Vegetation of the Guyra 1: 100 000 map sheet New England Bioregion, New South Wales

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Benson, J.S. and Ashby, E.M. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 2000. The natural vegetation of the Guyra 1: 100 000 map sheet, New England Bioregion, New South Wales. Cunninghamia *6(3): 747–872*.
The remnant natural vegetation (excluding native grasslands) of the Guyra 1: 100 000 map sheet area was sampled by way of 312 20 m × 20 m plots in which all vascular species were recorded using a modified Braun-Blanquet abundance rating. Sampling was stratified to cover the environmental factors of substrate, topographic position and altitude. Floristic analyses used the Kulczynski coefficient of dissimilarity in an agglomerative hierarchical cluster analysis and multidimensional scaling ordinations. Twenty-one plant communities were selected from the cluster analysis. The contribution of species to these groupings was investigated using a fidelity analysis. Another three communities were distinguished from aerial photographs and field traverse. These 24 plant communities are described and all except riparian vegetation are mapped. Their extent was mapped using aerial photography and ground traverses. The vegetation map was digitised at a scale of 1: 25 000 but has been reduced to 1: 100 000 for this publication. The minimum area mapped is 1 ha.

Eight hundred and eighty-nine plant taxa are reported for the study area, 681 of which were recorded during the survey. Common families are Poaceae, Asteraceae, Fabaceae, Myrtaceae, Orchidaceae and Cyperaceae. The status of the 28 nationally or State listed rare or threatened plant species, and other regionally rare species recorded in the area, is discussed. Some plant communities, such as those dominated by the stringybarks *Eucalyptus caliginosa* and *Eucalyptus laevopinea*, are ubiquitous in the landscape. Other communities are restricted in their geographic extent and contain a distinct suite of species. These included heath swamps, some forests on leucogranite and wetland vegetation in lagoons on basalt plateaux. 74% of the native woody vegetation has been cleared. This has particularly affected plant communities on higher nutrient soils including *Eucalyptus viminalis* and *Eucalyptus dalrympleana* subsp. *heptantha* open forest on basalt plateaux, *Eucalyptus nova-anglica* woodland in valleys, and *Eucalyptus blakelyi* and *Eucalyptus melliodora* woodland on sediments at lower altitudes. Most of the remnants have been grazed by stock thus influencing the understorey structure and species composition. Upright forbs and *Acacia* would appear to be less common now than prior to European settlement. Dieback of eucalypts over the last two decades has compounded the impacts of clearing. Logging and firewood cutting affects some plant communities. Weeds are most invasive where understorey disturbance is greatest, which is mainly in the small remnants on higher nutrient soil (basalt and sediments). Most of the lagoons in the study area have been drained or impounded, thus depleting wetland vegetation. Changes to fire regimes in the forest remnants may also have altered the populations of fire-dependent species. Most of the plant communities are poorly represented in conservation reserves. Conservation initiatives on private land are required to protect most of the communities. Key sites for conservationare listed.

Introduction

Approximately 60% of the woody vegetation in the New England bioregion of New South Wales has been cleared (Pressey et al. in press, Benson 1999). The Guyra 1: 100 000 map sheet is typical: more than 70% of the map sheet area has been cleared, but in a patchy way (Fig. 1). McIntyre and Barrett (1992) coined the term 'variegated landscape' to describe the New England countryside as it is composed of numerous patches of forest interspersed with cleared grazing country. Higher nutrient soils derived from basalt or alluviums have been most cleared, whereas large areas of vegetation growing on low nutrient soils derived from leucogranite in the region remain intact. Most of the understorey of forest remnants on private land have been extensively grazed over the last 130 years.

The aim of this project was to sample, document and map the extant native vegetation of the Guyra 1: 100 000 map sheet in the New England Bioregion. This will form a nucleus for further survey and mapping of the bioregion. This work concentrated on documenting the eucalypt-dominated open forests and woodlands (Walker & Hopkins 1990). We also surveyed and mapped shrublands, sedgelands and wetlands but did not survey or map natural or derived (Benson 1996) native grasslands. This work could be used to produce a pre-European vegetation map through further field survey and modelling (using methodology similar to that in Ferrier and Watson 1997 for example). However, by examining clearing patterns in the landscape, we provide estimates for the percentage remaining of each classified plant community.

Fig. 1. The New England Tableland Bioregion contains patches of forest of varying sizes scattered across a mainly cleared landscape.

The floristic data collected during this survey, along with the 1: 100 000 vegetation map (located inside the back cover) and the 1: 25 000 vegetation maps held on the geographic information system at the National Herbarium, will assist with land use planning in the study area. The data are particularly relevant for use in developing a regional vegetation plan under the Native Vegetation Conservation Act 1998.

Study area

The study area is defined by the Guyra 1: 100 000 map sheet (number 9237) on the Northern Tablelands (NT) botanical subdivision (Anderson 1961) of NSW (Fig. 2). It is located in the middle of the New England Bioregion (NEB) defined in Thackway and Cresswell (1995). Both regions are referred to in this paper. The main difference in the area covered by NT compared to NEB is that it includes western appendages along the Warrumbungle and Nandewar Ranges.

The Guyra map sheet is bounded by latitudes 30˚30'S and 30˚00'S and longitudes 151^0 30'E and 152˚00'E. The study area occupies approximately 2500 sq km and is bisected by the New England Highway running north-south along the Great Dividing Range. It is mainly within the Dumaresq and Guyra Shires with small proportions in the Uralla and Severn Shires. The area includes some of the higher parts of the Northern Tablelands of New South Wales. The town of Guyra is located centrally on a high basalt plateau, at the intersection of the New England Highway and the Ebor-Tingha roads. The northern part of the city of Armidale is on the southern boundary of the map area.

The study area contains some of the upper catchments of the eastern flowing Aberfoyle, Oban, Henry, Sara, Wollomombi and Gara rivers, and the western flowing Gwydir and McIntyre rivers. Altitudes range from 900 m in the south-east to above 1500 m on the Ben Lomond Range in the north.

The majority of the area is private land which is used principally for pastoralism. The more fertile, flat areas have been extensively cleared of native vegetation and native pastures have progressively been replaced with introduced pasture species that are reliant on fertilizers. Cropping is limited in extent due to the cold climate. There is increasing urbanisation of rural holdings closer to Armidale.

There are five conservation reserves totalling 1904 ha managed by the NSW National Parks and Wildlife Service. These cover only 0.72% of the study area. Parts of two small state forests (Armidale State Forest 230 ha and Avondale SF 220 ha) are also present, however Armidale State Forest is mostly a pine plantation.

Climate

The climate of the New England region is described in Hobbs and Jackson (1977). The region receives cold westerly or southwesterly winds in winter and mainly mild easterly winds in summer. Rain-bearing easterly winds, occasional cyclonic depressions and thunderstorms deliver maximum rainfall for the region in late spring and summer (Fig. 3). Some of this rain is high intensity, thus presenting an erosion hazard. Low pressure systems and cold fronts bring rain and occasionally snow in winter, peaking

in June. Regions at higher elevations receive higher rainfall in the study area. For example, Ben Lomond at 1360 m asl, receives an average of 1083 mm pa compared to Wandsworth at 1100 m asl which receives 827 mm and Armidale at 1000 m asl which receives 789 mm (Bureau of Meteorology 1996). A rainshadow exists in the valleys east of Armidale, including in the valley of the Wollomombi River that flows into the relatively dry Macleay gorges. Orographic factors increase precipitation on the ranges in the study area (such as Days Ridge and Mount Duval) that are exposed to moist easterly airstreams in summer.

Temperatures are warm in summer and cold in winter (Fig. 3). Summer temperatures are milder and winter temperatures colder than at locations at lower elevations

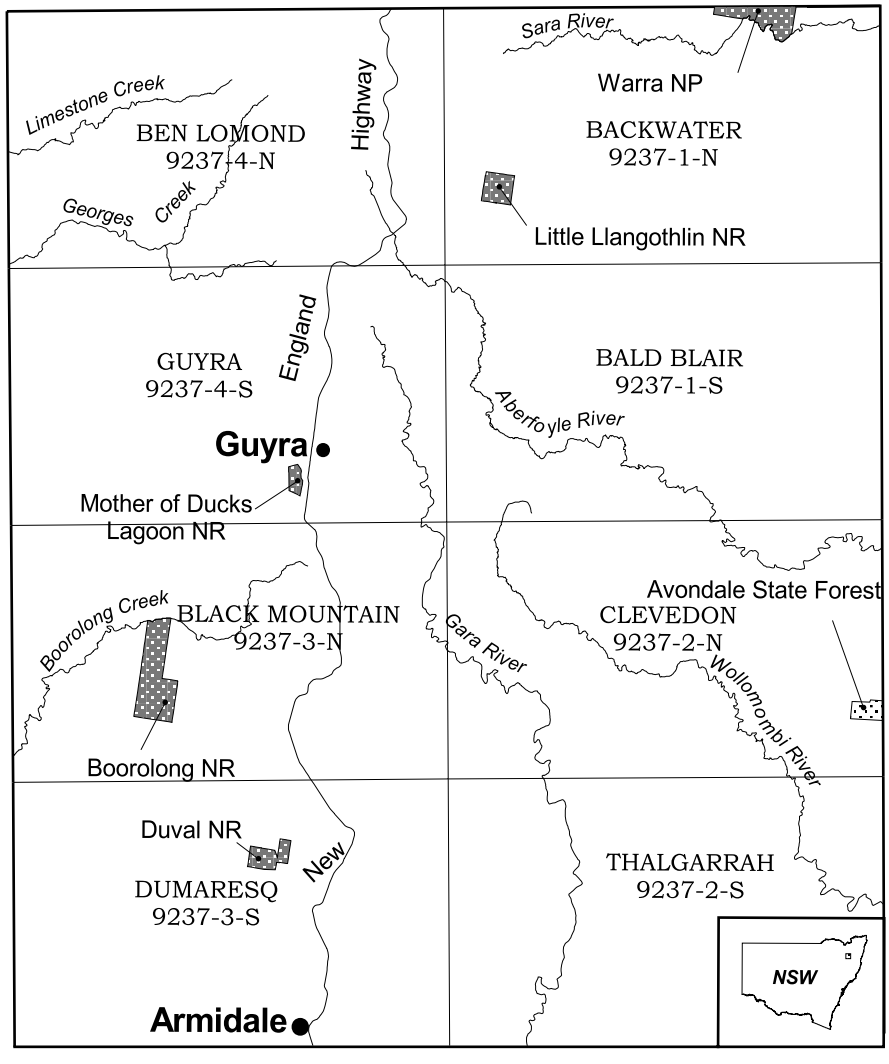

Fig. 2. Location of the Guyra 1: 100 000 map sheet, showing major rivers, conservation reserves, towns and the eight 1: 25 000 topographic maps that cover the area.

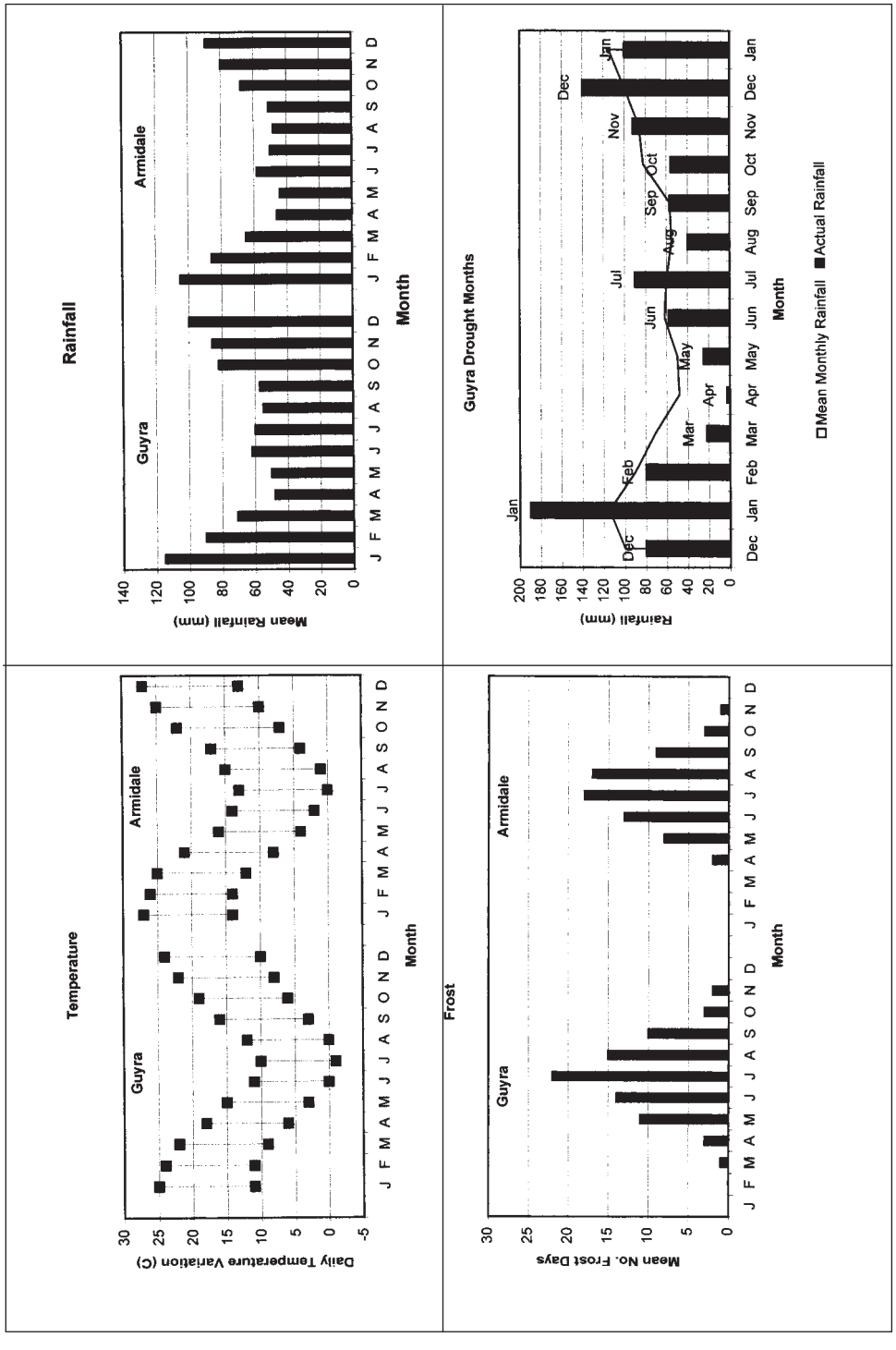

Fig. 3. Climate features of the towns of Guyra and Armidale including average monthly temperature, rainfall and frost days. Drought months for Guyra are shown for the period of field sampling, December 1992 to January 1994, by comparing the mean annual rainfall with actual rainfall for that period.

outside the study area on the Northern Tablelands or in adjoining regions. The high basalt plateau around Guyra is colder than lower parts such as Armidale. The latter has an average maximum summer temperature in January of 27°C compared to Guyra 24°C. Both have cold winters with an average minimum temperature in July of approximately zero. Frosts are common with an average of 20 frost days in Guyra and 17 in Armidale in July (Fig. 3). Cold air drainage affects most river valleys and hence the type of vegetation that occurs there.

Drought is less common on the tablelands than further west. The survey coincided with drought in eastern Australia and the study area was drought declared for 11 of the 14 months of the study period. During 1993, monthly rainfall fell below the average for nine out of the 12 months (Fig. 3).

Geology

The geology of the Northern Tablelands and adjoining coastal regions is depicted on the Dorrigo-Coffs Harbour 1: 250 000 geological map (NSW Department of Mines 1969). The Guyra 1: 100 000 map sheet is represented on the north-west corner of this map. Binns (1967) provides a summary of the geology and a geological map at 1: 250 000 scale covering the southern part of the New England Tableland including the Guyra region. A more accurate and detailed geological map covering the Guyra map sheet has been produced at a scale of 1: 100 000 by the NSW Department of Mineral Resources (1988).

The dominant structural feature of the Northern Tablelands is the New England Fold Belt, composed of a number of blocks of Paleozoic rocks including the New England Block (Harrington 1977, Rod 1974). These stratified rocks have been intensely folded and the strike line tends to follow the orientation of the major faults in the region, north to north west. A number of plutonic intrusions from the same era are present. Basalts from the Tertiary period overlay these rocks in parts of the region, particularly on the plateau between Guyra and Glen Innes.

In general, low elevations of the study area are composed of sedimentary or metamorphic rocks, while higher elevations tend to be composed of a range of granites, leucoadamellites (leucogranites) and Tertiary basalts. Acid volcanic rocks outcrop mainly west of the Great Dividing Range.

The Guyra 1: 100 000 geology map (Department of Mineral Resources 1988) shows the following main rock types:

- Metasediments of the Devonian Sandon Beds composed of lithic wacke, slate and chert cover much of the southern and south-western section of the study area;
- Devonian Uralla plutonic suite including the Mount Duval adamellite, Boorolong adamellite, Aberfoyle River porphyry and Llangothlin adamellite;
- Devonian and Permian leucadamellites in the Backwater-Oban River areas;
- Permian felsic volcanics (acid volcanics) in the north-western section of the area;
- Tertiary basalts on the plateau centred on Guyra and Ben Lomond, with outlying outcrops scattered over much of the rest of the area;
- Quaternary alluvials along rivers and in swamps.

