suckers in some populations. Most	Fox (1988), Benson & McDougall (1996).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
		Optimum 70 deg. C. Variable with population.						seedlings flowering within 2.5 years of high intensity fire.	
Acaena novae-zelandiae			Fruit	Dispersed by attachment to animal fur, clothing etc				First recorded 3m after fire in wet forest, 4m after fire in grassy forest. Regeneration greater 16-24m than 0-16m after fire.	Dickinson & Kirkpatrick (1987), Benson & McDougall (2000).
Acianthus exsertus	Obligate Resprouter								NPFR
Actinotus helianthi	Obligate Seeder	Fire promotes germination of seed		Seeds dispersed by wind.	2-4		1-5	Killed and re-established from soil-stored seed. Old plants of 'headland' form with thick stems (1cm) may be unaffected.	Bradstock et al. (1997), Benson (1985), Conroy (1996), Fox & Fox (1986), Clemens & Franklin (1980), Siddiqi et al. (1976), NPFR, Benson & McDougall (1993), Clarke (1989).
Adiantum aethiopicum	Resprouter			Diaspore: spores dispersed by wind. Probably no dormancy mechanism.				Fire sensitive in open situations but tolerant if rhizomes amongst rocks. Resprouts at ground level.	NPFR, Benson & McDougall (1993).
Adiantum hispidulum	Resprouter							Flush of growth from rhizome after fire	Benson & McDougall (1993), NPFR.
Aira cupaniana	Obligate Seeder	1yr after fire			<1			Seedlings in burnt and unburnt sites 1yr after fire - not noted before fire.	Lunt (1990), Purdie (1977), NPFR.
Ajuga australis				Erect flowering stems become horizontal at maturity, allowing short distance gravity dispersal of se				Grows rapidly after fire.	Benson & McDougall (1997), Lazarides & Hince (1993).
Alternanthera denticulata	Obligate Seeder							Probably killed	NPFR, Benson & McDougall (1993).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Amyema miquelii		Germination occurs only if fruit coat is removed, the embryo is green, & can begin to grow in dark.		Diaspore: fleshy fruit, bird-dispersed mainly by Mistletoe bird, transportation only about 45km.				Killed by high intensity fire.	Reid (1997), Benson & McDougall (1997).
Amyema pendulum	Obligate Seeder			Food plant (crimson rosella, brushtail & ringtail possums, koala, blue butterfly), Host plant (beetl				Killed by canopy scorch/ high intensity fire.	Reid (1997), NPFR, Mallick et al (1997).
Anagallis arvensis								Probably killed.	Benson & McDougall (1999).
Angophora floribunda	Resprouter	No dormancy mechanism, germinates without special treatment. Growth rate slow. Coloniser, open sites		Diaspore: seed. No special morphology. Probably wind-dispersed locally ie 20m.			100+	Resprouts from epicormic shoots.	Benson & McDougall (1998), Clarke (1989).
Aristida jerichoensis								Suggestion that prescribed burning may encourage less desirable and more fire tolerant grasses like A. jerichoensis	Gill (1981).
Aristida ramosa	Resprouter							Facultative root resprouter - fire resistant decreaser.	Purdie & Slatyer (1976).
Arthropodium milleflorum								First recorded 1m after fire in grassy & wet forests. Cover value similar in areas burnt by high & low intensity fires.	Dickson & Kirkpatrick (1987).
Asperula conferta	Resprouter			Fleshy fruit, no particular mechanism for					Lunt (1990), Benson & McDougall (2000).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
				dispersal. Rhizomatous vegetative spread.					
Asplenium flavellifolium				Diaspore: spores, wind-dispersed. Probably no dormancy mechanism.					
Bidens pilosa				Diaspore: fruit, animal dispersed (eg. on human clothing).	18wks		1yr	Probably killed, vigorous recruitment from seed after high-intensity fire, most likely from soil-stored seed. Mature fruit within 18wks of high intensity fire.	Benson & McDougall (1994).
Billardiera scandens	Resprouter					1.9yr		Resprouts at base or below from surviving rootstocks, seedlings recorded <!yr after fire.	Fox (1988), Purdie (1977), Benson & McDougall (1999).
Boronia anethifolia	Obligate seeder?		Seed	Seed dispersed ballistically from dehiscent 4-lobed fruit.					Benson & McDougall (2001).
Bossiaea neo-anglica	Resprouter			Diaspore: hard-coated seed. Soil stored seedbank.				pers. obs.	
Bossiaea prostrata	Resprouter							Facultative resprouter. First recorded 1m after fire in grassy forest. Regeneration greater 16-24m than 0-16m after fire.	Benson & McDougall (1996), Dickinson & Kirkpatrick (1987), NPFR.
Brachyloma daphnoides	Resprouter			Within 1 yr of fire		1 yr		From ground level or below	Fox (1988), Hunter (1991), Benson & McDougall (1995).
Brachyscome multifida					<1		1		
Bracteantha bracteata	Obligate Seeder	Disturbance related, fire or other		Diaspore: fruit, wind-dispersed.				Probably killed.	Benson & McDougall (1994).
Bursaria spinosa	Resprouter					16m		Adults resprouted from base. Susceptibility	Benson & McDougall (1999).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
								of seedlings unknown.	
Callitris endlicheri	Obligate Seeder	No soil-stored seedbank. 100% mortality when stem cut at ground level.		Diaspore: winged seed, wind-dispersed. Probably no dormancy mechanism.				100% scorch will kill. Killed by fire (100% scorch).	Benson & McDougall (1993).
Calotis cuneifolia	Obligate Seeder							Probably killed	Benson & McDougall (1994).
Calytrix tetragona	Variable	Soil-stored seedbank.		Diaspore: fruit, wind-dispersed locally, or gravity dispersed.				Resprouts. Killed after high intensity fire. Seedlings flowering 3.75 years after fire.	Benwell (1998), Myerscough et al (1995), Benson & McDougall (1998)
Carex breviculmis								First recorded 1m after fire in grassy forest. Fluctuating regeneration response.	Dickinson & Kirkpatrick (1987).
Cassinia aculeata	Obligate Seeder							Killed by high intensity fire, no seedlings 1 yr after fire	Benson & McDougall (1994).
Cassinia uncata				Diaspore: fruit, probably wind-dispersed.					
Cassytha pubescens		Reproduction sexual and vegetative, by seed propagation between 1-5yrs.		Seeds dispersed by animals.			5-30		Clarke (1989).
Centaurium erythraea				Diaspore: mobile seed, possibly animal and water dispersed.					
Centipeda minima				Diaspore: fruit. Possibly water dispersed. Coloniser.	<1		1		
Cerastium				Diaspore: seed,	<1		1	Probably killed. Seedlings observed. Fruited	Benson & McDougall (1995).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
glomeratum				mobile. Possibly animal, water and wind dispersed.				and seeds shed (with some still flowering) within 6m of high intensity fire.	
Cheilanthes distans	Resprouter							Facultative resprouter.	NPFR.
Cheilanthes sieberi	Resprouter			Diaspore: spores, wind-dispersed. Probably no dormancy mechanism.				Facultative resprouter.	NPFR, Benson & McDougall (1993).
Chloris truncata	Resprouter							Perennial.	Lunt (1990).
Chrysocephalum apiculatum	Variable	Germination promoted by light, strong after ripening requirement (dormancy).		Dormancy broken by high temperature but not cold-stratification or gibberellic acid.				Resprouter. Minor Obligate seeder regeneration. 100% scorch kills. Soil stored seed.	Lunt (1990), Lunt (1994), NPFR.
Chrysocephalum semipapposum	Resprouter							Resprouts from rootstock suckers and lateral roots, no seedlings 1 yr after fire	Purdie & Slatyer (1976), Purdie (1977), NPFR. Benson & McDougall (1994).
Cirsium vulgare	Obligate Seeder	Seedlings in burnt and unburnt sites 1yr after fire. Appears after disturbance, probably soil-stored		Seed dispersed by wind. Diaspore: fruit, wind-dispersed. Also animal and water dispersed.	1		2	Post burn seed coloniser. Obligate seed regenerator - therophyte. Possibly resprouted after high intensity fire, flower buds within 26 wks. Seedlings recorded <1yr after fire, prob. post-fire dispersa	Floyd (1966), Purdier & Slatyer (1976), Chesterfield et al. (1991), Dickinson & Kirkpatrick (1987), Bill (1981), NPFR, Purdie (1977).
Clematis glycinoides	?Obligate seeder			Diaspore: achene, wind dispersed. Coloniser, though growth rate appears slow.	?3-5y		?10-20y	Probably killed.	Benson & McDougall (2000).
Commelina	Uncertain	Reproduction both		Seeds dispersed			<5	Obligate seeder and basal resprouter.	NPFR.

cyanea		sexual and vegetative means, reproducing by seed propagation in first year.		by expulsion.				Survives 100% leaf scorch.	
Species	**Response**	**Germination**	**Diaspore**	**Disp. & Establ.**	**1Juv**	**2Juv**	**Lifespan**	**Notes**	**References**
Conyza albida	Obligate Seeder			Diaspore: fruit. Wind-dispersed locally & wide-spread, readily colonising disturbed sites.	<1		1-2	Killed. Seedlings recorded <1yr after fire, probably recruiting from wind-blown seed.	Purdie (1977), Benson & McDougall (1994).
Conyza bonariensis	Obligate seeder	Coloniser of disturbed sites.		Diaspore: fruit, wind-dispersed locally and probably long distance.	<1		1	100% scorch kills - no seed stored in burnt area. Probably killed, fruit within 15wks of high intensity fire. Possibly resprouts after low intensity fire.	Benson & McDougall (1994).
Correa reflexa	Obligate seeder		Seed	Seed dispersed ballistically from dehiscent 1-4 lobed fruits. Also myrmecochorous. No vegetative spread. Soil stored seedbank.					Benson & McDougall (2001).
Craspedia variabilis				Diaspore: fruit, probably wind-dispersed.				Maximum recruitment may take place if burning occurs very frequently, ie., every 1-2yrs.	Lunt (1994).
Crassula sieberiana	Obligate Seeder	Seedlings in burnt and unburnt areas 1yr after fire.		Diaspore: seed, mobile. Growing in winter.	< 1yr			Probably killed, seedlings recorded <1yr after fire, flowering within 7m after high intensity fire.	Purdie (1977), NPFR, Purdie (1977), Benson & McDougall (1995).
Cyperus fulvus	Resprouter							Survives 100% scorch - basal sprouts.	NPFR.
Cyperus sanguinolentus	Obligate Seeder				1			Therophyte.	Purdie & Slayter (1976), NPFR.

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Daucus glochidiatus	Obligate Seeder				<1 yr			Seedlings recorded < 1yr after fire	Benson & McDougall (1993), Purdie & Slayter (1976), Purdie (1977), NPFR.
Daviesia latifolia	Variable	Soil stored seedbank		Within 2 yrs of fire		>2 yr		(Killed by high intensity fire: pers. obs.) Resprouts from base	Floyd (1976), NPFR, Benson & McDougall (1996).
Desmodium brachypodum	Resprouter	Soil stored seedbank						pers. obs.	
Desmodium varians	Resprouter	Probably soil-stored seedbank.		Diaspore: 1-seeded segments, shed at maturity. Adhesive.		<1 yr		Flowering within 11 wks of high intensity fire. Resprouted.	Lunt (1990), NPFR, Benson & McDougall (1996).
Dianella caerulea	Resprouter								Roche et al. (1997).
Dichelachne crinita	Resprouter	Reprodcution sexual. Reproducing by seed in the first year.		Seeds dispersed by wind.			<5	Facultative resprouter. Regenerates after crown fire and partial burn by resprouting below ground.	Lunt (1990), NPFR, Clarke (1989).
Dichelachne micrantha	Resprouter							Facultative resprouter.	NPFR.
Dichondra repens	Variable	Reproduction both sexual and vegetative means. Reproducing by seed propagation in the first year.		Stolons. Diaspore: seed, no special dispersal morphology. Dispersed in mud on cars.			<5	Resprouter (7091), Obligate Seeder (NPFR). Did not flower within 9m of intense autumn fire. Probably resprouts from stolons.	Lunt (1990), NPFR, Benson & McDougall (1995), Clarke (1989).
Dillwynia sieberi	Obligate Seeder	Soil stored seedbank						Killed	Benson & McDougall (1996).
Dodonaea viscosa	Resprouter	Fire not obligatory. Recruitment promoted by fire.						Facultative resprouter. Adults moderately high mortality after fire.	Hodgkinson (1979), Hodgkinson & Griffen (1982), Hodgkinson & Oxley (1990), Gill (1981), NPFR.
Doodia aspera								24.6kg/ha dry wt. 1yr after slash burn - not	Floyd (1966).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
								recorded up to 1yr after tractor cleared.	
Drosera burmannii		Seedling recruitment not fire related.		Diaspore: seed.			3-6m	Probably killed.	Benson & McDougall (1995).
Drosera peltata	Resprouter	Germinate in 14 days without special treatment. Coloniser.		Diaspore: seed. No special dispersal morphology.		1-2yr		Resprouts, secondary juvenile period 2 years. Flowered March-April after January fire.	Benson & McDougall (1995).
Drosera spatulata	Resprouter					1 yr		Facultative resprouter. 100% scorch kills. Soil stored seed.	Benson & McDougall (1995), NPFR.
Echinopogon ovatus	Resprouter							Facultative resprouter. Survive 100% scorch. Root suckers.	NPFR.
Entolasia stricta	Resprouter			Vigorous growth after fire		< 1yr		pers.obs. Facultative resprouter. Survives 100% scorch - root suckers & basal shoots. Soil stored seed and clonal increaser.	Bradsotck et al. (1997), Lumley & Spencer (1990), Clark (1988), NPFR.
Epilobium billardierianum	Variable					<3m		Obligate seeder (NPFR-P). Resprouted after high intensity fire (P.Kubiak pers.comm)	NPFR, Benson & McDougall (1999).
Eryngium vesiculosum	Resprouter								Lunt (1990).
Eucalyptus blakelyi	Resprouter			Diaspore: seed. Dispersed locally by wind and gravity. No dormancy mechanism.			100+	Seedlings - remarkable tolerance to being burnt. Resprouts from epicormic buds.	Leigh & Holgate (1979), Gill (1997), Benson & McDougall (1998).
Eucalyptus bridgesiana	Resprouter	Seeds require light for germination, optimum temperature 25 degrees C.		Diaspore: seed, dispersed locally by wind and gravity. No dormancy mechanism.			<200	Resprouts from epicormic buds.	Benson & McDougall (1998).
Eucalyptus macrorhyncha	Resprouter	Lignotubers developed in		Diaspore: seed. Dispersed locally			100+	Regrows from surviving rootstocks, seedlings recorded <1yr after fire.	Purdie (1977), Benson & McDougall (1998).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
		seedlings 9-12 weeks old in greenhouse conditions.		by wind or gravity. No dormancy mechanism.					
Eucalyptus melliodora	Resprouter							Seedlings remarkable tolerance for being burnt.	Gill (1997), Leigh & Holgate (1979).
Euchiton involucratus	Obligate Seeder			Seedlings recorded 1 yr after fire				Obligate seeder. Therophyte. Seedlings 1yr after fire in burnt and unburnt areas.	Benson & McDougall (1994), Purdie & Slayter (1976), Purdie (1977), NPFR.
Euchiton sphaericus	Obligate Seeder			Diaspore: fruit. Coloniser.	<1		1-2	Probably killed by fire	NPFR, Benson & McDougall (1994).
Eustrephus latifolius	Resprouter							Facultative resprouter.	NPFR.
Exocarpos cupressiformis	Resprouter	Hard seed is difficult to germinate.	Fruit.	Limited root suckering. Hemi-parasite on roots of other plants, commonly eucalypts but also other species.			Indefinite.	Facultative resprouter. Fire resistant increaser. Survives 100% scorch by root suckers and basal sprouts. Resprouts with numerous suckers from lateral roots and from rootstock. Seedlings recorded <1y after fire.	NPFR; Benson & McDougall (2001).
Fimbristylis dichotoma	Resprouter							Resprouter.	Benwell (1998).
Galium binifolium	Obligate Seeder			Diaspore: seed, with no special morphology for dispersal.					NPFR, Benson & McDougall (2000).
Galium gaudichaudii	Obligate Seeder			No particular mechanism for dispersal. Vegetative spread by weak development of				100% scorch kills. Possibly resprouts.	NPFR, Benson & McDougall (2000).

Species	**Response**	**Germination**	**Diaspore**	**Disp. & Establ.**	**1Juv**	**2Juv**	**Lifespan**	**Notes**	**References**
				nodal roots up to 5 cm from rootstock.					
Galium propinquum	Resprouter			Diaspore: seed, with tiny hooks presumably for dispersal by attachment to animals. Vegetative spread.				Facultative resprouter.	NPFR, Benson & McDougall (2000).
Glossogyne tannensis	Resprouter							Probably resprouts from ground level after low intensity fires: pers obs	
Glycine clandestina	Resprouter	Rare in non-heated soil. Seed viability 100%, non-dormant fraction 4%.		Soil stored seed. Diaspore: hard-coated seed. No particular morphology for dispersal.			<5	pers.obs. Has persistent root stock. Probably resprouts. Regeneration from seed in soil (Clarke).	Floyd (1966), Auld & O'Connell (1991), Jarrett & Petrie (1929), NPFR. Benson & McDougall (1996), Clarke (1989).
Glycine tabacina	Resprouter	Soil-stored seedbank.		No particular mechanism for dispersal.				pers.obs. Resprouter from basal sprouts. Survives 100% scorch. Probably resprouts from above ground level (taxon B).	Stewart (1996), NPFR. Benson & McDougall (1996).
Gonocarpus micranthus	Variable	Seedlings within 3m of fire.		Rapidly thinning survivorship.				Probably killed after high intensity fire. Obligate seed regenerator - soil stored seed bank. Clonal reproduction after seedling establishment.	Keith (1992), Keith (1996), Benwell (1998), Benson & McDougall (1997), NPFR.
Gonocarpus tetragynus	Variable	Seedlings <1yr after fire (Purdie, 1977). May occur on disturbed sites.		Diaspore: fruit. No particular dispersal mechanism. Episodic recruitment mainly after fire.		2		Obligate Seeder (NPFR-CH, W?.) Facultative resprouter - regrowth & suckers from root stocks and lateral roots. Soil stored seed. Seedlings recorded <1yr after fire.	NPFR, Benson & McDougall (1997).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Gonocarpus teucrioides	Variable	Reproduction by sexual means in the first year.		Episodic recruitment mainly after fire. Seeds dispersed by wind.	2-4		<5	Soil stored seed. Resprouts from base.	Benson (1985), Keith (1996), Benson & McDougall (1997), NPFR, Clarke (1989).
Goodenia hederacea	Resprouter	Seedlings 1yr after fire.						Facultative resprouter from rootstocks and lateral roots. Fire resistant increaser. Survives 100% scorch by root suckers and basal sprouts.	Purdie & Slayter (1976), Purdie (1977), Purdie (1977), Clark (1988), Benson & McDougall (1997), NPFR.
Goodenia hederacea	Variable	Mucialginous rim may be mechanism for absorbing water to secure germination.		Diaspore: seed, no particular mechanism for dispersal.				Regrowth and suckers from rootstocks and lateral roots, but fire appeared to retard vegetative multiplication. Seedlings recorded <1yr after fire. Resprouting plants reached maturity in about 2 yrs.	Purdie (1977), Benson & McDougall (1997).
Gratiola peruviana	Obligate Seeder								NPFR.
Grevillea triternata	Resprouter			Via seed, likely to have ant adapted food body.				Probably resprouts from the base.	Benson & McDougall (2000).
Hakea microcarpa	Resprouter	Seed viability 81.2%. Waterlogging inhibits germination.		Diaspore: seed, gravity or short distance wind-dispersed.				Resprouts from lignotuber.	Benson & McDougall (2000).
Haloragis heterophylla	Resprouter			NO particular mechanism for dispersal.				Multiplied vegetatively after autumn fire. Probably killed (7114).	Lunt (1990), Benson & McDougall (1997), Benson & McDougall (1997).
Hardenbergia violacea	Variable	Seed viability 99%, non-dormant fration 5%. Coloniser of disturbed sites.		Seedlings recored 1 yr after fire and will establish in charcoal beds. Diaspore: seeds, ant-adapted.	1	>1 yr	5-30	From base or below (will survive annual fires: pers. obs.). Regrowth from surviving rootstocks, seedlings recorded <1yr after fire. Regeneration from seed in soil (Clarke)	Fox (1988), Floyd (1966), Auld & O'Connell (1991), Purdie (1977), NPFR, Benson & McDougall (1996), Clarke (1989).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Hibbertia acicularis	Variable	Soil stored seedbank						Killed by fire. Obligate seeder - soil stored. Facultative resprouter. Non-clonal decreaser.	Fox (1988), Benson & McDougall (1995), Benwell (1998), NPFR.
Hibbertia linearis	Obligate Seeder			within 7 m	<2 yr			Killed by high intensity, seedlings within 7 m flowering 18 m after fire	Benson & McDouall (1995).
Hibbertia obtusifolia	Variable	Within 1yr after fire (7020).		Seedlings within 1 yr				Resprout from suckers of roots and lateral root stock. Soil seedbank. Fire resistant increaser.	Benson & McDougall (1995), Fox & Fox (1986), Purdie & Slayter (1976), Siddiqi et al. (1976), Purdie (1977), Benwell (1998), NPFR.
Hibbertia riparia	Resprouter			Diaspore: seed, with ant-adapted food body. No particular dispersal mechanism.			60+	From base	Benson & McDougall (1995).
Histiopteris incisa	Resprouter							Facultative resprouter - most regeneration from rhizomes. Spores stored in soil.	Cremer & Mount (1965), Gill (1981), NPFR.
Homoranthus bornhardtiensis	Obligate Seeder								pers. obs.
Hybanthus monopetalus								100% scorch kills - soil stored seed.	NPFR.
Hydrocotyle laxiflora	Obligate Seeder								NPFR.
Hypericum gramineum	Resprouter	Will recruit heavily after fire		Diaspore: seed, mobile. Probably wind-dispersed.		1 yr	5-20	Will fruit within 3m after high intensity fire. Facultative root resprouter. Fire resistant decreaser. Also obligate seeder.	Benson & McDougall (1995), Lunt (1990), Purdie & SLatyer (1976), Dickinson & Kirkpatrick (1987), NPFR, Benson & McDougall (1995).
Hypochaeris radicata	Variable	decreased after burning. Seedlings up within 1yr of fire.		Seeds dispersed by wind.			<5	Obligate seeder - minor regeneration. Post burn seed coloniser. Facultative root resprouter. Fire resistant decreaser.	Lunt (1990), Hamilton et al. (1991), Purdie & Slatyer (1976), Dickinson & Kirkpatrick (1987), Purdie (1977), NPFR, Clarke

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
									(1989).
Imperata cylindrica	Resprouter							Facultative resprouter - veg. regeneration. Survives 100% scorch - root suckers. Absent from infrequently burnt sites.	Benson & McDougall (1993), Nieuwenhuis (1987), Gill (1981), NPFR.
Indigofera adesmiifolia				Diaspore: seed. Hard-coated? No particular mechanism for dispersal.					
Indigofera australis	Resprouter	Soil-stored seedbank.		Seedlings <1 yr after fire. Diaspore: hard-coated seed. No particular mechanism for dispersal.				From suckers, rootstocks and lateral roots. Fire resistant increaser. Seedlings recorded <1yr after fire.	Fox (1988), Benson & McDougall (1996), Gill (1975), Leigh & Holgate (1979), Purdie & Slatyer (1987), Purdie (1977), NPFR, Benson & McDougall (1996).
Isotoma axillaris	Resprouter							Probably from base after fire.	Benson & McDougall (1997).
Isotoma fluviatilis				Diaspore: probably seed.					
Juncus bufonius	Obligate Seeder							Significantly more abundant in burnt areas.	Lunt (1990), NPFR.
Juncus pauciflorus	Resprouter							Obligate resprouter.	NPFR.
Juncus subsecundus	Resprouter.							Obligate resprouter. Veg. regrowth. Root resprouter. Fire resistant increaser. Secondary juvenile period <9m after intense autumn fire.	Purdie & Slatyer (1976), Purdie & Slatyer (1976), Lunt (1990).
Juncus usitatus	Resprouter							Obligate resprouter.	NPFR.
Kunzea parvifolia				Diaspore: seed. May colonise open sites.					
Lagenifera stipitata	Resprouter			Diaspore: fruit. No special		< 1yr		Stems killed, resprouts from ground level, flowers 9 wks after high intensity fire and	Benson & McDougall (1994), NPFR, Benson & McDougall

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
				dispersal morphology.				12 wks fruiting. Seeds shed within 12 weeks of high intensity fire.	(1994).
Lepidosperma laterale	Resprouter	Reproduction by sexual means, reproducing by seed propagation in 1st year.		Seeds dispersed by wind.			<5	Facultative resprouter (NPFR-VE), obligate resprouter (NPFR - H, M, WO, CH.) Facultative and obligate resprouter. First recorded 1m after fire.	Hamilton et al. (1991),Dickinson & Kirkpatrick (1987), Gill (1989, NPFR, Dickinson & Kirkpatrick (1987), Hamilton et al. (1991), Clarke (1989).
Lespedeza juncea	Resprouter	Stimulated by fire				<1 yr			Benson & McDougall (1996).
Leucochrysum albicans		Diaspore: fruit, wind dispersed.							
Leucopogon lanceolatus	Resprouter					< 2yr		From ground level after fire, flowering within 20 m of fire	Benson & McDougall (1995).
Leucopogon muticus	Resprouter					1 yr		May resprout from after low to medium intensity fire and flower following winter	Benson & McDougall (1995).
Leucopogon neoanglicus	Obligate Seeder	Soil stored seedbank which lasts for many years		Will recruit in the absence of fire				pers. obs.	
Leucopogon virgatus	Resprouter			No seedlings within 1 yr of fire				Soil level or below. Facultative resprouter. Basal sprouts. Soil seedbank. Non-clonal decreaser. Fire resistant decreaser.	Fox (1988), Gill (1975), Fox & Fox (1986), Purdie & Slatyer (1976), Purdie (1977), Benwell (1998), NPFR, Benson & McDougall (1995).
Lissanthe strigosa	Resprouter			Diaspore: fruit. Adapted for dispersal by ingestion.				Resprouts from base after high intensity fire, one plant flowering within 9 months.	Benson & McDougall (1995).
Lissanthe strigosa	Resprouter			Diaspore: fruit. Adapted for dispersal by ingestion.				Resprouts from base.	Benson & McDougall (1995).
Lomandra confertifolia	Resprouter							Facultative and obligate resprouter.	NPFR.