A simplified geology map containing seven classes of substrate was developed by the National Parks and Wildlife Service in consultation with the NSW Geological Survey. This was used as one factor in stratifying the sampling of the vegetation of the study area.

Geomorphology

The Great Dividing Range runs north-south through the centre of the study area. It contains the upper catchments of both easterly and westerly-flowing river systems. Most of the landscape is undulating plateau broken by a number of higher ridges such as Mount Duval, Days Ridge and Mount Hourigan. An escarpment is present at the Devils Pinch separating the basalt plateau to the north from the Dumaresq Valley, mainly composed of sedimentary rocks, to the south.

On the top of the range on the basaltic plateau, the relief is small and the altitude high (up to 1509 m in the north at The Brothers). Lagoons are present in depressions on this plateau. More dissected country is found on the edge of the plateau where drainage lines have eroded the granites and leucogranites to the north east, the sediments and the granites of the south, and the acid volcanic rocks of the north-west. The altitude is still high in the valleys — down to a minimum of only 900 m along the Gara River in the south east. The most complex terrain is present on the leucogranite in the Backwater region where steep, rocky ridges are separated by valley flats, swamps and creek-lines.

The study area includes sections of five of the land provinces described by Morgan and Terrey (1990):

- Glen Innes-Guyra Basalts: occupying the central part of the study area, composed of rich soils on flat terrain at altitudes 1200–1500 m which has mostly been cleared;
- Armidale Plateau: in the south of the study area, mainly composed of sedimentary substrates of medium fertility at altitudes 900–1200 m;
- Wongwibinda Plateau: covering the south-eastern part of the area composed of sediments and basalts between 900–1100 m;
- Moredun Volcanics: in the north-western section of the area composed of acid volcanics and siliceous sedimentary substrates at altitudes 1000–1200 m;
- Nightcap Province: in the north-eastern section of the area mainly composed of leucogranites and granites with low soil fertility and hence containing the largest remnants of native vegetation.

Soils

Detailed descriptions of the soils of the New England Region, including the study area, are described and mapped in Jessup (1965), while Morgan and Terrey (1990) described soils of their land provinces on the New England Tableland.

The main soil associations in the study area are:

- Yellow podzolics and solodic soils, minor red earths and siliceous sands on sedimentary and metamorphic substrates in the vicinity of Armidale, Aberfoyle River and scattered localities elsewhere;

- Chocolate soils and krasnozems on ridges and weisenbodens in valleys on the basalt plateau at Guyra;
- Yellow sodolics on lower slopes and yellow podzolics on upper slopes on acid volcanics west of Guyra;
- Sandy yellow podzolics and gley podzolics on granites east of Llangothlin;
- Siliceous sands on upper slopes with gleyed podzolics in swamps on leucogranites near Backwater.

Gleyed solodic soils have a mottled B horizon with ironstone nodules in the A horizon. Podzolic soils have a contrast in texture with sharp boundaries between A and B horizons. Both solodic and podzolic soils are usually clayey. Chocolate soils on basalt are clayey with a mottled B horizon. Krasnozem soils on basalt are loamy gradational, reddish and well structured.

Land use history

Aboriginal occupation

At the time of European settlement the Anaiwan Tribe occupied much of the Northern Tablelands. Remaining physical evidence of these people's use of the Northern Tablelands includes rock shelters, camp sites, burials, ceremonial grounds, stone axes, axe grinding grooves (nearest at Tingha west of the study area) and art sites mainly under granite overhangs (Connah et al. 1977).

Aboriginal people lived in this area from at least 3000 B.C. This date is late compared to other regions of south-eastern Australia, either due to the cold post-ice age climate or because evidence of earlier occupation is lacking. It is likely that the cold, higher regions such as Guyra were sparsely populated and mainly used during the summer (Connah et al. 1977). This contrasts with evidence of larger populations on the nearby North Western Slopes.

Little is documented about how the Aborigines managed the land, as they were quickly displaced by the European invaders (Bowdler 1981). Explorers' notes of similar grassy woodland forest (for example, Mitchell 1848 referring to his crossing of the upper Hunter Valley in 1831) suggest that the understorey may have been burnt frequently for flushing game, stimulating growth of certain species and to ease access. This management regime may have reduced the number of saplings in the understorey, but there must have been sporadic regeneration events with appropriate climatic conditions. Aboriginal burning probably varied in different habitats. It was probably less frequent away from access routes and in the rougher granite and leucogranite regions of the study area. These areas contain shrubby species, many of which are in the same genera as the shrubs growing on Sydney sandstone that require variable fire regimes of between 8 and 25 years (Bradstock et al. 1995).

European exploration and settlement

A concise history of the early European explorations of the New England region is provided by Atchison (1977) and a history of the grazing industry is summarised in Nadolny (1998).

The first recorded European to traverse the Northern Tablelands was the Surveyor General John Oxley on his expedition of 1818 (Oxley 1820). The botanist Alan Cunningham accompanied Oxley.

The squatters moved in during the 1830s when Henry Dumaresq established the first pastoral run 'Saumarez' near modern-day Armidale. By 1839 pastoralists had moved north to Guyra (Atchison 1977). The large squatting runs withstood the threat of break up from the Robertson land acts in the 1860s. This legislation was designed to give free selectors the opportunity to take up and privatise land. An analysis of the impact of these acts on the New England pastoral runs revealed that the large pastoral runs mainly stayed intact (Ferry 1995).

It has been estimated that in the 1830s the Northern Tablelands were grazed by approximately 250 000 stock, with a stocking density of 0.6 sheep/ha (Campbell 1922 cited in Curtis 1989). By the late 1970s this increased to over 7 million, with 7 sheep/ha (Lodge et al. 1984) due to a combination of vegetation clearing and pasture improvement programmes (McDonald 1968 cited in Curtis 1989). Clearing would have been limited at first, but by 1890 about 10% of the Northern Tablelands had been ringbarked or cleared for grazing and cultivation. Curtis (1989) reports that teams of workers were employed on 'Saumarez' to ringbark and pull trees. Clearing was initially concentrated on the lower slopes and valleys where settlements were located. Lands close to mining areas were more intensively cleared. The two most active periods of clearing were 1870–1890 and after World War II. About 60% of the native tree cover has now been cleared across the Northern Tablelands (Benson 1999, Pressey et al. in press).

Pasture improvement, using a range of exotic grasses such as *Lolium perenne* and *Poa pratensis*, and legumes such as *Trifolium repens*, commenced in the 1920s but accelerated in the late 1940s. By 1973 19% of the region was sown to improved pasture. These imported grasses were aided in their establishment by the application of fertilizers, particularly superphosphate. Some of these pastures have been re-invaded by some native grasses and are termed natural pasture. Cultivation of crops has always been limited in extent.

Pre-European vegetation

At the time of European settlement the vast majority of the Northern Tablelands would have been covered in eucalypt forest and woodlands. Small patches of grassland would have occupied poorly-drained flats and river valleys that were affected by cold air drainage. Oxley (1820) observed and described a variety of forest vegetation. For example, he described travelling through 'the finest forest open country, or rather park, imaginable' (p. 291) as well as 'country … thickly timbered with stringybark and gum trees' (p. 293). However, Oxley's 'park-like' woodland

should not be interpreted as an 'open woodland' as defined in Walker and Hopkins (1990). Tree density estimates indicate grassy woodlands of south-eastern Australia contained on average about 30 large trees/hectare (Benson & Redpath 1997).

Armidale was built on a small open plain north of the larger Salisbury plain — an area of treeless or lightly wooded grassland. In 1838 John Everett noted plenty of stringybark in the region, peppermint in the valleys and on the open plains, and a range of wildlife including the Bustard (Curtis 1989). The botanist Campbell (1922) mentioned stringybarks monopolizing the slate ridges with peppermints and gums in the valleys. While the tree species distribution is similar to that of today (Williams 1985), albeit reduced in extent, the understorey has changed significantly in disturbed areas.

Comparing today's forests with that depicted in early descriptions (summarised in Curtis 1989), it would appear that the structure of the vegetation on the more fertile soils has changed. The open forests with well spaced, large trees noted by Oxley in 1818 and others, are now rare. Much of the forest today is regrowth from early clearing, being densely grouped and small in stature (Davidson & Davidson 1992).

It is likely, however, that the forests on the poorer soils (such as on the leucogranite near Backwater) are little changed.

Whalley et al. (1978) postulate there were three main types of grassland understorey in the region prior to European settlement. *Poa sieberiana* and *Themeda australis* dominated more fertile soils at high elevation, the same two species along with *Sorghum leiocladum* dominated on podsolic and solodic soils at lower elevations, and *Themeda australis*, *Aristida ramosa* and *Cymbopogon refractus* dominated on soils on well-drained, coarse grained granites. The most palatable *Themeda* and *Sorghum* grasses have been grazed out in many areas, while the less palatable snow grasses (*Poa* spp.) have persisted.

Previous botanical studies

Early botanical papers on the general region of the Northern Tablelands included Christie (1877) who commented on the relationship between plant species and the main substrates, Turner (1903) who prepared a plant species list and Cambage (1904) who reported on vegetation to the west of the tablelands. Turner's list shows that many exotic species were established in the region by the turn of the century. A more complete list of vascular plants on the New England Tablelands was prepared by Gray (1961), while Beadle (1971–1987) produced a Flora covering the north-eastern section of NSW. Norton (1971) dealt with the grasses of the region. Williams (1963) described the types of vegetation from the eastern scarp to the western slopes. Most of the vegetation on the Guyra 1: 100 000 map sheet is described as 'disturbed remnant' in the broad classification of Roberts (1992). The relatively intact vegetation near Backwater is described as 'plateau sclerophyll complex' in Roberts (1992). This classification was derived from LANDSAT TM images and covers the north-eastern region of NSW. McIntyre et al. (1993) documents understorey species in grassy forest on the New England Tablelands and discusses aspects of their rarity and sparseness.

More specific botanical surveys of locations in the study area include: Clarke (1980) who mapped and surveyed the vegetation on the Newholme Field Centre at Mount Duval; Binns (1992) who analyzed the forest communities of the state forests in the Glen Innes region including Warra State Forest; Brock and Britton (1994) who studied seedbanks of wetland plants in the basalt lagoons near Guyra; Tremont (1995) who investigated the phenologies of a range of native forbs near Armidale; and Hunter and Clarke (1998) who documented the vegetation growing on the granitic outcrops of the New England Batholith. Additionally, the University of New England has conducted student studies in various parts of the study area.

The natural pastures of the region have been the subject of considerable study beginning with Roe (1947), who suggested that native pastures should not be neglected because they are an important source of summer feed, and were so widespread. Subsequently, Lodge and Whalley (1989) described the native pastures of the region and commented on their management in relation to grazing and the application of fertilizer. Nadolny (1998) discusses the history of pasture use in the region, including the use of sown exotic species.

Methods

The project consisted of two components. Firstly, plot based sampling of the vegetation was undertaken to assist with predicting species occurrences and with the development of a floristic classification. This sampling targeted the main environmental classes of the study area (Keith & Bedward 1999, Benson 1995, Neldner 1993). It used outputs from a geographical information system to guide the development of the sampling programme. Secondly, the vegetation was mapped from aerial photographs and ground traverses. The vegetation map units are primarily based on the numerically-derived floristic classification developed from the plot data.

Floristic sampling

The vegetation was sampled across the entire map sheet based on a stratification of variables considered to influence vegetation — parent material (substrate), altitude (as a surrogate for rainfall and temperature), aspect and topographic position in the landscape. Digital layers were obtained under licence from NSW National Parks & Wildlife Service of tree cover, geology and altitude classes to aid in this process using the geographical information system Environmental Resource Mapping System (ERMS) (Ferrier 1988). The tree cover was determined from LANDSAT TM interpretation (Roberts 1992). No attempt was made to survey derived native grasslands in places where the original tree cover had been cleared.

The complex array of geological units mapped on published and unpublished geology maps for the region had previously been simplified by geologists from the Department of Mineral Resources in cooperation with National Parks and Wildlife Service staff. For the Guyra area there were initially seven of these derived geological categories: basalt (33%), granite (25%), acid volcanics (7%), leucogranite (6%), sedimentary (high quartz) (< 1%), sedimentary (low quartz) (27%) and Quaternary sand and alluvium

(1%). For the purposes of stratifying sampling, the two sedimentary geological categories were combined along with the Quaternary Sand and Alluvium to derive a geology map with five categories of substrate. This geology map is displayed on the vegetation map.

The tree cover data of Roberts (1992) was superimposed on these five substrates (Fig. 4). Approximately 20% of the map sheet was recorded with woody vegetation (> 20% crown cover) at the time of the study, based on the LANDSAT mapping (Roberts 1992). However, this did not include remnants less than 50 ha, natural swamps, open woodland and native grassland areas. Tree cover was distributed unevenly across geologies as different parent materials and landforms give rise to soils and landscapes with differing agricultural capability.

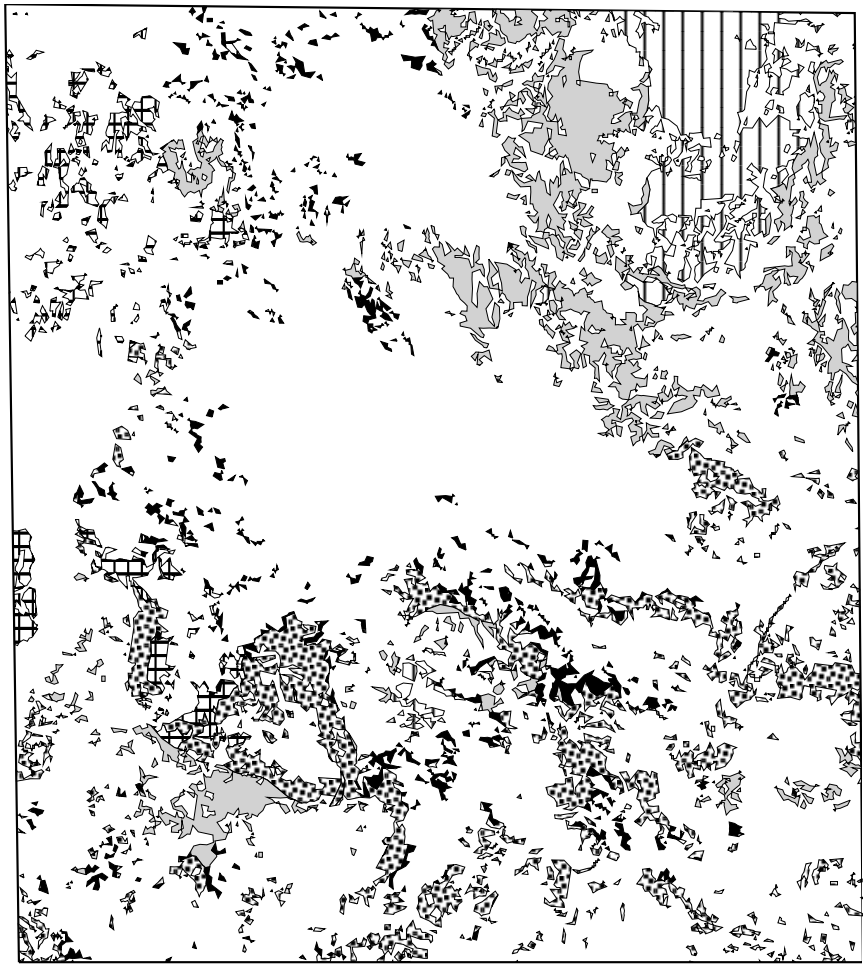

Fig. 4. Distribution of remnant vegetation detected from the LANDSAT TM image interpretation of Roberts (1992) over the five main substrates in the study area. Basalt = solid black, granite = light grey, leucogranite = vertical stripes, acid volcanic = checks, sedimentary = black blocks.

Using digitised terrain data in ERMS, altitude was classified into 6 bands: 900–1000 m, 1000–1100 m, 1100–1200 m, 1200–1300 m, 1300–1400 m, and > 1400 m. One category of slope was considered and aspect was considered to be of lesser importance to sample in parts of the study area with a gently undulating, basalt plateaux. Aspect was deemed to have a greater influence in the more dissected country at the mid-altitudes on non-basalt geologies.

The environmental cells and sampling requirements were developed by the following rules:

1. For landscape positions where aspect was irrelevant (ridge, flat and open depression) the number of sample sites was derived by multiplying five substrate types with six altitude classes by three replicates. This totalled 270.
2. For landscape positions requiring consideration of aspect (slopes greater than 5 degrees), the number of sample sites was derived by multiplying five substrate types with six altitude classes by four aspects by three replicates. This totalled 360.

The total number of sample sites required to sample all environmental cells defined in 1 and 2 above was 630 (sum of 1 and 2). However, it was found that considerably fewer sample plots were required in the field because some environmental cells were cleared (for example many sedimentary and alluvial areas), did not exist (for example, basalt at low altitudes), or existed very rarely and so could be discounted without great consequence (for example, low altitude granites).

Sampling intensity reflected the availability of vegetation on different geologies, with acid volcanics, basalt and leucogranites slightly over-sampled and granites and sedimentary and alluvium slightly under-represented (Table 1). Within the geology type, sample sites were spread across all available landscape positions (Table 2) and the sampling intensity tracked closely the relative availability of the various altitude classes (compare Table 2 with Table 1). Adequate replication and coverage of environmental cells was achieved by sampling a total of 312 sites. This included 12 sites in special habitats such as rocky outcrops and wetlands. Another consideration in the sampling stratification was geographic spread. In order to detect any geographic gradients, sample sites were spread across the map sheet where possible.

Sampling procedures

The vegetation was sampled in a total of 312 sites, each site being a 20 × 20 metre quadrat. This is a standard adopted by the National Herbarium of NSW as well as the NSW National Parks and Wildlife Service for coast and tablelands surveys (for example, Keith & Bedward 1999). The locations of these sites are shown on the vegetation map and details about them are stored on the flora survey database held by the Royal Botanic Gardens.

A total of 61 field days were spent by two person teams (i.e. 122 person days) to sample the vegetation. Twenty nine sites were sampled in December 1992, 36 in April 1993, 49 in October 1993, 117 in November 1993, and 80 in January 1994. Thus, in order to maximise the diversity of species recorded, sampling was spread across several seasons (spring, summer and autumn) and avoided the worst frost period May to

September (Fig. 3). However, at this time, the area was experiencing below average rainfall and the district was drought-declared for 11 of the 14 months of the study period (NSW Department of Agriculture pers. comm.). Plots were sampled once, so the plot data reflects the species present at one time.

All plant species were recorded in each quadrat and assigned a cover abundance based on a modified Braun-Blanquet 6-point scale (Poore 1955) (< 1%, 1–5%, 6–25%, 26–50%, 51–75%, 76–100%). The structure of the vegetation was also described by way of the number, type, height, crown cover and dominant species of each layer. A number of physiographic features were also noted for each site (slope, aspect, altitude, soil type, geology, azimuths) as well as an estimate of the degree and type of disturbance. Each site was located using a global positioning system device and verified and mapped on an aerial photo and 1: 25 000 topographic map for future reference.

Outside of the site sampling, the vegetation structure, dominant species and remnant size were also noted on topographic maps during extensive field traverses across the entire study area.

Plant species nomenclature conforms with that currently recognised by the National Herbarium of NSW and follows Harden (1990, 1991, 1992, 1993) and PlantNET (2000) for changes since Harden.

Table 1. Area (ha) of native vegetation remaining in each combination of geology and altitude compared with sampling intensity by geology (vegetation cover based on LANDSAT interpretation of Roberts 1992).

	Geology				
Altitude (m)	**Acid Volcanics**	**Basalt**	**Granites**	**Leucogranites**	**Sedimentary & Alluvium**
900–1000	0	0	69	166	416
1000–1100	10	648	1 091	2 334	5 687
1100–1200	2 475	1 067	3 218	4 121	5 912
1200–1300	2 400	1 690	4 414	3 621	5 054
1300–1400	317	1 777	8 066	455	274
1400 +	0	91	666	14	0
Total (ha)	**5 202**	**5 273**	**17 524**	**10 711**	**17 343**
	(9%)	(9%)	(31%)	(19%)	(31%)
No. of samples	**45**	**46**	**75**	**73**	**73**
	(14%)	(15%)	(24%)	(23%)	(23%)

Data analysis

All site data were entered into a relational database developed for vegetation data by NSW National Parks and Wildlife Service and used by the National Herbarium of NSW.

Data were investigated using multivariate techniques available in PATN (Belbin 1993) and unpublished software (Bedward pers. comm.). Floristic groups were determined by analysing presence/absence and cover abundance data. We selected the output generated by cover abundance data for the reasons outlined below.

Table 2: Number of sites sampled in each combination of environmental attributes. -= not sampled for reasons outlined in text.

		Landscape position and aspect								
Geology	**Altitude (m)**	**Special Habitats**	**Ridge**	**Flat**	**Open Depression**	**North-facing Slope**	**East-facing Slope**	**South-facing Slope**	**West-facing Slope**	**Total**
Acid Volcanics	900–1000	-	-	-	-	-	-	-	-	**0**
	1000–1100	-	-	-	-	-	-	-	-	**0**
	1100–1200	-	4	3	2	2	3	1	3	**18**
	1200–1300	-	5	2	-	4	4	3	2	**20**
	1300–1400	-	3	-	-	-	1	1	2	**7**
	1400 +	-	-	-	-	-	-	-	-	**0**
	Sub-total	**0**	**12**	**5**	**2**	**6**	**8**	**5**	**7**	**45**
Basalt	900–1000	-	-	-	-	-	-	-	-	**0**
	1000–1100	-	1	1	-	-	-	-	2	**4**
	1100–1200	-	3	1	-	1	1	1	1	**8**
	1200–1300	-	2	-	1	-	2	1	1	**7**
	1300–1400	7	2	4	-	2	2	3	-	**20**
	1400 +	-	4	-	-	1	1	1	-	**7**
	Sub-total	**7**	**12**	**6**	**1**	**4**	**6**	**6**	**4**	**46**
Granite	900–1000	-	-	-	-	-	-	-	-	**0**
	1000–1100	-	1	1	2	2	-	2	2	**10**
	1100–1200	-	3	4	2	1	3	3	3	**19**
	1200–1300	-	3	1	1	3	5	1	4	**18**
	1300–1400	2	5	1	-	2	4	3	4	**21**
	1400 +	-	2	-	-	2	1	1	1	**7**
	Sub-total	**2**	**14**	**7**	**5**	**10**	**13**	**10**	**14**	**75**
Leucogranite	900–1000	-	-	-	1	-	-	-	-	**1**
	1000–1100	-	3	4	3	2	2	3	3	**20**
	1100–1200	-	2	2	-	3	4	3	2	**16**
	1200–1300	3	3	4	2	3	3	3	3	**24**
	1300–1400	-	5	1	-	1	3	1	-	**11**
	1400 +	-	1	-	-	-	-	-	-	**1**
	Sub-total	**3**	**14**	**11**	**6**	**9**	**12**	**10**	**8**	**73**
Sedimentary & Alluvium										
	900–1000	-	-	2	-	-	-	1	1	**4**
	1000–1100	-	5	5	1	2	3	5	4	**25**
	1100–1200	-	4	2	1	3	6	3	4	**23**
	1200–1300	-	5	3	1	3	1	3	4	**20**
	1300–1400	-	1	-	-	-	-	-	-	**1**
	1400 +	-	-	-	-	-	-	-	-	**0**
	Sub-total	**0**	**15**	**12**	**3**	**8**	**10**	**12**	**13**	**73**
	Total	**12**	**67**	**41**	**17**	**37**	**49**	**43**	**46**	**312**

Presence/absence data are suitable to use where there are highly heterogeneous areas of vegetation to be classified (Lambert & Dale 1964, Orloci 1968), for example where there are variable ephemeral species such as in semi-arid herbfields and grasslands. For these reasons Benson et al. (1997) used presence/absence data in their analysis of the native grasslands of the Riverina. However, in less heterogeneous stands of vegetation, cover abundance data can assist classification (Goodall 1980). Cover abundance data provide a quantitative contribution of species dominance to a classification. This can deliver classifications that reflect ecological difference in places where perennial species comprise a high proportion of total species present. This would include most of eastern New South Wales. Faith et al. (1987) warn that abundance data can overly influence dissimilarities, although they also state that abundance data can minimise the impacts of sporadic or 'noisy' species which do not attain high abundances.

A hierarchical agglomerative classification was used to describe groupings of species and sites and their relationship to environmental features (Belbin 1991). The Kulczynski coefficient of dissimilarity was used. This coefficient is superior in ecological applications (Belbin 1993) because it describes the dissimilarity between sites based on their shared species composition and places no emphasis on the absence of species. This is particularly relevant in a fragmented landscape where species may be absent due to disturbance rather than due to an inherent likelihood of occurrence, or seasonal differences in time of sampling.

The homogeneity of the group associations was investigated using homogeneity analysis as presented in Bedward et al. (1992). A hierarchical classification of sites was then derived from a clustering strategy using a Beta value of -1 in a flexible unweighted pair group arithmetic averaging (UPGMA).

To check for misclassified sites in the resultant groups, a checking routine of nearest neighbours (Bedward, unpublished software) was used. This examines the nearest neighbours of all sites (as measured in the association matrix) and assesses whether any given site is grouped with its nearest neighbours. A misclassified site is one in a group where none of that site's nearest neighbours are present, and where none of the other sites in the group has that site as a nearest neighbour.

Once the classification was checked to conform with these criteria, the resulting dendrogram was investigated for environmental descriptors. The relationship between floristic composition and environmental variables was examined using a semi-strong hybrid multidimensional scaling ordination in two dimensions (SSH), as discussed in Belbin (1991, 1993) and Faith (1991).

Five environmental attributes were chosen for further investigaiton: altitude, geology, aspect, geographical position and topographical position. Although many other variables were recorded at each site (e.g. fire history, grazing pressure), these 5 were chosen as they were objectively measured and mappable. Categorical data of geology, slope and aspect were converted to continuous data. Geology was coded as an index for increasing nutrient status from 1 (poorest) to 5 (richest): leucogranite, acid volcanic, granite, sedimentary and basalt. Aspect and topographic position were coded as an

index reflecting increasing exposure. A vector for each variable was fitted in the ordination using principal axis correlation (Belbin 1993). This produces a correlation coefficient measuring the fit of the vector with the association measures in ordination space. As few biological data conform to linearity along an environmental attribute gradient, the significance of a correlation coefficient is difficult to determine. In this case we used a Monte Carlo procedure for 1000 iterations, where correlation coefficent is recalculated for each randomisation. Thus, the significance of the original result is measured against the set of correlation coefficients possible from the data set.

Once the floristic groupings were finalised, a measure of fidelity to those groupings was generated for each species within that group (Bedward, unpublished software) to elucidate the contribution each species made to the definition of the group. The algorithm of Bedward follows the approach of Westhoff and van de Maarel (1980). It relates maximum proportion of occurrence of the species in any group to the sum of all proportions of occurrences in all groups. Species were selected as being indicators of each floristic group (plant community) when fidelity was set at a minimum of 0.8 and species occurred in at least 50% of sites within that group.

Vegetation mapping

Native vegetation was mapped at 1: 25 000 scale using the numerically-derived floristic groups as the basis for the map units. Aerial photo interpretation was undertaken only after the numerical analysis. This method contrasts with traditional vegetation mapping where patterns discerned by API have usually dictated the field sampling program and the definition of plant communities.

Colour aerial photographs at 1: 25 000 scale dated September 1989 (Land Information Centre 1989) were used to delineate native vegetation (excluding native grasslands) and to extrapolate vegetation patterns across the landscape. More recent aerial photography or satellite imagery were not analysed to ascertain recent clearing. Our observations suggest that only small areas were cleared during the 1990s, compared with the 1980s. A LANDSAT TM analysis of clearing in NSW from 1995–1997 detected less than 50 ha of clearing in the Guyra 1: 100 000 map sheet area (Environmental Research and Information Consortium 1998). If recent clearing was observed during field traverses, the map was modified. Recent ringbarking was mapped as cleared land, although in some places regrowth was occurring.

There was extensive field checking in February 1998 of the initial markup of vegetation units on the aerial photographs. All major and minor roads (including many farm tracks) were traversed.

Digital data for terrain, cultural features and drainage for all eight 1: 25 000 topographic map sheets that cover the Guyra 1: 100 000 map sheet were obtained from the Surveyor General's Department. 'Master positives' were produced from these data on archival matte film. A transfer scope was used to transfer the vegetation map unit boundaries from the aerial photographs to these master positives. The vegetation polygons were then digitised into ERMS and transferred into ArcView for analysis and presentation. Polygons were captured at 1: 25 000 scale and reduced to 1: 100 000 for the published

map. Users of the 1: 100 000 map should be aware that the data exist at a larger scale and that hardcopies of 1: 25 000 maps can be issued on request.

Multi-attribute codes for typing the structure and floristics of the vegetation were applied. These were based on the structural classification of Walker and Hopkins (1990) and the codes used by the NSW NPWS (1995) in mapping the vegetation of upper north-eastern NSW. At sample sites we recorded actual measurements of height and density for each vegetation stratum. These site data assisted with applying attribute codes to each polygon delineated on the aerial photographs. These attribute codes are not shown on the printed map but can be generated from the GIS map coverage. The attributes assigned were:

- Height: 1 = > 25m; 2 = 12–25 m; 3 = < 12 m;
- Crown cover: a = < 10%; b = 10–30%; c = 30–50%; d = 50–80%; e = > 80%;
- Plant community number developed from the UPGMA classification, API or by field observation;
- API canopy disturbance categories:
  u = undisturbed
  d = estimated up to 25% thinned and/or lightly grazed;
  D = estimated 25–50% thinned/cleared and/or heavily grazed;
  s = scattered trees between 50% and 70% cleared and heavily grazed;
  A = > 70% cleared - agricultural land;
- API ground cover disturbance categories:
  y = natural ground cover (estimated to contain > 50% native plant cover);
  x = exotic ground cover.

An example of a composite code in a polygon is 2c17dy. This implies it is an open forest (2c), composed of plant community number 17 *Eucalyptus obliqua-Eucalyptus nobilis* (Messmate-Forest Ribbon Gum), which has been lightly disturbed (d), and has a native ground cover (y).

To assign an estimate of thinning, assumptions had to be made about the pre-European canopy. We assumed that the pre-European canopy of forests in the region were between one and two tree crown widths apart in valleys that contain medium to high nutrient soils (Benson & Redpath 1997, Curtis 1989) with denser (touching) crowns on steeper slopes and siliceous ridges. Canopy disturbance does not necessarily correspond to an equivalent degree of disturbance of lower strata.

The minimum sized remnant mapped is 1 ha. This is difficult to discern on the 1: 100 000 map sheet, but is quite visible at the 1: 25 000 scale. Small clumps of isolated trees in land that has been > 70% cleared are not delineated. Also, derived native grasslands (grasslands remaining after removal of woody canopy species) are not shown on the vegetation map.

The mapped plant communities closely reflect the floristic groups generated in the UPGMA. Some plant communities, such as New England Peppermint (*Eucalyptus nova-anglica*), swamps and wetlands were easily discernible from aerial photographs. Others, such as the four communities (2–5) composed of open forest dominated by various species of stringybark were difficult to separate. They were distinguished

using site data and field traverse. As we could not field check every remnant, errors are likely to be present in the extrapolation of some communities across the landscape using API.

Riparian Shrubland (plant community 23), is restricted to narrow strips along watercourses and is not shown on the map. API was used to split *Eucalyptus stellulata* (Black Sallee Woodland, plant community 7) from *Eucalyptus viminalis-Eucalyptus dalrympleana-Eucalyptus pauciflora* (Ribbon Gum-Mountain Gum-Snow Gum Open Forest, plant community 6). API and ground traverse distinguished *Eucalyptus acaciiformis-Eucalyptus caliginosa-Eucalyptus radiata* subsp. *sejuncta* (Wattle-leaved Peppermint-Broad-leaved Stringybark-Narrow-leaved Peppermint Open Forest, plant community 19) from *Eucalyptus caliginosa* (Broad-leaved Stringybark Open Forest plant community 2) in the Avondale Road area north-east of Armidale. Using API and substrate, the poorly sampled and depleted *Eucalyptus nova-anglica* New England Peppermint occurring on basalt (plant community 8) was split from other New England Peppermint forests occurring on leucogranites/granites (plant community 10) and sediments/acid volcanics/western granites (plant community 9).

Exotic pine plantations and stands of poplar trees on farms were delineated on the aerial photographs but were not transferred to the vegetation maps.

The pre-European extent of the plant communities in the study area has not been accurately mapped or modelled. However, it has been estimated by examining the relationship of the extant distribution of plant communities with landscape position and substrate, and extrapolating this to cleared areas. This was done by comparing the 1: 25 000 topographic maps and the simplified geology map with the current distribution of the vegetation shown on the vegetation map. The pre-European extent of the plant communities was extrapolated over the geology, landforms and geographical locations most likely to have contained them. Aerial photographic interpretation along with field notes recorded during ground traverse assisted with these estimates. The pre-European extent of community 24 (basalt lagoons) was estimated by examining the topographic maps that depict most of the past (drained) and present lagoons.

Assessing the threat and reservation status of plant communities

Criteria for assessing the threat status of ecological or plant communities have been developed by Benson (1989), Hager and Benson (1994), Sattler and Williams (1999), English and Blyth (1999) and Environment Australia (2000). The remaining extent threshold criterion based on Benson (in review) and Environment Australia (2000) was used to assign a threat category to each plant community. This required comparing the GIS calculated measurement of the area of each plant community (excluding the unmapped riparian vegetation — community 23), with estimates of the proportion that had been cleared. These estimates were derived by examining clearing patterns in relation to landforms and existing remnants.

The threat codes used are:

CE = 'critically endangered' implies that:

- it was a 'common' plant community at the time of European settlement (> 10 000 ha) and that > 90% of it has been cleared or severely degraded, or
- it was a 'naturally restricted' plant community (> 1000 < 10 000 ha original extent) and that > 80% of it has been cleared or severely degraded, or
- it was a 'rare' plant community at the time of European settlement (< 1000 ha original extent) and that > 70% of it has been cleared or severely degraded.