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Lomandra filiformis	Resprouter							Survives 100% scorch. Facultative resprouter.	NPFR.
Lomandra longifolia	Variable	Reproduction sexual, reproducing by seed propagation beween 1-5 yrs.		Seeds dispersed by animals, Vegetative dispersal by landslip.			5-30	Obligate Seeder (E). Facultative and obligate resprouter. Clonal decreaser. Survives 100% scorch - root suckers. Fire resistant increaser. Clonal decreaser.	Hamilton et al. (1991), Fox et al. (1979), Leigh & Holgate (1979), Dickinson & Kirkpatrick (1987), Purdie (1977), Benwell (1998), NPFR, Clarke (1989).
Lomandra multiflora	Resprouter	Seed viability 96%. Smoke increases germination.				2yrs		Facultative and obligate resprouter. Fire resistant increaser. Obligate root resprouter. veg. regeneration. Absent from infrequently burnt sites.	Nieuwenhuis (1987), Purdie & Slatyer (1976), Purdie (1977), Roche et al. (1997), NPFR.
Lomatia silaifolia	Resprouter	No dormancy mechanism. Germination related to seed mass, viable seed > 7mg.		Diaspore: seed, wind-dispersed. Recruitment mainly after fire.		1y	>60y	Stems killed, resprouts from lignotuber within 2 months. Survives 100% scorch - basal sprouts. Flowers abundantly only in first year after fire has destroyed previous shoot system, predominantly in second summer after flowering.	Bradstock (1990), Beadle (1940), Keith (1996), Gill (1997), NPFR, Benson & McDougall (2000), Benson & McDougall (2000).
Maytenus silvestris	Resprouter	Germinates easily, 3-10 weeks.		Diaspore: seed, ant-adapted food-body for dispersal.			30+	Stems killed, resprouts from base. May form dense colonies of suckers.	Benson & McDougall (1995).
Melichrus urceolatus	Resprouter			No seedlings within 1 yr of fire. Diaspore: fruit, adaptation for dispersal by ingestion.				From rootstock. Facultative root resprouter. Fire resistant decreaser.	Gill (1975), Purdie & Slatyer (1976), Purdie (1977), NPFR, Benson & McDougall (1995).
Microseris lanceolata								Probably resprouts at ground level or below.	Benson & McDougall (1994).
Monotoca scoparia	Resprouter			No seedlings within < 1 yr after fire. Diaspore: fruit,		< 2yr		Stems killed, resprout from soil level or below, may flower within 17 m of fire.	Benson & McDougall (1995), Fox & Fox (1986), Leigh & Holgate (1979), Purdie & Slatyer (1976), Purdie (1977),

				adapted for dispersal by ingestion.					Benwell (1998), NPFR.
Species	**Response**	**Germination**	**Diaspore**	**Disp. & Establ.**	**1Juv**	**2Juv**	**Lifespan**	**Notes**	**References**
Opercularia aspera	Variable	Reproduction sexual, reproducing by seed propagation in the first year.		Diaspore: seed, ant-adapted food body for dispersal. Coloniser. Plants taller on better soils. Seeds dispersed by wind.		<33w	<5	Obligate seeder after hot fire. Soil stored seed. Resprouted after high intensity fire.	Benson & McDougall (2000), Fox & Fox (1986), Clemens & Franklin (1980), NPFR, Clarke (1989).
Opercularia diphylla	?Resprouter			Soil stored seedbank.				100% scorch kills, soil stored seed. Probably resprouts (herbarium specimen).	NPFR, Benson & McDougall (2000).
Opercularia hispida	Resprouter			Diaspore: seed. No particular morphology for dispersal.				Survives 100% scorch - basal sprouts.	NPFR, Benson & McDougall (2000).
Ophioglossum lusitanicum		Light inhibits germination of spores, must be covered with humus or washed into holes or cracks.		Diaspore: spores, wind-dispersed. Probably no dormancy mechanism.					
Opuntia stricta		Germinate at any time, bristled seeds vulnerable in exposed situations.		Diaspore: seed / vegetative. Stem fragments dispersed by animals, water, wind. Seeds bird-dispersed.	3				
Oxalis perennans	Variable.							Resprouter. Minor Obligate seeder. Seedlings not flowered within 9m of autumn fire.	Lunt (1990).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Pandorea pandorana	Variable	Reproducing by seed propagation between 1-5 years of age.		Seeds dispersed by wind.		< 1yr	5-30	Killed and known to resprout after high intensity fire, few plants flowering after 26-29 wks	Fox (1988), Benson & Howell (1994), NPFR, Clarke (1989).
Patersonia sericea	Resprouter							Facultative resprouter, with transient seedbank. Non-clonal decreaser. No veg. spread.	Clark (1988), Bradstock et al. (1997), Lumley & Spencer (1990).
Persicaria decipiens								Probably resprouts. Flowering within 5m after high intensity fire.	Benson & McDougall (1999).
Persoonia chamaepeuce	?Resprouter	Triggers unknown.		Diaspore: fruit, probably dispersed by large birds e.g. Currawongs, and possibly large mammals, kangaroos, possums.				Probably resprouts from rootstock and rhizomes.	Benson & McDougall (2000).
Petrorhagia nanteuilii				Diaspore: seed. No particular dispersal morphology. Dispersed in mud on cars.	<1		1	Probably killed.	Benson & McDougall (1995).
Phyllanthus gunnii	Variable							Resprouter from base (3453, 4264). Obligate Seeder (NPFR-W).	Benson & Howell (1994), Benson & McDougall (1995), NPFR.
Phyllanthus subcrenulatus	Resprouter	From soil stored seedbank				< 1yr		From base	pers. obs.
Phyllanthus virgatus	Resprouter	From soil stored seedbank		No particular dispersal morphology.		< 1yr		Will resprout and flower within 6 m of fire	pers. obs.
Pimelea linifolia	Variable	Seedlings within 1st		Good recruitment	2-4			Killed by fire. Soil stored seed. Fire	Benson (1985), Clemens &

		year after fire in burnt and unburnt sites.		but high mortality. Soil stored seed possibly lives up to 20yrs.				sensitive decreaser. Obligate seeder and facultative resprouter.	Franklin (1980), Purdie & Slatyer (1976), Purdie (1977), Clark (1988), Bradstock et al. (1997), Benwell (1988), NPFR.
Species	**Response**	**Germination**	**Diaspore**	**Disp. & Establ.**	**1Juv**	**2Juv**	**Lifespan**	**Notes**	**References**
Pittosporum undulatum	Variable	Reproduction sexual, reproducing by seed propagation after 5yrs.		Seeds dispersed by animals.			30+	Obligate seeder, killed by fire. Fire sensitive: thin bark & incapacity to coppice. Survives fire by suckering. Crown fire: obligate seeder. Partial burn: resprouts above ground.	Benson & Howell (1994), Hill (1982), Chesterfield et al. (1991), Melick & Ashton (1991), NPFR, Clarke (1989).
Plantago lanceolata	Resprouter							Obligate resprouter (CH). Seeder? Regenerative strategy uncertain (7091).	Lunt (1990), NPFR.
Plantago varia	Resprouter							Facultative resprouter. Recorded 1 month after fire in grassy forest.	NPFR, Dickinson & Kirkpatrick (1987).
Plectranthus parviflorus								Killed after high intensity fire. Soil stored seedbank.	Benson & McDougall (1997).
Pleurosorus subglandulosus				Diaspore: spores, wind-dispersed. Probably no dormancy mechanism.					
Podolepis jaceoides	Resprouter							Perennial.	Lunt (1990).
Polygala japonica								Possibly resprouts.	Benson & McDougall (1999).
Pomax umbellata	Obligate Seeder	Reproduction by sexual means, reproducing by seed propagation in the first year.		Diaspore: seed, ejected ballistically when ripe capsules touched (?and by wind). Coloniser. Soil stored seedbank.	<1y		<5	Soil stored seed - no veg. regeneration in dry heath. 100% scorch kills.	Benson & McDougall (2000), Benwell (1998), NPFR, Clarke (1989).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
Poranthera microphylla	Obligate Seeder	Readily after fire from soil stored seedbank		Within 5 m of fire. Diaspore: seed. Both ballistic & ant-adapted dispersal mech. Coloniser.	< 1yr		1	(Will have an initial flush after fire which is reduced soon after: pers. obs.) Flowers profusely after high intensity fire. Killed. Seedlings recorded <1yr after fire.	Benson & McDougall (1995), Purdie & Slatyer (1976), Bradfield (1981), NPFR, Fox (1988), Purdie (1977).
Pteridium esculentum	Resprouter	Dormant rhizome buds may remain dormant for at least 10 years.		Diaspore: spores, wind-dispersed. Probably no dormancy mechanism.		< 1yr		Resprouts rapidly, maybe indicative of fire, survives annual burning, may become dominant after low intensity burn but not spread after high, biomass increase 1 yr after spring fire, autumn fire not	Fox (1988), Benson (1985), Barker (1990), Hamilton et al. (1991), Fox et al. (1979), Keith (1996), Dickinson & Kirkpatrick (1987), Cremer & Mount (1965), NPFR, Benson & McDougall (1993).
Ranunculus lappaceus				Diaspore: achene with morphology for dispersal by adhesion.					Benson & McDougall (2000).
Ranunculus sessiliflorus				Diaspore: achene. No particular morphology for dispersal.	<1y		<1y		Benson & McDougall (2000).
Rhytidosporum procumbens								One plant resprouted and flowered <10m after high intensity fire, but most plantswere seedlings.	Benson & McDougall (1999).
Rubus parvifolius	?Resprouter			Diaspore: attractive fleshy edible fruits, vertebrate adapted dispersal. Vegetative spread.			Indef.	Probably resprouts.	Benson & McDougall (2000).
Rumex brownii	Resprouter					<5m		Resprouted after high intensity fire.	Benson & McDougall (1999).
Schoenus	Variable							Variable, obligate seeder and facultative	NPFR, Dickinson & Kirkpatrick

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
apogon								and obligate seeder. Secondary juv. period <9m after intense autumn fire. 1st recorded 3m after fire in wet forest, 1m after fire in grassy forest.	(1987), Lunt (1990).
Species	**Response**	**Germination**	**Diaspore**	**Disp. & Establ.**	**1Juv**	**2Juv**	**Lifespan**	**Notes**	**References**
Scleranthus biflorus				No particular dispersal morphology.					
Senecio diaschides	Obligate Seeder	Many after fire		Diaspore: fruit, wind-dispersed.				Killed, many seedlings after fire. Seedlings grow vigorously after fire.	Benson & McDougall (1994), NPFR, Benson & McDougall (1994).
Senecio lautus	Variable			Seeds dispersed by wind.			<5	Obligate seeder and facultative resprouter. No seed storage. 100% scorch kills.	Fox (1988), NPFR.
Senecio lautus		Germination 80%.		Diaspore: fruit, probably wind-dispersed.	<1				
Senecio sp. E				Diaspore: fruit. Probably wind-dispersed.					
Solenogyne bellioides	Resprouter							Probably resprouts from ground level or below	Benson & McDougall (1994).
Sonchus oleraceus	Obligate Seeder.			Seeds dispersed by wind.	1		1-2		Lunt (1990), Clarke (1989).
Stackhousia monogyna	Variable							Obligate Seeder (CH, BU). Facultative resprouter (W, WO, E?). 100% scorch kills - soil seed storage.	Lunt (1990), NPFR.
Stackhousia viminea	Obligate Seeder								Keith (1996), NPFR.
Stellaria angustifolia				Diaspore: seed. No particular dispersal morphology.					
Stellaria flaccida	Obligate Seeder			Diaspore: seed / stem fragments				Probably killed.	Melick & Ashton (1991), Jarrett & Petrie (1929), NPFR, Benson

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
				that take root. Coloniser.					& McDougall (1995).
Stellaria pungens	Variable							Obligate Seeder (W). Resprouter (HO?). Survives 100% scorch by root suckers.	NPFR.
Stylidium graminifolium	Variable							Obligate Seeder (E). Obligate and facultative resprouter. Root resprouter. Fire resistant decreaser. Non-clonal decreaser. Soil seed bank.	Leigh & Holgate (1979), Purdie & Slatyer (1976), Kirkpatrick (1984), Puride (1977), Purdie (1977), Benwell (1998), NPFR.
Stypandra glauca	Resprouter							Facultative resprouter. Survives 100% scorch - basal sprouts.	NPFR. Roche et al. (1997).
Taraxacum officinale				Diaspore: fruit. Wind-dispersed many kilometres.				Probably resprouted. Flowering within 11 wks and fruiting within 25 wks of high intensity fire.	Benson & McDougall (1994).
Themeda triandra	Resprouter							Facultative resprouter. Tussocks. Non-clonal decreaser. Soil seedbank. Survives 100% scorch - root suckers.	Benson & McDougall (1994), Rowley & Brooker (1987), Lunt (1990), NPFR.
Tricoryne elatior	Resprouter	fresh seed : 0% germination. 76% initial viability.						Facultative resprouter. Veg. regrowth. Survives 100% scorch - basal sprouts. soil stored seed.	Lunt (1991), Clancy (1981), Roche et al. (1997), Benwell (1998), NPFR.
Trifolium repens		Usually germinates in autumn.		No particular morphology for dispersal. Dispersed in mud on cars, & by wind, animals & humans.					
Triptilodiscus pygmaeus	Obligate Seeder							Probably killed by fire	Benson & McDougall (1994).
Urtica incisa								Prolific after fire, eg. Tasmania.	Gill (1981), Melick & Aston (1991).
Viola hederacea	Variable	Reproduction sexual and vegetative, reproducing by seed		Seeds dispersed by expulsion. Vegetative			<5	Facultative resprouter from rhizomes. Obligate seeder. 100% scorch kills - soil stored seed.	Hamilton et al. (1991), Bradfield (1981), Jarrett & Petrie (1929), NPFR, Clarke (1989).

Species	Response	Germination	Diaspore	Disp. & Establ.	1Juv	2Juv	Lifespan	Notes	References
		propagation in the first year.		dispersal by landslip.					
Vittadinia cuneata	Resprouter							Perennial.	Lunt (1990).
Vittadinia cuneata	Resprouter								
Vittadinia cuneata	Resprouter			Diaspore: fruit, wind-dispersed.					
Wahlenbergia communis	Obligate Seeder	Soil-stored seedbank. Coloniser.		Diaspore: seed. Wind-dispersed. No particular dispersal morphology.	3-6m			Killed, flowers within 15 wks, flower and fruit 10 months high intensity fire	Benson & McDougall (1995), NPFR, Fox (1988), Benson & McDougall (1995).
Wahlenbergia gracilis	Variable			Seeds dispersed by expulsion.	< 1yr		1-2	Probably killed by high intensity fire, flowering within 4 m and fruiting within 6 m of fire. Regenerates after crown fire & partial burn by resprouting above ground.	Benson & McDougall (1995), NPFR, Clarke (1989).
Wahlenbergia graniticola	Obligate Seeder	Vigorous to regular fire			< 1yr			Will respond to regular burning	Benson & McDougall (1995).
Wahlenbergia luteola				Diaspore: seed, mobile.					
Zieria aspalathoides			Seed	Seed dispersed ballistically from dehiscent segmented fruit.					Benson & McDougall (2001).
Zieria cytisoides			Seed	Seed dispersed ballistically from dehiscent segmented fruit.					

3.12 Uses and traits of individual taxa

The following represents a review of some of the current knowledge of uses.

Table 11: Some known uses and traits of taxa found in Ironbark Nature Reserve and *Bornhardtia* Voluntary Conservation Area.

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Acacia cheelii			Poison?			
Acacia implexa		Lazarides & Hince (1993).	Poison?	Fodder.	C3. Drought tolerant. Intolerant of waterlogging, salinity and wind.	Gums, timber, fuel, honey (pollen).
Acacia neriifolia				Fodder.		Shelter.
Acacia penninervis	The bark can stupefy fish.					
Acacia pruinosa						Pollination by polylectic red fly (Lauxaniidae), nectary output.
Acaena novae-zelandiae	Leaves once used as a substitute for tea.	Lazarides & Hince (1993).		Weed. Fruit burrs troublesome to humans and stock.		Wind pollinated. Spreading by stolons.
Acetosella vulgaris			Poison?	Possibly grazed by stock. Suspected of poisoning stock.		The leaves can be eaten raw or cooked or made into a soup.
Acianthus collinus	Tuber edible.					
Acianthus exsertus	Tuber edible.					
Actinotus helianthi					C3. Seedlings shade intolerant, sun tolerant.	Tertiary sand coloniser, propagation by seed, garden plant, floral display.
Aira cupaniana				Fodder.		Weed.
Ajuga australis				Fodder.		Ornamental.
Alternanthera denticulata				Fodder.		
Amyema miquelii	Fruits eaten.	Cunningham et al.		Readily grazed if		

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
		(1981).		lopped.		
Amyema miraculosum	Fruits eaten.	Cunningham et al. (1981).		Readily grazed if lopped.		
Amyema pendulum	Fruits eaten.			Fodder.		Food, weed.
Anagallis arvensis			Poison.	Fodder.		Weed, poisonous to horses, cattle, sheep, birds, dogs, rabbits and guinea pigs.
Angophora floribunda				Fodder.	C3. Drought tolerant. Intolerant of wind, waterlogging and salinity.	Tertiary sand coloniser, by seed propagation. Garden & shade plant. Bee attractant. Firewood, timber.
Arenaria leptoclados						Weed.
Aristida ramosa				Unpalatable to stock, except when young.		
Aristida vagans				Useful drought fodder.		
Arthropodium milleflorum	Roots eaten raw or roasted.			Fodder, moderate forage.		
Arundinella nepalensis				Fodder.		
Asperula conferta				Fodder. Drought resistant forage plant providing green fodder rapidly after summer rains.		Palatable to rabbits.
Asplenium flavellifolium				Contains HCN, but unlikely to cause stock poisoning.		
Austrodanthonia bipartita				Fodder.		
Austrostipa setacea				Readily eaten in young stages, particularly by cattle.		
Austrostipa verticillata				Rarely observed to be grazed.		
Axonopus affinis				Fodder.		Weed.

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Bidens pilosa						Honey, weed, medicinal. Seed burrs troublesome to clothing and wool. Medicinal uses in South Africa.
Billardiera scandens	Fruit edible raw & tastes like stewed apples when ripe.					
Bothriochloa decipiens				Not readily eaten by stock.		Shelter. Drought resistant, colonises scalded soils.
Brachychiton populneus	Young roots can be boiled & taste like turnips. Seeds are edible & can make a beverage. Leaves also edible.	Lazarides & Hince (1993).	Poison.	Fodder.		Gums, timber, honey, ornamental.
Brachychiton populneus	Young roots can be boiled & taste like turnips. Seeds are edible & can make a beverage. Leaves also edible.					
Bromus diandrus				Moderate to good quality forage in early stages.		Weed. Spear-like awns cause injury and losses in lambs.
Bursaria spinosa	Medicinal. Used for production of Aesculin (suntan lotions).					
Calandrinia eremaea	Eaten as greens. Seeds are also edible.			Palatable to stock, contributes to water requirements of animals.		
Callitris endlicheri				Antihelminthic for horses.		Gums, timber, fuel, medicinal, shelter.
Calotis cuneifolia				Useful forage. Barbed seeds prolific and troublesome to sheep		Honey, weed.

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
				and fleece.		
Calotis lappulaceae				Fodder.		Seeds contribute to vegetable fault in fleeces.
Calytrix tetragona	The fruit is edible.					
Carduus tenuiflorus				Flowerheads and rosette leaves grazed.		Proclaimed noxious weed in Vic, Tas, SA and part of WA.
Carex appressa	The leaves were used by aborigines for weaving baskets and other such articles.	Cunningham et al. (1981), Lazarides & Hince (1993).		Fodder.		Shelter. Controls creek bank erosion, harbours rabbits.
Cassinia aculeata			Causes dermatitis in humans.			Weed.
Cassytha pubescens	Flesh surrounding the small fruit is edible.				C3.	
Casuarina cunninghamiana				Fodder.		Timber used for ornamental turnery and fuel. Gums, Honey (pollen), shelter, ornamental.
Centaurium erythraea						Weed.
Centipeda cunninghamii	Medicinal.	Lazarides & Hince (1993).		Fodder.		Medicinal.
Cerastium glomeratum						Weed of gardens, disturbed ground and pastures.
Cheilanthes distans			Poison?			
Cheilanthes sieberi			Poison?			
Chenopodium pumilio			Poison.	Eaten sparingly in times of fodder shortage. Cause of sheep deaths.		Weed.
Chloris truncata			Poison?	Widespread, valuable, warm-season grass.		Shelter. Useful for grassing waterways.
Ciclospermum leptophyllum				Fodder.		Weed. Reported to taint milk.

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Cirsium vulgare						Honey, weed, miscellaneous. Fleshy roots laced with strychnine formerly sold as rabbit bait. Noxious in Vic, Tas, SA, part of NT.
Clematis glycinoides						Flowers visited by honeybees for pollen.
Clematis glycinoides			Poison?			Medicinal, ornamental.
Commelina cyanea					C3.	Used as a cooked green vegetable by early settlers to combat scurvey.
Conyza albida					C3. Wind tolerant, drought tolerant, intolerant of waterlogging.	Secondary sand coloniser, floral display. Cosmopolitan species, on the foredune & backdune. Honey (pollen), weed.
Conyza bonariensis						Weed.
Correa reflexa						Leaves and roots eaten by wombat. Pollen eaten by Red Wattlebird, Crescent Honeyeater, New Holland Honeyeater, Tawny-crowned Honeyeater & Eastern Spinebill.
Crassula colorata				Palatable to stock.		
Crassula sieberiana				Fodder, palatable to stock but limited in value due to its small size or inaccessible habitats.		
Cymbonotus lawsonianus						Weed, medicinal.
Cymbopogon obtectus				Drought resistant, lemon-scented fodder.		
Cymbopogon refractus	Medicinal.	Lazarides & Hince (1993).		Heavily grazed when young, unpalatable when mature.		Shelter.

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Cyperus bifax	Rhizomes used by aborigines of Barcoo Rr in a decoction for treatment of gonorrhea.	Webb (1948), Cunningham et al. (1981), Lazarides & Hince (1993).				
Cyperus fulvus						Ornamental.
Daucus glochidiatus	Tuber edible.			Fodder.		
Daviesia latifolia						Food, medicinal.
Desmodium brachypodum			Poison?			
Desmodium varians				Fodder.		
Dianella caerulea	Fruits & roots edible. Stems can be pounded to make a fibre.					
Dianella revoluta	Fruits & roots edible. Stems can be pounded to make a fibre.					
Dichelachne crinita				Fodder.	C3. Intolerant of waterlogging and salinity.	Secondary sand coloniser. Tertiary sand coloniser, by transplants, propagation by seed. Cosmopolitan species, on the backdune.
Dichelachne micrantha				Fodder.		
Dichondra repens				Fodder.	C3. Wind intolerant, drought intolerant, tolerant of waterlogging, intolerant of salinity.	Tertiary sand coloniser. Gums, weed.
Dipodium variegatum	Roots eaten raw or roasted.					
Dodonaea viscosa	Timber.	Lazarides & Hince (1993).		Fodder.		Food, gums, honey (pollen), shelter, ornamental.
Drosera peltata			Poison?			Ornamental.
Drosera spatulata			Poison?			Ornamental.
Echinopogon ovatus				Fodder, low forage		

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
				value.		
Einadia polygonoides			Poison?	Palatable fodder, taints milk. Cattle poison and suspected cause of jaundice.		
Entolasia stricta				Fodder, low palatability.		
Eragrostis brownii				Fodder.		
Eragrostis lacunaria				Reasonable feed for sheep.		
Eragrostis leptostachya				Fodder.		
Eryngium vesiculosum				Fodder.		
Eucalyptus albens				Fodder.		Timber, honey, fuel.
Eucalyptus andrewsii						Timber, honey.
Eucalyptus blakelyi						Gums, timber, fuel, honey.
Eucalyptus bridgesiana						Gums, honey.
Eucalyptus caliginosa						Timber, fuel, honey.
Eucalyptus macrorhyncha	Foliage used in commercial production of Rutin.					Gums, timber, honey, medicinal, fibre.
Eucalyptus melliodora						Gums, timber, fuel, honey (nectar).
Eustrephus latifolius	Tubers are sweet and edible.					
Exocarpos cupressiformis	Succulent yellow to red pedicel of fruit edible. Food, timber, gums, ornamental.	Cunningham et al. (1981), Benson & McDougall (2001).	Foliage reputed to be poisonous to stock and horses.			Small fly (Diptera) feeds on flowers. Fruit eaten by Black-faced Cuckoo-shrike. Seed eaten by Aust. King Parrot, Crimson Rosella. Host to parasitic shrub Viscum articulatum. Host plant of Cerambycid beetle. Foodplant of various butterfly & moth larvae.
Festuca asperula				Fodder.		

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Ficus rubiginosa	Fruit can be eaten raw or made into a jelly.					
Fimbristylis dichotoma				Must be utilised while green for forage.		
Gahnia aspera	Red-brown seeds were pounded by the aborigines to produce a flour. The roots are also edible.	Cribb & Cribb (1974), Cunningham et al. (1981), Lazarides & Hince (1993).		Fodder, of little forage value.		
Galium gaudichaudii						Palatable to rabbits.
Geranium solanderi	Roots can be roasted & eaten.					
Glycine clandestina	The root can be eaten.			Fodder.	C3.	Secondary sand coloniser. Cosmopolitan species, on the foredune and backdune.
Glycine tabacina	Taproot has liquorice flavour and was chewed by Aborigines.	Lazarides & Hince (1993).	Poison?	Fodder.		
Gonocarpus teucrioides						Grows on sandstone and sand, on backdune.
Hardenbergia violacea	Food.	Lazarides & Hince (1993).	Poison.	Fodder.	C3. Wind intolerant, drought tolerant, intolerant of waterlogging and salinity.	Tertiary sand coloniser, propagation by seed, garden plant, floral display. Cosmopolitan species, on backdune. Food, ornamental.
Hibbertia acicularis						Ornamental.
Hibbertia obtusifolia			Poison?	Fodder.		
Hibbertia riparia						Ornamental.
Hypericum gramineum			Poison.	Fodder. Causes enteritis in sheep.		
Hypochaeris glabra				Fodder.		Weed.
Hypochaeris radicata				Fodder.	C3. Wind tolerant, drought	Secondary & tertiary sand

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
					tolerant, intolerant of waterlogging, intolerant of salinity.	coloniser. Cosmopolitan species, on the backdune. Honey, weed.
Hypoxis exilis	Tubers eaten.					
Imperata cylindrica				Fodder, grazed when young.		
Indigofera australis	Poison.	Lazarides & Hince (1993).	Poison?	Fodder. Contains HCN; toxic when flowering and suspected cattle poison.		Ornamental.
Indigofera brevidens				Fodder.		
Isotoma anethifolia			Poison.			
Isotoma axillaris			Poison.			Ornamental.
Juncus bufonius				Grazed by stock. Not highly regarded as a forage plant.		
Kunzea parvifolia						Ornamental.
Lactuca serriola			Poison?	Fodder.		
Lepidium hyssopifolium				Relatively palatable to stock. Eaten in quantity it taints dairy products and eggs. Used as a cress for human consumption.		
Lepidosperma laterale					C3. Wind intolerant, drought intolerant, intolerant of salinity and waterlogging.	Tertiary sand coloniser, propagation by transplants and seed.
Leptospermum novae-angliae						Host specific gall.
Leucopogon lanceolatus	Fruits are edible.					
Lomandra longifolia	Leaf bases edible & taste like peas. Leaves used for baskets. Flowers edible.		Poison?	Not observed to be grazed by stock, but suspected of causing a	C3. Tolerant of wind, drought and salinity. Intolerant of waterlogging.	Secondary & tertiary sand coloniser. Wind barrier. Propagation by transplants and

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
				type of paralysis in stock.		seed. Bee & mammal attractant.
Lomandra multiflora			Poison?	Suspected of poisoning sheep.		
Lotus australis	The seeds are edible.		Poison.	Fodder. Drought resistant and palatable. HCN toxic to sheep and cattle, especially actively growing plants, pods and seeds.		
Lotus cruentus			Poison.	Fodder. HCN toxic to sheep, especially young leaves and pods.		
Lotus uliginosus				Fodder.		Weed.
Macrozamia heteromera	Nut kernels eaten after pounding, maceration & leaching.		Poison.			
Macrozamia humilis	Nut kernels eaten after pounding, maceration & leaching.					
Mentha diemenica						Medicinal.
Microseris lanceolata	Coconut-flavoured tubers a food raw or roasted.	Lazarides & Hince (1993).		Highly palatable to stock.		
Mirbelia pungens						Ornamental.
Modiola caroliniana			Poison?	Suspected cause of nervous disorders in sheep, cattle and goats.		Weed.
Monotoca scoparia	Fruits are edible.					
Murdannia graminea	Roots baked then eaten.					
Notelaea microcarpa				Fodder.		
Opercularia aspera					C3. Intolerant of wind, drought, waterlogging and salinity.	Tertiary sand coloniser. Cosmopolitan species, on the

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
						backdune. Eaten by rabbits.
Opuntia stricta						Weed, ornamental. Biologically controlled by cactoblastis moth.
Opuntia stricta	Fruit is edible, can be made into a jam or candied. Young stems can be eaten if boiled.					Weed, ornamental. Biologically controlled by Cactoblastis moth.
Pandorea pandorana	Long wiry branches used as spear shafts by Aborigines.	Lazarides & Hince (1993).		Moderately palatable fodder.	C3. Wind intolerant, drought intolerant, intolerant of waterlogging and salinity.	Tertiary sand coloniser, propagation by seed, garden plant, floral display. Cosmopolitan species, on the backdune.
Panicum effusum	Seeds utilised to make bread.		Poison?	Palatable when young. Overconsumption can cause photo-sensitisation and 'yellow bighead' in sheep. Susceptible to close grazing.		
Panicum simile				Fodder.		
Paronychia brasiliana						Weed.
Parsonsia eucalyptophylla			Poison?	Often eaten by sheep and cattle as drought fodder. Suspected sheep poison at certain times.		
Paspalum dilatatum			Poison.	Heavy producer of palatable fodder. Ingested fungus may poison livestock.	Withstands heavy grazing and drought. Frost tender.	Weed. Fungus attacks seed, causing ergot. Sticky exudate harmful to humans.
Persicaria hydropiper	Salks can be roasted, peeled & eaten. Leaves can also be eaten but are hot.					
Persoonia chamaepeuce	Fruit is edible.					Suckers from rootstock. Long-tongue bees Leioproctus

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
						filamentosa forages on flowers, probably not effective pollinators.
Persoonia cornifolia	Fruit is edible.					
Persoonia sericea	Fruit is edible.					
Petrorhagia nanteuilii						Weed.
Phragmites australis	Used by aborigines in Victoria for making bags or baskets.	Cunningham et al. (1981).		Young growth relatively palatable to stock. Useful forage plant.	Susceptible to sea-strength salinity.	Shelter, fibre.
Pimelea linifolia			Poison.	Fodder, of limited forage value.		Ornamental.
Pittosporum undulatum					C3. Intolerant of wind, drought, waterlogging and salinity.	Tertiary sand coloniser, propagation by seed, garden & shade plant. Gums, weed.
Plantago debilis	Leaves are edible.					
Plantago lanceolata				Fodder.		Honey (pollen), weed.
Plantago varia	Leaves are edible.					Weed.
Plectranthus parviflorus	Medicinal.	Lazarides & Hince (1993).				Ornamental.
Podolepis jaceoides	Roots roasted.			Fodder.		
Pomax umbellata			Poison?	Fodder. Reputedly cyanogenetic, but rarely grazed. Considered to be a potential producer of hydrocyanic acid.	C3. Drought tolerant. Intolerant of wind, waterlogging and salinity.	Tertiary sand coloniser. Cosmopolitan species, on the backdune.
Poranthera microphylla			Poison?	HCN positive; suspected of deaths in sheep and cattle.		
Prostanthera nivea						Ornamental.
Psydrax odoratum	Food.	Lazarides & Hince (1993).	Poison?	Fodder.		
Pteridium esculentum	Food, medicinal.	Lazarides & Hince	Poison.	Causes poisoning of		Gums, weed.