E = 'endangered' implies that:

- it was a'common'plant community at the time of European settlement (> 10 000 ha) and that 70–90% of it has been cleared or severely degraded, or
- it was a 'naturally restricted' plant community (> 1000 < 10 000 ha original extent) and that 60–80% of it has been cleared or severely degraded, or
- it was a 'rare' plant community at the time of European settlement (< 1000 ha original extent) and that 50–70% of it has been cleared or severely degraded.

V = 'vulnerable' implies that:

- it was a'common'plant community at the time of European settlement (> 10 000 ha) and that 50–70% of it has been cleared or severely degraded, or
- it was a 'naturally restricted' plant community (> 1000 < 10 000 ha original extent) and that 40–60% of it has been cleared or severely degraded, or
- it was a 'rare' plant community at the time of European settlement (< 1000 ha original extent) and that 30–50% of it has been cleared or severely degraded.

NT = 'near threatened' implies that:

- it was a'common'plant community at the time of European settlement (> 10 000 ha) and that 35–50% of it has been cleared or severely degraded, or
- it was a 'naturally restricted' plant community (> 1000 < 10 000 ha original extent) and that 25–40% of it has been cleared or severely degraded, or
- it was a 'rare' plant community at the time of European settlement (< 1000 ha original extent) and that 15–30% of it has been cleared or severely degraded.

LC = 'least concern' implies that:

- it was a'common'plant community at the time of European settlement (> 10 000 ha) and that < 35% of it has been cleared or severely degraded, or
- it was a 'naturally restricted' plant community (> 1000 < 10 000 ha original extent) and that up to 25% of it has been cleared or severely degraded, or
- it was a 'rare' plant community at the time of European settlement (< 1000 ha original extent) and that up to 15% of it has been cleared or severely degraded.

A reservation status code is assigned to each plant community for the study area. This is based on the proportion of the pre-European extent of each plant community that is represented in conservation reserves. The extant area of each plant community in reserves is calculated from the GIS, while the pre-European extent is an estimate. The reservation codes are based on the area reserved classes of Hager and Benson (1994):

- **VP =** 'Not or very poorly reserved' (i.e. < 1%);
- **P =** 'poorly reserved' (1–5%);
- **M** = 'moderately well conserved' (5–10%);
- **AC** = 'adequately conserved' (10–25%);
- **EC** = 'exceptionally well conserved' (> 25%).

State and national assessments of the threat and reservation status of the plant communities would be realised with further mapping of vegetation outside the study area, and modelling of its pre-European extent.

Results

Data Analysis

The dendrogram derived from the Kulczynski association and UPGMA clustering analysis (adjusted for misclassifications), is shown in Fig. 5. Twenty-one plant communities were defined at the dissimilarity measure of 0.7. Homogeneity analysis of these groups based on floristic composition reveals that 21 groups coincides with the first turning point of the homogeneity curve (Fig. 6). This is a desirable level of grouping because past this point there is less relative gain in homogeneity for further group definition i.e. the solution becomes less efficient (Bedward et al. 1992).

Major increases in homogeneity correspond with primary divisions in the dendrogram. At the first split of the dendrogram (and the first major increase in homogeneity), the forest and woodland groups pull away from the swamp, lagoon, river, scrub and rocky outcrop groups. The next significant point of division delineate the open forests of the leucogranite and granite geologies from the forest and woodlands of other geologies.

At a dissimilarity measure of approximately 1.0, 10 major groups are defined in the dendrogram and 70% of the homogeneity described by 21 groups has been reached.

These relationships were further investigated with ordination using Semi-Strong Hybrid- Multi-Dimensional Scaling in the PATN package (Fig. 7). Vectors fitted for easting (0.518), northing (0.691), nutrient rating (0.671) and altitude (0.484) were all significant at $p < 0.01$. Aspect (0.379) and topographic position (0.228) were significant at $p < 0.02$.

These numerical analyses revealed 21 floristic groups in 10 major groupings that were responding to a combination of environmental factors such as substrate, altitude and geographical position (the last two probably acting in concert as a surrogate for rainfall), together with availability of special habitat niches such as rocky outcrops and closed depressions (illustrated on Fig. 8). The floristic groups form the bulk of the vegetation units that are mapped. They are described in detail in a later section, but broadly, the 10 major groups delineated are:

1. Open forests on sedimentary substrates at mid-low altitudes with Blakely's Red Gum (*Eucalyptus blakelyi*) with Yellow Box (*Eucalyptus melliodora*) on lower slopes and Broad-leaved Stringybark (*Eucalyptus caliginosa*) on ridges (communities 1, 2, 19);
2. Open forests composed of Silver-topped Stringybark (*Eucalyptus laevopinea*) on various geologies at slightly higher altitudes than 1 above (communities 3 and 4);
3. Open forests composed of Youmans Stringybark (*Eucalyptus youmanii*) and *Eucalyptus subtilior* with Western New England Blackbutt (*Eucalyptus andrewsii*) on acid volcanic geology (community 5);
4. Tall open forests and open forests composed of Ribbon Gum (*Eucalyptus viminalis*), Snow Gum (*Eucalyptus pauciflora*), Black Sallee (*Eucalyptus stellulata*), Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*) on basalt plateaux, and New England Peppermint (*Eucalyptus nova-anglica*) open forest and woodland in valleys on various substrates subjected to cold air drainage (communities 6–10);

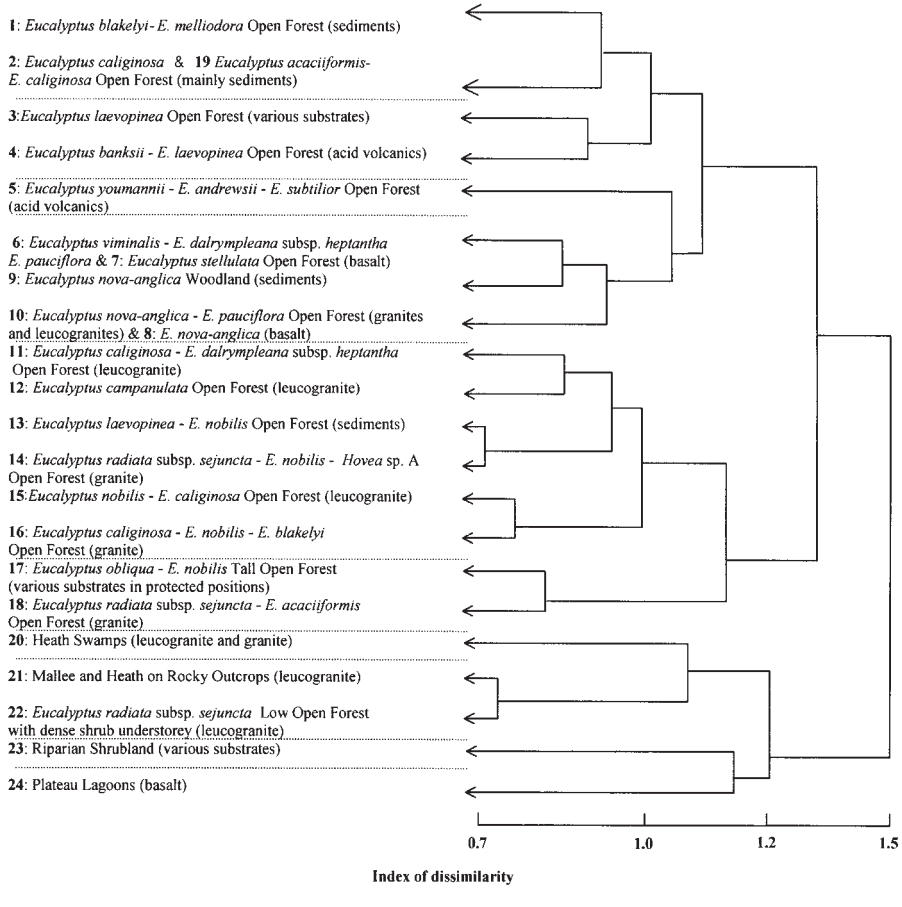

Fig. 5. Dendrogram showing the plant communities in 10 major groupings (divided by dotted lines) produced using Kulczynski association and flexible UPGMA fusion strategy and a ß value of -0.1 (see text for detailed descriptions of the communities).

5. Open forest principally on leucogranites and granites and mainly in the north-east of the study area dominated by Broad-leaved Stringybark (*Eucalyptus caliginosa*), New England Blackbutt (*Eucalyptus campanulata*), Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*) and Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*) (communities 11–16);
6. Tall open forest composed of Messmate (*Eucalyptus obliqua*), Forest Ribbon Gum (*Eucalyptus nobilis*) and open forest composed of Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*) and Wattle-leaved Peppermint (*Eucalyptus acaciiformis*), mainly on granites and leucogranites (communities 17–18);
7. Heath swamps on granites and leucogranites dominated by Sedges (Cyperaceae), Restionaceae and shrubs such as *Leptospermum gregarium*, *Banksia cunninghamii* subsp. A and *Epacris breviflora* (community 20);
8. Mallee Ash (*Eucalyptus codonocarpa*) with a dense heath-shrub understorey leucogranite on rocky outcrops, and Low Open Forest containing Broad-leaved Stringybark (*Eucalyptus caliginosa*) and Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*) with a tall dense shrub understorey composed of shrubs such as *Mirbelia confertiflora, Petrophile canescens* and *Leptospermum novae-angliae* on coarse sands on leucogranite (communities 21–22);

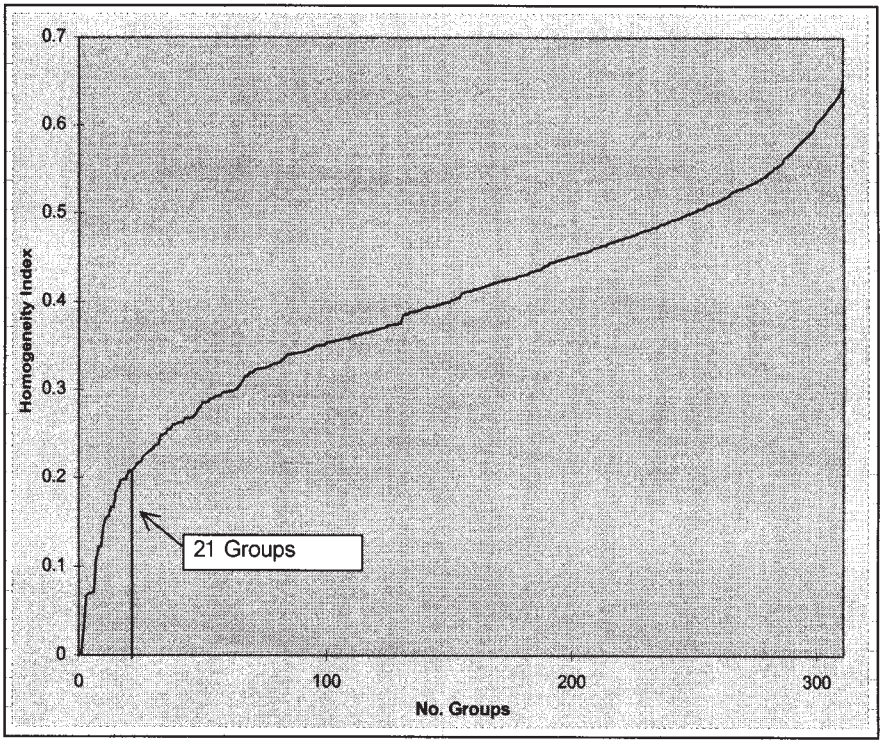

Fig. 6. Homogeneity of full floristic composition with increasing number of groups.

9. Riparian shrubland dominated by *Leptospermum polygalifolium* subsp. *transmontanum* on a number of substrates (community 23);

10. Water plants of the genera *Potamogeton*, *Myriophyllum*, *Eleocharis*, *Juncus*, and *Nymphoides* growing in open water in shallow lagoons on basalt (community 24).

Floristic composition

A total of 889 plant taxa in 118 families (18 families of pteridophytes, one family of gymnosperm and 99 families of angiosperms) have been recorded for the study area (Appendix 1). This represents 14% of the NSW flora. Only vascular plants were included in the survey.

A total of 681 taxa were recorded during the survey, the remaining 208 taxa were cited from herbaria collections and records supplied by local botanists. Of the total number of taxa, 743 were native and 146 (17%) were exotic being mainly pasture weeds. Families of angiosperms that contained 10 or more taxa are: Apiaceae (20); Asteraceae (97); Brassicaceae (10); Cyperaceae (43); Epacridaceae (18); Fabaceae (77); Juncaceae (20); Lamiaceae (10); Myrtaceae (41) (including 27 *Eucalyptus* species); Orchidaceae (44); Poaceae (135) (including 13 *Austrodanthonia*, 6 *Poa*, 8 *Eragrostis*, 7 *Aristida*, 10 *Austrostipa*, 7 *Deyeuxia*); Polygonaceae (12); Proteaceae (15); Rhamnaceae (10); Rubiaceae (14); Rutaceae (12); and Scrophulariaceae (19).

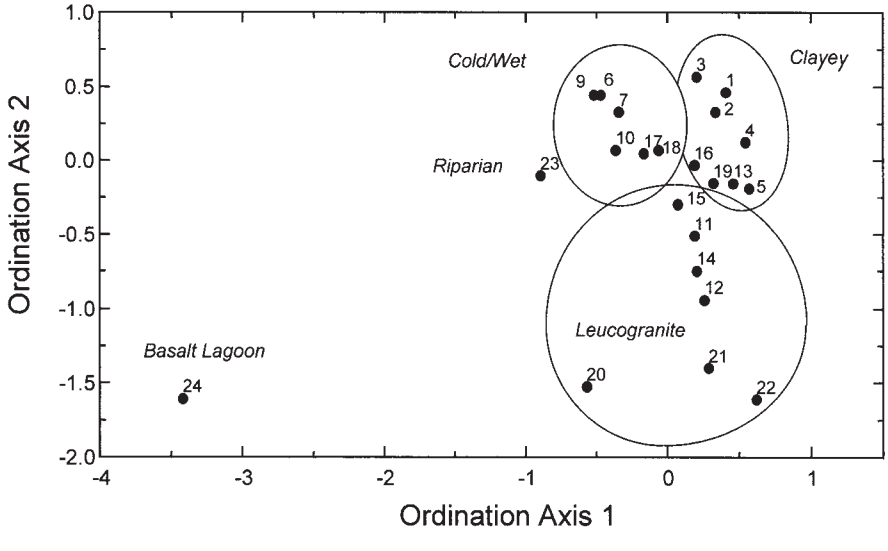

Fig. 7. Distribution of sites (centroids, labelled by plant community) in two-dimensional space. Five groups are evident in the ordination. Basalt Lagoon (24) and New England Riparian Shrubland (23) are highly distinct; communities 11, 12, 14, 15, 20, 21 & 22 occur on leucogranite; communities 1–5, 16 and 19 occur on clay soils derived from either sedimentary or acid volcanic substrate; and communities 6, 7, 9, 10, 17 & 18 experience cold temperature and/or high soil moisture at high altitudes or in valley bottoms.

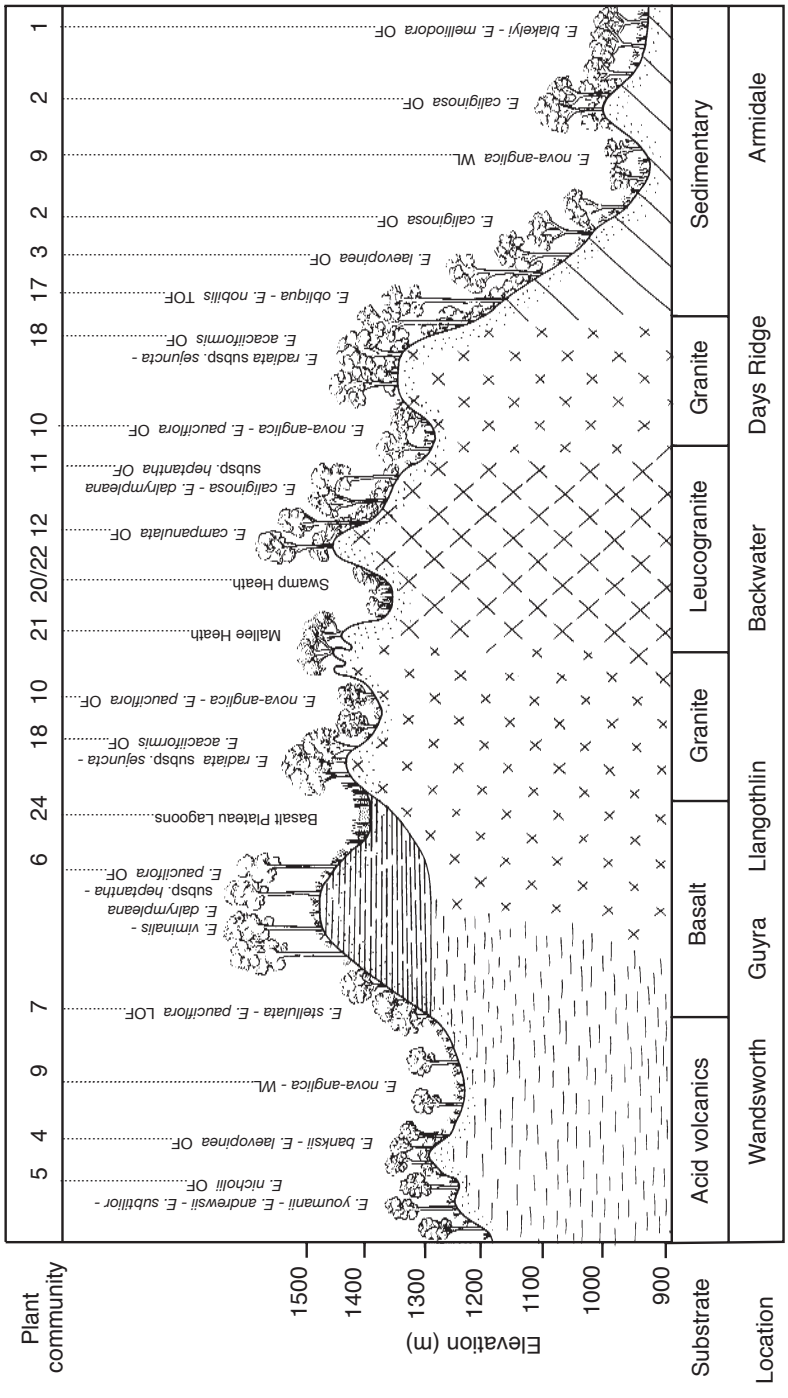

Fig. 8. Schematic transect of the landscapes present in the area covered by the Guyra 1: 100 000 map sheet showing the relationship between topographic position, elevation, substrate and plant communities. OF = Open-Forest, WL = Woodland, LOF = Low Open-Forest, TOF = Tall Open-Forest (after Walker & Hopkins 1990).

By examining Appendix 1 it can be seen that widespread (present in 75% of the communities) and commonly recorded taxa were: *Pteridium esculentum*, *Cheilanthes sieberi* subsp. *sieberi*, *Dichopogon fimbriatus*, *Hydrocotyle laxiflora*, *Brachyscome microcarpa*, *Senecio* sp. E, *Wahlenbergia stricta* subsp. *stricta*, *Scleranthus biflorus*, *Hypericum gramineum*, *Dichondra repens*, *Crassula sieberiana*, *Hibbertia linearis*, *Leucopogon lanceolatus* var. *lanceolatus*, *Melichrus urceolatus*, *Poranthera microphylla*, *Acacia dealbata*, *Acacia filicifolia*, *Desmodium varians*, *Hardenbergia violacea*, *Geranium solanderi* subsp. *solanderi*, *Gonocarpus tetragynus*, *Luzula densiflora*, *Ajuga australis*, *Lomandra longifolia*, *Lomandra multiflora* subsp. *multiflora*, *Eucalyptus caliginosa*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Eucalyptus nobilis*, *Eucalyptus radiata* subsp. *sejuncta*, *Leptospermum polygalifolium* subsp. *transmontanum*, *Oxalis radicosa*, *Bursaria spinosa*, *Plantago gaudichaudii*, *Cymbopogon refractus*, *Austrodanthonia racemosa*, *Dichelachne micrantha*, *Echinopogon* spp., *Elymus scaber*, *Poa sieberiana*, *Austrostipa rudis* subsp. *nervosa*, *Themeda australis*, *Lomatia silaifolia*, *Ranunculus lappaceus*, *Acaena novae-zelandiae*, *Rubus parvifolius*, *Asperula conferta*, *Galium ciliare*, *Opercularia* spp., *Veronica calycina*, *Veronica plebeia* and *Viola betonicifolia*.

The most common weeds recorded were: *Hypochaeris radicata*, *Cirsium vulgare*, *Conyza albida*, *Taraxacum officinale*, *Trifolium repens*, *Anthoxanthum odoratum*, *Aira elegantissima* and *Rubus ulmifolius*.

Most species are sparsely distributed in the landscape and relatively few occur frequently across a number of plant communities.

Certain groups of plants tended to be more frequently recorded in some plant communities. For example, community 17, *Eucalyptus obliqua-Eucalyptus nobilis* contained more ferns than other communities. Communities 23 (riparian shrubland) and 24 (lagoons) contained more sedges (Cyperaceae) than other communities. More grasses were recorded in communities on higher nutrient soils, for example communities 1, 6, 7 and 9 than on low nutrient soils such as communities 11, 12, 20–22 which are restricted to leucogranite. This trend was reversed for species in the Proteaceae where more species from this family were recorded on the low nutrient soils compared to high nutrient soils.

Rare or threatened plant species

A total of 28 rare or threatened taxa has been recorded from the study area (Table 3) of which 10 were recorded in our survey. The remaining 18 species are from collections in the N.C.W. Beadle Herbarium of the University of New England, the National Herbarium of NSW, and various survey records. 25 of these taxa are listed in the national listing of rare or threatened Australian plant species (ROTAP) (Briggs and Leigh 1995). Nine of these taxa along with two other species, *Monotaxis macrophylla* and *Aldrovandra vesiculosa* (which are more common in other states but endangered in NSW), are listed in Schedules 1 or 2 of the NSW Threatened Species Conservation Act 1996. One unlisted species recorded in the survey, *Brachyloma saxicola*, could be considered nationally rare (Briggs and Leigh 1995) or Near Threatened using the criteria of IUCN (1999).

Table 3. List of rare or threatened plant species recorded from the Guyra 1: 100 000 map sheet area.

ROTAP code refers to Briggs and Leigh (1995). TSC Act refers to the threat category under the *NSW Threatened Species Conservation Act 1996*.

Species name	ROTAP Code	NSW TSC Act
Acacia brunioides subsp. *brunioides*	3RC-	Not listed
Aldrovandra vesiculosa	Not listed	Endangered
Asperula charophyton	3RCa	Not listed
Bothriochloa biloba	3V	Vulnerable
Brachyloma saxicola	Not listed (suggest 3RCa)	Not listed
Brasenia schreberi	3RC-	Not listed
Callitris oblonga subsp. *parva*	3VCa	Vulnerable
Cryptandra lanosiflora	3RCa	Not listed
Daviesia elliptica	3RC-	Not listed
Dichanthium setosum	3VC-	Vulnerable
Discaria pubescens	3RCa	Not listed
Eucalyptus camphora subsp. *relicta*	3VC-	Endangered
Eucalyptus codonocarpa	3RC-	Not listed
Eucalyptus michaeliana	3RCa	Not listed
Eucalyptus nicholii	3V (suggest 3VC-)	Vulnerable
Eucalyptus youmanii	2R (suggest remove)	Not listed
Euphrasia orthocheila	3RC-	Not listed
Goodenia macbarronii	3VC-	Vulnerable
Grevillea scortechinii subsp. *sarmentosa*	3VC-	Vulnerable
Monotaxis macrophylla	Not listed	Endangered
Muehlenbeckia costata	3KC-	Not listed
Persoonia procumbens	2RC-	Not listed
Leionema ambiens	3RC-	Not listed
Pseudanthus divaricatissimus	3RCa	Not listed
Pultenaea campbellii	3V (suggest R or remove)	Not listed
Thelionema grande	3RC-	Not listed
Thesium australe	3VCi (suggest R)	Vulnerable

Discussions of the rare or threatened taxa follow. Risk codes in capital letters are from Briggs and Leigh (1995) — consult this for an explanation of the codes. Codes in lower case refer to the taxon's listing under the NSW Threatened Species Conservation Act.

Acacia brunioides subsp. ***brunioides*** (Fabaceae) (3RC-): This shrub was recorded once in community 12 along the Sara River. This rare species is restricted to granite substrates in the New England Bioregion of NSW and Queensland.

Aldrovandra vesiculosa (Droseraceae) (e): This free floating aquatic herb was not recorded during the survey but has since been recorded in Llangothlin and Billy Bung Lagoons near Guyra (D. Bell pers. comm.). This species seems to appear and disappear in wetlands and has a low seed set. It is probably introduced by migratory waterbirds from time to time. It is a cosmopolitan species but it is likely the Australian entity is taxonomically distinct from the European one (S. Jacobs pers. comm.).

Asperula charophyton (Rubiaceae) (3RCa): This forb was recorded once during the survey on the edge of Mother of Ducks Lagoon in community 24 (basalt lagoon), near

the town of Guyra. It would appear to be very restricted in the study area but is recorded from the Warrumbungles National Park in the Nandewar Bioregion (north-western slopes).

Bothriochloa biloba (Poaceae) (3V) (v): This grass was once widespread and there are collections in the National Herbarium of NSW from western Sydney, the Hunter Valley, the Northern Tablelands and most commonly on the North Western Slopes near Inverell and Warialda. It has probably been reduced by grazing and cultivation and is not known to be conserved in a reserve. Recent surveys of the western slopes and plains indicate that the species may still be common in some places (Department of Land and Water Conservation pers. comm.). If so, the species may warrant removal from Schedule 2 of the TSC Act and down listing on ROTAP. While not recorded during the survey, there is a National Herbarium of NSW record collected from the New England Highway between Guyra and Armidale in 1955 by M. Gray.

Brachyloma saxicola (Epacridaceae): This shrub is restricted to seven areas of granitic outcrops on the Northern Tablelands (Hunter & Williams 1994). It was recorded a number of times in our survey on granitic rocky outcrops in the Backwater area (community 21). Hunter and Williams (1994) suggested this species should be coded 2VC under Briggs and Leigh (1995). This was revised by Richards and Hunter (1997) who suggested a ROTAP code of 3RCa. We consider it is not threatened and therefore should be coded as 3RCa under ROTAP and as Near Threatened under IUCN (1999).

Fig. 9. The threatened native conifer *Callitris oblonga* subsp. *parva* grows along several creeks in the study area and is susceptible to frequent fire.

Brasenia schreberi (Cabombaceae) (3RC-): This stoloniferous aquatic herb was not recorded during the survey, but has recently been collected from Llangothlin Lagoon (D. Bell pers. comm.). It occurs spasmodically in wetlands in eastern Australia and other parts of the world.

Callitris oblonga subsp. ***parva*** (Cupressaceae) (3VCa) (v): There are three subspecies of this taxon which is commonly known as Pigmy Cypress Pine: subsp. *oblonga* occurs in northern Tasmania, subsp. *corangensis* grows along the Corang River on the Southern Tablelands of NSW, and subsp. *parva* occurs in a number of locations on the Northern Tablelands of NSW. The distribution of the NSW locations of *Callitris oblonga* is documented in Nadolny and Benson (1993). In the study area, *Callitris oblonga* subsp. *parva* (Fig. 9) is restricted to leucogranite in the Backwater area, particularly along the Sara River, Stuttering Dicks Creek and Backwater Creek. It is mainly restricted to community 23 (riparian shrubland). The species is threatened by too-frequent fire and other disturbances along the watercourses where it grows.

Cryptandra lanosiflora (Rhamnaceae) (3RCa): This rare stunted shrub occurs on the Northern Tablelands and the tablelands of southern Queensland. J.T. Hunter collected this species in 1996 from leucogranite outcrops north of Backwater.

Daviesia elliptica (Fabaceae) (3RC-): This shrub was recorded once during the survey in community 10 adjacent to the Sara River near Mount Mitchell on leucogranite. This is the southern-most record for the species. It is very rare in the study area but National Herbarium of NSW collections reveal it is present on granite to the north in Boonoo Boonoo National Park, near the Timbarra River on the Glen Innes-Grafton Road and on the Darling Downs in Queensland. This species requires a targeted survey to establish its abundance and threat status.

Dichanthium setosum (Poaceae) (3VC-) (v): This grass is known from the Northern Tablelands, Western Slopes, North Western Plains and Queensland. National Herbarium of NSW records from the 1940s reveal that it grew along the Guyra-Ebor Road. The UNE herbarium has a record of this species from the original 'Saumarez' landholding, just south of Armidale. This grass would appear to be rare and requires specific surveys to establish its status.

Discaria pubescens (Rhamnaceae) (3RCa): This widespread rare shrub occurs along the tablelands of NSW in areas that have been protected from intense grazing. It was not recorded during the survey, but herbarium records reveal it has been collected from the Paddys Gully area near Backwater, Oban River, near Boorolong and near Guyra during the period 1967–1989. It was also recorded in Little Llangothlin Nature Reserve in 1994 (D. Bell pers. comm.).

Diuris pedunculata (Orchidaceae) (2E) (e): This ground orchid is probably the most endangered plant species in the study area and one of the rarest on the Northern Tablelands in general. It was not recorded during the survey but there is a herbarium record from 'Hardacres' near Boorolong (UNE herbarium database) and several records from the 1930s and 1940s by McKie for 'just south of Guyra'. Over the last decade the species has been found on the railway easement near Armidale (but could not be re-located there in 1994, Metcalfe pers. comm.), adjacent to the New England

Fig. 10. The mallee, *Eucalyptus codonocarpa*, is listed as a rare species nationally. It occurs on rocky leucogranite outcrops near Backwater.

highway south of Uralla, near the Ebor Trout Hatchery and near 'Sandy Creek' on a travelling stock reserve (TSR) on the Guyra-Inverell Road north-west of Guyra. It would appear this is a critically endangered species requiring special research and conservation effort.

Eucalyptus camphora subsp. ***relicta*** (Myrtaceae) (3VC-) (e): A small population of this species occurs in the northern edge of the Guyra map sheet overlapping onto the Glen Innes map sheet to the north. Its only population in the study area is in a heath-swamp (community 20) along a creek on the eastern side of Crown Mountain in Warra National Park (formerly state forest). There are only a few other localities for this taxon and it is correctly ranked as an endangered subspecies in NSW.

Eucalyptus codonocarpa (Myrtaceae) (3RC-): This mallee-eucalypt is restricted to granite outcrops on the Northern Tablelands and is found in Gibraltar Range, Cathedral Rock and Girraween National Parks. In the study area it was confined to community 21 on leucogranite outcrops north of Backwater (Fig. 10). If some of the leucogranite country at Backwater was protected in reserves, this species should then be considered adequately reserved ie 3RCa.

Eucalyptus michaeliana (Myrtaceae) (3RCa): This species is most common on the escarpment of the Macleay gorges to the south-east of the study area (NSW NPWS 1985). There is a single University of New England record of this species in the study area, at Brookside along the Rockvale Road. Despite searching for it in this area the species was not recorded during the survey.

Eucalyptus nicholii (Myrtaceae) (3V) (v): This species was recorded only in community 5. It occurs mainly on acid volcanic substrates in the north-western section of the study area and is more common further west near Tingha. Most of its habitat has been cleared and little is protected in reserves, although the proposed Moredun Creek Nature Reserve to the west of the map sheet, if declared, would protect a stand of this species. The recent dedication of Single State Forest as a national park protects a stand of *Eucalyptus nicholii* west of the study area.

Eucalyptus youmanii (Myrtaceae) (2R): This stringybark was recorded in community 1 and in community 5. Most of its habitat has been cleared and it is poorly represented in reserves. It is not as rare as previously thought and should be removed from ROTAP. However, it is not as widespread as other stringybark species on the Northern Tablelands.

Euphrasia orthocheila (Scrophulariaceae) (3RC-): There is one specimen in the National Herbarium of NSW from the study area 12 km east of Guyra collected by J. Boorman in 1917. It was not recorded during the survey. It has been recorded in Girraween and Mount Kaputar National Parks.

Fig. 11. *Grevillea scortechinii* subsp. *sarmentosa* is listed as vulnerable species nationally. It is restricted to the leucogranite outcrops northeast of Backwater in the study area.

Goodenia macbarronii (Goodeniaceae) (3VC-) (v): This forb was not recorded during the survey, but two old specimens from the area are held in the National Herbarium of NSW. One from Chandlers Peak near Guyra was collected by Boorman in 1917, and another from Moredun Creek, collected by E. McKie in 1948. Most collections of this species are from the Pilliga Scrub region on the North Western Slopes. This species may be extinct on the Northern Tablelands.

Grevillea scortechinii subsp. ***sarmentosa*** (Proteaceae) (3VC-) (v) (Fig. 11): This decumbent shrub is restricted to a few granite outcrops on the Northern Tablelands. It was recorded in communities 11, 12, 19, 22, and 23. It was found to be locally common in forests on the leucogranite outcrop north of Backwater. If some of its populations were protected for conservation in this area this species should be down-listed to the rare category in ROTAP and/or Near Threatened in IUCN (1999). It should be removed from Schedule 2 (vulnerable) of the TSC Act.

Monotaxis macrophylla (Euphorbiaceae) (e): Collected once in the area by J.T. Hunter. This is a new record for the Northern Tablelands where it was located growing in post-fire regrowth on leucogranite near Backwater. In the National Herbarium, there are specimens collected in 1904 from the North-western Slopes and North-western Plains and in 1991 from the South Coast. This species appears to be very rare and may require certain fire regimes to persist.

Muehlenbeckia costata (Polygonaceae) (3KC-): This decumbent scrambler occurs on and between rocky outcrops in Warra National Park (J.T. Hunter pers. comm.). This species is a fire ephemeral and germinates prolifically after fire but then dies back soon afterwards (Hunter et al. 1998). It has also been recorded in Bald Rock and Girraween National Parks to the north and Butterleaf State Forest to the east of the study area. Given its rarity and dependence on certain fire regimes, it should be listed as a vulnerable species under both ROTAP and the TSC Act.