	Rhizomes & young fronds contain starch which is chewed out and beaten to a paste. Rhizomes roasted. Carbohydrate content better than potatoes.	(1993).		horses and cattle.		

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
Pterostylis boormanii	Tubers eaten.			Possibly eaten by stock.		
Pterostylis curta	Tubers eaten.					
Pterostylis longifolia	Tubers eaten.					
Pterostylis mutica	Tubers eaten.			Probably palatable to stock.		
Pterostylis parviflora	Tubers eaten.					
Pterostylis rufa	Tubers eaten.			Probably grazed when accessible to stock.		
Ranunculus lappaceus				Not keenly sought after by stock. More suited to cattle than sheep.		
Ranunculus sessiliflorus				Fodder.		
Rubus fruticosus				Fruit eaten by numerous animals and birds.		Fruits collected for making jams and pies. Ornamental, weed. Declared noxious in Qld, ACT, Vic, Tas, SA, WA.
Rubus parvifolius	Fruits eaten raw or made into a jam.	Lazarides & Hince (1993).				Adult jewel beetles Alcinous nodosus during early summer on leaves, larvae feed in stems and later pupate in hollowed out chamber.
Rumex brownii	Leaves and midrib can be steamed or boiled & used as a substitute for silverbeet. Thick yellow		Poison.			

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
	taproot can be ground, roasted & used as a coffee substitute.					
Schoenus apogon				Fodder.		
Secale cereale				Fodder.		Food (rye), weed, shelter.
Senecio lautus			Poison?	Fodder. Contains alkaloids.	C3. Wind tolerant, drought tolerant, tolerant of salinity, intolerant of waterlogging.	Secondary sand coloniser. Grows on sand dunes and headlands, on the foredune. Honey, weed, ornamental.
Sida cunninghamii				Fodder, readily grazed.		
Solanum nigrum	Edible but vary in flavour from aniseed to tomato or tamarillo flavour.		Poison?			Weed.
Sonchus oleraceus	Food. Eaten as a vegetable.	Lazarides & Hince (1993).	Poison?	Fodder. Suspected cause of photo-sensitisation in cattle. Readily grazed by stock.	C3. Wind intolerant , drought intolerant, intolerant of waterlogging and salinity.	Cosmopolitan species, on the backdune. Juice used medicinally. Weed.
Sorghum leiocladum				Fodder.		
Sporobolus elongatus				Fodder.		
Stackhousia monogyna				Fodder.		
Stellaria angustifolia				Possibly eaten by cattle.		
Stellaria media						Edible as a vegetable, either cooked or raw.
Stypandra glauca						Shelter, ornamental.
Swainsona galegifolia	Seeds are edible.		Poison.	Fodder.		Honey, weed, ornamental.
Taraxacum officinale						Honey
Thelymitra pauciflora	Tubers eaten.					
Themeda triandra				Very palatable, heavily grazed in eastern NSW. Sparingly grazed in Western NSW.Young		

Name	Use	Use References	Toxicity	Agricultural Use	Physiology	Other
				growth utilised		
Trachymene incisa	Edible tap root eaten raw or roasted.					
Tricoryne elatior				Eaten by stock but lacks bulk.		
Trifolium repens				Fodder, honey.		
Tripogon loliiformis				Should be utilised quickly. Quite palatable.		
Triptilodiscus pygmaeus				Fodder.		
Urtica incisa	Young shoots edible when boiled.	Lazarides & Hince (1993).	Painfall when contacted.			
Verbena bonariensis			Poisonous ?	Fodder.		
Verbena rigida			Poisonous ?			
Vicia villosa				Fodder.		
Viola hederacea					C3. Tolerant of waterlogging. Intolerant of wind, drought and salinity.	Tertiary sand coloniser. Propagation by cuttings, transplants and seed. Garden plant, floral display.
Vittadinia cuneata				Fodder.		
Wahlenbergia communis				Fodder, palatable to stock.		
Wahlenbergia gracilis				Palatable forage in cooler months.	C3. Wind intolerant, srought intolerant, intolerant of waterlogging and salinity.	Tertiary sand coloniser. Garden plant, floral display. Cosmopolitan species, on the backdune.

Discussion

4.1 Floristic and environmental relationships

4.1.1 Richness and diversity

477 taxa were found within Ironbark Nature Reserve and the *Bornhardtia* Voluntary Conservation Area representing approximately 7% of the New South Wales flora and 24% of the flora of the Northern Tablelands. The number of species predicted to occur in total is around 470 taxa (Figure 17), potentially indicating that almost all species likely to occur have been discovered and that further systematic surveying is unlikely to increase the capture of species but that opportunistic observations are likely to capture the more cryptic taxa. The number of taxa found is medial in terms of both richness and the regional diversity index (Table 4) and species accumulation and beta-diversity (in-between site differences) as described by Coleman curves (Figure 20). In terms of these diversity measures the reserve has similar patterns as shown by the Severn River and Burnt Down Scrub Nature Reserves, Warra, Mt Kaputar and Kwiambal National Parks. In terms of nearby conservation reserves the study area has a better diversity than Indawarra Nature Reserve but slightly less than that of Warrabah National Park.

In terms of average site species richness on a 0.04 ha site the study area is again seen as medial (35 per 0.04 ha). Almost as many previous investigations are richer or poorer with the highest average richness reached at Kings Plains National Park (51 per 0.04 ha) and the lowest at Gibraltar Nature Reserve (26 per 0.04 ha). The richness per site is similar to that found at Gibraltar Range (36) and Mt Kaputar (36) National Park and Arakoola (36) and Curry's Gap (37) Nature Reserves.

In terms of overall diversity and flora species richness the study area is medial not being particularly diverse and rich or poor and is similar to many other conservation areas within the broader region.

Despite the capture of species within the conservation areas was considered as almost complete, the capture of species associated with the individual communities was low. This is not surprising as communities extend beyond the boundaries of reserves and are richer and more diverse than what can be captured in such a small area. Figure 18 gives an indication of the potential adequacy of reservation of each community at the local level. It is apparent that no community is adequately sampled for its variety within the study area. In fact, Community 8 and 10 have less than 50% of their predicted local richness captured within the two reserves and the remaining communities have only up to 70% of their variety captured. Community 2 and 8 appear to be the most sufficiently sampled.

The diversity of each community is remarkably different. It appears that Communities 5 to 7 are the most heterogeneous in terms of beta-diversity (between site variation) as indicated by Coleman curves (Figure 19). Communities 9 and 10 are the least diverse, in particular Community 10 at the eight sample level reaches a richness of 65 species whereas Community 5 reaches a richness of 180 species. Thus Community 5 is almost three times as rich as Community 10 at the same intensity of sampling. Coleman curves can also be used to indicate the adequacy of sampling each vegetation unit by assessing the nature of the curve. It can be noted that many of the curves barely reach a point of inflexion, in particular it seems that the variation within Communities 3, 5 and 10 are insufficiently sampled.

4.1.2 Community distribution and biogeography

Eleven communities have been circumscribed within the two conservation areas based on the analysis of 110 survey sites. Based on analysis and mapping the two conservation areas (the Nature Reserve and VCA) capture significantly different proportions of communities, and in fact, a number of these communities are only distributed in one or the other. Thus, neither conservation area substantially captures the same variety of communities and both complement each other. For example Communities 2 is entirely restricted to the VCA and is very common their, Communities 1, 5, 6 and 9 have most of their distribution within the VCA, while Communities 4, 7, and 8 only occur in the Nature Reserve and the remaining Communities 3, 10 and 11 are common in both areas.

Based on the general distribution of sites and communities on the dendrogram and ordination (Figures 11 & 12) it appears that these assemblages are distributed based on an inferred moisture gradient. It appears from the ordination (Figure 12) that at this level of resolution (number of sites per area) that the assemblages overlap and clear distinctions are only able to be drawn from extreme samples. Community 11 is a clear exception to this. Communities 3 and 8 are fairly distinctive to a lesser degree in terms of ordination. Based on analysis of measured site variables by constrained ordination (Figure 13) a number of environmental gradients were highly significant in terms of assemblage distribution. Many of the significant factors are somewhat defacto measures of inferred ability to retain moisture such as Physiography, Protection from the North, Drainage, Soil Depth and Rock Type. Drainage was the most significant overall explanatory variable both being significant at the 0.001% and having the longest measured arrow.

The cosmopolitinality of the each community was measured by the distribution of its component species within the New South Wales botanical divisions (Table 5). The average distribution of all communities was 63, this is higher than other conservation areas for example the communities within Warra National Park scored 54 overall (Hunter 2001) and the Tenterfield Reserves scored 57 (Hunter 2002). Thus the flora of the study area may be fairly cosmopolitan in general terms. Individually the most cosmopolitan assemblage was Community 1 and the least and thus more ‘endemic’ assemblage was Community 11. Surprisingly Communities 9 and 10 are divergent in terms of measured cosmopolitinality though both are restricted to rock outcrops. Community 9 is one of the ‘endemic’ assemblages scoring 60 while Community 10 is one of the more widespread with a score of 64. However, McGann (2002) [Hunter] has shown that insularity of rock outcrops decreases at lower altitudes and on warmer drier sites. So the results here suggest that even in a single study area the same observations can be made as Community 10 is more common at lower altitudes or on more exposed situations and those of Community 9 are at higher altitudes in less exposed positions.

In terms of geographic affinities, the flora of the study area is most closely associated with the North Western Slopes, but then surprisingly with the coastal regions, particularly the Central and Southern Coasts. Thus, the flora in general has affinities with warmer areas such coastal regions before affinities are shared with other tablelands or slopes areas. The high percent of species shared with the North Western Slopes (100% in Community 3) shows definitively that the study area represents a cross over of the flora on the slopes and tablelands. Communities 3, 9 and 10, all of which are associated with rock outcrops or scree areas have greater affinities for the North Coast before the Central Coast in contrast to the other assemblages. Hence rocky areas appear to have floras with greater restricted to the north east.

Community 10 has the highest number of species shared with the furthest Botanical Divisions, the North Far Western Plains and the South Far Western Plains. McGann (2002) [Hunter] has shown that rock outcrop sites particularly in western areas of the New England Batholith have a number of taxa from much more arid climes that are restricted to the dry and arid rock outcrop sites within a more mesic woodland matrix.

Surprisingly Community 11, which is the most ‘endemic’ has the lowest affinities with the North Western Slopes and very low affinities, one third less than other assemblages, for the Central Western Slopes. Yet, this assemblage has a comparatively very high association with Southern Tablelands. It appears that in general the flora of Community 11 are largely restricted to cooler climes and are very different from all other assemblages within the study are in this regard.

4.1.3 Species distributions

Patterns in canopy species distributions can be discerned from the data collected (Figure 14). *Eucalyptus macrorhyncha* was found to be the most common and dominant eucalypt species (Table 3) throughout the study area and not surprisingly it was found to be almost unresponsive to the variables found significant in constrained ordination. In other words this species is largely unaffected by all significant environmental variables found to affect community and species distributions and can be considered as ubiquitous and uninformative in terms of community definition. *Casuarina cunninghamii, Eucalyptus albens* and to a lesser extent *Eucalyptus dealbata, Brachychiton populneus* and *Eucalyptus melliodora* in contrast were very strongly correlated with measured environmental variables and were divergent from all other species in they way they were affected. Overall two general groups can be discerned in the ordination which are on separate sides of the centroid. These are characterised by *Eucalyptus caleyi* (with *E. prava* & *E. andrewsii*) which is found on poorly drained shallow soils, on crests and ridges towards the south. The other group is typified by *Eucalyptus bridgesiana* (with *E. quinniorum, E. subtilior, E. blakelyi, Angophora floribunda* and *Pittosporum undulatum*) which are associated with lower slopes and open depressions on deeper more poorly drained areas towards the north.

Surprisingly *Eucalyptus albens, E. melliodora* and *E. blakelyi* have quite divergent patterns in terms of their responses to the significant environmental variables. Thus despite this community being listed as a Vulnerable community on the *TSC* Act examples of it were found sporadically through more than one described assemblage and not as a single unit.

As has been found in similar analyses at Kings Plains National Park (Hunter 2000f) a majority of the rare and threatened species are associated with decreasing soil depth. Almost all rare and threatened species within the study area are associated with one side of the centroid in constrained ordination. Most were associated with shallow, well drained, exposed physiographic sites. There were only two exceptions to this rule, *Eucalyptus quinniorum* and *Callistemon pungens* which were associated with protected sites that were less well drained.

4.2 Fire

Fire is a natural component of many communities within Australia, particularly for the southeast. A lot of research has been conducted over recent years into the effects of fire regimes (in terms of frequency, intensity and seasonality) on individual species and communities as a whole. Much of this research has centred on temperate communities such as coastal forests and heaths. This research is also habitat and site specific and the usefulness of findings to other areas, even somewhat synonymous ones, is debatable. Table 9 shows the responses of some of the study area species to the effects of fire. Several of these observations may be based on miss-classification of functional type or the taxa in question being a complex of yet undefined entities. Recent research suggests that other factors may also be involved; plant age (Hansen *et* *al.* 1991), seed age and dormancy requirements (Roche *et al*. 1997; Hunter *et al.* 1998), local population differences (Benwell 1998; Hunter 1999a), the cumulative effects of fires, stem size (Morrison & Renwick 2000), post fire climate (Cohn & Bradstock 2000), or presence of predators (Clarke *et al.* 1996; Cohn & Bradstock 2000). The application of fire regimes at the community level based on the culmination of the responses of individual taxa is of debatable use. Morrison and Renwick (2000) warn that land managers should be aware that predictions on community dynamics based on placing species into categories according to perceived generalised response to fires are highly suspicious as no simple category can cover the potential range of post fire behaviours. Differences in fire responses within individual species and/or populations may exist in nearby or the same sites. However, from the literature and the responses of individual taxa broad general statements can be formulated for many communities. These suggestions should then be modified to suite the local variation in responses, as data that is more specific becomes available. Research and constant monitoring can only achieve this.

Other facets of fire management include the post fire environment. Studies in temperate Australia have shown that grazing after fires can effect species composition significantly and this can be greater in smaller and/or patchy burns (Leigh & Holgate 1979). Grazing pressure from introduced rabbits, but also from native fauna such as Kangaroos is accentuated in small burns if dry conditions follow in the post fire environment (Cohn & Bradstock 2000). There is a need to regulate feral animals such as rabbits if good seedling recruitment is to occur in the post fire environment (Cohn & Bradstock 2000).

Morrison and Renwick (2000) have highlighted a number of issues that may need to be considered when applying management burning regimes and these include:

- Population dynamics of different species will diverge after a prescribed fire in comparison to a wildfire.
- Any particular fire intensity affects some species more than others and any regime will favour a particular subset of species within a community

- No simple classification scheme of plant responses to fires can cover the potential range of post-fire behaviour
- To predict the fate of a population in response to a fire it is necessary to know whether the individuals have been subjected to 100% leaf scorch rather than whether it is fire-tolerant or fire-sensitive
- Species subject to previous fires will be more susceptible to further fires.
- It is clearly inappropriate to predict community responses from a limited study of one or a few species, because species will vary considerably even within a single category.

Prescribed fires probably will have little effect on the occurrence or intensity of the subsequent wildfire, low intensity fires have little affect on fuel loads, as such they will be inadequate as a fire-control measure.

Fire research has often emphasized species richness as a management goal. In most situations, overall richness is achieved by maintaining communities at an intermediate stage of development by constant and moderate disturbance. However, as Gill (1977) comments, managers should consider recommending protection of older stands of vegetation from fire so that chronosequences remain. Variability and adaptability in fire regimes is the goal suggested by recent research (Bradstock *et al.* 1995; Conroy 1996). Rigorously imposed fire regimes based on blocks in the landscape are unachievable. Single wildfire events can severely disrupt imposed fire regimes. It is suggested that overall, the results of wildfires should be incorporated in an adaptive regime that creates a variability in chronosequences (Bradstock *et al.* 1995) and that some mature systems be maintained even though richness will decline. Some species even within a single assemblage are associated with more regular fires and others will only occur in longer unburned stands. Maintenance of chronosequences will require that the extent and effects of fire both natural and human induced are constantly monitored and updated. This approach should be modified in communities that are highly restricted or have known frequency thresholds, in such communities management of fire regimes will need to be more direct. The extremes of the frequency scale of fires should be based on the population extinction risk of taxa of importance rather than richness and density (i.e. diversity) (Bradstock *et al.* 1995).

Due to the very large gap in knowledge of responses of some communities, both in terms of frequency and intensity of fire, only a few broad management guidelines can be recommended.

- Collation of fire records, verbal reports and evidence from aerial photographs.
- When fires occur, accurate boundary maps of the extent of fires should be made. This needs to include accurate ground truthing.
- Map opportunistic evidence of lightning strikes.
- Site specific research needs to be conducted in each of the communities within the reserve.
- Fires should be excluded from Dry Rainforest and associated ecotonal areas.
- Old age stands (absence of fire) of all community types should be maintained in possible.
- Feral animal control will need to precede or accompany any management burns particularly if weather conditions are dry post fire.

4.2.1 *Callitris* dominated woodlands

The affects of fire and its various aspects on the natural communities within the study area can only be guessed at based on the scanty information that exists for some of major species. Most communities within the study area are dominated by *Callitris endlicheri* and various Ironbarks and Gums. *Callitris* spp. are very sensitive to fire, being killed outright if crown scorch occurs (Bowman *et al.* 1988; Bowman & Latz 1993; Latz 1995). Furthermore, high intensity fires can have a longer lasting affect beyond simply removing the adult trees. The long-term management of *Callitris* spp. requires a reduced fire intensity (Bowman & Latz 1993) as seed production has been shown to decline after severe fires (Hawkins 1966). Seedlings of *Callitris* spp. are easily killed by browsing animals such as rabbits, sheep and goats (Johnson 1967) when regenerating.

Callitris endlicheri however, is an aggressive coloniser of new sites in the absence of severe wildfires or grazing (Forestry Commission of New South Wales 1988; Young

& McDonald 1989). Although *Callitris* seeds have no longevity the species are prolific seeder and will regenerate thickly, but the species lacks a self-thinning strategy (Forestry Commission of New South Wales 1988). In the absence of fire *Callitris* can become mono-dominant and exclude most other species. For example, at Howell the region has gone from eucalypt dominated woodlands where *Callitris* was rare, to one that is almost mono-dominant with *Callitris* due to the lack of fire (Hunter 1998). Thinning will only occur through low intensity fires and its subsequent removal of individual trees rather than a whole population (Forestry Commission of New South Wales 1988).

Gill (1981) describes a replacement series in *Callitris* – *Eucalyptus* woodlands. The simplest scenario describes *Eucalyptus* species as being resprouters that will regenerate from seed only after fire. *Callitris* is killed by fire yet the canopy- stored seed will be released and can germinate any time in the inter-fire period. *Callitris* seedlings however take ten years to become reproductively mature. Without fire *Callitris* will dominate, as it will continue to recruit while the *Eucalyptus* species will eventually die out (c. 100 years). Fire intervals of less than ten years will promote *Eucalyptus* as the only survivor. For a mixed stand to develop, according to this basic model, fires need to be greater than ten years and less than 100 years. As more species are considered however the model becomes more complex.

4.2.2 Fire and areas of impeded drainage

Only a small number of areas exist with impeded drainage and these have wet heath and sedgeland species. Research in sedgelands conducted within the Gibraltar Range National Park suggests that composition is little changed by time since fire and richness does not decrease (Williams 1995). Williams (1995) suggests that although fires as frequent as six years apart can be tolerated but 10 yrs is probably more appropriate. The composition of wet heath sites is reported to be different due to time since fire. Williams (1995) suggested that wet heaths within Gibraltar Range National Park require a fire frequency of between 10-15 yrs and that although higher frequencies can be tolerated they are likely to be destructive. The wetland areas within the study area do not conform to those studied in Gibraltar Range though, and they posses a greater percentage of grasses and other non cyperoid forms. It is likely that longer inter-fire intervals may also be sustainable.

4.2.3 Fire and granite outcrops

Fire studies of sclerophyllous heath vegetation in Australia have occurred primarily in coastal southeastern Australia (Williams 1995). Subsequently it has been thought that all sclerophyllous vegetation is subject to frequent recurring fire events. Specht (1981) states that dense sclerophyllous vegetation contains species with a remarkable capacity for regeneration after fire and that fire is a major factor determining seedling germination. Gill and Bradstock (1981) also consider fire is of major importance to the perpetuation of heathlands of the world.

Shrubs are thought to dominate the vegetation on outcrops within eastern Australia (Clarke 2002a,b) and sclerophyllous heaths have been described on rock outcrops within the New England Batholith of eastern Australia (Hunter & Clarke 1998). These outcrop heaths share genera with the surrounding matrix vegetation that are known to require frequent fire for regeneration. Assumptions that fires are important in structuring rock outcrop heaths are reinforced by these shared genera (Hunter & Clarke 1998; Hunter 1999; Clarke 2002b). Clarke and Fulloon (1999) suggest that the fire history of rock outcrops should be conservatively estimated from the fire regimes of the surrounding matrix. However, evidence collected from rock outcrops indicates the flora from these environments are not adapted to the high frequency of fires that occur within the surrounding matrix (Ashton & Webb 1977; Fuls *et al*. 1992; Gr★ger & Barthlott 1996; Beard 1997; Hopper *et al.* 1997; Heinze *et al.* 1998; Hunter 1998a; Lawler *et al.* 1998; Hopper 2000).

Published evidence suggests that under a continuous frequent burning regime the flora of outcrops may lose their distinctiveness. For example, Binns (1992) found that a high frequency of fire on granitic outcrops, in the same region, caused heaths that were dominated by outcrop endemic taxa to be reduced to grasslands and herbfields dominated by ubiquitous species such as *Lomandra longifolia* and *Imperata cylindrica*. Hunter *et al.* (1999) has made similar anecdotal observations at Demon NR.

Limited quantitative information has been available recently regarding the fire responses of the flora on rock outcrops in eastern Australia (Hunter 1995; Hunter *et al.* 1998; Hunter 1998a; Hunter 1999; Clarke & Fulloon 1999). From this information it has been hypothesized that convergence has occurred on rock outcrops to favour obligate seeding traits in a general matrix of fire prone vegetation due to the physical barrier of rock limiting fire incursions (Clarke 2002a,b).

Hunter (2002) has shown that only 5.6% of species found on outcrops within the New England Batholith of eastern Australia are entirely endemic to this habitat, but that a further of 18% were primarily outcrop occurring. Thus, the majority of species are shared between outcrops and the surrounding vegetated matrix within the Batholith, this is typical of habitat islands (Cook *et al*. 2002). Despite the large number of shared species a significant pattern of fire-response divergence is apparent. Within the Batholith, the proportion of obligate seeders is generally greater on rock outcrops than in the surrounding vegetated matrix. This pattern has been anecdotally reported for the New England (Binns 1995) and quantitatively reported for the Torrington pluton (Clarke 2002b) and the Bald Rock pluton (Hunter *et al* 1998; Hunter 1999). The same pattern has been observed in other regions of Australia such as in Victoria (Ashton and Webb 1977; Hunter 1998) and Western Australia (Erickson *et al.* 1991; Beard 1997; Hopper *et al.* 1997).

Hunter (2003a) has shown from region wide analyses of fire response traits that there is an increase in the importance of obligate seeders on rock outcrops which was statistically significant across the New England Batholith (Figure 52). It is important to note that despite the increase in the abundance of obligate seeders on rock outcrops compared to the surrounding matrix in most plutons, Hunter (2003a) found that in no instance were more than 50% of records in this category. This study found that the most abundant species on rock outcrops throughout the New England were resprouters. Clarke (2002b) also found that resprouters were more abundant than obligate seeder on rock outcrops in the New England. In contrast, Clarke (2002a,b) states that the most abundant species on rock outcrops were shrubs killed by fire even though obligate seeders in total in his study only accounted for less than 20% of all species recorded on rock outcrops (Clarke 2002b).