Persoonia procumbens (Proteaceae) (2RC-): This low growing shrub has a similar distribution to *Grevillea scortechinii* subsp. *sarmentosa* in that it grows on granite substrates on the Northern Tablelands. It was recorded in communities 11, 12 and 14. It occurs in Warra National Park, but its largest populations in the study area are on private land near Backwater.

Leionema ambiens (Rutaceae) (3RC-): This shrub is restricted to some of the rocky outcrops in the Warra National Park and also occurs near Backwater in community 21. It has been collected in the northern part of the Northern Tablelands at Bald Rock, Timbarra, Tenterfield and Bismuth and occurs in Queensland.

Pseudanthus divaricatissimus (Euphorbiaceae) (3RCa): This prostrate shrub occurs in small populations from East Gippsland along the Great Dividing Range to Queensland. It has been collected by J.T. Hunter from the leucogranite in the study area.

Pultenaea campbellii (Fabaceae) (3V): This shrub is mainly located on acid volcanic substrates in the north-western section of the study area. It has been recorded in communities 1, 2 and 5. This species is not vulnerable and could be removed from ROTAP. It has recently been removed from schedule 2 of the NSW TSC Act.

Thelionema grande (Phormiaceae) (3RC-): This tufted herb has been found on sandy soils derived from granites. It occurs on the New England Tablelands in southern Queensland and NSW. In NSW this species has been collected at Boonoo Boonoo, Tenterfield and Torrington. J.T. Hunter collected it in the mid-1990s on leucogranite near Backwater.

Thesium australe (Santalaceae) (3VCi) (v): A widespread semi-parasitic forb occurring from Victoria to Queensland. It has probably been reduced in abundance due to grazing (Archer 1984). In NSW it is conserved in a number of north coast reserves and Kosciuszko National Park, and Namadgi National Park in the ACT. It was recorded in community 6 on basalt and in community 18 on granite. Most of these sites are in strips of roadside vegetation. It is usually found with the grass *Themeda australis* which it parasitises (Griffith 1992). Other populations in the study area have recently been documented by the University of New England including several in Little Llangothlin Nature Reserve (D. Bell pers. comm.). It would appear that this rather cryptic forb may be more common than previously thought and could be considered rare rather than vulnerable. Its conservation would be enhanced if protection could be afforded to some of its known populations near Guyra.

Regionally rare species

Using the results of the survey and herbaria data, it would appear that a number of plant species could be considered rare in the context of the study area, although many of these are known to be more common elsewhere. The following list includes some of the species that were recorded once during the survey, and/or species that have been rarely collected in the past, but known from herbaria collections from the area. Plants were excluded from the list if they are known to respond to seasonal conditions or occur in habitats that have not been thoroughly surveyed. These include most of the grasses, geophytes such as orchids, various families of water plants, and most of the sedges (Cyperaceae) and rushes (Juncaceae).

After applying this filter, species deemed to be regionally rare in the area covered by the Guyra 1: 100 000 map sheet are:

- the ferns *Blechnum minus* and *Botrychium australe*;
- the forbs *Eryngium ovinum*, *Hydrocotyle peduncularis*, *Caesia parviflora*, *Burmannia disticha*, *Centrolepis strigosa*, *Atriplex semibaccata*, *Chenopodium carinatum*, *Swainsona monticola*, *Swainsona oroboides*, *Centaurium spicatum*, *Geranium retrorsum*, *Goodenia gracilis*, *Velleia paradoxa* and *Plantago varia*;
- the sedges *Baumea nuda* and *Caustis pentandra*;
- the daisies *Lagenifera gracilis*, *Microseris lanceolata*, *Olearia alpicola*, *Olearia cydoniifolia*, *Olearia rosmarinifolia*, *Podolepis jaceoides*, *Podolepis neglecta*, *Pseudognaphalium luteoalbum*, *Senecio bipinnatisectus*, *Senecio gunnii*, *Stuartina muelleri*, *Vittadinia dissecta* var. *hirta*;
- the shrubs *Acacia leucolobia* (extension of range), *Daviesia acicularis*, *Bossiaea prostrata*, *Dillwynia juniperina*, *Pultenaea myrtoides*, *Sphaerolobium minus*, *Prostanthera nivea*, *Persoonia oleoides*, *Pomaderris andromedifolia*, *Pomaderris eriocephala*, *Boronia microphylla*, *Santalum obtusifolium*, *Zieria laevigata*, *Tasmannia stipitata*;

- the grass, *Poa clivicola* was recorded once at site 235 in New England Peppermint regrowth, a northern extension of its range. A northern form of *Poa costiniana* was recorded at a number of sites, mainly in community 6 on basalt.

Description of plant communities

Approximately 69 000 ha or 26% of the Guyra 1: 100 000 map sheet area was mapped as native vegetation using aerial photographic interpretation. However, as mentioned previously, we did not map native grasslands or patches of vegetation less than one hectare in size.

The 24 mapped plant communities are described below, complemented by a photograph of each community. Some are more homogeneous in their floristic composition than others. Some are widely distributed, for example communities 2, 3, 17 and 23. Others are geographically restricted, for example communities 13, 14, 20, 21 and 24. The fidelity analysis (Bedward unpublished software) revealed that the ubiquitous stringybark plant communities 2 and 3 contain one and no indicator species respectively. Most species in them are common across the landscape. In contrast, communities 24 (swamps on basalt) and 21 (rocky outcrops on leucogranite) contain a large number of indicator species that are restricted to those communities.

The 24 plant communities are described using dominant canopy species as the main descriptor. Codes from previous forest classifications that best match the plant communities are listed. The relevant previous classifications referred to are the forest plant communities of Hager and Benson (1994) and the forest types of Forestry Commission of New South Wales (1989). Generally, forest types are much broader in their definition than Hager and Benson (1994) or the classification derived in this survey.

Sites classified into each community are listed. Information on location, physical features and floristics for each sample site is held by the Royal Botanic Gardens. The structural classification follows Walker and Hopkins (1990). The mean number of species recorded in the 20 × 20 m plots per community is given. Indicator species were those species that occurred in > 50% of the sites in a community and had a high fidelity to that group (> 0.8 derived from the fidelity analysis, Bedward unpublished software). The frequency of occurrence of each species in each community is shown in Appendix 1.

A threat status code for the plant communities in the study area have been derived by comparing the area of extant vegetation with an estimate of the pre-European extent (see thresholds in methods section and Table 4). The reservation code is based on percentage protected in reserves compared to an estimate of pre-European extent. The threat and reservation codes given for New South Wales are estimates only based on the authors' knowledge of the distribution and abundance of each plant community over its geographical range.

Community 1: Blakely's Red Gum (*Eucalyptus blakelyi*)-Yellow Box (*Eucalyptus melliodora*) Open Forest (Fig. 12)

Equivalent in Hager and Benson (1994): EF712b&c, EF446c; **Forest Type:** 172, 177

Sample sites (23): 1, 2, 29, 69, 74, 76, 77, 78, 82, 84, 113, 159, 217, 219, 220, 223, 225, 227, 250, 282, 283, 284, 303

Landform: Mainly flats and lower slopes adjoining valleys, occasionally ridges

Substrate: Fine-grained sedimentary rocks such as shale, mudstone and medium nutrient volcanics

Soils: Grey, red or brown clay podsolics

Elevation: 980–1200 m

Distribution: Mainly in the south near Armidale, Old Armidale Road, Boorolong Road, Devils Pinch, Gara River valley and near Thalgarrah

Extant area: native understorey: 4847 ha; exotic understorey: 1765 ha; **Total:** 6612 ha

Estimated remaining extent of pre-European extent: 20%

Structure: Open forest with trees between 12 and 20m with a mid-dense (30–50%) crown cover; shrubs sparse with a mid-dense ground cover

No. native species: 185; **Mean no. per site:** 33 +/- 8.9

No. exotic species: 38; **Mean no. per site:** 5.9 +/- 4.6

Indicator native species: *Eucalyptus blakelyi*, *Eucalyptus melliodora, Bothriochloa macra*

Common native species:

- Trees: *Eucalyptus blakelyi, Eucalyptus melliodora* with either *Eucalyptus caliginosa, Eucalyptus laevopinea* or *Eucalyptus youmanii*
- Shrubs: *Acacia implexa, Bursaria spinosa, Lissanthe strigosa*, *Hibbertia linearis*, *Opercularia aspera*, *Pimealea curviflora* var. *divergens*, *Rubus parvifolius*
- Ground cover: *Poa sieberiana*, *Dichondra repens*, *Geranium solanderi* var. *solanderi* , *Desmodium varians*, *Bothriochloa macra*, *Asperula conferta*, *Acaena ovina*, *Themeda australis*, *Sclerolaena biflorus*, *Wahlenbergia planifolia* subsp. *planifolia*, *Austrodanthonia* species

Common exotic species: *Hypochaeris radicata*, *Rosa rubiginosa*, *Plantago lanceolata*, *Paronychia brasiliana*, *Vulpia myuros*, *Trifolium* species

Variability: This community includes a small stand of *Eucalyptus moluccana* on Rockvale Road. The stringybark, *Eucalyptus youmanii*, is occasionally

Fig. 12. Community 1 *Eucalyptus blakelyi-Eucalyptus melliodora* open forest on fine-grained sedimentary substrate on a travelling stock reserve near Boorolong west of Armidale.

present. Stringybarks are often common in this community and this community often merges with community 2. Understorey varies depending on grazing pressure and aspect, but contains a suite of grasses, forbs and shrubs.

Condition: Most of the original extent has been cleared, although regrowth occurs in some areas and remnants occur along roadsides and in travelling stock routes. Remnants on private land generally contain a highly modified understorey due to continuous grazing.

Threats: As this community occurs on medium nutrient soils, areas are still prone to clearing. Dieback killed many trees in the 1970s and remains a threat. Understorey of most remnants on private land has been altered by grazing. Exotic pasture species have been sown or have invaded many places.

Threat status: Guyra: E(i), **NSW:** E(i)

Reservation code: Guyra: VP, **NSW:** VP

No. reserves in study area containing this community: 1; **Area reserved:** 1 ha

Conservation status: Small remnants occur on roadsides and on private land, only one hectare is protected in reserves. Reduced to about 20% of its original extent.

Key sites for conservation: Site 84, Rockvale Road TSR near Chandlers Road which has a low grazing pressure and a tablelands occurrence of *Eucalyptus moluccana*. Site 223 roadside on Old Armidale Road. Site 82 adjoining Thalgarrah Field Studies Centre. Site 113, Devils Pinch which contains *Eucalyptus youmanii* in a Crown reserve.

Community 2: Broad-leaved Stringybark (*Eucalyptus caliginosa*) Open Forest (Fig. 13)

Equivalent in Hager and Benson (1994): EF481a,b,c; **Forest Type:** 122

Sample sites (40)**:** 23, 25, 26, 66, 68, 70, 73, 81, 83, 85, 86, 87, 88, 89, 91, 92, 99, 102, 106, 108, 109, 157, 158, 175, 189, 203, 207, 209, 213, 231, 238, 239, 240, 269, 291, 292, 302, 307, 308, 309

Landform, substrate and soils: Mainly confined to ridges and upper slopes on siliceous sedimentary rocks (greywacke), granite and acid volcanics with brown, sandy clay soils.

Distribution: Widely scattered over southern and western sections of the study area. Absent from the granites and leucogranites in the north-east, although *Eucalyptus caliginosa* itself is common as a co-dominant tree in other plant communities on these geologies. It is the most common plant community in the study area.

Fig. 13. Community 2, *Eucalyptus caliginosa* open forest is widespread and usually occurs on ridges composed of siliceous sediments. This shows site 68 just east of Armidale, composed of regrowth with a heavily grazed understorey.

Extant area: native understorey: 9844 ha; exotic understorey: 1302 ha; **Total:** 11 146 ha

Estimated remaining extent of pre-European extent: 60% (mainly regrowth)

Structure: Open forest, trees 15–25 m high with a mid-dense (30–50%) crown cover, some regrowth areas have a dense (50–80%) crown cover. Shrubs sparse, ground cover sparse, to mid-dense

No. native species: 212; **Mean no. per site:** 30 +/- 7

No. exotic species: 41; **Mean no. per site:** 7 +/- 4

Common native species:

- Trees: *Eucalyptus caliginosa* with either *Eucalyptus melliodora*, *Eucalyptus blakelyi*, *Eucalyptus bridgesiana*, *Eucalyptus viminalis*
- Shrubs: *Lissanthe strigosa*, *Melichrus urceolatus*, *Hibbertia linearis*, *Acacia implexa*
- Ground cover: *Geranium solanderi* var. *solanderi*, *Dichondra repens*, *Poa sieberiana*, *Glycine clandestina*, *Scleranthus biflorus*, *Poranthera microphylla*, *Rumex brownii*, *Veronica calycina*, *Hypericum gramineum*

Indicator native species: *Eucalyptus caliginosa*

Common exotic species: *Hypochaeris radicata*, *Trifolium repens*, *Paronychia brasiliana*, *Taraxacum officinale*, *Rosa rubiginosa*

Variability: Very variable with low species fidelity compared to some other communities. The closely related community 19 occurs along Rockvale Road north-east of Armidale and is dominated by *Eucalyptus acaciiformis.*

Condition: Extensively cleared and now mainly regrowth. Understorey often heavily grazed but the stringybark trees are less affected by dieback than other tree species. Some fenced off areas have denser shrub layers.

Threats: Due to this community occurring on ridges and poorer soils, it is less threatened than valley communities and many areas have regrown after clearing in the early 20th century.

Threat status: Guyra: LC (i); **NSW:** LC(i)

Reservation code: Guyra: P; **NSW:** M

No. reserves in study area containing this community: 2; **Area reserved:** 443 ha

Conservation status: Represented in Mount Duval and Boorolong Nature Reserves.

Key sites for conservation: Site 92 roadside reserve on Eastview Road, site 95 along Rockvale Road near 'Tarrangower', site 309 'Caer Timvil' off New England Highway, site 175 Wandsworth Road near 'Glen Park', site 213 Little Mount Duval.

Community 3: Silver-top Stringybark (*Eucalyptus laevopinea*) Open Forest (Fig. 14)

Equivalent in Hager and Benson (1994): EF479a,c; **Forest Type:** 167

Sample sites (41)**:** 28, 71, 72, 75, 79, 90, 94, 104, 105, 111, 112, 114, 161, 176, 188, 190, 195, 196, 197, 198, 199, 200, 201, 202, 204, 205, 206, 208, 224, 226, 228, 229, 230, 237, 248, 249, 285, 286, 294, 301, 304

Landform, substrate and soils: Often occurs on steep escarpment slopes and often on rich soils such as those derived from basalt — but also occurs on sedimentary, acid volcanic and granitic substrates. At elevations 970–1300 m.

Distribution: Widespread on different substrates from near Armidale and Mount Duval in the south-west, Black Mountain to Ben Lomond in the central-west and Lagune Sugarloaf in the east.

Structure: Open forest with trees 12–25 m high, generally mid-dense (30–50%) crown cover but more dense in some regrowth stands. Sparse to mid-dense shrub layer (10–50% cover); mid-dense to dense ground cover (30–80 %) cover.

Extant area: native understorey: 9000 ha; exotic understorey: 1084 ha; **Total:** 10 084 ha

Estimated remaining extent of pre-European extent: 50% (much is regrowth)

No. native species: 205; **Mean no. per site:** 32 +/- 8

No. exotic species: 50; **Mean no. per site:** 6 +/- 4

Common native species:

- Trees: *Eucalyptus laevopinea* commonly with *Eucalyptus melliodora*, *Eucalyptus bridgesiana*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Angophora floribunda*
- Shrubs: *Bursaria spinosa*, *Lissanthe strigosa*, *Acacia dealbata*, *Hibbertia linearis*
- Ground cover: *Poa sieberiana*, *Dichondra repens*, *Glycine clandestina*, *Veronica calycina*, *Desmodium varians*, *Geranium solanderi* var. *solanderi*, *Acaena novae-zelandiae*, *Hydrocotyle laxiflora*, *Elymus scaber*

Indicator native species: The fidelity analysis did not identify any indicator species for this community reflecting that it contains species that commonly occur in other communities.

Fig. 14. Community 3, *Eucalyptus laevopinea* open forest is common on slopes and ridges composed of fine-grained sedimentary, basalt or acid volcanic rocks. Trees are over 20 m high at site 105 shown here in Boorolong Nature Reserve.

Common exotic species: *Hypochaeris radicata*, *Vulpia myuros*, *Taraxacum officinale*, *Paronychia brasiliana*, *Cirsium vulgare*

Variability: A number of subgroups are geographically based, for example, the sites on Mount Duval are floristically similar to each other.

Condition: Mostly cleared. Most remnants are 50 year + regrowth. The understorey is generally in poor condition except in areas protected from excessive grazing–for example Mount Duval.

Threats: Clearing (including ringbarking) threatens areas on better soils such as basalt, although in some places trees are regrowing from past clearing, particularly on steep slopes. The understorey of most remnants on private land is degraded due to heavy grazing.