Clarke (2002b) argues that outcrop habitats should not be regarded as fire 'refugia' as the vegetation is flammable and outcrops are burnt with a greater frequency than every 100 years. Clarke (2002b) further argues that the species are merely fire sensitive rather than intolerant, as most species require fire-related germination cues. However, Clarke and Fulloon (1999) showed that outcrop endemic species were '… *recalcitrant showing little or no germination despite the imposition of fire related cues.*'. Evidence was provided showing outcrop endemics germinated when exposed to light and moisture (Clarke & Fulloon 1999). Species found to respond to fire related germination cues were those found more commonly in the surrounding matrix.

Incursions of fire occur regularly on rock outcrops in the New England particularly where 'tongues' of vegetation rise from the surrounding matrix. Evidence of fire can be found on many outcrops in these places. However, the true outcrop vegetation found in soil basins within rock pavements (Porembski *et al.* 2000) are only likely to be burnt in the most extreme fire events. In 1994, intensive and broadscale fires occurred along the east coast of Australia, these fires burnt out 90% of some of the rock outcrop areas areas, yet the vegetation on most outcrops still did not burn (Hunter *et al.* 1998). It is apparent that fire intervals on outcrops are likely to be greater than 100 years and may indeed be several hundred years in these instances.

Rock outcrops, particularly granitic outcrops, form ancient and stable landscapes (Burbank and Platt 1964; Porenbski *et al.* 1994; Bussell and James 1997; Porembski *et al.* 1997) with some outcrops being exposed for at least 200 000 years and others for millions of years (McVaugh 1943). Fire frequencies are likely to have increased within Australia in the late Tertiary and particularly in the Quaternary and this has continued to the present day. Such increased fire frequencies may have increased selection for resprouters over obligate seeders (Clarke 2002b). The flora primarily occurring and endemic to rock outcrops within the New England would have colonised these ancient habitats before the increase in aridity and fire regimes of the later Tertiary, including the shrub taxa associated with heaths (Specht 1979a). Obligate seeding is the ancestral state and resprouting the derived state (Clarke 2000a).

Refuge theory suggests that certain restricted areas have continuously supported the same vegetation type throughout periods of generally unfavorable conditions (Huston 1994). Convergence is the development of similarities between organisms of different groups resulting from adaptation to similar habitats. This necessarily implies that species have come from one state and have moved to another due to a similarity in evolutionary pressure.

Although some species primarily or entirely restricted to the rock outcrop habitat are flammable (though these are not the major life form type), there is no evidence to support the suggestion that most rock outcrop species require fire related cues for germination. Obligate seeding is the ancestral state and fire regimes on outcrops are likely to have intervals greater than 100 years in many instances, indicating outcrops are refuges from frequent fire rather and that convergence has occurred in the surrounding matrices for the resprouter response trait. However, outcrops do produce ‘fire shadows’ in the surrounding vegetation, which is achieved due to protection by the physical nature of the rocks and from the increased runoff associated with the impermeable rock surface (Moran & Hopper 1983; Lawler *et al.* 1997; Wyatt 1997), which can support a more mesic skirt of vegetation.

In fire experiments carried out by Hunter (1999) outcrop species fire responses to treatments imposed were individualistic and based on the species pool available at each site (outcrop or matrix area) and the initial composition of each plot. Similar results have been obtained in many Australian systems and illustrate the ‘initial floristic composition’ model (Engler 1954), where the initial species composition after a disturbance determines the subsequent composition (Purdie 1977ab; Noble & Slatyer 1981; Clark 1988; Williams & Gill 1995). It is apparent that there is a great inherent variability in responses that are based on initial composition and individual site characteristics. Such inherent variability has been found consistently in studies of granitic outcrops and their component floras at all levels. Such responses would enable the maintenance of a high level of biodiversity and richness on a habitat (beta diversity) and landscape (gamma diversity) scale. Richness and diversity however, would be limited on the local scale (alpha diversity) by initial composition and the available species pool.

Bradstock and Auld (1995) have shown that low-intensity fires may be detrimental, as the heat may be insufficient to stimulate the germination of buried and dormant seeds. Even after the very large 1994 fires in this region, a number of vegetation outcrops did not change dramatically in their composition even when they occurred on the same outcrop as patches that did.

The frequency of large and extensive fires such as those that occurred in 1994 is low. The development of management strategies for the promotion of these species is problematical. General fuel reduction burning for asset protection in the surrounding forest and woodland systems is common in and near these reserves. Such strategies are likely to decrease the likelihood of extreme fires that are needed to promote germination on the larger outcrops. Direct ignition of outcrops is labour intensive and the required combination of environmental factors for promoting these fire-ephemeral species is unknown. Certainly fires of the wrong intensity or at the wrong time of the year could be harmful (Bradstock & Auld 1995). The experimental results suggest that the responses of patches of vegetation on outcrops are highly individualistic and framed by the initial species composition and source pools both in the seed bank and as above ground extant individuals. These communities, particularly on high altitude granitic outcrops, have evolved with a frequency of fire that is much reduced compared with the surrounding vegetated matrix. Also the recorded history of the district does not shed much light on past fire frequency. Therefore, an increase in the frequency of fires on outcrops may have undesirable effects on outcrop communities, particularly as the majority of species may be fire evaders. Thus, fire management for conservation of granitic outcrop floras is problematical and will need separate consideration from fire management regimes for the region in general.

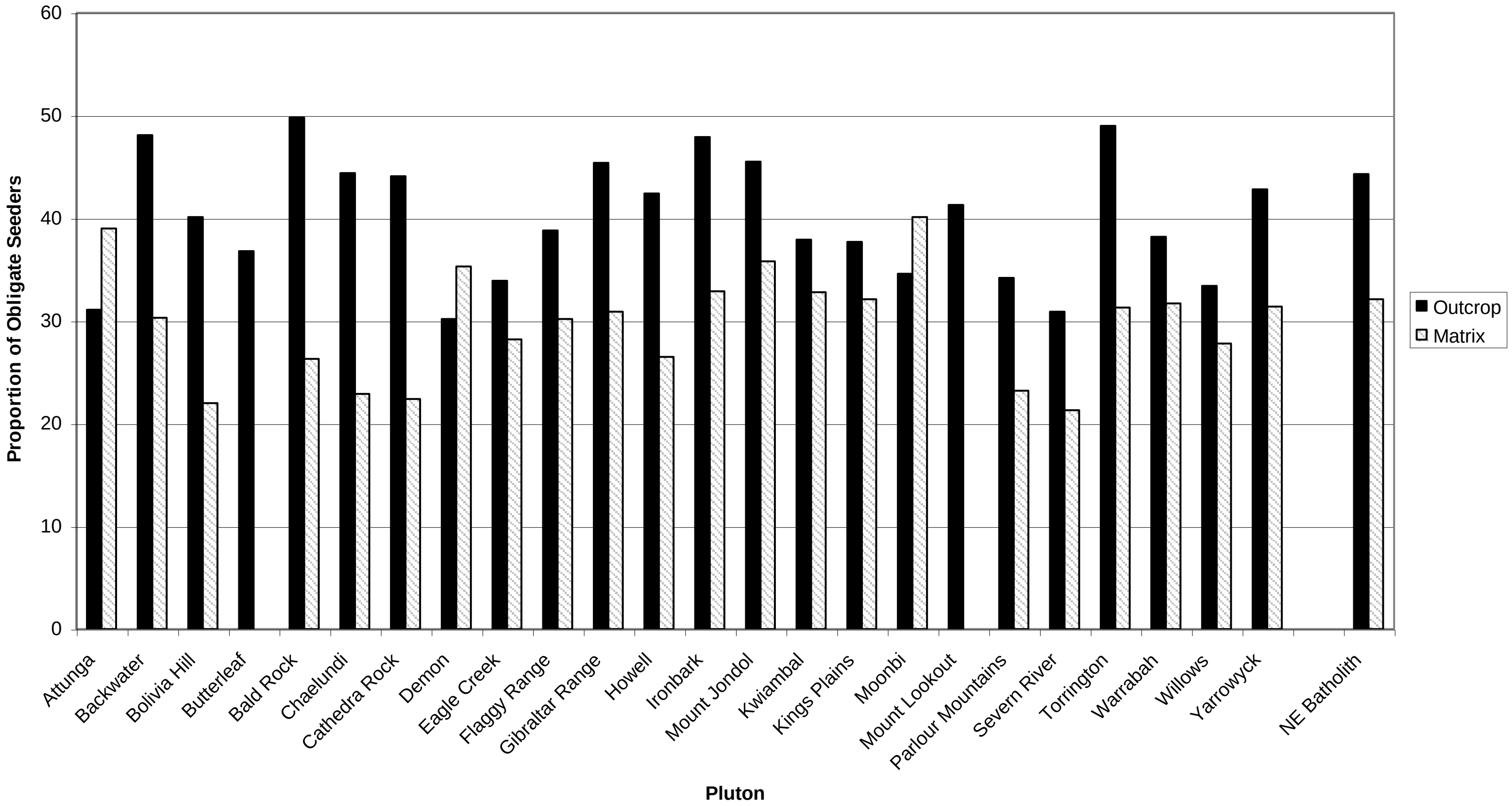


Figure 52: Differences in the proportion of obligate seeders for the flora of outcrops in each pluton compared to the proportion of obligate seeders for the surrounding vegetated matrix. Note two of the plutons did not have the surrounding matrix sampled. (From Hunter 2003a).

Table 12: Suggested fire regimes for each of the eleven defined communities. The suggestions made here are only broadly applicable.

Community	Suggested Fire Regimes
Community 1: Red Stringybark – Red Gum Woodlands	No two fires within a 10 year period. Fires generally within a 20-50 yr period with a maximum of 100 yrs. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr period after a high intensity fire.
Community 2: Caley's Ironbark – Blackbutt Woodlands	No two fires within a 15 yr period. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches. Generally a 30 to 100 yr fire intervals to maintain the mixed nature of the dominants.
Community 3: Orange Gum – Blackbutt Woodlands	No two fires within a 10 yr period. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches. Generally a 30 to 100 yr fire intervals to maintain the mixed nature of the dominants.
Community 4: Tumbledown Gum – Blackbutt Woodlands	No two fires within a 15 yr period. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches. Generally a 30 to 100 yr fire intervals to maintain the mixed nature of the dominants.
Community 5: Orange Gum – Red Gum Woodlands	No two fires within a 15 yr period. Fires to be of greater intervals following high intensity fires i.e. not within a 25 yr period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches. Generally a 30 to 100 yr fire intervals to maintain the mixed nature of the dominants.
Community 6: Quinn's Gum – Orange Gum Forests	No two fires within a 20 yr period. Fires to be of greater intervals following high intensity fires i.e. not within a 30 yr period after a high intensity fire. Small low intensity fires may occur of higher frequency but only in small patches. Generally a 30 to 100 yr fire intervals to maintain the mixed nature of the dominants.
Community 7: Rough-barked Apple – Red Gum Woodlands	No two fires within a 10 year period. Fires generally within a 10 to 30 yr period and a maximum of 50 yrs.
Community 8: River Oak – Red Gum – Apple Forests	Highly variable fire regime on a site by site basis. Exclude fires from *Casuarina cunninghamiana* sites; of intervals between 50 + years where rock outcrops dominate banks and within 10 to 30 and up to 50 yrs in grassy Apple and Box sections.

Community	Suggested Fire Regimes
Community 9: Fringe Myrtle – Daisy Bush Open Shrublands	No requirement for management burns. No two fires within a 20 yr period. Fires between 20 yrs to indefinite. Some areas maintained with high fire intervals
Community 10: Homoranthus Open Shrublands	No requirement for management burns. No two fires within a 20 yr period. Fires between 20 yrs to indefinite. Some areas maintained with high fire intervals
Community 11: Tea-tree Wetland	Fires or flooding required to stimulate changeover of species. No two fires within a 15 yr period. Fires at least 20 yrs part but generally not longer than 50 yrs.

4.3 Introduced taxa

In most instances, introduced plants require some form of disturbance or modification of the environment, such as an increase in nutrients, to become established. Within the study area there 9% of the flora was found to be introduced in origin. This is similar to other reserves within the same bioregion such as Severn River Nature Reserve, Stony Batter NR and Warra National Park (Table 4), however it is still lower than the 31% recorded for the nearby Warrabah National Park and the 11% of Single National Park (Table 3). Most of the exotic taxa are associated with tracks, areas of past clearing, and disturbed creek margins.

The occurrences of introduced species are disproportionately distributed within certain communities. Community 3 for example had no recorded weed taxa yet Community 8 had 15% of its flora introduced in origin flowed by Community 11 with 14% and Community 4 with 11%. All other communities had between 3 and 6% weeds. All of the most heavily infested communities are associated with riparian or wetland areas and the next most infested were associated with gullies and areas previously cleared.

Almost all species are fairly ubiquitous and are general environmental weeds that pose little direct problem to ecosystem processes (Table 8). The most common introduced species overall was *Hypochaeris radicata* (Catsear) followed by *Conyza albida* (Fleabane). Many species were only found with a summed cover of only 1 or 2 across 110 sites. Other species were only noted opportunistically. *Rubus chlooocladus*

(Blackberry) appears to be the only serious weed that will need constant control. This species obtained the fourth highest combined cover score for weeds and was considered a serious problem along some creeks.

In contrast to the rare and threatened species (Section 3.4.3) the majority of introduced species are associated with lower topographic sites on deeper less well drained soils (Figure 16). Most of the introduced species are divided in the constrained ordination between those that are correlated with a north and western distribution and those with an eastern occurrence. A number of introduced species are also correlated with areas protected from the north and where more common in the north.

The most serious weed threat for the conservation areas relate to a potential threat rather than one that exists at present. Currently some of the more invasive troublesome weeds occur along the main unsealed roads leading to the conservation areas. These include *Hyparrhenia hirta* (Coolatai Grass), *Eragrostis curvula* (African Lovegrass) and *Andropogon virginicus* (Whiskey Grass) to name a few. All of these are currently listed as a key threatening process. All of these, and in particular Coolatai Grass has the potential to overtake and devastate the understorey of nearly all the assemblages described here, including affecting the recruitment of overstorey species. This grass also has the potential to exclude many fauna species associated with the understorey flora species. This has occurred in a number of conservation reserves already including parts of Mt Yarrowyck Arakoola and Mann River Nature Reserve and Kwiambal National Park. In cannot be stated strong enough that the introduction of these grasses and their establishment must be avoided.

The control of exotic plants within a conservation area is a complex issue. Application of herbicides can be inappropriate as native vegetation or animals in streams may be affected. The affects on native vegetation needs to be minimised. Many weeds while a problem due to their widespread occurrence in natural areas may be left as a low priority for management. Some examples include *Hypochaeris radicata*, and *Stellaria* spp. which are in general ubiquitous to most communities and would be impossible to control.

4.3.1 Riparian zones

The greatest number of introduced taxa occur along the more accessible parts of the larger creeks probably due to a combination of previous grazing and clearing and flood damage. Increased nutrients from fertilizer application on neighboring land, the naturally richer soils and higher soil moister can also favour exotic species. The most troublesome weed in this area is Blackberry.

It should be noted however that invasions from upstream outside the boundaries of the reserve are difficult or impossible to manage from the perspective of the managers. In the short term many species can be rapidly replaced due to seeds from upstream, these weed invasions should be controlled to reduce their incidence and subsequent build up of seed banks.

4.3.2 Fire trails

Exotic taxa occur along boundaries and tracks but they will usually be restricted to a short distance from the disturbed area. The movement of vehicles along tracks encourages the spread of weeds. This is particularly true if vehicles have to move through heavily infested areas prior to reaching the desired trails. This is the case in most situations as the main trails pass through private grazing land before entering the reserve.

If trails are to be upgraded at any time, then modification of creek crossings may need to occur so that they are less prone to vehicle damage and erosion. Braiding of trails should be avoided as this only increases the area disturbed and open for weed establishment.

4.4 Conservation status of taxa and communities

Approximately 60% of the woody vegetation in the New England Bioregion has been cleared (Benson 1999). Most of the assemblages within the Park are considered adequately reserved of little concern currently. Temperate eucalypt woodlands area amongst the most poorly conserved and threatened ecosystems in Australia having borne the brunt of agricultural development for well over 150 years (Yates & Hobbs 2000). Tree cover has been reduced to only 15% of its cover on the slopes are of the Namoi Catchment (DeVries 2000). Dieback is a significant problem in the Namoi Catchment particularly in the tablelands areas and along watercourses (DeVries 2000).

Morgan and Terrey (1999) considered the Eastern Nandewars (Province 16), of which the study area is included, to be at a critical stage of development. Severe soil damage is likely if current development practices continue (Morgan & Terry 1999) and at present soil structure decline is moderate to severe in 35% of the Namoi catchment (DeVries 2000). Most of the developed areas are acid soils with an overuse of nitrogenous fertilisers and introduced legumes and these leached nutrients are causing problems in the Namoi River (Morgan & Terry 1999). In addition, the Namoi Catchment is a major source of phosphorus to the Barwon-Darling River (DeVries 2000). 60% of the Namoi River and its major tributaries have erosion problems (North West Catchment Management Committee 1999). The riparian vegetation of most creeks in the upper catchment of the Namoi River is in poor condition because of grazing pressure and clearing which is usually extended to creek banks (DeVries 2000).

The middle sections of the Bundarra-Barraba Rd which is where the study area lies is considered a priority for conservation in the Nandewar Bioregion (Morgan & Terrey 1992). Within the Nandewar Bioregion this area consists of 13075 ha of remnant (area 56) and is considered a Core Area of significance (DeVries 2000). Both reserve areas are covered by a Key Regional Habitat Corridor.

4.4.1 Communities

Throughout both conservation areas grassy White Box – Yellow Box – Blakely's Red Gum occur. Communities with one or more of these species as dominants are considered as Endangered on the *TSC* Act. In addition, Grassy White Box Woodlands are considered to be Endangered on the federal *EPB&C* Act. Parts of what could be termed Grassy White Box Woodlands occur within Ironbark Nature Reserve. Thus some parts of both conservation areas are listed as Endangered.

In terms of the communities as circumscribed here, none are considered to be overly represented in the conservation network. Only a few assemblages such as Community 2, 3, 9 and 10 were thought to be reasonably conserved locally but were poorly conserved across their range. Community 7 was considered endangered and Community 4, 8 and 11 were thought to be vulnerable. All other assemblages were neither conserved well locally or across their range.

Quality is often not considered adequately in discussion of representation within conservation areas, yet this is as important as the capture of types. One of the more significant features of both conservation areas are sections that are old growth. Very little old growth exists in general and even less on the western side of the tablelands. Old growth woodlands of any type are Endangered and areas of old growth occur across all the assemblages described. Some localities may have the potential to develop depauperate vine thickets if left unburned for sufficient time, for example gullies on Townsend's Mountain. A number of the significant species discussed in the next section are associated with western dry rainforests and vine thickets.

At present, the most significant threats to these assemblages are pigs and stray cattle. Pigs in particular have caused extensive damage in creek and gully areas and on rock outcrops. Goats have browsed heavily in some rock outcrop areas degrading some stands significantly. Blackberry is a problem in limited areas also. The small extent of some assemblages means that they probably are not self sustainable in the long term if fragmentation continues outside of the conservation areas. The overall area of the current reserves is likely to be inadequate to preserve the long term ecologically processes within them without further addition of lands. The invasion of exotic grasses such as Coolatai Grass is a Key Threatening Process that is a serious potential threat to all assemblages within the conservation areas.

4.4.2 Species

39 species were considered of significance within the conservation areas under investigation. Of these nine were considered to be rare or threatened, nine are listed as RoTAPs or listed under that criteria and two on the *TSC* Act one as Vulnerable and

one as Endangered. Two of these species are thought to be largely restricted to the study area, both of which have their type localities within *Bornhardtia*. This is a significant number for a conservation area of this size. The number of significant species may increase with further investigations. A number of the rare or threatened species may not be secure within the study area and were only noted from opportunistic recordings and some only during previous investigations. Targeted searches for these sparser species would be of benefit and an assessment of their population sizes are necessary.

Many of the species of significance are outliers from other regions. In particular, a number of species associated with vine thickets and western dry rainforest were found in low numbers.

4.5 Management considerations

Due to the number of rare or threatened species a number of management options may need to be considered and these could include:

- Targeted surveys to establish the population sizes of rare species.
- Targeted searches for species not yet found, but which are likely to occur.
- Research into appropriate fire regimes.
- Finding major weed infestations of Blackberry.
- Limit and control weed invasions into areas of vegetation of regional significance or restricted distribution in the reserve.
- Reduce the potential of Key Threatening weeds establishing.
- Limiting the use of trails to dry weather conditions.
- Upgrading sections of trails to lessen impact on creeks and gullies.
- Avoid braiding trails by using new paths.
- Co-ordination of weed programs with local authorities and neighbours to ensure infestations do not build up around boundaries.
- Control of feral pigs.
- Control of feral goats.
- Control of feral rabbits.

- Removal of stray cattle.
- Consolidation of boundaries.
- Land acquisition or further VCA agreements to limit fragmentation around the conservation areas and to insure ecological resilience.

4.6 Conclusion

Ironbark Nature Reserve and *Bornhardtia* Voluntary Conservation Area complement each other in terms of the species found and the communities described. A number of species and some of the communities are only found in one or other of the conservation areas but not both. The *Bornhardtia* VCA captures areas that are of limited extent within Ironbark Nature Reserve. In total nine national significant flora species and up to 39 significant flora species in total occur in these conservation areas. At least one community is listed as Endangered on the *TSC* Act, another is listed on the *EPB&C* Act, and all assemblages described are inadequately reserved across their range. Many areas exist that are Old Growth in structure despite past clearing of some areas. The representation of old growth woodlands across many vegetation assemblages is as important a feature of these conservation areas as endangered species and communities.

The study area represents a crossover of the floras of the slopes and tablelands and is a highlighted significant remnant under the major north southwestern regional corridor. The region is at a critical stage of development were further degradation will cause significant changes to the region, and if development is not increased many of the natural features and ecosystem services may be maintained.

Currently few problems exist in terms of invasive weeds, Blackberry being the most significant problem. Pigs and goats are a serious threat to some areas. The conservation areas alone are not large enough to ensure continued ecosystem processes or the long-term viability of all species. Addition of lands, or the incorporation of lands under conservation agreements around these areas is needed to ensure the values within the study area.

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Appendix A: Site Record Forms.

Glen Innes: Vegetation Survey Form	

Date: _____________ Recorder: _________________________________Site No: ___________________

Film No: ___________ Photo No: _____________________ Quadrat Size:_________________________

General Location: ____

Map Name: _____________________ Scale: _____________________
AMG Ref: _____________________E _________________________N
Lat:______________________'S Long: _________________________'E

Landform Pattern: ____
Physiography:(circle)
Crest Upper Slope Mid-slope Lower Slope Flat Open Depression

Altitude: _____________________metres
Slope: _____________________degrees
Aspect: _____________________degrees (magnetic)
Horizontal Elevation: N_____NE_____E_____SE_____S_____SW_____W_____NW_____

Map Geology: ________________________________ Lithology: ________________________________

Soil: (circle)
Drainage: Waterlogged Damp Moist Well drained
Texture: _____________________________________
Colour: _____________________________________
Depth: Deep (>1m) Shallow (0.3-1m) Skeletal (<0.3m)

Fire History (how determined)____

Other Disturbance: (circle) clearing logging grazing erosion feral animals
other
(state):____

Vegetation Structure: (Walker & Hopkins, 1990)

Stratum	Height (m)	% Cover	Dominant Species

Structural Formation Class: ____
Comments:____
____
____
____
____

Appendix A: Site Record Forms.

Floristic Composition: Site No:

No.	Species	C/A	Canopy Spp	Data	No.	Species	C/A	Canopy Spp	Data
1					31				
2					32				
3					33				
4					34				
5					35				
6					36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				

C/A: Cover Abundance Scale -Modified Braun Blanquet
Data: to be marked when entered into computer database

1 = cover less than 5% of site and uncommon
2 = cover less than 5% of site and common
3 = cover of 6-20% of site
4 = cover of 21-50% of site
5 = cover of 51-75% of site
6 = cover of 76-100% of site

Appendix B: Taxon list with recognised authorities and common names.

Flora of
Bornhardtia VCA
and
Ironbark Nature Reserve
(Dr John T. Hunter)

Pteridophytes & Allies

Adiantaceae
Adiantum aethiopicum L. ....Common Maidenhair
Adiantum hispidulum Sw...Rough Maidenhair

Aspleniaceae
Asplenium flabellifolium Cav. ....Necklace Fern
Pleurosorus subglandulosus (Hook. & Grev.) Tindale ....Blanket Fern

Blechnaceae
Blechnum wattsii Tindale ....Hard Water Fern
Doodia aspera R.Br...Prickly Rasp Fern
Doodia caudata (Cav.) R.Br..Rasp Fern

Dennstaedtiaceae
Histiopteris incisa (Thunb.) J.Sm..Bat’s Wing Fern
Hypolepis glandulifera Brownsey & Chinnock ....Ground Fern
Pteridium esculentum (G.Forst.) Cockayne...Bracken Fern

Grammitaceae
Grammitis billardieri Willd...Finger Fern

Ophioglossaceae
Ophioglossum latiusculum L. ....Adder’s Tongue

Polypodiaceae
Pyrrosia rupestris (R.Br.) Ching ....Rock Felt Fern

Psilotaceae
Psilotum nudum (L.) P.Beauv...Skeleton Fork Fern

Sinopteridaceae
Cheilanthes distans (R.Br.) Mett. ....Hairy Rock Fern
Cheilanthes sieberi Kunze
subsp. *sieberi*..Narrow Rock Fern
Pellaea nana (Hook.) Bostock ....Sickle Fern
Pellaea paradoxa (R.Br.) Hook. ....Sickle Fern

Cycads

Zamiaceae
Macrozamia heteromera D.L.Jones ....Cycad

Conifers

Cupressaceae
Callitris endlicheri (Parl.) F.M.Bailey ....Black Cypress Pine

Monocotyledons

Anthericaceae
Arthropodium milleflorum (DC.) J.F.Macbr...Vanilla Lily
Arthropodium sp. A...Vanilla Lily
Laxmannia compacta Conran & P.I.Forst. ....Compact Wire Lily
Tricoryne elatior R.Br. ....Yellow Lily

Asphodelaceae
Bulbine bulbosa (R.Br.) Haw. ....Golden Lily

Centrolepidaceae
Centrolepis strigosa (R.Br.) Roem. & Schult.
subsp. *strigosa*..Centrolepis

Colchicaceae
Wurmbea biglandulosa (R.Br.) T.D.Macfarl..Early Nancy

Commelinaceae
Commelina cyanea R.Br..Scurvey Weed
Murdannia graminea (R.Br.) G.A.Bruckn. ....Lily

Cyperaceae
Carex appressa R.Br. ....Sedge
Carex breviglumis R.Br. ....Sedge
Carex gaudichaudiana Kunth ....Sedge
**Cyperus aggregatus* (Willd.) Endl. ....Sedge
Cyperus bifax C.B.Clarke ....Sedge
Cyperus fulvus R.Br..Sticky Sedge
Cyperus gracilis R.Br. ....Sedge
Cyperus lucidus R.Br..Sedge
Cyperus sanguinolentus Vahl. ....Sedge
Cyperus secubans K.L.Wilson ....Sedge
Cyperus sphaeroides L.A.S.Johnson & O.D.Evans ....Sedge
Eleocharis pusilla R.Br. ....Sedge
Eleocharis sphacelata R.Br. ....Sedge
Fimbristylis dichotoma (L.) Vahl. ....Common Fringe Rush
Gahnia aspera (R.Br.) Spreng...Sedge
Isolepis hookeriana Boeck. ....Hookers Isolepis
Lepidosperma gunnii Boeck. ....Saw Sedge
Lepidosperma laterale R.Br. ....Variable Saw Sedge
Rhynchospora brownii Roem. & Schult. ....Grassy Beak Rush
Schoenus apogon Roem & Schult. ....Sedge
Scirpus polystachyus F.Muell. ....Large-head Club Rush
Scleria mackaviensis Boeck. ....Sedge

Haemodoraceae
Haemodorum planifolium R.Br. ....Blood Root

Hydrocharitaceae
Villisneria gigantea Graeb. ....Ribbon Weed

Hypoxidaceae
Hypoxis hygrometrica Labill. ....Golden Star

Iridaceae
Patersonia sericea R.Br. ex Ker......Blue Flag
Sisyrinchium sp. A......Scourweed

Juncaceae
**Juncus bufonius* L......Toad Rush
Juncus continuus L.A.S.Johnson......Rush
Juncus fockei Buchenau......Rush
Juncus holoschoenus R.Br......Rush
Juncus pauciflorus R.Br......Rush
Juncus remotiflorus L.A.S.Johnson......Rush
Juncus subglaucus L.A.S.Johnson......Rush
Juncus subsecundus L.A.S.Johnson......Rush
Juncus usitatus R.Br......Rush
Juncus vaginatus R.Br......Rush
Luzula flaccida (Buchenau) Edgar
forma B......Grass Rush

Juncaginaceae
Triglochin multifructum Aston......Arrowgrass

Lomandraceae
Lomandra confertiflora
subsp. *pallida* Britten......Matt Rush
Lomandra filiformis (Thunb.) Britten
subsp. *filiformis*......Wattle-leaved Mattrush
Lomandra longifolia Labill......Long-leaved Mattrush
Lomandra multiflora (R.Br.) Britten......Hard Mattrush
Lomandra sp. aff. *cylindrica*......Round-leaved Mattrush

Luzuriagaceae
Eustrephus latifolius R.Br. ex Ker Gawl......Wombat Berry

Orchidaceae
Acianthus exsertus R.Br......Acianthus
Acianthus collinus D.L.Jones......Acianthus
Caladenia fimbriatus (R.Br.) Rchb.f......Fringed Helmet Orchid
Caladenia fuscata (Rchb.f.) M.A.Clem. & D.L.Jones......Fairy Orchid
Calochilus gracillimus Rupp......Slender Beard Orchid
Corybas fimbriatus (R.Br.) Rchb.f......Fringed Helmut Orchid
Cymbidium canaliculatum R.Br......Tiger Orchid
Dipodium variegatum D.L.Jones & M.A.Clem......Hyacinth Orchid
Diuris abbreviata Benth......Lemon Doubletail
Dockrillia linguiforme (Sw.)......Tongue Orchid
Lyperanthus suaveolens R.Br......Brown Beaks
Microtus unifolia (G.Forst.) Rchb.f......Common Onion Orchid
Pterostylis coccina Fitzg......Greenhood
Pterostylis curta R.Br......Blunt Greenhood
Pterostylis longiflora R.Br......Tall Greenhood
Pterostylis mutica R.Br......Midget Greenhood
Pterostylis parviflora R.Br......Greenhood
Pterostylis rufa R.Br......Rusty Hood
Spiranthes sinensis
subsp. *australis*......Ladies Tresses
Thelymitra pauciflora R.Br......Sun Orchid

Phormiaceae
Dianella caerulea Sims
subsp. *caerulea*......Blue Flax Lily

Dianella revoluta R.Br.
var. *revoluta* ....Blue Flax Lily
Stypandra glauca R.Br. ....Blue Lily
Thelionema grande (C.T.White) R.J.F.Hend. ....Granite Tufted Lily

Poaceae

Aira cupaniana Guss ....Silvery Hairgrass
Aristida calycina R.Br.
var. *calycina* ....Three-awn Grass
Aristida jerichoensis
var. *subspinulifera* Henrard....................Jericho Wire Grass
Aristida ramosa
var. *speciosa* Henrard....................Three-awned Grass
Aristida vagans Cav. ....Wire Grass
Arundinella nepalensis Trin. ....Reedgrass
Austrodanthonia fulva (Vickery) H.P.Linder ....Wallaby Grass
Austrodanthonia laevis (Vickery) H.P.Linder....................Wallaby Grass
Austrodanthonia monticola (Vickery) H.P.Linder ....Wallaby Grass
Austrodanthonia racemosa var. *obtusata* (Benth.) H.P.Linder ....Wallaby Grass
Austrostipa ramosissima (Trin.) S.W.L.Jacobs & J.Everett....................Stout Bamboo Grass
Austrostipa scabra (Lindl.) S.W.L.Jacobs & J.Everett ....Speargrass
Austrostipa setacea (R.Br.) S.W.L.Jacobs & J.Everett ....Corkscrew Grass
Austrostipa verticillata (Nees ex Spreng) S.W.L.Jacobs & J.Everett....................Spear Grass
**Axonopus affinis* Chase ....Millet Swamp Grass
Bothriochloa decipiens (Hack.) C.E.Hubb. ....Red Grass
**Briza minor* L. ....Small Shivery Grass
**Bromus diandrus* Roth ....Great Brome
Chloris truncata R.Br. ....Windmill Grass
Cleistochloa rigida (S.T.Blake) R.D.Webster....................Cleistochloa
Cymbopogon obtectus S.T.Blake....................Silky Heads
Cymbopogon refractus (R.Br.) A.Camus ....Barbed Wire Grass
Deyeuxia mckiei Vickery....................Plume Grass
Dichelachne crinita (Lf.) Hook.f. ....Longhair Plumegrass
Dichelachne micrantha (Cav.) Domin ....Plumegrass
Dichelachne sieberiana Trin. & Rupr. ....Plumegrass
Digitaria breviglumis (Domin) Henrard....................Umbrella Grass
Digitaria ramularis (Trin.) Henrard....................Panic
Echinopogon caespitosus C.E.Hubb.
var. *caespitosus* ....Hedgehog Grass
Echinopogon cheelii C.E.Hubb. ....Large Hedgehog Grass
Echinopogon ovatus C.E.Hubb. ....Forest Hedgehog Grass
Entolasia stricta (R.Br.) Hughes ....Rice Flowered Grass
Eragrostis brownii (Kunth.) Nees ....Browns' Lovegrass
Eragrostis elongata (Willd) J.Jacq. ....Clustered Lovegrass
Eragrostis lacunaria F.Muell. ex Benth. ....Purple Lovegrass
Eragrostis leptostachya Labill....................Lovegrass
Festuca asperula Vickery....................Graceful Fescue
Imperata cylindrica
var. *major* P.Beauv. ....Blady Grass
Joycea pallida (R.Br.) S.W.L.Jacobs ....Silvertop Wallaby Grass
Microlaena stipoides (Labill.) R.Br.
var. *stipoides* ....Meadow Rice Grass
Notodanthonia longifolia (R.Br.) H.P.Linder....................Long-leaved Wallaby Grass
Oplismenus aemulus (R.Br.) Roem & Schult. ....Oplismenus
Panicum effusum R.Br. ....Hairy Panic
Panicum simile Domin ....Two Coloured Panic
**Paspalum dilatatum* Poir. ....Paspalum
Pennisetum alopecurioides (L.) Spreng. ....Swamp Foxtail
Phragmites australis (Cav.) Trin. ex Steud. ....Common Reed
Poa sieberiana Labill. ....Snow Grass

**Secale cereale* L. ....Cereale Rye
Sorghum leiocladum (Hack.) C.E.Hubb. ....Native Sorghum
Sporobolus creber De Nardi....................Rats Tail Crass
Themeda triandra Forssk. ....Kangaroo Grass
Tripogon loliiformis (F.Muell.) C.E.Hubb. ....Five Minute Grass

Restionaceae
Baloskion stenocoleum
(L.A.S.Johnson & O.D.Evans) B.G.Briggs & L.A.S.Johnson ....Rush

Xanthorrhoeaceae
Xanthorrhoea johnsonii A.T.Lee....................Grasstree

Dicotyledons

Amaranthaceae
Alternanthera denticulata R.Br. ....Lesser Joyweed

Apiaceae
Actinotus helianthi Labill. ....Flannel Flower
**Ciclospermum leptophyllum* (Pers.) Spraque ....Slender Celery
Daucus glochidiatus (Labill.) Fischer, C.Meyer & Ave-Lall....................Native Carrot
Eryngium visculosum Labill. ....Prostrate Blue Devil
**Foeniculum vulgare* Mill.....................Fennel
Hydrocotyle geraniifolia F.Muell.....................Forest Pennywort
Hydrocotyle laxiflora DC. ....Stinking Pennywort
Hydrocotyle peduncularis R.Br. ex A.Rich. ....Pennywort
Lilaeopsis polyantha (Gand.) Hj.Eichler....................Lilaeopsis
Trachymene incisa Rudge ....Native Parsnip

Apocynaceae
Parsonsia eucalyptophylla F.Muell.....................Vine

Araliaceae
Astrotricha longifolia Benth.....................Star-hair Bush

Asclepiadaceae
**Gomphocarpus fruticosus* (L.) R.Br. ex Spreng. ....Balloon Fruit

Asteraceae
Bidens pilosa L.....................Cobblers Tacks
Brachyscome arculeata (Labill.) Less. ....Hill Daisy
Brachyscome microcarpa F.Muell. ....Daisy
Brachyscome multifida DC.
var. *multiflora*....................Cut-leaved Daisy
Brachyscome nova-anglica G.L.R.Davis ....New England Brachyscome
Brachyscome stuartii Benth.....................Granite Brachyscome
Bracteantha bracteata (Vent.) Andberg. & Heigi ....Everlasting
Calotis cuneifolia R.Br.....................Purple Burr Daisy
Calotis lappulaceae Benth. ....Bogan Flea
Cassinia uncata A.Cunn. ex DC. ....Cough Bush
Cassinia quinquefaria R.Br.....................Common Cassinia
Centipeda cunninghamii (DC.) A.Braun. & Asch. ....Common Sneezeweed
Centipeda minima (L.) A.Braun & Asch.
var. *minima*....................Spreading Sneezeweed
Chrysocephalum apiculatum (Labill.) Steetz ....Common Everlasting
Chrysocephalum semipapposum (Labill.) Steetz....................Clustered Everlasting
**Cirsium vulgare* L. ....Thistle
**Conyza albida* Willd. ex Spreng.....................Tall Fleabane
**Conyza bonariense* (L.) Cronq. ....Flaxleaf Fleabane

Craspedia variabilis Everett & Doust. ....Billy Buttons
Cymbanotus lawsonianus Gaudich. ....Bears Ears
Euchiton involucratus (G.Forst.) Holub ....Cudweed
Euchiton sphaericus Holub. ....Cudweed
Glossogyne tannensis (Spreng.) Garn.-Jones ....Cobblers Tacks
Hyalosperma semisterile (F.Muell.) Paul G.Wilson...Daisy
**Hypochaeris glabra* L. ....Catsear
**Hypochaeris radicata* L...Catsear
**Lactuca serriola* L. ....Prickly Lettuce
Lagenifera stipitata (Labill.) Druce..Blue Bottle-daisy
Leucochrysum albicans (A.Cunn.) Paul G. Wilson
    var. *albicans* ....Sunray
Microseris lanceolata (Walp.) Schulz-Bip. ....Daisy
Olearia elliptica DC. ....Sticky Daisy Bush
Olearia erubescens (Sieber ex DC.) Dippel ....Daisy Bush
Olearia ramosissima (DC.) Benth. ....Blue Daisy Bush
Olearia rosmarinifolia (DC.) Benth. ....Daisy Bush
Olearia viscidula (F.Muell.) Benth. ....Sticky Daisy Bush
Ozothamnus obcordatus DC. ....Granite Daisy Bush
Podolepis jaceoides (Sims) Voss ....Copper-wire Daisy
Podolepis neglecta G.L.R.Davis ....Copper-wire Daisy
Rhodanthe anthemoides (Spreng.) Paul G. Wilson ....Sunray
Rhodanthe diffusa
    subsp. *leucactina* (F.Muell.) Paul G. Wilson ....Daisy
Senecio diaschides Drury ....Fireweed
Senecio hispidulus A.Rich.
    var. *dissectus* (Benth.) Belcher..Hill Fireweed
    var. *hispidulus* ....Hill Fireweed
Senecio lautus J.R.Forst. ex Willd.
    subsp. *dissectifolius* Ali..Variable Groundsel
Senecio sp. E...Fireweed
Sigesbeckia australiensis D.L.Schultz..Indian Weed
**Sigesbeckia orientalis* L.
    subsp. *orientalis* ....Sigesbeckia
**Sonchus oleraceus* L...Common Sowthistle
**Taraxacum officionale* L. ....Dandelion
Triptilodiscus pygmaeus Turcz. ....Daisy
Vernonia cinerea (L.) Less ....Vernonia
Vittadinia cervicularis N.T.Burb
    var. *cervicularis*..Fuzzweed
Vittadinia cuneata
    var. *cuneata*
        forma *minor* N.T.Burb..Fuzzweed
    var. *hirsuta* N.T.Burb. ....Fuzzweed
Vittadinia muelleri N.T.Burb..Fuzzweed
Vittadinia sulcata N.T.Burb. ....Fuzzweed

Bignoniaceae
Pandorea pandorana (Andrews) Steenis ....Wonga Vine

Brassicaceae
Lepidium pseudohyssopifolium Hewson..Peppercress

Cactaceae
**Opuntia aurantiaca* Lindl...Tiger Pear
**Opuntia stricta* (Haw.) Haw. ....Prickly Pear

Campanulaceae
Wahlenbergia communis Carolin ....Tufted Bluebell
Wahlenbergia gracilis (Forst.f.) A.DC. ....Sprawling Bluebell

Wahlenbergia graniticola Carolin...Granite Bluebell
Wahlenbergia luteola P.J.Sm. ....Bluebell
Wahlenbergia planiflora
subsp. *longipila* Carolin ex P.J.Sm..Bluebell

Caryophyllaceae
**Anagallis arvensis* L..Anagallis
**Arenaria leptocladus* (Reichb.) Guss ....Thyme-leaved Sandwort
**Cerastium glomeratum* Thuill. ....Mouse-ear Joyweed
**Cerastium vulgare* Hartn. ....Mouse-ear Joyweed
**Paronychia brasiliana* DC. ....Brazilian Whitlow
**Petrorhagia nanteuilii* (Burnat) B.W.Ball & Haywood ....Proliferous Pink
Scleranthus biflorus (G.Forst. & Forst.f.) Hook.f. ....Knawel
Stellaria angustifolia Hook. ....Chickweed
Stellaria flaccida Hook..Chickweed
**Stellaria media* Villars ....Common Chickweed
Stellaria pungens Brongn. ....Prickly Starwort

Casuarinaceae
Casuarina cunninghamiana Miq...River Oak

Celastraceae
Cassine australis
var. *angustifolia* (Benth.) Jessup ....Red Olive Plum
Maytenus silvestris Lander & L.A.S.Johnson..Orange Bark

Chenopodiaceae
Chenopodium pumilio R.Br..Small Crumbweed
Einadia hastata (R.Br.) A.J.Scott...Saloop
Einadia polygonoides (Murr) Paul G.Wilson...Saltbush
Einadia trigonos
subsp. *stellulata* (Benth.) Paul G.Wilson ....Saltbush

Clusiaceae
Hypericum gramineum Forst.f..Small St. Johns Wort
Hypericum japonicum Thunb. ....St. Johns Wort

Convulvulaceae
Dichondra repens G.Forst. & Forst.f. ....Kidney Weed
Dichondra sp. A ....Kidney Weed

Crassulaceae
Crassula helmsii (T.Kirk) Cockayne...Stonecrop
Crassula sieberiana (Schultes & Schultes f.) Druce ....Stonecrop

Dilleniaceae
Hibbertia acicularis (Labill.) F.Muell...Prickly Guinea Flower
Hibbertia cistoidea (Hook.) C.T.White...Guinea Flower
Hibbertia linearis R.Br. ex DC. ....Guinea Flower
Hibbertia obtusifolia DC...Guinea Flower
Hibbertia riparia (R.Br. ex DC.) Hoogl..Common Guinea Flower
Hibbertia sp. nov..Guinea Flower

Droseraceae
Drosera burmannii Vahl. ....Sundew
Drosera peltata Thunb. ....Sundew
Drosera spatulata Labill. ....Sundew

Epacridaceae

Brachyloma daphnoides
subsp. *glabrum* (Blakely) J.T.Hunter .... Red-flowered Daphne Heath
Leucopogon lanceolatus (Sm.) R.Br.
var. *lanceolatus* ....Lance-leaf Beard Heath
Leucopogon melaleucoides A.Cunn. ex Benth. ....Beard Heath
Leucopogon muticus R.Br. ....Beard Heath
Leucopogon neo-anglicus F.Muell. ex Benth. ....Prickly Beard Heath
Leucopogon virgatus (Labill.) R.Br. ....Beard Heath
Lissanthe strigosa
subsp. *subulata* (R.Br.) J.M.Powell..Peach Heath
Melichrus urceolatus R.Br. ....Urn Heath
Monotoca scoparia (Sm.) R.Br. ....Broom Heath

Euphorbiaceae

Phyllanthus gunnii Hook.f. ....Spurge
Phyllanthus subcrenulatus F.Muell. ....Creek Spurge
Phyllanthus virgatus Forst.f. ....Spurge
Poranthera microphylla Brongn ....Small Poranthera

Fabaceae

Acacia buxifolia A.Cunn.
subsp. *buxifolia* ....Box-leaved Wattle
Acacia cheelii Blakely ....Motherumbah
Acacia implexa Benth. ....Mountain Wattle
Acacia leucocalyx (Domin) Pedley ....Wattle
Acacia montana Benth. ....Sticky Wattle
Acacia neriifolia A.Cunn. ex Benth. ....Oleander Wattle
Acacia obtusifolia A.Cunn. ....Mountain Wattle
Acacia penninervis Sieber ex DC. ....Mountain Hickory
Acacia pruinosa A.Cunn. ex Benth. ....Frosted Wattle
Acacia rubida A.Cunn. ....Red-stemmed Wattle
Acacia triptera Benth. ....Spurwing Wattle
Acacia ulicifolia (Salisb.) Court ....Prickly Moses
Acacia venulosa Benth. ....Veiny Wattle
Acacia viscidula Benth. ....Sticky Wattle
Aotus subglauca
var. *filiformis* Blakely & McKie ....Pea
Bossiaea obcordata (Vent.) Druce ....Bush Pea
Bossiaea prostrata R.Br. ....Bossiaea
Daviesia latifolia R.Br. ....Bitter Pea
Desmodium brachypodum A.Gray ....Tick Trefoil
Desmodium varians (Labill.) Endl. ....Slender Tick Trefoil
Dillwynia retorta (Wendl.) Druce ....Parrot Pea
Dillwynia sieberi Steud. ....Prickly Parrot Pea
Glycine clandestina Wendl. ....Twining Glycine
Glycine stenophita B.Pfeil & Tindale ....Glycine
Glycine tabacina (Labill.) Benth. ....Variable Glycine
Hardenbergia violacea (Schneev.) Stearn ....False Sarsaparilla
Hovea apiculata A.Cunn. ex G.Don ....Grey-leaved Hovea
Hovea graniticola I.Thomps. ....Hovea
Hovea heterophylla A.Cunn. ex Hook.f. ....Hovea
Hovea lanceolata Sims ....Hovea
Indigofera adesmiifolia A.Gray ....Indigo
Indigofera australis Willd. ....Indigo
Jacksonia scoparia R.Br. ....Dogwood
Lespedeza juncea
subsp. *sericea* (Thunb.) Steenis..Tall Clover
Lotus australis Andrews ....Australian Trefoil
Lotus cruentus Court. ....Lotus

Lotus uliginosus Schk. .... Bird's Foot Trefoil
**Medicago polymorpha* L. .... Burr Medic
Mirbelia pungens A.Cunn. ex G.Don .... Prickly Mirbelia
Mirbelia speciosa Sieber ex DC.
subsp. *speciosa* .... Blue Mirbelia
Pultenaea campbellii Maiden & E.Betche [*P. setulosa*] .... Egg & Bacon Pea
Pultenaea spinosa (DC.) H.B.Will .... Bush Pea
Pultenaea foliolosa A.Cunn. ex Benth. .... Small-leaved Bush-pea
Pultenaea sp. C .... Shiny-leaved Bush-pea
Pultenaea sp. G .... Bush Pea
Swainsona galegifolia (Andrews) R.Br. .... Smooth Darling Pea
**Trifolium repens* L. .... White Clover
**Vicia villosa* Roth. .... Russian Vetch
Zornia dyctiocarpa DC.
var. *dyctiocarpa* .... Zornia

Gentianaceae
Centaurium erythraea Rafn. .... Common Century

Geraniaceae
Geranium solanderi Carolin
var. *grande* Carolin .... Native Geranium
var. *solanderi* .... Native Geranium
Pelargonium australe Willd .... Rock Pelargonium

Goodeniaceae
Goodenia bellidifolia
subsp. *argentea* Carolin .... Goodenia
Goodenia glabra R.Br. .... Goodenia
Goodenia hederacea Sm.
subsp. *hederacea* .... Trailing Goodenia
Goodenia macbarronii Carolin .... Goodenia
Goodenia rotundifolia Sm. .... Goodenia

Haloragaceae
Gonocarpus micranthus Thunb.
subsp. *micranthus* .... Swamp Raspwort
Gonocarpus teucrioides DC. .... Raspwort
Gonocarpus tetragynus Labill. .... Raspwort
Haloragis heterophylla Brongn. .... Variable Raspwort
Haloragis serra Brongn .... Raspwort
Myriophyllum crispatum Orch. .... Water-milfoil
Myriophyllum pedunculatum Hook.f. .... Water-milfoil

Lamiaceae
Ajuga australis R.Br. .... Austral Bugal
Mentha satureioides R.Br. .... Mintbush
Plectranthus graveolens R.Br. .... Mintbush
Plectranthus parviflorus Willd .... Mintbush
Prostanthera graniticola Maiden & E.Betche .... Granite Mintbush
Prostanthera nivea A.Cunn. ex Benth.
var. *nivea* .... Snowy Mintbush
Scutellaria humilis R.Br. .... Dwarf Skullcap
Westringia eremicola A.Cunn. ex Benth. .... Westringia

Lauraceae
Cassytha pubescens R.Br.. .... Devil's Twine

Lentibulariaceae
Utricularia dichotoma Labill. .... Fairies Aprons

Lobeliaceae
Isotoma anethifolia Summerh. ....Isotome
Isotoma fluviatilis
subsp. *borealis* McComb..Swamp Isotome
Lobelia gracilis Andrews ....Trailing Lobelia
Pratia purpurascens (R.Br.) E.Wimm. ....Purple Pratia

Loranthaceae
Amyema miquelii (Lehmn. ex Miq.) Tieghem..Drooping Mistletoe
Amyema miraculosum
subsp. *boormanii* (Blakely) Barlow ....Mistletoe
Amyema pendula (Sieber ex Spreng.) Tieghem..Mistletoe
Dendrophthoe glabrescens (Blakely) Barlow ....Mistletoe

Lythraceae
Lythrum salicorn L. ....Purple Loosestrife

Malvaceae
**Modiola caroliniana* (L.) G.Don..Red Flowered Mallow
Sida cunninghamii C.T.White ....Sida

Menyanthaceae
Nymphoides geminata (R.Br.) Kuntze..Marshwort

Moraceae
**Ficus carica* L. ....Edible Fig
Ficus rubiginosa Desf. ex Vent. ....Fig

Myrtaceae
Angophora floribunda (Sm.) Sweet...Rough-barked Apple
Callistemon pungens Lumley & Spencer ....Prickly Bottlebrush
Calytrix tetragona Labill. ....Fringe Myrtle
Eucalyptus albens Benth. ....White Box
Eucalyptus andrewsii Maiden ....Western New England Blackbutt
Eucalyptus blakelyi Maiden..Blakely’s Red Gum
Eucalyptus bridgesiana R.T.Baker..Apple Box
Eucalyptus caleyi Maiden
subsp. *caleyi* ....Caley’s Ironbark
Eucalyptus dealbata A.Cunn. ex Schauer ....Tumbledown Gum
Eucalyptus macrorhyncha F.Muell. ex Benth. ....Red Stringybark
Eucalyptus melliodora A.Cunn. ex Schauer...Yellow Box
Eucalyptus prava L.A.S.Johnson & K.D.Hill ....Orange Gum
Eucalyptus quinniorum J.T.Hunter & J.J.Bruhl..Quinn’s Mallee
Eucalyptus subtilior L.A.S.Johnson & K.D.Hill ....Stringybark
Homoranthus bornhardtiensis J.T.Hunter...Homoranthus
Kunzea obovata Byrnes...Purple Kunzea
Kunzea parvifolia Schauer ....Hairy Pink Kunzea
Leptospermum brachyandrum (F.Muell.) Druce ....Tea-tree
Leptospermum brevipes F.Muell. ....Grey Tea-tree
Leptospermum novae-angliae Joy Thomps. ....New England Tea-tree
Leptospermum polygalifolium
subsp. *montanum* Joy Thomps. ....Mountain Tea-tree
subsp. *transmontanum* Joy Thomps. ....Creek Tea-tree
Leptospermum variabile Joy Thomps. ....Variable Tea-tree
Micromyrtus sessilis J.W.Green ....Myrtle Heath

Oleaceae
Jasminum sauvissimum Lindley ....Jasmin

Notelaea microcarpa R.Br.
var. *microcarpa* .... Western Mock Olive
var. *velutina* (Bailey) P.Green .... Mock Olive

Onagraceae
Epilobium billardierianum
subsp. *cinereum* (Rich.) Raven & Engelhorn .... Willowherb

Oxalidaceae
Oxalis chnoodes Lourteig .... Wood Sorrel
Oxalis perennans Haw. .... Wood Sorrel

Phytolaccaceae
**Phytolacca octandra* L. .... Red Ink Weed

Pittosporaceae
Billardiera scandens Sm.
var. *scandens* .... Appleberry
Bursaria spinosa
var. *obovata* E.Bennett .... Prickly Bursaria
Pittosporum undulatum Vent. .... Pittosporum
Rhytidosporum procumbens (Hook.) F.Muell. .... Rhytidosporum

Plantaginaceae
Plantago debilis R.Br. .... Shade Plantain
**Plantago lanceolata* L. .... Plantain
Plantago varia R.Br. .... Variable Plantain

Polygalaceae
Polygala japonica Houtt. .... Polygala

Polygonaceae
**Acetosella vulgaris* Fourr. .... Sheep Sorrel
Persicaria decipiens (R.Br.) K.L.Wilson .... Persicaria
Persicaria hydropiper (L.) Spach .... Water Pepper
Persicaria praetissima (Hook.f.) Hara .... Persicaria
Rumex brownii Campd .... Swamp Dock

Portulacaceae
Calandrinia eremaea Ewart .... Small Purselane
Portulaca bicolor F.Muell. .... Portulaca

Proteaceae
Grevillea floribunda R.Br. .... Rusty Grevillea
Grevillea triternata R.Br. .... Spider Flower
Hakea eriantha R.Br. .... Hakea
Hakea microcarpa R.Br. .... Swamp Hakea
Lomatia silaifolia (Sm.) R.Br. .... Crinkle Bush
Persoonia chamaepeuce Lhotsky ex Meissner .... Geebung
Persoonia cornifolia A.Cunn. ex R.Br. .... Broad-leaved Geebung
Persoonia fastigata R.Br. .... Narrow-leaved Geebung
Persoonia sericea A.Cunn. ex R.Br. .... Silky Geebung

Ranunculaceae
Clematis aristata R.Br. ex Ker Gawl. .... Forest Clematis
Clematis glycinoides DC. .... Headache Vine
Ranunculus lappaceus Sm. .... Common Buttercup
Ranunculus sessiliflorus R.Br. ex DC.
var. *sessiliflorus* .... Buttercup
Ranunculus sp. A .... Buttercup

Rhamnaceae
Cryptandra amara
var. *floribunda* Maiden & Betche ....Red Cryptandra

Rosaceae
Acaena novae-zelandiae Kirk..Bidgee Widgee
**Rosa rubiginosa* L. ....Rose Hip
**Rubus chloocladus* W.C.R.Watson ....Blackberry
Rubus parvifolius L. ....Small-leaved Bramble

Rubiaceae
Asperula conferta Hook.f. ....Asperula
Galium binifolium Wakef. ....Bedstraw
Galium gaudichaudii DC. ....Rough Bedstraw
Galium migrans Ehrend & McGillivray..Bedstraw
Galium propinquum A.Cunn. ....Bedstraw
Opercularia aspera Gaertn...Stinkweed
Opercularia diphylla Gaertn. ....Stinkweed
Opercularia hispida Spreng. ....Hairy Stinkweed
Pomax umbellata (Gaertn.) Soland. ex A.Rich. ....Pomax
Psydrax odoratum (G.Forst.) S.T.Reynolds & R.J.Hend ....Iamboto

Rutaceae
Boronia anethifolia A.Cunn. ....White & Red Boronia
Correa reflexa (Labill.) Vent.
var. *reflexa* ....Green Correa
Zieria aspalathoides A.Cunn. ex Benth. ....Zieria
Zieria cytisoides Sm. ....Downy Zieria
Zieria odorifera Armstrong ....Smelly Zieria

Santalaceae
Exocarpus cupressiformis Labill. ....Native Cherry
Leptomeria drupacea (Labill.) Druce...Current Bush

Sapindaceae
Alectryon subdentatus (F.Muell. ex Benth.) Radlk.
forma *subdentatus*
Dodonaea boroniifolia G.Don...Hop Bush
Dodonaea viscosa
subsp. *spatulata* (Sm.) J.G.West ....Hop Bush

Scrophulariaceae
Derwentia arenaria (A.Cunn. ex Benth.) B.G.Briggs & Ehrend ....Fine-leaved Speedwell
Derwentia perfoliata (R.Br.) B.G.Briggs & Ehrend.......................................Speedwell
Gratiola peruviana L...Brooklime
**Verbascum thapsus* L. ....Aaron's Rod
Veronica calycina R.Br. ....Hairy Speedwell

Solanaceae
Cyphanthera albicans (A.Cunn.) Miers
subsp. *albicans* ....Cyphanthera
Solanum amblymerum Dunal...Nightshade
Solanum cinereum R.Br...Narrawa Burr
Solanum elegans Dunal ex Poir...Nightshade
**Solanum nigrum* L. ....Black-berry Nightshade

Stackhousiaceae
Stackhousia monogyna Labill..Creamy Candles
Stackhousia viminea Sm. ....Yellow Stackhousia

Sterculiaceae
Brachychiton populneus (Schott. & Endl.) R.BR. .... Kurrajong

Stylidiaceae
Stylidium graminifolium Sw. ex Willd. .... Grass Triggerplant

Thymeliaceae
Pimelea linifolia
subsp. *caesia* Threlfall .... Common Rice Flower
Pimelea strigosa Gand. .... Rice Flower

Urticaceae
Urtica incisa Poiret.. Stinging Nettle

Verbenaceae
**Verbena bonariense* L. .... Purpletop
**Verbena rigida* Spreng. .... Veined Verbena

Viscaceae
Notothixos subaureus Oliv. .... Golden Mistletoe

Violaceae
Hybanthus monopetalus (Schult.) Domin.. Slender Violet Bush
Viola betonicifolia Sm. .... Viola
Viola caleyana G.Don .... Swamp Violet
Viola hederacea Labill. .... Viola

Appendix C: Introduced taxa: their life history, control and distribution. The distribution of these taxa within the defined communities are given within the description of each community in section 3.5. A priority scale of invasiveness is suggested with 1 being of highest priority for eradication due to high invasiveness in natural habitats to 5 either ubiquitous or non invasive.