Threat status: Guyra: NT(i), **NSW** NT(i)

Reservation code: Guyra: P, **NSW:** P

No. reserves in study area containing this community: 2; **Area reserved:** 373 ha

Conservation status: This community is inadequately reserved, but is represented in the newly dedicated Mount Duval and Boorolong Nature Reserves, and is on Crown land at Devils Pinch.

Key sites for conservation: Crown land at Thunderbolts Cave near Devils Pinch (site 28).

Community 4: Tenterfield Woollybutt *(Eucalyptus banksii)*-Silver-top Stringybark *(Eucalyptus laevopinea)* Open Forest (Fig. 15)

Equivalent in Hager and Benson (1994): EF507c; **Forest Type:** nil

Sample sites (8)**:** 80, 103, 110, 297, 299, 300, 305, 306

Landform, substrate and soils: Steep, rocky upper slopes or ridges on acid volcanic or sedimentary substrates with grey clay soils. At elevations 1140–1270 m.

Distribution: Restricted to a few locations. In the south-western part of the study area it occurs in the Devils Pinch-Black Mountain region. Present on Little Duval, and on higher peaks of Boorolong Nature Reserve. Most common on the acid volcanic substrate of the western part of the study area, for example near Abington Creek.

Extant area: native understorey: 328 ha; exotic understorey: 9 ha; **Total:** 337 ha

Estimated remaining extent of pre-European extent: 70%

Structure: Trees 10–20 m high, with a mid-dense to dense (30–80%) crown cover; sparse or no shrub layer; sparse to mid-dense ground cover.

No. native species: 87; **Mean no. per site:** 30 +/- 10

No. exotic species: 17; **Mean no. per site:** 2 +/- 1

Common native species:

- Trees: *Eucalyptus banksii*, *Eucalyptus laevopinea*
- Shrubs: *Olearia viscidula*, *Opercularia aspera*, *Hibbertia linearis*, *Lissanthe strigosa*
- Ground cover: *Poa sieberiana*, *Poranthera microphylla*, *Lomandra filiformis* subsp. *coriacea*, *Dichelachne micrantha*. *Joycea pallida* formed a dense grass cover at two sites.

Indicator native species: *Eucalyptus banksii*, *Eucalyptus laevopinea*, *Olearia viscidula*, *Lomandra filiformis* subsp. *coriacea*

Common exotic species: *Hypochaeris radicata*

Variability: Little variation. Some understorey differences between sites such as the presence of *Joycea pallida*.

Condition: Relatively good, few weeds, due to its location on siliceous substrates and rocky ground. Fenced-off areas have a more dense understorey than areas subjected to grazing by stock.

Threats: Main threats are grazing of the understorey and cutting trees for firewood.

Threat status: Guyra: NT(ii); **NSW:** NT(ii)

Reservation code: Guyra: P; **NSW:** M

No. reserves in study area containing this community: 1; **Area reserved:** 13 ha

Reservation status: Poorly conserved — a small patch is reserved in Boorolong Nature Reserve.

Fig. 15. Community 4, *Eucalyptus banksii-Eucalyptus laevopinea* mainly occurs on upper slopes on acid volcanic rocks. It also occurs on siliceous sedimentary rocks such as this stand at site 110 on an escarpment 20 km north of Armidale.

Key sites for conservation: Site 80 on Sunnyside Road where the tufted grass *Joycea pallida* dominates the ground layer. Also sites 299 and 306 on acid volcanic substrate in the Abington Creek region.

Community 5: Youman's Stringybark (*Eucalyptus youmanii*)-Western New England Blackbutt (*Eucalyptus andrewsii*)-*Eucalyptus subtilior* +/- Narrow-leaved Black Peppermint (*Eucalyptus nicholii*) Open Forest (Fig. 16)

Equivalent in Hager and Benson (1994): EF486a; **Forest Type:** 122

Sample sites (17)**:** 8, 9, 12, 13, 14, 160, 177, 178, 179, 215, 221, 287, 288, 289, 290, 295, 298

Landform, substrate and soils: Ridges and slopes on acid volcanic substrates with yellow-brown clays.

Distribution: North-west of Guyra including Happy Valley, Wandsworth Road, Whans Road, Elderberry Creek at elevations 1110–1320 m.

Extant area: native understorey: 3154 ha; exotic understorey: 176 ha; **Total:** 3330 ha

Estimated remaining extent of pre-European extent: 15%

Structure: Open forest with trees 12–18 m high and with a mid-dense to dense (30–80%) crown cover, very sparse shrub layer and sparse ground cover.

No. native species: 173; **Mean no. per site:** 31 +/- 9

No. exotic species: 29; **Mean no. per site:** 4 +/- 5

Common native species:

- Trees: *Eucalyptus andrewsii, Eucalyptus youmanii*, *Eucalyptus subtilior, Eucalyptus caliginosa, Eucalyptus dalrympleana* subsp. *heptantha, Eucalyptus nicholii,* with a subgroup containing *Eucalyptus prava* on ridges in one area
- Shrubs: *Melichrus urceolatus*, *Hibbertia linearis*, *Hovea linearis*, *Pultenaea campbellii*
- Ground cover: *Poranthera microphylla*, *Oxalis radicosa*, *Hardenbergia violacea*, *Gonocarpus tetragynus*, *Dichondra repens*, *Dichelachne micrantha*, *Poa sieberiana*, *Goodenia hederacea* subsp. *hederacea*

Indicator native species: *Eucalyptus andrewsii*, *Goodenia bellidifolia* subsp. *bellidifolia*, *Oxalis radicosa*

Common exotic species: *Hypochaeris radicata*, *Aira elegantissima*, *Trifolium repens*

Variability: This community is defined by its understorey. The sites are pulled together in the floristic analysis due mainly to the sharing of common understorey species growing on acid volcanic soils in the drier, western part of the study area. There is considerable variation in tree species

Fig. 16. Community 5, at site 14 adjacent to the Guyra-Tingha Road containing *Eucalyptus subtilior*, *Eucalyptus andrewsii* and *Eucalyptus caliginosa* on acid volcanic rock.

depending on the landform position (high slope to lower slopes). For example, *Eucalyptus nicholii*, *Eucalyptus youmanii* and *Eucalyptus dalrympleana* subsp. *heptantha* tend to grow on lower slopes or flatter terrain (most of which has been cleared). In contrast, *Eucalyptus prava* and *Eucalyptus andrewsii* occur on shallow soils on rocky steeper-sloped terrain (much of which remains uncleared). It is likely that further sampling to the west of the study area would yield data that would warrant splitting this community.

Condition: Lower slopes mainly cleared, large remnants on rocky ridges persist.

Threats: Most of the occurrences of this community on lower slopes or flat terrain have been cleared for grazing. Subdivision and hobby farms threaten larger remnants in rocky terrain. Heavy grazing of remnant understorey and firewood cutting are the main threats.

Threat status: Guyra E(i); **NSW:** E(i)

Reservation code: Guyra VP; **NSW:** P

No. reserves in study area containing this community: 0; **Area reserved:** 0

Reservation status: The recent dedication of Single State Forest as Single Nature Reserve to the west of the study area protects a sample of this threatened plant community. Parts of Kings Plains National Park and Torrington State Recreation Area sample vegetation that is similar. This community is not protected in reserves in the study area.

Key sites for conservation: A number of sites are important due to degree of clearing of the community and the presence of the rare species (*Eucalyptus nicholii*): Sites 12 and 13 along Wandsworth Road, site 14 TSR on Tingha Road north of Wandsworth, sites 288, 289 and 290 near Reedy Creek, site 215 Fleetwood Road west of Boorolong, site 178 Happy Valley.

Community 6: Ribbon Gum (*Eucalyptus viminalis*)-Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*)-Snow Gum (*Eucalyptus pauciflora*) Open Forest-Tall Open Forest with a Grassy Understorey on Basalt (Fig. 17)

Equivalent in Hager and Benson (1994): EF415b; **Forest Type:** 159

Sample sites (17): 6, 7, 10, 11, 30, 31, 46, 155, 156, 180, 181, 182, 185, 186, 187, 253, 310

Landform, substrate and soils: Mainly confined to the high undulating, basalt plateau centred on Guyra with deep, chocolate or krasnozem loam soils. Numerous swampy depressions are present on the plateau.

Distribution: Extending along the spine of the Great Dividing Range at high elevations (1200–1500 m), from Ben Lomond in the north to Black Mountain in the south. Outlying occurrences occur on Mount Mitchell in the north-east and near Armidale in the south.

Extant area: native understorey: 3119 ha; exotic understorey: 3524 ha; **Total:** 6643 ha

Estimated remaining extent of pre-European extent: 15%

Structure: Open forest to tall open forest. Trees mainly about 20 m high but up to 30 m. Mid-dense cover (30–50%); shrub layer is very sparse (10%) and ground cover is dense or very dense (50–100%) and dominated by grass species.

No. native species: 155; **Mean no. per site:** 32.9 +/- 9

No. exotic species: 50; **Mean no. per site:** 10 +/- 5.2

Common native species:

- Trees: *Eucalyptus viminalis*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Eucalyptus pauciflora* occasionally *Eucalyptus stellulata*
- Shrubs: *Acacia dealbata*, *Pultenaea microphylla*, *Pimelea linifolia*
- Ground cover: *Geranium solanderi* var. *solanderi*, *Hydrocotyle laxiflora*, *Glycine clandestina*, *Rubus parvifolius*, *Asperula conferta*, *Themeda australis*, *Poa sieberiana*, *Poa labillardieri*, *Acaena novae-zelandiae*, *Acaena ovina*, *Viola betonicifolia*, *Dichondra repens*, *Wahlenbergia stricta* subsp. *stricta*, *Bracteantha bracteata, Desmodium varians*, *Scleranthus biflorus*, *Diuris abbreviata*, *Galium ciliare*, *Hypericum gramineum*, *Ranunculus lappaceus*

Indicator native species: *Eucalyptus viminalis*, *Ranunculus lappaceus*, *Pultenaea microphylla*, *Ammobium alatum*

Common exotic species: *Hypochaeris radicata*, *Trifolium repens*, *Cirsium vulgare*, *Taraxacum officinale*, *Petrorhagia nanteullii*

Variability: Community 6 is similar to community 7 in the floristic composition of the understorey. The tall forest of *Eucalyptus viminalis* and *Eucalyptus dalrympleana* subsp. *heptantha* would have originally dominated much of the basalt plateau and is now only surviving in small remnants. *Eucalyptus pauciflora* is more common on the highest (coldest) ridges and in cold air drainage valleys.

Condition: Poor. Mostly cleared with less than 10% of this community remaining and much of that is regrowth or has had its understorey adversely

Fig. 17. Community 6, *Eucalyptus viminalis-Eucalyptus dalrympleana* subsp. *heptantha* on undulating basalt plateau near Guyra. Less than 15% of this forest type is estimated to remain uncleared and most remnants are in poor condition.

affected by grazing or weed invasion. The best remnants are along roadsides such as the New England Highway.

Threats: An endangered plant community threatened by further clearing of remnants, grazing of understorey and weed invasion.

Threat status: Guyra: E(i); **NSW:** E(i)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 1; **Area reserved:** 17 ha

Conservation status: Small area held in Llangothlin Nature Reserve.

Key sites for conservation: Site 10 Crown reserve south of Ben Lomond on Wandsworth Road; the road reserve (including sites 6 and 7) on the New England Highway; site 155 on Baldersleigh Road (which has a population of the rare plant *Thesium australe)*; sites 180, 181 and 182 along Aberfoyle Road for *Thesium australe*; sites 186 and 187 on the top of Mount Ben Lomond; and site 310 on the ridge above the Lagoon Farm wetland.

Community 7: Black Sallee (*Eucalyptus stellulata*)-Snow Gum (*Eucalyptus pauciflora*) Low Open Forest or Low Open Woodland with a grassy understorey

Equivalent in Hager and Benson (1994): EF412a; **Forest Type:** 137

Note: Community 7 has a lower canopy height (< 12 m) than community 6 and is dominated by Black Sallee while community 6 is a taller (> 12 m) forest dominated by Ribbon Gum or Mountain Gum. The two communities were distinguished for the vegetation map through aerial photographic interpretation and field traverse.

Sample sites (4): 184, 194, 251, 254

Landform, substrate and soils: Mainly confined to the high undulating, basalt plateau centred on Guyra with deep, chocolate or krasnozem loam soils. Often on valley sides or swampy depressions. Sometimes on other soil types.

Distribution: Mainly confined to the Guyra plateau from Ben Lomond in the north to Black Mountain in the south.

Extant area: native understorey: 606 ha; exotic understorey: 1213 ha; **Total:** 1819 ha

Estimated remaining extent of pre-European extent: 10%

Structure: Low open forest or low woodland with trees less then 12m high and generally with a mid-dense to open crown cover (10–50%).

No. native species: 86; **Mean no. per site:** 34.5 +/-6.2

No. exotic species: 28; **Mean no. per site:** 12 +/-4.7

Common native species:

- Trees: *Eucalyptus stellulata*, *Eucalyptus pauciflora*
- Shrubs: *Acacia dealbata*, *Pultenaea microphylla*, *Pimelea linifolia*
- Ground cover: *Geranium solanderi* var. *solanderi*, *Hydrocotyle laxiflora*, *Glycine clandestina*, *Rubus parvifolius*, *Asperula conferta*, *Poa sieberiana*, *Acaena novae-zelandiae*, *Dichondra repens*, *Hypericum gramineum*, *Scleranthus biflorus*, *Wahlenbergia stricta* subsp. *stricta*

Indicator native species: *Eucalyptus stellulata, Ammobium alatum*

Common exotic species: *Acetosella vulgaris*, *Hypochaeris radicata*, *Trifolium repens*, *Cirsium vulgare*, *Taraxacum officinale*, *Rubus ulmifolius*

Variability: Crown cover varies considerably depending on degree of thinning or regrowth.

Condition: Poor. Mostly cleared with less than 10% of this community remaining and much of that is regrowth or has had its understorey altered by grazing or pasture weed invasion.

Threats: An endangered plant community threatened by further clearing of remnants, grazing of understorey and weed invasion.

Threat status: Guyra: E(i); **NSW:** V(i)

Reservation code: Guyra: VP; **NSW:** M

No. reserves in study area containing this community: 1; **Area reserved:** 27 ha

Conservation status: Small area held in Llangothlin Nature Reserve.

Community 8: New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Basalt (Fig. 18)

Equivalent in Hager and Benson (1994): EF517a; **Forest Type:** 142

Sample sites: not sampled-nearly extinct.

Landform, substrate and soils: Base of valleys on basalt plateaux.

Fig. 18. Community 8, affected by dieback. New England Peppermint *Eucalyptus nova-anglica* on basalt (community 8) near Guyra. This community has been extensively cleared and only a few patches remain.

Distribution: Mainly confined to the basalt plateau around Guyra.

Extant area: native understorey: 172 ha; exotic understorey: 173 ha; **Total:** 345 ha

Estimated remaining extent of pre-European extent: 5%

Structure: Woodland, tree height varies from 8–20 m with a sparse (up to 30%) cover. Few shrubs are present but ground cover is usually dense.

No. native species: NA; **Mean no. per site:** NA

No. exotic species: NA; **Mean no. per site:** NA

Common native species:

- Trees: *Eucalyptus nova-anglica*
- Shrubs: No common shrubs
- Ground cover: *Poa sieberiana, Asperula conferta* and other grasses and forbs

Indicator native species: NA

Common exotic species: NA

Variability: NA

Condition: Nearly extinct. Almost entirely cleared and what remains has been affected by dieback and the understorey has been heavily grazed.

Threats: A critically endangered plant community threatened by further clearing of remnants, dieback, grazing of understorey, weed invasion.

Threat status: Guyra: CE(i); **NSW:** CE(i)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 0; **Area reserved:** 0

Conservation status: Not reserved

Key sites for conservation: Few remnants remain. Patches occur along Wards Mistake and Handebos Roads east of Guyra township.

Community 9: New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Sediments (Fig. 19)

Equivalent in Hager and Benson (1994): EF517a; **Forest Type:** 142

Sample sites (7)**:** 15, 67, 93, 96, 191, 216, 222

Landform, substrate and soils: Valley flats subject to cold air drainage composed of fine-grained sedimentary and acid volcanic substrates with poorly drained loam-clay soils.

Fig. 19. Community 9, *Eucalyptus nova-anglica* regrowth woodland on sedimentary rock at site 67, 5 km to the east of Armidale. This woodland has been severely affected by dieback over the last two decades.

Distribution: Mainly confined to the southern section of the study area near Armidale and Boorolong, and in the western section on the Tingha Road near Wandsworth; at elevations 900–1180 m.

Extant area: native understorey: 1167 ha; exotic understorey: 812 ha; **Total:** 1979 ha

Estimated remaining extent of pre-European extent: 15%

Structure: Woodland, tree height varies from 8–20 m with a sparse (up to 30%) cover. Few shrubs are present but ground cover is usually dense.