Acetosella vulgaris

Family: Polygonaceae.

Synonymy: *Rumex acetosella*, *A. angiocarpa.*

Common name: Sheep Sorrel, Sorrel.

Priority: 4.

Habit: Slender erect herb, 10-50 cm high with creeping underground stems.

Life cycle: A vigorous winter to spring growing plant.

Origin & distribution: Probably native of Europe, now widespread especially in temperate regions. NC, CC, SC, NT, CT, ST, NWS, CWS, SWS, SWP in NSW. Qld, Vic., Tas., SA and WA.

Dispersal: Nut 1-1.5 mm long and vegetatively from pieces of the underground stems.

Habitat: Often on soils of an acid nature often in old gardens or areas of habitation, usually in higher rainfall areas.

Properties: Leaves can poison stock they contain oxalate and cause kidney trouble.

Control & management: Control not easy with 2,4-D but can use dicamba.

Aira cupaniana

Family: Poaceae.

Synonymy:

Common name: Silvery Hairgrass.

Priority: 3.

Habit: Slender annual, erect or occasionally geniculate at the base to 0.5 m tall.

Life cycle: Flowers spring-early summer. Seeds in spring and winter growing. Can form monospecific stands following favourable autumn and winter rains.

Origin & distribution: Native to the Mediterranean. Found in all divisions except NFWP and SFWP, within all states except the NT.

Dispersal: Via cariopsis.

Habitat: Grows in pastures, disturbed grassland or open woodland on all soil types.

Properties:

Control & management: Burning will increase population numbers.

Arenaria leptocladus

Family: Caryophyllaceae.

Synonymy: *Arenaria serphyllifolia* var. *leptocladus.*

Common name: Lesser Thyme-leaved Sandwart.

Habit: Annual herb to 20 cm high.

Life cycle: Produces numerous seeds.

Origin & distribution: Probably native of Europe; NC, CC, NT, CT, ST, NWS, CWS; Vic; SA;WA.

Dispersal: Seed.

Habitat: Wed of sandy places.

Properties:

Control & management:

Axonopus affinis

Family: Poaceae.

Synonymy:

Common name: Narrow-leaved Carpet Grass, Mat Grass.

Priority: 4.

Habit: Glabrous rhizomatous and stoloniferous perennial to 0.5 m tall often forming dense mats.

Life cycle: Flowers during warmer months.

Origin & distribution: Native of America. NC, CC, SC, NT, ST and SWP in NSW. Qld.

Dispersal: Via cariopsis.

Habitat: Lawns, naturalized in run down pastures on alluvial soils. A serious weed of wetter regions.

Properties:

Control & management: Difficult to eradicate once established. Spot spraying with kerosene or diesel distillate. Glyphosate.

Anagallis arvensis

Family: Primulaceae.

Synonymy:

Common name: Scarlet Pimpernel, Blue Pimpernel.

Habit: Small perennial or annual herb to 30 cm tall.

Life cycle:

Origin & distribution: Native of Europe, Asia, North Africa; NC, CC, SC, NT, CT, ST, NWS, CWS, NWP, SWP, NFWP; Qld; Vic.; Tas.; SA; WA.

Dispersal:

Priority: 3.

Habitat: Usually in damp places in gardens, wasteland, roadsides, creek banks and irrigated and natural grasslands.

Properties: Has poisoned horses, sheep, cattle, birds and tested to be toxic to dogs and rabbits.

Control & management: MCPA or 2,4-D are partially effective on seedlings; Ioxynil will kill the plant, hand weeding.

Bidens pilosa

Family: Asteraceae.

Synonymy:

Common name: Cobbler's Pegs, Stick-tights, Pitch-forks.

Habit: Erect annual forb 60 cm to 1 m with angular branches.

Life cycle: Germinates spring & summer after rain, flowers throughout year but mainly late summer-autumn.

Origin & distribution: Native of tropical South America; now spread throughout warm regions of world; widespread north of Milton NSW and ACT; coastal Qld, LHI, Vic, NT, SA, WA.

Priority: 2.

Dispersal: Seeds which readily attach to fur/clothing by the 2 barbed spines.

Habitat: Gardens, cultivated land, waste areas, roadsides; usually on loam or clay loam soils (Western NSW).

Properties: One report indicates it may taint milk.

Control & management: Spray with 2,4–D or MCPA.

Briza minor

Family: Poaceae

Synonymy:

Common name: Shivery Grass.

Priority: 3.

Habit: Annual to 0.6 m.

Life cycle: Flowers spring.

Origin & distribution: Native to Europe. NC, CC, SC, NT, CT, ST, NWS, CWS, SWS, NWP, SWP. All states except NT.

Dispersal: Via caryopsis. Sometimes found in pasture seed.

Habitat: Weed of disturbed areas, cultivation and waste ground.

Properties: -.

Control & management: -.

Bromus driandrus

Family: Poaceae.

Synonymy: *Bromus gussonii*

Common name: Great Brome, Jabbers.

Priority: 3.

Habit: Loosely tufted, annual grass to 0.3 m tall.

Life cycle: Prefers a wet winter or spring.

Origin & distribution: Introduced from Europe. Grows in all divisions of New South Wales and also south-eastern Queensland.

Dispersal: Seed.

Habitat: Usually damp areas and by creeks in disturbed areas.

Properties: Not aggressive and does not persist. The mature seeds can cause death to browsing animals.

Control & management: Regeneration of denuded areas should control the species, which is not a seriously invasive weed.

Centaurium erythraea

Family: Gentianaceae.

Synonymy:

Common name: Century.

Priority: 3.

Habit: Erect herb with basal rosette to 40 cm tall.

Life cycle: Flowers spring to summer.

Origin & distribution: Native to Europe. All division except SFWP in NSW. All mainland states except NT.

Dispersal: Capsule.

Habitat: Widespread in settled areas.

Properties:

Control & management: Chipping but make sure tap root removed. Spot spraying. Fire is known to increase population sizes.

Cerastium glomeratum

Family: Caryophyllaceae.

Synonymy: NA.

Common name: Lesser Mouse-ear Chickweed.

Priority: 5.

Habit: Annual herb.

Life cycle: Flowers spring.

Origin & distribution: Native of Europe. NT, CT, ST, CWS in NSW. SA.

Dispersal: Cylindrical capsule.

Habitat: Uncommon weed of disturbed ground.

Properties:

Control & management: Chipping and spot spraying.

Cerastium vulgare

Family: Caryophyllaceae.

Synonymy: NA.

Common name: Mouse-ear Chickweed.

Priority: 5.

Habit: Annual herb.

Life cycle: Flowers spring.

Origin & distribution: Native of Europe. NT, CT, ST, CWS in NSW. SA.

Dispersal: Cylindrical capsule.

Habitat: Uncommon weed of disturbed ground.

Properties:

Control & management: Chipping and spot spraying.

Ciclospermum leptophyllum

Family: Apiaceae

Synonymy: *Apium leptophyllum, Cyclospermum leptophyllum* (orthographic variant).

Common name: Slender Celery.

Priority: 3.

Habit: Erect annual herb to 70 cm tall.

Life cycle: Flowers throughout the year but mainly in spring to summer.

Origin & distribution: Native of America. Widespread, NC, CC, SC, NT, CT, ST, NWS, CWS, SWS, NWP of NSW. Qld, Vic. NT and SA.

Dispersal: Via mericarp.

Habitat: Weed usually of disturbed sites.

Properties:

Control & management: Chipping and spot spraying.

Cirsium vulgare

Family: Asteraceae.

Synonymy: *Carduus lanceolatus, Carduus vulgaris, Cnicus lanceolatus*.

Common name: Spear thistle, Bull thistle, Scotch thistle (NZ), swamp thistle.

Habit: Erect biennial to 1.5 m high.

Life cycle: Seeds germinate mostly after autumn rains; winter development of root system; rosette grows through summer to next spring of the second year when it flowers August - April; plant dies end of summer-early autumn; grows after spring and summer rains.

Origin & distribution: Native to Europe, western Asia and North Africa. In all Australian states except NT; in all divisions NSW; common throughout central and southern Qld, particularly on the Darling Downs; naturalised in Vic in 1850s, Tas, SA, WA;

Priority: 3.

Dispersal: Seed – wind, water, mud, vehicles, and in feed.

Habitat: Weed of old cultivated land, run-down pastures and newly cleared Brigalow country in Qld.

Properties: Noxious weed (all Vic; Tas, parts NSW and WA); smothers pastures; stock avoid grazing amongst plants; seeds short dormancy; low wind dispersal potential; rarely eaten by stock but infections are transmitted to animal by the spines of spear thistle; positive response to increased fertility.

Control & management: Spray with 2,4-D or MCPA (but old plants are fairly resistant) in the rosette to early flowering stages, or cut annual plant at base just as flower buds are opening and remove root; in cleared Brigalow it often disappears after 2 years being replaced by other plants.

Conyza albida

Family: Asteraceae.

Synonymy:

Common name: Tall Fleabane.

Habit: Robust erect spreading annual herb to 2 m high.

Life cycle: Flowers summer to autumn (mainly December – ?August)

Origin & distribution: native of North America; NC CC SC NT CT ST NWS CWS SWS SWP, LHI; Qld, Vic, SA, WA.

Dispersal: Achenes.

Priority: 3.

Habitat: Cultivated areas, pastures, wasteland.

Properties:

Control & management: Spraying with 2,4-D o MCPA plus dicamba.

Conyza bonariensis

Family: Asteraceae.

Synonymy: *Erigeron bonariensis*

Common name: Flax-leaf Fleabane.

Habit: Annual herb up to 1-2 m high.

Life cycle: Active growth starts spring-early autumn; seed production over long period; flowers throughout year.

Origin & distribution: Native of South America; widespread all divisions NSW, all states.

Dispersal: Seed by wind.

Priority: 3.

Habitat: Most soil types and plant communities particularly in disturbed soil e.g. roadsides, cultivation and lawns.

Properties: Suspected of poisoning stock; may irritate skin.

Control & management: Spraying with 2,4-D o MCPA plus dicamba. Pulling by hand probably an easy way for removing individuals.

Cyperus aggregatus

Family: Cyperaceae.

Synonymy:

Common name: Umbrella Sedge.

Priority: 2.

Habit: Robust erect tufted perennial with very short thick woody rhizome to 1m tall.

Life cycle: Summer to autumn flowering. May die back in dry periods resprouting from rhizomes.

Origin & distribution: Native to north and south America. All divisions except NFWP in NSW. All states except NT. This species range has extended considerably over the last 30 years.

Dispersal: Via nut and short rhizome.

Habitat: Most situations in temperate to subtropical regions on a range of soils. Often in roadside gutters, rocky creeks and disturbed sandy sites.

Properties: Blocks channels and drains and competes well with native species. Very persistent once established.

Control & management: 2,4-D sprays and manual removal as long as all material is removed.

Hypochaeris glabra

Family: Asteraceae.

Synonymy:

Common Name: Smooth Catsear, Flatweed, Glabrous Catsear.

Habitat: Glabrous annual forb with basal rosette and simple or branched flowering stems 10-40 cm high.

Life Cycle: Flowers in spring to autumn.

Priority: 4.

Origin & Distribution: Native of Europe, Asia and Africa. All divisions in NSW. All states.

Dispersal: Achenes dispersed by wind.

Habitat: Found in many plant communities, common in woodlands and pastures as well as disturbed sites.

Properties:

Control & Management:

Hypochaeris radicata

Family: Asteraceae.

Synonymy:

Common name: Catsear, Flatweed, False Dandelion.

Habit: Perennial rosette herb 30-60 cm high with taproot; may act as an annual (western NSW).

Life cycle: Flowers spring-autumn but mainly spring & summer.

Origin & distribution: Native of Europe; widespread - in all divisions NSW except NWP; all states.

Dispersal: seed

Priority: 5.

Habitat: Common weed in almost all situations, gravelly waste to pastures & lawns, roadsides, disturbed habitats.

Properties:

Control & management: Killed by spraying with 2,4-D (0.1-0.2%) or MCPA; hand weeding below crown in early spring.

Juncus bufonius

Family: Cyperaceae.

Synonymy: *Juncus plebeius*.

Common name: Toad Rush.

Habit: Tufted annual.

Life cycle: Plants often cleistogamous.

Origin & distribution: Native to temperate regions, this species occurs in all states and most divisions in New South Wales.

Priority: 4.

Dispersal: Seed.

Habitat: Primarily in poorly drained areas.

Properties:

Control & management: This is not a serious weed. Can be controlled by mowing in spring and spraying of regrowth by 2,4-D, Glyphosate, or Dicamba plus MCPA. This species however is widespread and best left as is while regeneration of infested areas may aid in decreasing numbers.

Lactuca saligna

Family: Asteraceae.

Synonymy:

Priority: 3

Common name: Prickly lettuce, Milk thistle, Compass Plant (leaves orient N–S)

Habit: Biennial herb 1-2 m high.

Life cycle: Grows from seed or rootstock spring-early summer; growth continues provided sufficient water available; flowers September-April.

Origin & distribution: Native of Europe and Asia; weed in all divisions, all states.

Dispersal: Achenes.

Habitat: Common widespread weed of gardens, roadsides, wasteland, cultivation, degraded pastures and along channel banks.

Properties: Grazing of young plants and regrowth prior to prickle development on stems and leaves has resulted in poisoning of stock overseas. It is thought to cause lung problems in cattle and is mildly narcotic.

Control & management: –

Lactuca serriola

Family: Asteraceae.

Synonymy:

Common name: Prickly lettuce, Milk thistle, Compass Plant (leaves orient N–S)

Habit: Biennial herb 1-2 m high.

Life cycle: Grows from seed or rootstock spring-early summer; growth continues provided sufficient water available; flowers September-April.

Origin & distribution: Native of Europe and Asia; weed in all divisions, all states.

Dispersal: Achenes.

Habitat: Common widespread weed of gardens, roadsides, wasteland, cultivation, degraded pastures and along channel banks.

Properties: Grazing of young plants and regrowth prior to prickle development on stems and leaves has resulted in poisoning of stock overseas. It is thought to cause lung problems in cattle and is mildly narcotic.

Control & management: –

Opuntia aurantiaca

Family: Cactaceae.

Synonymy:

Common name: Tiger Pear, Jointed Cactus.

Habit: Low growing plant with prostrate stems; segments 4-10 cm long.

Life cycle: All new plants result from detached segments; plants are very long lived.

Origin & distribution: Native of Argentina & Uruguay; NC, CC, SC, NT, CT, NWS, CWS, SWS, NWP, SWP; Qld; central & easternVic.

Priority: 1.

Dispersal: Propogates from segments and fruit - by animals and water.

Habitat: Infestations general follow watercourses.

Properties: Noxious weed; drought resistant.

Control & management: Biological control using tiger pear cochineal insect, *Dactylopius austrinus*, has been reasonably effective in Qld but not consistent in NSW, also Cactoblastis *Tucumania tapiacola* feeds on tiger pear but is more effective during long dry spells; physically remove and burn all segments, remove roots by chipping; chemical control by herbicides not always effective and areas must be re-checked and sprayed.

Opuntia stricta

Family: Cactaceae.

Synonymy:

Common name: Common Prickly Pear, Pest Pear, Erect Prickly Pear, Gayndah Pear.

Habit: Bush, clumped plant, distinct trunks absent, usually <1.5 m tall.

Life cycle: New plants arise from seed or from detached segments, plants are long lived and seeds are viable for at least 20 years.

Origin & distribution: Native of southern North America; all divisions and mainland states.

Priority: 3.

Dispersal: Segments spreading by animals, floods and vehicles.

Habitat: Semi arid savannas in warm temperate, subtropical and tropical regions.

Properties: Noxious weed; drought resistant; irritating spines.

Control & management: Biological control using *Cactoblastis cactorum* and *Dactylopius opuntiae* then disposal of remaining plants by spraying with arsenical preparations, or grubbing, heaping and burning.

Paronychia brasiliana

Family: Caryophyllaceae.

Synonymy:

Common name: Chilean Whitlow Wort, Brazilian Whitlow.

Habit: Prostrate perennial herb to 10 cm tall.

Life cycle: Perennial.

Origin & distribution: Native of South America; NC, CC, SC, NT, CT, ST, NWS, SWS, NWP; Qld; Vic; SA.

Dispersal: Seed.

Habitat: Weed of lawns, pastures, waste places, cheifly sandy soils.

Properties:

Control & management:

Paspalum dilatatum

Family: Poaceae.

Synonymy:

Common name: Paspalum, Dallas Grass, Water Couch, Golden Crown Grass.

Habit: Tufted perennial to 2 m tall.

Life cycle: Flowers summer and autumn.

Origin & distribution: Native of South America. Throughout New South Wales. All states except the Northern Territory.

Priority: 3.

Dispersal: Seed.

Habitat: A pasture species also found in lawns and disturbed areas. Usually in drainage lines and creek banks.

Properties: Has an underground rootstock. Ergot infested seeds are poisonous and can cause dermatitis on humans.

Control & management: Can be controlled by diesel or kerosene. May be cut below the crown. This species is widespread and fairly ubiquitous, management would probably be ineffectual particularly on riversides.

Plantago lanceolata

Family: Plantaginaceae.

Synonymy:

Common name: Lamb's Tongues, Common Plantain, Ribwort, Ribgrass, Buckhorn Plantain.

Habit: Annual or biennial herb with a well developed and persistent tap root.

Life cycle: Flowers mainly September to April.

Origin & distribution: Native to Europe and north and central Asia. NC, CC, SC, NT, CT, ST, NWS, CWS, SWS, SWP in NSW. All states except NT.

Priority: 3.

Dispersal: Capsule.

Habitat: Grows in disturbed sites such as roadsides and waste places.

Properties: Important cause of hay fever and a host for some plant diseases.

Control & management: Chipping and hand pulling, Spot spraying.

Petrorhagia nanteuilii

Family: Caryophyllaceae.

Synonymy: *Petrorhagia prolifer*.

Common name: Proliferous Pink.

Habit: Erect annual herb to 60 cm tall.

Life cycle: Winter to spring annual.

Origin & distribution: Native to Europe; CC, SC, NT, CT, ST, NWS, CWS, SWS, NWP, SWP; Qld; Vic; Tas; SA; WA.

Dispersal: Seed.

Priority: 2.

Habitat: Pastures, roadsides and damp disturbed sites.

Properties: Plentiful in years of high cool-season rainfall.

Control & management:

Rubus chloocladus

Family: Rosaceae.

Synonymy: *Rubus procerus*.

Common name: Blackberry.

Priority: 1.

Habit: Scrambling semi-deciduous shrub to 2 m, with primo-canes erect and arching rooting at the apex.

Life cycle: As above.

Origin & distribution: Native to Europe. NC, CC, SC, CT, ST, NWS in NSW. Vic., SA, WA.

Dispersal: Spread by birds when fruit is succulent. Arching canes can root and the thickets can be spread vegetatively.

Habitat: Mainly in areas with fertile soils, common on roadsides, stream banks and can be invasive in native bush.

Properties: May overcrowd and eliminate native species.

Control & management: Bulldoze large plants then rip to bring large roots out to surface dry, spray or pull emerging seedlings. Imazapyr or triclopyr during the early flowering period can be effective but the plants need to be thoroughly wetted. Dead canes should be left for 6 months and then burnt.

Sigesbeckia orientalis subsp. orientalis

Family: Asteraceae.

Synonymy: *Sigesbeckia microcephala*.

Common name: Indian Weed.

Priority: 5.

Habit: Erect annual herb to 80 cm tall or sometimes to 2 m.

Life cycle: Flowers summer to autumn. Growth commences in cooler months and may continue through summer especially in shaded and sheltered sites.

Origin & distribution: Native of east Asia and Africa. NC, CC, SC, NT, CT, ST, NWP, SWP in NSW. All mainland states.

Dispersal: Achene.

Habitat: Grows in stony soils and riverbanks. Prefers wet situations or more fertile soils and is often abundant after fires.

Properties: Used medicinally for skin problems.

Control & management: Pulling and chipping. A high fire frequency is likely to increase population numbers.

Solanum nigrum

Family: Solanaceae.

Synonymy: *Solanum opacum*.

Common name: Black-berry Nightshade, Black Nightshade, Nightshade, Potato Bush, Tomato Bush, Wild Currents.

Priority: 3.

Habit: Annual or short-lived perennial herb.

Life cycle:

Origin & distribution: Native of Europe; all divisions; all states.

Dispersal:

Habitat: Mainly areas of high soil fertility and rainfall, associated with waste or cultivations but sometimes well away from habitation.

Properties: Toxicity of berries varies, toxic when unripe.

Control & management: Susceptible to MCPA and 2,4-D.

Sonchus asper subsp. *glaucescens*

Family: Asteraceae.

Synonymy:

Common name: Rough Sow thistle, Prickly Sow thistle, Spiny Sow thistle, Rough Milk Thistle.

Habit: Erect annual or over wintering herb 20-150 cm high, with woody taproot.

Life cycle: Grows in cooler seasons and die after flowering October-December if favourable conditions do not persist; otherwise they grow throughout the year and flower at any time.

Origin & distribution: Native of Europe; all divisions except NWS NWP; all states.

Dispersal: Achene - readily dispersed.

Priority: 3.

Habitat: Weed of most habitats, particularly roadsides, cultivation, gardens, wasteland.

Properties: May causing photosensitization in cattle.

Control & management: Cultivation followed by hand weeding or hoeing of scattered plants; mow waste places before seeds form.

Stellaria media

Family: Caryophyllaceae.

Synonymy:

Common name: Common Chickweed.

Habit: Annual or biennial with weak stems rooting at nodes.

Life cycle: Winter-spring annual.

Origin & distribution: Native of Europe; all divisions except NFWP; Qld; Vic.; Tas.; SA; WA.

Dispersal: Seed.

Priority: 4.

Habitat: Weed of cultivation; sometimes river flats; shaded crevices and valleys on rocky hillsides.

Properties:

Control & management: Hand weeding, mecoprop and various herbicides.

Taraxacum officinale

Family: Asteraceae.

Synonymy:

Common name: Dandelion, Common Dandelion.

Habit: Prostrate perennial herb 15-30 cm and basal rosette of leaves, scapes 5-40 cm high.

Life cycle: Flowers most of year, in spring in western NSW; reproduces by seeds and new shoots from roots.

Origin & distribution: Native of Europe; NC, CC, SC, NT, CT, ST, NWS, SWS, NWP, SWP; all states except NT.

Dispersal: Achene

Habitat: Widespread weed of lawns, roadsides, wasteland, cultivated land and pastures; found where there is adequate moisture available throughout year; favours cool climates.

Priority: 4.

Properties: Not known to be poisonous; medicinal properties

Control & management: Spot spraying with selective herbicides and rotary hoe in arable land or cut crown below soil surface when hand pulling; very difficult to eradicate once established.

Tradescantia fluminensis

Family: Commelinaceae.

Synonymy:

Common name: Wandering Jew.

Priority: 3.

Habit: Creeping succulent herb with stems rooting at nodes and ascending at flowering tips.

Life cycle: Flowers spring to summer.

Origin & distribution: Native of Mexico and central America. NC, CC, NWS in NSW. Qld.

Dispersal:

Habitat: Cultivated as an ornamental occasionally naturalized in closed forest.

Properties:

Control & management: Hand pulling is effective.

Trifolium repens

Family: Fabaceae.

Synonymy:

Common name: White Clover.

Priority: 4.

Habit: Prostrate perennial herb with branches to 30 cm long.

Life cycle:

Origin & distribution: Native to Europe, Middle East and North Africa. NC, CC, SC, NT, CT, ST, NWS, SWS in NSW. Qld, Vic., Tas, SA, WA.

Dispersal: Via fruit often attached to animals.

Habitat: Frequently cultivated often on roadsides and waste places.

Properties: Can form roots at stem nodes.

Control & management: Spraying with mecoprop or 2,4.5-T amine at 0.2% or MCPA plus dicamba. Sulphate of ammonia crystals.

Verbascum thapsus

Family: Scrophulariaceae.

Synonymy:

Common name: Great Mullein, Blanket Weed, Aaron's Rod, Flannel Leaf, Velvet Mullein.

Habit: Erect, densely hairy biennial herb to 2.5 m tall.

Life cycle: Seeds germinate in autumn and spring; flowers January to March; die in autumn; seeds mostly viable and long lived.

Origin & distribution: Native of Eurasia; CC, SC, NT, CT, ST, NWS, CWS, SWP, NFWP; Qld; Vic.; Tas; SA.

Dispersal: Only be seeds.

Habitat: Temperate regions of moderate summer temperatures and more than 500 mm annual rainfall, on dry well drained soils, sites of lower fertility and high pH; disturbed land, woodlands an pastures.

Properties: Doesn't persist when soil fertility raised.

Priority: 3.

Control & management: Removal of individual plants with as much taproot as possible, glyphosate can be applied at rosette stage.

Verbena bonariensis

Family: Verbenaceae.

Synonymy:

Common name: Purpletop, Cluster-flower Verbena, Cluster-flower Vervain, Blue Top.

Priority: 2.

Habit: Rigid hairy perennial herb to 2 m tall.

Life cycle: Flowers mainly from October to June.

Origin & distribution: Native of South America. NC, CC, SC, NT, CT, ST, NWS, CWS, SWS, NWP, SWP in NSW. Qld, Vic., SA.

Dispersal: Prolific seeder and very persistent.

Habitat: An invasive weed in wasteland and neglected areas, often on roadsides and waterlogged areas.

Properties:

Control & management: Young plants susceptible to 2,4-D at 0.2%. Older plants are resistant. Chipping and removal of flowering material.

Verbena rigida

Family: Verbenaceae.

Synonymy:

Common name: Veined Verbena, Wild Verbena.

Habit: Perennial herb to 60 cm tall.

Life cycle: Flowers throughout the year.

Origin & distribution: Native of South America; NC, CC, SC, NT, NWS, SWS, Qld.

Dispersal:

Priority: 2.

Habitat: Widespread weed of waste ground, roadsides, creek banks and run down pastures.

Properties:

Control & management: Spraying with 2,4-D/2,4,5-T mixtures or sodium chlorate.

Vicia villosa

Family: Fabaceae.

Synonymy:

Common Name: Common Vetch.

Habitat: Trailing or climbing annual forb forming a tangled mass to 80 cm high.

Life Cycle: A cool season grower flowering in winter-spring.

Priority: 3.

Origin & Distribution: Native of western Asia. CC, ST, NWS, CWS, SWS, SWP, NFWP, in NSW. SA, WA.

Dispersal: Seed. Sometimes sown as fodder species or green manure crop.

Habitat: Widespread. Often in drainage lines, channel banks and other moist spots. Also a weed of cereal crops and habitation.

Properties: Reputedly poisonous to stock, though mostly regarded as useful forage plant.

Control & Management:

Appendix D: Two-way table of species occurrences within communities.

Species	**BI1**	**BI2**	**BI3**	**BI4**	**BI5**	**BI6**	**BI7**	**BI8**	**BI9**	**BI10**	**BI11**	**Total**
Acacia buxifolia		1	1			1						3
Acacia cheelii				1					1			2
Acacia falciformis		1										1
Acacia implexa			1	1			1	1				4
Acacia leiocalyx	1	1			1							3
Acacia neriifolia	1	1	1	1	1	1	1		1	1		9
Acacia obtusifolia		1										1
Acacia penninervis	1	1	1	1		1	1			1		7
Acacia pruinosa	1		1				1					3
Acacia rubida					1							1
Acacia triptera						1	1		1	1		4
Acacia ulicifolia	1	1										2
Acacia viscidula			1		1				1			3
Acaena novae-zelandiae	1	1		1	1	1	1					6
Acetosella vulgaris					1		1					2
Actinotus helianthi			1						1	1		3
Adiantum aethiopicum					1	1	1	1				4
Adiantum hispidulum						1						1
Aira cupaniana		1			1					1		3
Ajuga australis	1	1	1	1		1	1			1		7
Alternanthera denticulata								1				1
Amyema miquelii	1			1	1		1					4
Amyema miraculosum									1			1
Anagallis arvensis					1		1	1				3
Angophora floribunda	1	1	1	1	1	1	1	1				8
Arenaria leptoclados		1										1
Aristida calycina	1	1	1	1	1	1	1		1	1		9
Aristida ramosa				1			1	1	1	1		5
Aristida vagans	1	1	1	1	1	1	1		1	1		9
Arthropodium milleflorum	1	1		1	1	1	1	1	1	1	1	10
Arthropodium sp. A					1							1
Arundinella nepalensis					1		1	1		1		4
Asperula conferta	1				1	1	1					4
Asplenium flavellifolium				1		1						2
Austrodanthonia laevis	1	1				1			1			4
Austrodanthonia monticola									1			1
Austrodanthonia racemosa		1		1		1	1			1		5
Austrostipa ramosissima				1								1
Austrostipa scabra							1					1
Austrostipa setacea	1			1	1	1	1			1		6
Austrostipa verticillata	1											1
Axonopus affinis					1						1	2
Baloskion stenocoleum					1						1	2
Bidens pilosa						1	1	1				3
Billardiera scandens		1				1						2
Boronia anethifolia									1			1
Bossiaea neo-anglica	1	1										2
Bothriochloa decipiens					1		1					2
Brachychiton populneus	1			1			1	1				4
Brachyloma daphnoides	1	1	1	1		1	1		1	1		8

Species	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	Total
Brachyscome microcarpa	1	1										2
Brachyscome multifida	1	1	1		1					1		5
Brachyscome nova-anglica									1	1		2
Brachyscome stuartii									1			1
Bracteantha bracteata		1										1
Bromus diandrus				1								1
Bursaria spinosa				1		1	1					3
Caladenia fuscata	1	1			1	1			1	1		6
Calandrinia eremaea		1	1		1				1	1		5
Callistemon pungens					1	1	1	1			1	5
Callitris endlicheri	1	1	1	1	1	1	1		1	1		9
Calotis cuneifolia		1										1
Calotis lappulaceae							1					1
Calytrix tetragona		1	1		1	1			1	1		6
Carex appressa	1			1	1	1	1	1				6
Carex breviculmis	1	1			1	1	1					5
Carex gaudichaudiana	1				1	1	1	1			1	6
Cassinia quinquefaria	1	1	1	1	1	1	1		1	1		9
Cassinia uncata	1											1
Cassytha pubescens		1				1			1			3
Casuarina cunninghamiana								1				1
Centaurium erythraea	1	1			1		1					4
Centipeda cunninghamii							1					1
Centipeda minima					1							1
Cerastium glomeratum					1							1
Cheilanthes distans		1		1					1	1		4
Cheilanthes sieberi	1	1	1	1	1	1	1		1	1		9
Chenopodium pumilio								1				1
Chloris truncata				1								1
Chrysocephalum apiculatum	1	1				1	1			1		5
Chrysocephalum semipapposum	1	1	1							1		4
Ciclospermum leptophyllum								1				1
Cirsium vulgare	1				1	1	1					4
Cleistochloa rigida		1										1
Clematis glycinoides	1	1	1	1	1	1	1					7
Commelina cyanea				1			1	1	1	1		5
Conyza albida	1	1			1	1	1	1				6
Conyza bonariensis							1	1				2
Correa reflexa	1	1	1	1	1	1						6
Corybas fimbriatus		1				1						2
Craspedia variabilis	1	1			1	1						4
Crassula colorata					1							1
Crassula sieberiana	1	1	1		1	1			1	1		7
Cryptandra amara				1					1	1		3
Cymbonotus lawsonianus	1						1					2
Cymbopogon obtectus										1		1
Cymbopogon refractus	1	1	1	1	1	1	1	1	1	1		10
Cyperus aggregatus							1	1				2
Cyperus fulvus				1						1		2
Cyperus gracilis	1					1	1		1			4
Cyperus lucidus								1				1

Species	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	Total
Cyperus sanguinolentus					1							1
Cyperus secubans		1							1	1		3
Cyperus sphaeroideus					1							1
Cyphanthera albicans									1			1
Daucus glochidiatus	1						1					2
Daviesia latifolia		1										1
Derwentia arcuata	1	1	1		1							4
Derwentia arenaria		1		1	1	1	1					5
Derwentia perfoliata						1						1
Desmodium brachypodum	1			1		1	1			1		5
Desmodium varians	1	1		1	1	1	1	1		1		8
Dianella caerulea	1	1	1	1	1	1	1			1		8
Dianella revoluta	1	1	1	1	1	1	1	1				8
Dichelachne crinita				1								1
Dichelachne micrantha	1	1	1	1	1	1	1		1	1		9
Dichelachne parva		1										1
Dichelachne sieberiana			1		1							2
Dichondra repens	1	1		1	1	1	1	1				7
Dichondra sp. A	1		1	1		1	1	1				6
Digitaria breviglumis							1			1		2
Digitaria ramularis				1	1		1		1			4
Dillwynia sieberi					1							1
Dipodium variegatum	1											1
Diuris abbreviata		1							1			2
Dodonaea boroniifolia		1										1
Dodonaea viscosa	1	1	1		1		1			1		6
Doodia aspera						1						1
Drosera burmannii		1							1	1		3
Drosera peltata					1	1				1		3
Drosera spatulata										1		1
Echinopogon caespitosus	1	1		1	1	1	1	1				7
Echinopogon mckiei							1					1
Echinopogon ovatus	1				1		1					3
Einadia hastata				1								1
Einadia polygonoides							1	1				2
Einadia trigonos								1				1
Eleocharis pusilla					1							1
Entolasia stricta		1	1		1	1	1		1	1		7
Epilobium billardierianum	1				1	1	1				1	5
Eragrostis elongata	1			1			1		1	1		5
Eragrostis lacunaria	1											1
Eragrostis leptostachya	1			1	1		1			1		5
Eryngium vesiculosum											1	1
Eucalyptus albens				1			1					2
Eucalyptus andrewsii	1	1	1	1	1	1	1					7
Eucalyptus blakelyi	1				1	1	1	1		1		6
Eucalyptus bridgesiana	1	1			1	1	1	1				6
Eucalyptus caleyi	1	1	1	1	1	1	1			1		8
Eucalyptus dealbata	1	1		1			1		1	1		6
Eucalyptus macrorhyncha	1	1	1	1	1	1	1	1				8
Eucalyptus melliodora	1	1	1	1		1	1					6

Species	**BI1**	**BI2**	**BI3**	**BI4**	**BI5**	**BI6**	**BI7**	**BI8**	**BI9**	**BI10**	**BI11**	**Total**
Eucalyptus prava	1	1	1	1	1	1		1	1	1		9
Eucalyptus quinniorum	1	1	1	1	1	1						6
Eucalyptus subtilior						1						1
Euchiton sphaericus	1	1			1	1	1					5
Eustrephus latifolius					1	1						2
Exocarpos cupressiformis	1	1	1			1						4
Festuca asperula										1		1
Ficus rubiginosa		1		1		1						3
Fimbristylis dichotoma	1				1		1		1	1		5
Gahnia aspera		1	1	1	1					1		5
Galium binifolium	1				1	1						3
Galium gaudichaudii	1	1				1	1					4
Galium migrans	1	1			1	1	1	1		1		7
Galium propinquum	1	1				1						3
Geranium solanderi	1	1		1	1	1	1	1		1	1	9
Glossogyne tannensis				1								1
Glycine clandestina	1	1			1	1	1	1				6
Glycine stenophita							1					1
Glycine tabacina	1	1	1	1		1	1			1		7
Gonocarpus micranthus					1						1	2
Gonocarpus oreophilus									1			1
Gonocarpus tetragynus	1	1	1		1	1	1		1	1		8
Gonocarpus teucrioides	1	1		1	1	1			1	1		7
Goodenia bellidifolia	1											1
Goodenia hederacea	1	1	1	1	1	1				1		7
Goodenia macbarroni	1	1	1		1					1		5
Goodenia rotundifolia		1										1
Gratiola peruviana					1	1						2
Grevillea triternata	1		1	1	1		1			1		6
Hakea microcarpa											1	1
Haloragis heterophylla	1				1	1	1			1		5
Haloragis serra						1	1					2
Hardenbergia violacea	1	1	1	1	1	1	1					7
Hibbertia acicularis			1	1								2
Hibbertia cistoidea									1			1
Hibbertia linearis		1							1			2
Hibbertia obtusifolia	1	1	1	1	1	1	1	1		1		9
Hibbertia riparia	1	1	1						1	1		5
Hibbertia sp. "grandiflora"			1						1			2
Histiopteris incisa						1						1
Homoranthus bornhardtiensis									1	1		2
Hovea apiculata		1							1			2
Hovea graniticola			1							1		2
Hovea heterophylla	1	1	1		1							4
Hovea lanceolata										1		1
Hybanthus monopetalus	1											1
Hydrocotyle geraniifolia						1						1
Hydrocotyle laxiflora					1		1					2
Hydrocotyle peduncularis	1	1			1	1		1		1	1	7
Hypericum gramineum	1	1			1	1	1		1	1		7
Hypericum japonicum	1	1			1							3

Species	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	Total
Hypochaeris glabra							1		1			2
Hypochaeris radicata	1	1			1	1	1	1	1	1		8
Hypoxis exilis							1					1
Imperata cylindrica	1		1	1	1	1	1	1				7
Indigofera adesmiifolia	1	1		1	1	1						5
Indigofera australis	1	1	1				1					4
Isolepis hookeriana					1			1				2
Isotoma anethifolia									1			1
Isotoma axillaris									1	1		2
Isotoma fluviatilis					1			1				2
Jasminum suavissimum			1									1
Joycea pallida	1	1	1	1	1	1	1	1	1	1		10
Juncus bufonius					1		1					2
Juncus fockei					1						1	2
Juncus pauciflorus						1	1	1				3
Juncus subsecundus					1	1						2
Juncus usitatus	1				1							2
Juncus vaginatus	1				1	1	1	1			1	6
Kunzea parvifolia							1		1			2
Lactuca serriola	1				1							2
Lagenifera stipitata	1				1		1					3
Laxmannia compacta			1	1	1				1	1		5
Laxmannia gracilis									1			1
Lepidium hyssopifolium							1					1
Lepidosperma gunnii		1										1
Lepidosperma laterale	1	1	1	1	1	1	1		1	1		9
Leptospermum brevipes						1	1		1	1		4
Leptospermum novae-angliae									1			1
Leptospermum polygalifolium	1				1	1	1	1			1	6
Lespedeza juncea	1						1	1				3
Leucochrysum albicans										1		1
Leucopogon lanceolatus	1	1				1			1			4
Leucopogon melaleucoides				1								1
Leucopogon muticus	1	1	1	1	1	1	1		1	1		9
Leucopogon neoanglicus									1			1
Leucopogon virgatus	1		1									2
Lissanthe strigosa	1	1	1		1	1	1					6
Lobelia gracilis									1	1		2
Lomandra confertifolia	1											1
Lomandra cylindrica	1					1						2
Lomandra filiformis	1	1	1	1		1	1					6
Lomandra longifolia	1	1	1	1	1	1	1	1		1		9
Lomandra multiflora	1	1	1	1	1	1	1	1		1		9
Lomatia silaifolia		1				1						2
Lotus australis	1				1							2
Lotus cruentus	1	1			1							3
Lotus uliginosus					1						1	2
Luzula flaccida	1	1		1	1	1	1			1		7
Macrozamia heteromera	1	1	1			1				1		5
Maytenus silvestris	1			1		1	1	1				5
Melichrus urceolatus	1	1	1	1	1	1	1			1		8

Species	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	BI9	BI10	BI11	Total
Mentha diemenica					1	1	1					3
Microlaena stipoides	1		1		1	1	1	1				6
Microseris lanceolata					1	1						2
Mirbelia pungens									1	1		2
Modiola caroliniana								1				1
Monotoca scoparia	1	1	1	1	1	1	1					7
Murdannia graminea	1				1		1			1		4
Myriophyllum crispatum					1			1				2
Notelaea microcarpa	1		1	1	1	1	1	1		1		8
Notodanthonia longifolia									1			1
Olearia elliptica	1	1	1	1	1	1	1	1		1		9
Olearia erubescens		1										1
Olearia ramosissima		1										1
Olearia rosmarinifolia		1				1						2
Olearia viscidula	1	1	1	1	1	1	1	1				8
Opercularia aspera	1			1			1					3
Opercularia diphylla	1	1	1				1			1		5
Opercularia hispida		1			1							2
Ophioglossum lusitanicum									1			1
Oplismenus imbecillis				1	1	1		1				4
Opuntia stricta		1		1			1			1		4
Oxalis chnoodes	1	1		1	1	1	1					6
Oxalis perennans	1				1		1	1				4
Ozothamnus obcordatus			1						1	1		3
Panicum effusum	1	1		1			1			1		5
Panicum simile		1			1		1					3
Paronychia brasiliana		1			1							2
Parsonsia eucalyptophylla				1								1
Paspalum dilatatum					1							1
Patersonia sericea	1	1	1									3
Pellaea falcata						1						1
Pellaea nana		1		1		1						3
Pellaea paradoxa						1						1
Pennisetum alopecuroides					1							1
Persicaria decipiens					1							1
Persicaria hydropiper							1	1				2
Persoonia chamaepeuce			1									1
Persoonia cornifolia	1	1	1		1	1	1					6
Persoonia sericea	1	1	1		1	1						5
Petrorhagia nanteuilii	1				1							2
Phragmites australis					1						1	2
Phyllanthus subcrenulatus							1					1
Phyllanthus virgatus	1						1					2
Pimelea linifolia			1									1
Pimelea strigosa				1								1
Pittosporum undulatum				1		1						2
Plantago debilis	1					1						2
Plantago lanceolata					1							1
Plantago varia	1	1		1	1	1	1			1		7
Plectranthus graveolens				1								1
Poa sieberiana	1	1	1	1		1	1			1		7

Species	**BI1**	**BI2**	**BI3**	**BI4**	**BI5**	**BI6**	**BI7**	**BI8**	**BI9**	**BI10**	**BI11**	**Total**
Podolepis jaceoides	1						1					2
Podolepis neglecta										1		1
Polygala japonica	1											1
Pomax umbellata	1	1	1	1	1				1	1		7
Poranthera microphylla	1	1			1	1	1					5
Prostanthera granitica									1			1
Prostanthera nivea					1				1			2
Psilotum nudum		1										1
Pteridium esculentum		1				1	1	1				4
Pterostylis curta	1	1			1	1						4
Pterostylis longifolia		1										1
Pterostylis mutica	1					1				1		3
Pterostylis parviflora		1			1							2
Pterostylis rufa	1								1			2
Pultenaea campbellii		1				1						2
Pultenaea cunninghamii		1	1									2
Pultenaea foliolosa	1	1	1									3
Pultenaea sp. C	1		1	1		1	1					5
Pultenaea sp. G	1	1		1	1	1				1		6
Ranunculus lappaceus	1	1			1	1						4
Ranunculus sessiliflorus						1						1
Ranunculus sp. A											1	1
Rhodanthe anthemoides					1							1
Rhynchospora brownii											1	1
Rhytidosporum diosmoides	1											1
Rhytidosporum procumbens			1									1
Rubus chloocladus	1				1	1	1	1				5
Rubus parvifolius		1			1	1						3
Rumex brownii	1				1	1	1	1				5
Schoenus apogon	1	1			1	1					1	5
Scirpus polystachyus								1				1
Scleranthus biflorus	1	1	1	1	1	1	1					7
Scleria mackaviensis				1								1
Scutellaria humilis	1	1		1	1	1	1	1				7
Secale cereale	1			1			1					3
Senecio diaschides	1	1		1	1	1	1					6
Senecio hispidulus		1				1		1				3
Senecio lautus		1				1				1		3
Senecio sp. E					1							1
Sida cunninghamii							1					1
Sigesbeckia australiensis	1	1				1	1					4
Solanum amblymerum			1									1
Solanum elegans		1				1						2
Solanum nigrum						1		1				2
Sonchus oleraceus					1		1					2
Sorghum leiocladum	1	1		1	1		1					5
Sporobolus elongatus										1		1
Stackhousia monogyna	1	1				1	1					4
Stackhousia viminea	1	1										2
Stellaria angustifolia					1	1	1	1			1	5
Stellaria flaccida					1							1

Species	**BI1**	**BI2**	**BI3**	**BI4**	**BI5**	**BI6**	**BI7**	**BI8**	**BI9**	**BI10**	**BI11**	**Total**
Stellaria media							1	1				2
Stellaria pungens						1	1					2
Stylidium graminifolium	1		1				1					3
Stypandra glauca									1	1		2
Swainsona galegifolia							1					1
Taraxacum officinale					1							1
Thelionema grande		1			1				1	1		4
Thelymitra pauciflora		1										1
Themeda triandra	1	1	1	1	1	1						6
Trachymene incisa		1		1					1	1		4
Tradescantia fluminensis							1					1
Tricoryne elatior	1	1										2
Trifolium repens	1				1	1					1	4
Triglochin multifructum					1							1
Tripogon loliiformis	1	1		1			1		1	1		6
Triptilodiscus pygmaeus										1		1
Urtica incisa							1	1				2
Verbascum thapsus							1					1
Verbena bonariensis	1				1							2
Verbena rigida	1											1
Vernonia cinerea		1					1	1				3
Veronica calycina	1	1	1			1						4
Vicia villosa					1							1
Viola betonicifolia	1	1	1		1	1						5
Viola caleyana					1			1				2
Viola hederacea					1			1				2
Vittadinia cervicularis				1				1				2
Vittadinia cuneata	1	1			1	1	1			1		6
Vittadinia muelleri							1		1	1		3
Wahlenbergia communis	1	1	1	1	1	1	1			1		8
Wahlenbergia gracilis	1	1			1	1			1			5
Wahlenbergia graniticola	1					1						2
Wahlenbergia luteola	1											1
Wahlenbergia planiflora	1	1		1	1	1	1			1		7
Westringia eremicola		1			1	1						3
Westringia sericea	1				1							2
Wurmbea biglandulosa	1	1				1				1		4
Xanthorrhoea johnsonii	1	1		1		1	1					5
Zieria odorifera			1									1
Zornia dyctiocarpa					1		1					2

Appendix E: Locality and site information.

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI1A	2/10/2001	315	2	300615	6642800	Flat rock exposed in site. Pig disturbance nearby. Soils loamy, med-dark grey-brown.	1	2	1	2	3	2	1	1	885	2	4	6
BI2A	2/10/2001	290	1	300610	6642220	Pig diggings. Soil loam, dark-grey brown. Fire < 7 yrs.	1	1	2	2	3	3	0	0	880	1	3	5
BI3A	2/10/2001	325	2	300580	6642420	A spring was in the quadrat. Site just within boundaries of reserve. Fire < 7yrs previous. Cattle in vacinity, pig ruttings. Soil loam, yellow-brown.	2	2	2	3	3	1	1	1	875	1	3	6
BI4A	2/10/2001	310	2	300160	6642310	Pig ruttings. Soil coarse sandy-loam, light grey brown.	1	1	2	3	5	2	1	0	880	1	4	2
BI5A	2/10/2001	34	6	300000	6642320	Outcrop. Soil coarse sandy peat, dark brown black.	1	1	1	2	3	0	0	0	880	3	4	4
BI6A	2/10/2001	2	2	299850	6642330	Soil loam, med yellow brown.	1	1	2	4	4	1	0	0	880	3	2	3
BI7A	2/10/2001	0	4	299850	6642190	Soil coarse loamy sand, dark yellow-brown. Pig rutting nearby.	1	1	1	4	5	3	0	0	910	2	3	3
BI8A	2/10/2001	75	2	299840	6642600	Soil coarse sandy peat, black. Rabbits on outcrop.	0	0	0	0	0	0	1	0	940	3	4	1
BI9A	3/10/2001	220	3	299820	6638620	Soil sandy, light grey. Some tree removal and ringbarking.	2	2	1	1	0	0	1	2	925	1	4	4
BI10A	3/10/2001	170	2	299880	6638408	Soil loamy sand, light grey. Fire about 7 yrs previous.	2	2	1	1	1	0	1	2	915	1	4	5
BI100A	18/04/2002	304	2	294835	6646275	Soil sandy loam, light cream brown. Heavily ringbarked in the past. Fire ca. > 20 yrs previous.	2	2	2	3	2	1	0	3	660	1	4	4
BI101A	12/09/1999	275	1	299960	6638350	Soil clayey loam, chocolate brown. Fire about 10yrs previous, light intensity. Picnic Spot on Bald Rock Creek.	3	2	2	3	1	1	3	3	910	2	1	6
BI102A	12/09/1999	300	1	299280	6639280	Soil loamy sand, brown. Little Bald Rock Creek.	4	6	3	3	4	2	1	3	900	1	3	6
BI103A	10/04/2001	2	5	300286	6640525	Soil loamy sand, grey brown. Fauna site.	0	1	1	2	1	1	0	0	940	2	4	2

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI104A	10/04/2001	280	1	299955	6641931	Soil dark brown loam. Fauna site. Sometimes waterlogged.	6	3	2	3	3	2	2	3	870	1	3	6
BI105A	10/04/2001	320	2	299167	6641288	Soil loamy sand, grey brown. Fauna site. Winter grazing for 1 month, none prior for 4 yrs.	1	2	3	4	3	2	0	1	950	2	4	2
BI106A	10/04/2001	110	1	299812	6638837	Soil sandy loam, grey brown.	3	3	1	1	0	0	2	2	950	1	4	3
BI107A	18/04/2002	108	1	299486	6645054	Soil sandy loam, grey. Fire ca. > 15 yrs previous.	1	2	2	1	1	2	2	2	860	1	4	3
BI108A	18/04/2002	153	2	299986	6644566	Soil sandy loam, grey brown. Fire ca. > 15 yrs previous.	1	3	5	2	0	0	2	1	880	1	4	2
BI109A	18/04/2002	274	6	299978	6644682	Rock outcrop. Soil loamy coarse sand, red brown. Fire > 20 yrs previous.	2	4	7	2	0	0	0	0	890	3	4	2
BI11A	3/10/2001	230	3	299420	6638460	Soil sandy loam, brown.	6	5	3	2	1	2	4	5	900	2	4	3
BI110A	18/04/2002	178	3	300306	6644262	Soil sandy loam, grey brown. Some ringbarking. Fire > 15 yrs previous.	6	5	1	1	0	0	0	2	910	1	4	3
BI12A	3/10/2001	150	3	299332	6638432	Soil sandy loam, dark brown.	4	3	2	2	1	0	3	6	900	2	4	6
BI13A	3/10/2001	255	2	299327	6638290	Soil sandy loam, brown. Pig ruttings.	4	8	5	4	2	0	3	5	880	3	4	6
BI14A	3/10/2001	126	3	299490	6638640	Soil sandy loam, brown.	3	2	0	0	0	3	3	3	940	2	4	2
BI15A	3/10/2001	153	4	299436	6638760	Outcrop. Soil sandy loam, brown.	1	1	0	0	0	1	1	1	950	3	4	1
BI16A	3/10/2001	30	3	299540	6638820	Soil sandy loam, light brown.	0	3	1	0	0	1	1	0	950	3	4	1
BI17A	3/10/2001	170	3	299674	6638819	Soil sandy loam, brown. Rabbit and hairs noted.	4	3	2	0	0	0	2	1	950	2	4	6
BI18A	3/10/2001	97	1	299634	6638667	Soil sandy loam, light brown. Some tree removal, pig damage and rabbits noted.	2	1	0	0	0	0	1	2	950	1	4	5
BI19A	3/10/2001	30	2	299083	6638702	Outcrop. Evidence of goats. Soil sandy loam, brown.	0	1	0	0	2	2	4	0	960	3	4	2
BI20A	4/10/2001	351	6	299666	6639127	Soil coarse sandy loam, brown.	3	5	2	3	5	2	0	1	920	3	4	2
BI21A	4/10/2001	270	3	299948	6639100	Soil loam, dark red brown.	9	7	3	5	6	2	1	4	910	2	2	6
BI22A	4/10/2001	195	7	299842	6639200	Soil coarse loamy sand, yellow grey brown.	8	9	4	1	3	3	0	0	940	2	3	3
BI23A	4/10/2001	218	6	299786	6639223	Soil sandy loam, dark yellow brown.	8	9	3	2	3	0	1	4	920	2	3	3

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI24A	4/10/2001	224	6	299435	6639282	Soil sandy loam, grey brown. Bee honeycomb found.	7	6	3	4	2	0	0	1	920	2	4	3
BI25A	4/10/2001	258	1	299211	6639304	Soil loamy sand, dark brey brown.	3	6	3	5	2	1	1	2	870	1	3	6
BI26A	4/10/2001	54	7	298785	6639489	Outcrop. Soil loam, dark red brown.	0	2	0	1	3	8	7	2	910	3	4	2
BI27A	4/10/2001	170	9	298713	6639336	Soil coarse sandy loam, dark red brown.	8	3	2	2	1	0	3	8	850	2	3	3
BI28A	4/10/2001	260	7	298632	6639125	Soil coarse sandy loam, dark grey brown.	8	5	3	6	6	4	0	4	815	3	3	6
BI29A	4/10/2001	168	3	298333	6639139	Soil coarse sandy loam, grey brown. Pig wollows common.	5	4	2	3	4	2	1	6	840	2	3	4
BI30A	4/10/2001	205	3	299085	6639349	Soil sandy loam, dark grey brown. Many pig wollows, highly disturbed.	4	2	2	3	1	1	2	4	860	1	3	4
BI31A	5/10/2001	134	3	299140	6639481	Soil sandy loam, dark grey brown.	3	3	4	2	1	0	1	4	900	2	3	2
BI32A	5/10/2001	180	3	299061	6639655	Soil sandy loam, dark red brown.	4	2	1	1	1	0	1	1	915	2	3	1
BI33A	5/10/2001	48	4	298939	6639891	Outcrop. Soil coarse sandy loam, dark brown black.	1	1	1	0	2	5	0	0	920	3	4	1
BI34A	5/10/2001	320	6	298891	6639983	Outcrop. Soil loam, light brown.	1	1	2	7	4	0	0	0	900	3	4	1
BI35A	5/10/2001	30	5	299145	6640028	Soil coarse sandy loam, dark red brown.	1	0	4	0	0	0	0	0	940	2	4	1
BI36A	5/10/2001	174	2	299305	6639556	Soil sandy loam, dark grey brown.	3	4	4	1	0	1	3	3	900	2	3	6
BI37A	5/10/2001	337	2	299569	6639936	Soil loam, light brown.	1	1	2	3	4	3	1	0	900	1	4	3
BI38A	5/10/2001	17	4	299324	6640227	Soil loam, light cream brown.	4	2	2	4	6	4	0	2	890	2	4	3
BI39A	5/10/2001	278	2	299345	6640397	Soil loam, dark red brown.	8	6	3	6	8	5	1	4	830	2	3	6
BI40A	5/10/2001	0	6	299385	6640424	Soil coarse sandy loam, grey brown.	9	6	3	3	4	1	0	3	850	2	4	4
BI41A	5/10/2001	259	2	299801	6640055	Soil sandy loam, dark red brown.	2	1	4	4	2	1	0	1	900	2	4	4
BI42A	6/10/2001	164	2	300031	6640227	Soil coarse sandy loam, dark grey brown.	4	4	2	2	2	1	1	3	890	2	4	4
BI43A	6/10/2001	206	7	300048	6640384	Soil coarse sandy loam, dark grey brown.	5	3	1	1	1	0	1	5	920	2	4	2
BI44A	6/10/2001	232	2	300322	6640735	Soil coarse sandy loam, dark grey brown.	2	2	1	1	1	0	0	1	945	1	4	2
BI45A	6/10/2001	250	4	300214	6640970	Soil sandy loam, light grey brown.	3	3	2	1	0	0	0	2	940	2	4	2
BI46A	6/10/2001	3	4	300236	6641226	Soil coarse sandy loam, dark grey brown.	0	0	2	3	7	0	0	0	940	2	4	2
BI47A	6/10/2001	291	3	300238	6641367	Outcrop. Soil coarse sandy peat, dark red brown.	0	0	3	2	1	0	0	1	920	3	4	2

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI48A	6/10/2001	333	2	299962	6640980	Soil loam, dark red brown. Wild cattle.	1	3	2	2	2	3	1	2	915	1	3	6
BI49A	6/10/2001	347	3	299928	6640795	Soil coarse sandy loam, grey brown.	0	1	1	2	3	2	0	0	930	2	4	2
BI50A	6/20/2001	35	2	299580	6640909	Soil sandy loam, dark grey brown. Bull ants in plot.	0	0	0	1	2	0	0	0	940	1	4	1
BI51A	9/10/2001	298	2	299739	6638180	Soil sandy loam, light cream brown. Wild cattle grazing.	0	1	1	1	1	0	0	1	920	2	4	2
BI52A	9/10/2001	295	3	299231	6637767	Soil coarse loamy sand, light grey brown. Wild cattle grazing.	2	4	2	1	2	1	1	2	890	2	3	6
BI53A	9/10/2001	140	2	299045	6637906	Soil loam, dark grey brown. Wild cattle in the area.	3	1	1	1	1	2	2	2	900	2	4	2
BI54A	9/10/2001	90	2	298828	6638160	Soil coarse sandy loam, dark brown. Swamp Wallaby at site.	2	1	1	2	2	1	0	1	900	2	4	1
BI55A	9/10/2001	325	2	299749	6638326	Outcrop. Soil coarse sandy loam, dark red brown.	1	1	1	2	1	0	1	2	910	3	4	2
BI56A	9/10/2001	347	2	299374	6640933	Soil coarse sandy loam, light grey brown. Bull ants in site.	1	1	2	2	1	1	0	0	930	2	4	2
BI57A	9/10/2001	320	2	298938	6641162	Soil coarse sandy loam, light cream brown.	1	1	2	2	1	1	0	0	920	2	4	2
BI58A	9/10/2001	322	2	299267	6641693	Soil loam, dark red brown. Pig ruttings and wild cattle.	2	2	2	2	3	4	1	2	870	1	3	6
BI59A	9/10/2001	222	2	299277	6641866	Soil clay loam, black. Ponded by small dam. Wild cattle and much pig damage.	4	3	2	2	4	3	1	1	850	1	1	6
BI60A	3/02/2002	317	2	299210	6642659	Soil sandy loam, dark brown.	0	0	1	4	4	2	1	0	860	1	3	2
BI61A	3/02/2002	82	2	299832	6642862	Sandy loam, yellow brown. Some anchient selective clearing.	1	0	0	1	2	2	3	3	850	1	3	3
BI62A	3/02/2002	338	2	299916	6642928	Sandy loam, yellow brown. Some old cattle dung.	3	4	2	1	2	4	4	2	840	2	3	6
BI63A	3/02/2002	203	12	299724	6643154	Loamy sand, grey brown. Some old cattle dung.	6	3	1	2	3	0	2	6	830	2	4	3
BI64A	3/02/2002	259	4	299593	6643450	Loamy sand, grey brown.	1	1	1	0	0	0	0	0	990	3	4	1
BI65A	3/02/2002	337	3	299410	6642492	Sandy peat, grey black.	0	0	0	2	2	0	0	0	910	3	4	2
BI66A	27/03/2002	221	2	294909	6645129	Coarse sandy loam, light chocolate brown.	2	2	2	2	0	0	0	1	740	3	3	3

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI67A	27/03/2002	312	1	294334	6644143	Soil loam, light chocolate brown.	3	3	3	2	2	2	1	2	630	1	3	4
BI68A	27/03/2002	340	2	294512	6644301	Soil clay loam, chocolate brown. Some selective logging.	3	4	4	2	2	2	1	1	640	1	3	4
BI69A	27/03/2002	213	3	294329	6644584	Soil sandy loam.	2	3	3	1	2	3	1	1	640	2	4	4
BI70A	27/03/2002	292	1	294746	6643445	Soil sandy loam, dark brown. Pig damage. Light grass fire 5-10 yrs previous.	4	5	3	3	3	3	1	1	630	1	3	6
BI71A	27/03/2002	237	7	295052	6643274	Soil sandy loam, dark brown.	6	4	2	2	3	2	1	1	650	3	4	3
BI72A	27/03/2002	247	4	295172	6642829	Soil clay loam. Fire 5-10 yrs previous light.	4	6	5	2	3	5	2	2	640	1	3	5
BI73A	27/03/2002	318	1	295343	6642578	Soil loamy coarse sand, yellow brown. Fire < 10 yrs previous.	4	6	3	1	4	5	2	2	640	1	2	6
BI74A	27/03/2002	253	1	295745	6642371	Soil sandy loam, light brown. Fire 5-10 yrs previous.	4	2	3	2	4	4	1	4	650	1	3	4
BI75A	27/03/2002	177	6	295775	6642562	Soil sandy loam, dark brown black.	7	2	2	1	3	3	4	7	680	3	4	3
BI76A	5/04/2002	177	2	296842	6644433	Soil sandy loam, dark brown. Fire ca. 10 yrs previous.	0	0	2	0	0	0	0	0	960	2	4	1
BI77A	5/04/2002	265	5	297374	6644109	Soil sandy loam, dark brown. Fire ca. 8-12 yrs previous.	0	0	0	0	0	0	0	0	950	2	4	1
BI78A	5/04/2002	178	9	297222	6644199	Soil sandy loam, dark brown. Fire ca. 8-15 yrs previous.	10	6	7	0	1	0	0	5	900	2	4	2
BI79A	5/04/2002	340	6	297180	6644441	Soil sandy loam, dark brown. Fire ca. 10 yrs previous.	0	1	2	6	8	5	2	0	880	2	4	2
BI80A	5/04/2002	201	3	296782	6644143	Soil sandy loam, dark chocolate brown. Fire ca. 15 yrs previous.	10	8	5	1	1	1	2	6	750	1	3	3
BI81A	5/04/2002	245	2	296806	6643819	Soil loamy sand, yellow brown. Fire ca. 15 yrs previous.	5	7	6	3	1	2	2	3	690	2	4	4
BI82A	5/04/2002	201	2	296686	6643239	Soil sandy loam, dark brown. Fire ca. 15 yrs previous. Some old tree removal.	4	5	4	3	2	2	2	3	670	1	4	6
BI83A	5/04/2002	58	2	295693	6642959	Soil sandy loam, yellow brown. Pig rutting. Fire ca. > 20 yrs.	2	2	2	2	3	3	4	2	700	3	4	4
BI84A	5/04/2002	111	1	296240	6643299	Soil sandy loam, dark chocolate brown. Some ringbarking.	4	3	3	1	2	2	4	3	670	1	4	4

Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
BI85A	10/04/2002	241	4	296775	6643020	Soil sandy loam, chocolate brown. Fire ca. 5-10 yrs previous.	4	10	8	4	3	2	2	2	680	1	3	4
BI86A	10/04/2002	195	4	296884	6643122	Soil loamy sand, dark brown black. Fire ca. 20 yrs previous.	5	3	2	3	2	0	1	2	710	2	4	3
BI87A	10/04/2002	210	2	297094	6643341	Soil loamy sand, grey brown. Fire > 20 yrs previous.	7	4	3	4	2	2	1	2	760	2	4	1
BI88A	10/04/2002	319	5	297164	6643466	Soil loam, grey brown. Small acid volcanic dyke. Fire ca. 15 yrs +.	6	12	1	2	2	4	1	0	760	1	3	1
BI89A	10/04/2002	108	9	297440	6643612	Soil loamy coarse sand, grey brown. Fire > 20 yrs previous.	8	2	1	1	1	1	7	16	780	2	4	3
BI90A	10/04/2002	137	7	297518	6643747	Soil loam, dark brown black. Fire ca. 5-10 yrs previous.	12	6	2	2	7	10	12	14	750	2	3	6
BI91A	10/04/2002	289	4	298085	6643761	Soil loamy coarse sand, orange brown. Outcrop. Fire > 20 yrs previous.	4	4	4	2	1	1	5	5	720	1	4	4
BI92A	10/04/2002	259	2	297976	6643366	Soil loamy sand, yellow brown. Fire > 20 yrs previous.	3	3	3	4	2	2	4	6	695	1	4	4
BI93A	10/04/2002	225	1	297625	6643353	Soil sandy loam, dark brown. Fire ca. 5-10 yrs previous.	5	3	3	3	4	2	3	4	690	1	3	6
BI94A	15/04/2002	5	2	300610	6642682	Rock outcrop. Soil red brown sandy loam.	3	2	1	3	1	1	2	2	870	3	4	4
BI95A	18/04/2002	237	2	296524	6645232	Soil sandy loam, grey brown. Area within reserve but fenced out for grazing in neighbours. Fire > 15 yrs.	5	4	3	4	3	2	1	1	760	1	4	3
BI96A	18/04/2002	345	2	296317	6645506	Soil sandy loam, grey brown. Heavily cleared in the past, now dense regrowth tea-tree.	2	4	4	2	3	2	1	1	750	1	4	2
BI97A	18/04/2002	26	3	295842	6645486	Soil loamy coarse sand, grey brown.	2	2	2	4	5	4	2	1	720	2	4	3
BI98A	18/04/2002	192	3	296564	6645361	Soil coarse sandy loam. Fire ca. > 20 yrs.	7	6	2	2	2	1	0	3	760	2	4	3
BI99A	18/04/2002	287	1	294862	6646619	Soil sandy loam, grey brown. Fire ca. > 20 yrs previous.	2	3	2	3	2	2	3	2	650	1	3	6
IB1A	12/09/1999	280	1	299550	6638420	Some grazing 2 yrs previous. Soil clayey loam, chocolate brown. Fire c. 15 yrs previous.	3	2	2	3	1	1	3	3	910	2	2	6
IB2A	12/09/1999	290	1	299720	6639230	Some grazing 2 yrs previous. Soil sandy loam, brown. Fire c. 15 yrs previous.	4	6	3	3	4	2	1	3	900	1	3	6

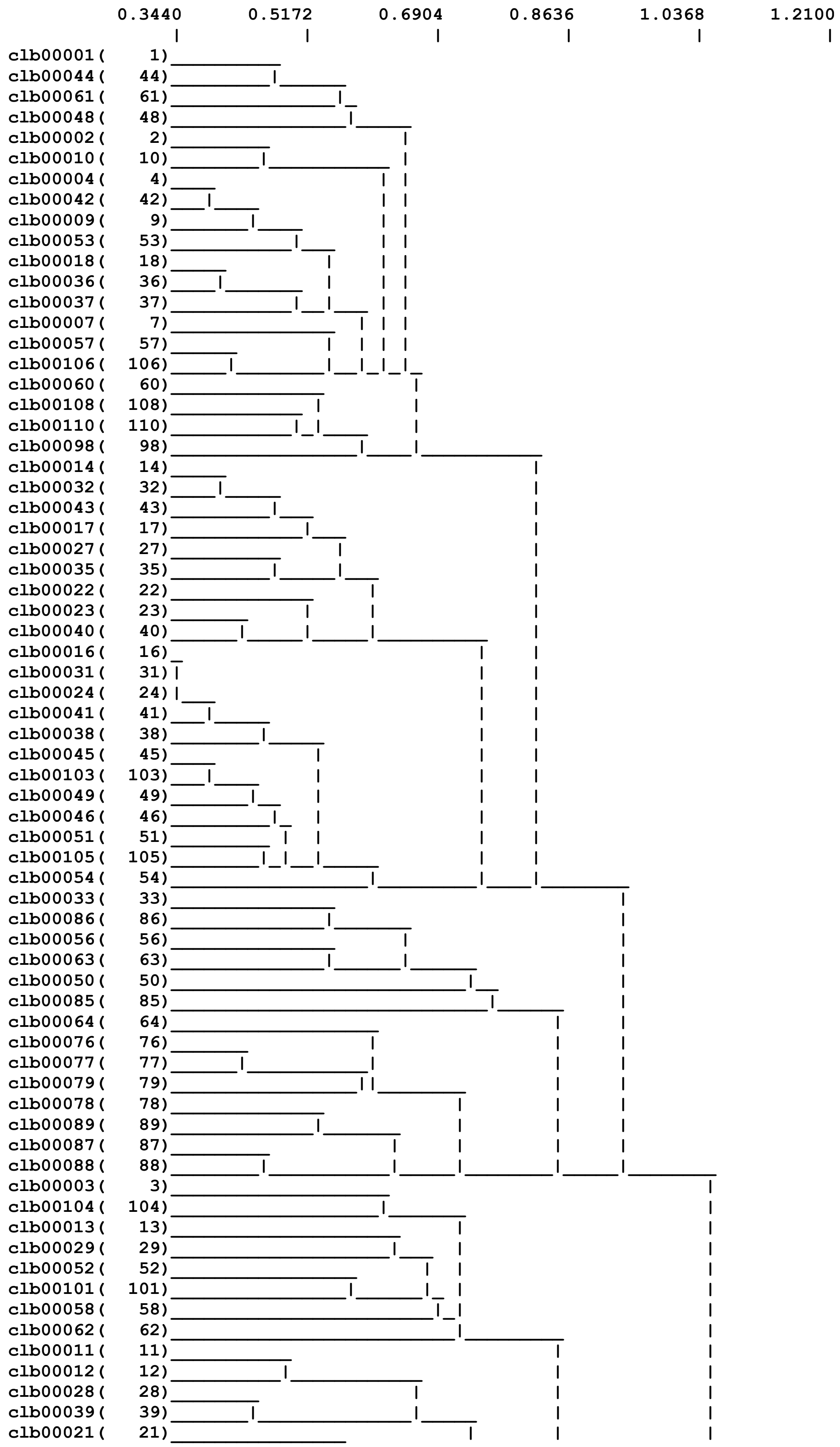
Site	Date	Aspect	Slope	Easting	Northing	Notes	N	NE	SE	S	SW	W	NW	N	Altitude	Sdep	Drain	Phys
IB3A	10/04/2001	2	5	300286	6640525	Some winter grazing in 2000. Soil loamy sand, grey brown. Fire c. 20 yrs previous.	0	1	1	2	1	1	0	0	930	2	4	2
IB4A	10/04/2001	320	2	299167	6641288	Some winter grazing in 2000. Soil loamy sand, grey brown. Fire c. 20 yrs previous.	1	2	3	4	3	2	0	1	920	2	3	2
IB5A	10/04/2001	280	1	299955	6641931	Some winter grazing in 2000. Soil loam, dark brown. Fire c. 6 yrs previous.	6	3	2	3	3	2	2	3	870	1	2	6
IB6A	10/04/2001	110	1	299812	6638837	Some winter grazing in 1998. Soil sandy loam, grey brown. Fire c. 15 yrs previous. Some selective tree felling.	3	3	1	1	0	0	2	2	930	1	3	3
IB1FA	9/07/1997	110	40	299220	6639130	rabbit and goat	4	2	0	0	1	2	5	3	945			
IB1FB	9/07/1997	280	40	299310	6638930	rabbit and goat	0	2	2	1	4	3	0	0	945			
IB1FC	9/07/1997	100	30	299490	6639120	rabbit and goat	0	1	0	1	2	2	1	0	935			
IB1FD	10/07/1997	170	30	299820	6639730	rabbit and goat	2	4	7	3	1	0	2	3	950			
IB1FE	10/07/1997	185	10	299950	6638790	rabbit and goat	2	1	1	1	1	0	2	3	925			
IB1OA	9/07/1997	26	60	299300	6638980	rabbit and goat	0	1	0	1	4	3	3	0	960			
IB1OB	9/07/1997	330	50	299230	6638950	rabbit and goat	0	0	0	1	2	0	0	0	960			
IB1OC	9/07/1997	206	90	298900	6638740	rabbit and goat	3	2	1	0	0	0	0	2	955			
IB1OD	9/07/1997	220	50	299250	6638850	rabbit and goat	5	2	1	0	0	0	0	4	945			
IB1OE	9/07/1997	70	70	299270	6638960	rabbit and goat	0	1	1	0	1	4	7	3	945			
IB2OA	9/07/1997	275	50	299240	6639220	rabbit and goat	1	4	5	5	5	4	0	0	935			
IB3OA	9/07/1997	170	40	299710	6639050	rabbit and goat	2	1	1	0	0	0	3	1	940			
IB4OA	10/07/1997	3	80	300200	6639650	rabbit and goat	0	0	0	0	1	2	0	0	1,015.00			
IB4OB	10/07/1997	164	40	300200	6639680	rabbit and goat	2	0	0	0	0	0	0	1	1,015.00			
IB4OC	10/07/1997	236	70	300110	6639700	rabbit and goat	7	8	6	2	0	0	0	3	1,005.00			
IB5OA	10/07/1997	0	70	299830	6639860	rabbit and goat	0	0	4	2	1	2	2	0	950			
IB6OA	10/07/1997	180	30	299800	6639750	rabbit and goat	3	2	1	1	0	0	2	3	950			
IB7OA	10/07/1997	92	50	299890	6638710	rabbit and goat	2	2	1	1	1	0	2	2	905			
IB8OA	10/07/1997	192	90	299650	6638890	rabbit and goat	4	3	1	0	0	2	4	3	920			
IB8OB	10/07/1997	208	40	299750	6638850	rabbits and goats	4	3	1	1	0	0	3	2	920			

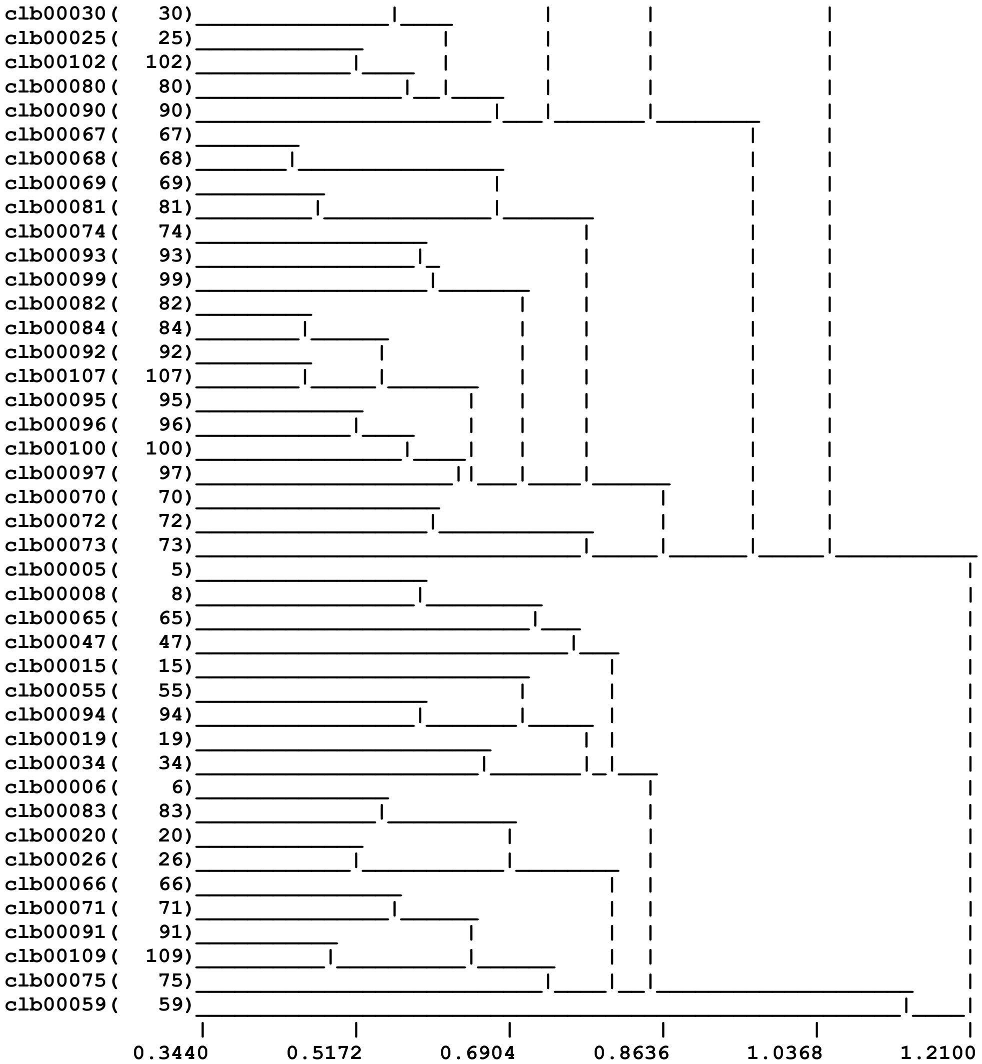
Appendix F: Nomenclature.

Current Name	Previous Name in Flora of NSW	Reference
Austrodanthonia fulva	*Danthonia fulva*	Linder (1996)
Austrodanthonia laevis	*Danthonia laevis*	Linder (1996)
Austrodanthonia monticola	*Danthonia monticola*	Linder (1996)
Austrodanthonia racemosa	*Danthonia racemosa*	Linder (1996)
Austrostipa ramosissima	*Stipa ramosissima*	Jacobs & Everett (1997)
Austrostipa scabra	*Stipa scabra*	Jacobs & Everett (1997)
Austrostipa setacea	*Stipa setacea*	Jacobs & Everett (1997)
Austrostipa verticillata	*Stipa verticillata*	Jacobs & Everett (1997)
Baloskion stenocoleum	*Restio stenocoleus*	Briggs & Johnson (1998)
Brachyloma daphnoides subsp. *glabrum*	*Brachyloma daphnoides* var. *glabrum* (Not in Fl. NSW)	Hunter & Williams (1994)
Brachyscome aculeata	*Brachycome aculeata*	ICBN amendment
Brachyscome multifida	*Brachycome multifida*	ICBN amendment
Brachyscome nova-anglica	*Brachycome nova-anglica*	ICBN amendment
Brachyscome tenuiscapa	*Brachycome tenuiscapa*	ICBN amendment
Brachyscome stuartii	*Brachycome stuartii*	ICBN amendment
Breynia cernua	*Breynia oblongifolia*	Bruhl (*in prep.*)
Dillwynia sieberi	*Dillwynia juniperina*	Reinstatement of original name
Euchiton gymnocephalus	*Gnaphalium gymnocephalus*	Reinstatement of original name
Euchiton involucratus	*Gnaphalium involucratum*	Reinstatement of original name
Euchiton sphaericus	*Gnaphalium sphaericum*	Reinstatement of original name
Hovea heterophylla	*Hovea linearis*	Thompson (2000)
Hovea pedunculata	*Hovea* sp. A	Thompson (2000)
Joycea pallida	*Chionochloa pallida*	Linder & Verboom (1996)
Phyllanthus occidentalis	*Phyllanthus hirtellus* subsp. B	Hunter & Bruhl (1997)
Psydrax odoratum	*Canthium odoratum*	Reynolds & Henderson (2000)
Rhytidosporum diosmoides	*Rhytidosporum procumbens*	Cayzer *et al.* (1999)
Themeda triandra	*Themeda australis*	Reinstatement of original name
Thonandia longifolia	*Danthonia longifolia*	Linder (1997)

Appendix G: Original analysis including all sites.

07/08/02 17:33:25.45 dend Bornhardtia & Ironbark 110 sites

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