No. native species: 94; **Mean no. per site:** 27 +/- 3

No. exotic species: 29; **Mean no. per site:** 9 +/- 7

Common native species:

- Trees: *Eucalyptus nova-anglica* occasionally with *Eucalyptus dalrympleana* subsp. *heptantha*
- Shrubs: No common shrubs
- Ground cover: *Asperula conferta*, *Themeda australis*, *Juncus filicaulis*, *Dichondra repens*, *Carex inversa*, *Rumex brownii*, *Acaena ovina*, *Desmodium varians*

Indicator native species: *Eucalyptus nova-anglica*, *Carex inversa*, *Haloragis heterophylla*, *Juncus filicaulis*, *Cymbonotus lawsonianus*, *Leucopogon fraseri*

Common exotic species: *Hypochaeris radicata*, *Aira elegantissima*, *Rosa rubiginosa*

Variability: Variation is present in structure due to stages of regrowth after clearing or dieback.

Condition: Poor. Mostly cleared and what remains has been severely affected by dieback and the understorey has been heavily grazed.

Threats: An endangered plant community threatened by further clearing of remnants, dieback, grazing of understorey, weed invasion.

Threat status: Guyra: E(i); **NSW:** E(i)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 2; **Area reserved:** 54 ha

Conservation status: Small areas are sampled in Duval and Boorolong Nature Reserves. Remnants also occur in some TSRs and road reserves.

Key sites for conservation: Sites 15 and 191 on Tingha Road, site 93 Rockvale Road at Wollomombi River, site 67 also on Rockvale Road.

Community 10: New England Peppermint (*Eucalyptus nova-anglica*)-Snow Gum (*Eucalyptus pauciflora*) Open Forest on Granite and Leucogranite (Fig. 20)

Equivalent in Hager and Benson (1994): EF517b; **Forest Type:** 142

Sample sites (9)**:** 17, 22, 37, 44, 115, 140, 143, 235, 246

Landform, substrate and soils: Flats and lower slopes subject to cold air drainage, on granite and leucogranite substrates with poorly drained yellow-brown sandy loam soils.

Distribution: North-eastern section of the study area including Backwater, Sara River, Oban River at elevations 980–1280 m.

Extant area: native understorey: 4040 ha; exotic understorey: 418 ha; **Total:** 4458 ha

Estimated remaining extent of pre-European extent: 25%

Structure: Open forest, trees 18 m high with a mid-dense (30–50%) cover with a sparse shrub cover but with tall grasses or bracken (*Pteridium esculentum*), and a dense ground cover.

No. native species: 126; **Mean no. per site:** 35 +/- 9

No. exotic species: 28; **Mean no. per site:** 6 +/- 2

Common native species:

- Trees: *Eucalyptus nova-anglica*, *Eucalyptus pauciflora*, *Eucalyptus stellulata*
- Shrubs: *Rubus parvifolius*, *Bursaria spinosa*, *Leucopogon fraseri*
- Ground cover: *Themeda australis*, *Pteridium esculentum*, *Glycine clandestina*, *Acaena novae-zelandiae*, *Scleranthus biflorus*, *Hypericum gramineum*, *Poa sieberiana*, *Imperata cylindrica*

Indicator native species: *Eucalyptus stellulata*, *Eucalyptus pauciflora*, *Grevillea juniperina*

Common exotic species: *Hypochaeris radicata*, *Trifolium repens*, *Acetosella vulgaris*, *Holcus lanatus*

Variability: Forest height varies, being taller along the Oban River where Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*) is present. There is also more *Pteridium* and *Imperata* along the Oban River, perhaps indicating more frequent fire in that area.

Condition: Poor. Mostly cleared and only small remnants remain. Dieback has severely impacted on this community.

Threats: Further clearing and dieback, tin-mining and grazing of remnants. Not reserved and one of the most endangered plant communities on the New England Tableland.

Threat status: Guyra: E(i); **NSW:** E(i)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 1; **Area reserved:** 2 ha

Conservation status: Tiny portion of this community is within Warra National Park.

Key sites for conservation: Site 235 near Granite Springs, site 143 adjacent to Oban River, site 22 Wards Mistake Road, site 37 Sara River.

Community 11: Broad-leaved Stringybark (*Eucalyptus caliginosa*)-Mountain Gum (*Eucalyptus dalrympleana* subsp. *heptantha*) Open Forest on Leucogranite (Fig. 21)

Equivalent in Hager and Benson (1994): EF413c; **Forest Type:** nil

Sample sites (13)**:** 3, 20, 33, 41, 55, 58, 60, 64, 65, 256, 261, 264, 265

Landform, substrate and soils: Flats and lower slopes on leucogranite substrate with sandy, low nutrient soil.

Distribution: Confined to the north-eastern section of the study area between Backwater, Mount Mitchell and Paddys Gully Road at elevations 1020–1240 m.

Extant area: native understorey: 4356 ha; exotic understorey: 41 ha; **Total:** 4397 ha

Estimated remaining extent of pre-European extent: 60%

Fig. 20. Community 10, on leucogranite on the property Wattleridge near Backwater showing New England Peppermint (*Eucalyptus nova-anglica*)**.**

Structure: Open forest, trees 20 m mid-dense-dense (30–80%) crown cover. One to several shrub layers present, sparse to mid-dense. Ground cover sparse to mid-dense.

No. native species: 168; **Mean no. per site:** 42 +/- 7

No. exotic species: 4; **Mean no. per site:** 1.4 +/- 0.8

Common native species:

- Trees: *Eucalyptus caliginosa*, *Eucalyptus dalrympleana* subsp. *heptantha* occasionally *Eucalyptus radiata* subsp. *sejuncta*
- Shrubs: *Persoonia cornifolia*, *Bossiaea scortechinii*, *Acacia filicifolia*, *Opercularia hispida*, *Hovea linearis*, *Banksia integrifolia* subsp. A, *Rubus parvifolius*, *Brachyloma daphnoides*
- Ground cover: *Pteridium esculentum*, *Goodenia hederacea* subsp. *hederacea*, *Themeda australis*, *Stylidium graminifolium*, *Gonocarpus tetragynus*, *Dichelachne micrantha*, *Imperata cylindrica*

Indicator native species: *Eucalyptus dalrympleana* subsp. *heptantha*, *Bossiaea scortechinii*, *Hovea linearis*, *Stylidium graminifolium*

Common exotic species: *Hypochaeris radicata*

Variability: Little variation in species mix. Site 20 on Paddys Gully Road lacks *Eucalyptus dalrympleana* subsp. *heptantha* and contains *Jacksonia scoparia* as an understorey dominant.

Condition: While clearing has eliminated some areas, intact patches remain that are in good condition lacking weeds and have not been affected by dieback.

Threats: The main threat is the continual clearing of this marginal agricultural land by traditional and hobby farmers**,** although this community is less threatened than communities 8, 9 and 10.

Threat status: Guyra: NT(i); **NSW**: LC(i)

Reservation code: Guyra: P; **NSW:** M

No. reserves in study area containing this community: 1; **Area reserved:** 56 ha

Conservation status: Poorly represented in reserves but it is sampled in Warra National Park.

Key sites for conservation: Most sites are in good condition and warrant protection. Of particular importance are sites 55 and 261 on 'Wattleridge' and sites 58 and 256 on portion 14, Parish of Hall, County Clarke. These two properties contain the largest and most intact vegetation remnant in the study area. They contain outstanding conservation values for a number of plant communities and rare plant species.

Fig. 21. Community 11, *Eucalyptus caliginosa-Eucalyptus dalrympleana* subsp. *heptantha* on flats on leucogranite at site 41 in Warra State Forest northeast of Backwater.

Community 12: New England Blackbutt (*Eucalyptus campanulata*) Open Forest on Leucogranite (Fig. 22).

Equivalent in Hager and Benson (1994): EF505a,b,c; **Forest Type:** 163

Sample sites (18)**:** 19, 54, 57, 62, 63, 116, 120, 129, 133, 233, 234, 236, 242, 243, 244, 258, 259, 260

Landform, substrate and soils: Rocky ridges and upper slopes on leucogranite with shallow, low nutrient, sandy soils.

Distribution: Confined to the leucogranite outcrop north-east of Backwater at elevations 1100–1300 m.

Extant area: native understorey: 2118 ha; exotic understorey: 0 ha; **Total:** 2118 ha

Estimated remaining extent of pre-European extent: 90%

Structure: Open forest, trees 15–20 m high mid-dense (30–50%) crown cover. Very sparse, small tree layer of *Allocasuarina littoralis* often present. Shrub and ground layers sparse to mid dense.

No. native species: 161; **Mean no. per site:** 34 +/-8.0

No. exotic species: 6; **Mean no. per site:** 0.5 +/-0.8

Common native species:

- Trees: *Eucalyptus campanulata* with *Eucalyptus caliginosa* or *Eucalyptus radiata* subsp. *sejuncta*
- Shrubs: *Lomatia silaifolia*, *Allocasuarina littoralis*, *Persoonia cornifolia*, *Monotoca scoparia*, *Brachyloma daphnoides*, *Banksia integrifolia* subsp. A
- Ground cover: *Goodenia hederacea* subsp. *hederacea*, *Gonocarpus tetragynus*, *Pteridium esculentum*, *Entolasia stricta*, *Poranthera microphylla*

Indicator native species: *Eucalyptus campanulata*, *Eucalyptus cameronii*, *Pomax umbellata*, *Patersonia sericea*, *Allocasuarina littoralis*

Common exotic species: *Hypochaeris radicata*

Variability: Associate tree species vary, for example at site 260 on 'Wattleridge', *Eucalyptus acaciiformis* is dominant. Understorey varies with aspect and fire history, for example site 242 upslope from Backwater Creek is dominated by the fern *Gleichenia dicarpa*. Some large leucogranite boulders provide habitat for ferns.

Condition: Good condition. Little affected by clearing due to its presence on rough terrain. Very few weeds.

Fig. 22. Community 12, dominated by *Eucalyptus campanulata,* commonly occurs on leucogranite ridges in the Backwater region.

Threats: As this community occurs on rocky low nutrient terrain it is not threatened, although there is some clearing of this non-agricultural land by hobby farmers.

Threat status: Guyra: LC(ii); **NSW:** LC(i)

Reservation code: Guyra P; **NSW:** M

No. reserves in study area containing this community: 1; **Area reserved:** 126 ha

Conservation status: Poorly represented in reserves but it is sampled in Warra National Park.

Key sites for conservation: Most remaining areas are in good condition. A number of rare species occur in this community. If the eastern part of 'Wattleridge' and portion 14 Parish Hall were protected in a reserve, this community would be classed as well conserved.

Community 13: Silver-top Stringybark (*Eucalyptus laevopinea*)-Forest Ribbon Gum (*Eucalyptus nobilis*) Open Forest on Sediments

Equivalent in Hager and Benson (1994): EF479d; **Forest Type:** 167

Sample sites (4)**:** 100, 101, 262, 273

Landform, substrate and soils: Ridges and slopes on fine-grained sedimentary substrate with light brown, clay soil.

Distribution: Restricted to Avondale State Forest and nearby areas in the south-east of the study area at elevations 1180–1250 m.

Extant area: native understorey: 923 ha; exotic understorey: 0 ha; **Total:** 923 ha

Estimated remaining extent of pre-European extent: 30%

Structure: Open to closed forest, trees 20 m with a dense (50–80%) crown cover probably due to dense regrowth after logging or thinning. Shrub layer absent or very sparse. Ground cover very sparse.

No. native species: 22; **Mean no. per site:** 15 +/- 3

No. exotic species: 2; **Mean no. per site:** 1.5 +/- 0.7

Common native species:

- Trees: *Eucalyptus laevopinea*, *Eucalyptus nobilis*, *Eucalyptus radiata* subsp. *sejuncta*
- Shrubs: *Melichrus urceolatus*, *Lissanthe strigosa*, *Indigofera australis*
- Ground cover: *Poa sieberiana*, *Lomandra multiflora* subsp. *multiflora*, *Hardenbergia violacea*

Indicator native species: *Eucalyptus nobilis*, *Indigofera australis*, *Brachyscome microcarpa*

Common exotic species: *Hypochaeris radicata*

Variability: Uniform, some variation in understorey.

Condition: Much of the forest is regrowth after logging. Grazing may have reduced the biomass in the understorey.

Threats: Much of this stringybark forest has been cleared, although remnants remain in and around Avondale State Forest. Logging and clearing remain the main threats.

Threat status: Guyra: V(i); **NSW:** NT(i)

Reservation code: Guyra: VP; **NSW:** P

No. reserves in study area containing this community: 0; **Area reserved:** 0

Conservation status: Not reserved. Located in Avondale State Forest which could be reserved.

Key sites for conservation: Avondale State Forest

Community 14: Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*)-Forest Ribbon Gum (*Eucalyptus nobilis*)-*Hovea* sp. A Open-Closed Forest (Fig. 23)

Equivalent in Hager and Benson (1994): nil; **Forest Type:** 111

Sample site (3)**:** 163, 164, 275

Landform, substrate and soils: Ridgelines on granite substrate with shallow sandy-loam soil.

Distribution: Naturally restricted community occurring on Mount Nobbler near Backwater in the north-western section of the study area at elevations 1330–1390 m.

Extant area: native understorey: 512 ha; exotic understorey: 0 ha; **Total:** 512 ha

Estimated remaining extent of pre-European extent: 90%

Structure: Open to closed forest (50–80%) crown cover, trees 14 m high, dense shrub cover, sparse ground cover.

No. native species: 45; **Mean no. per site:** 27 +/- 4

No. exotic species: 1; **Mean no. per site:** -

Common native species:

- Trees: *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus nobilis*
- Shrubs: *Hovea* sp. A, *Lomatia silaifolia*, *Leucopogon lanceolatus*, *Platysace ericoides*, *Monotoca scoparia*

Fig. 23. Community 14, *Eucalyptus radiata* subsp. *sejuncta-Eucalyptus nobilis* with a dense understorey dominated by *Hovea* sp A, is restricted to ridges near Mount Nobbler, 3 km northwest of Backwater.

- Ground cover: *Poa sieberiana*, *Poranthera microphylla*, *Lomandra longifolia*, *Hardenbergia violacea*

Indicator native species: *Hovea* sp. A, *Olearia oppositifolia*, *Platysace ericoides*

Common exotic species: None.

Variability: Density of the understorey varies, perhaps due to fire history.

Condition: Very good. Only one weed recorded and not subject to clearing due to the terrain.

Threats: Not threatened as it occurs on steep, rocky ridges. Subject to grazing and some logging.

Threat status: Guyra: LC(iii); **NSW:** LC (iii)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves containing this community: 0; **Area reserved:** 0

Conservation status: Not reserved.

Key sites for conservation: Area including sites 163 and 164 on Mount Nobbler.

Community 15: Forest Ribbon Gum (*Eucalyptus nobilis*) -Broad-leaved Stringybark (*Eucalyptus caliginosa*) Open Forest on Leucogranite (Fig. 24)

Equivalent in Hager and Benson (1994): EF414b; **Forest Type:** 160

Sample sites (10)**:** 34, 35, 38, 40, 118, 126, 128, 131, 245, 255

Landform, substrate and soils: Flats and lower slopes on leucogranite substrate with deep, low nutrient, sandy-loam soils.

Distribution: Leucogranite outcrop north of Backwater, particularly near Mount Mitchell in the north-eastern section of the study area, at elevations 1090–1270 m.

Extant area: native understorey: 811 ha; exotic understorey: 0 ha; **Total:** 811 ha

Estimated remaining extent of pre-European extent: 60%

Structure: Open forest to tall open forest, trees 15–25 m high, mid-dense to dense (30–80%) cover. Sparse small tree layer usually present. Shrub layer mid-dense with a sparse ground cover.

Fig. 24. Community 15, *Eucalyptus radiata* subsp. *sejuncta-Eucalyptus nobilis* open forest with an understorey dominated by *Monotoca scoparia* at site 34, 2 km east of Mount Mitchell.

No. native species: 146; **Mean no. per site:** 46 +/-8

No. exotic species: 4; **Mean no. per site:** 1.5 +/-1

Common native species:

- Trees: *Eucalyptus caliginosa*, *Eucalyptus nobilis*, *Eucalyptus radiata* subsp. *sejuncta*, *Banksia integrifolia* subsp. A
- Shrubs: *Leucopogon lanceolatus*, *Senecio* sp. E, *Rubus parvifolius*, *Acacia filicifolia*, *Persoonia cornifolia*, *Monotoca scoparia*
- Ground cover: *Poa sieberiana*, *Poranthera microphylla*, *Pteridium esculentum*, *Glycine clandestina*, *Geranium solanderi* var. *solanderi*, *Viola betonicifolia*, *Lomandra longifolia*, *Imperata cylindrica*, *Gonocarpus tetragynus*

Indicator native species: *Lomandra filiformis* subsp. *filiformis*, *Acacia filicifolia*, *Viola hederacea*, *Brachyscome nova-anglica*

Common exotic species: *Hypochaeris radicata*

Variability: Understorey varies depending on aspect and recovery period from last fire.

Condition: Good. Little disturbed because it occurs on poor soils.

Threats: Subdivision of land and subsequent development is the main threat to this plant community.

Threat status: Guyra: NT(ii); **NSW:** NT(ii)

Reservation code: Guyra: P; **NSW:** P

No. reserves in study area containing this community: 1; **Area reserved:** 115 ha

Conservation status: A small area is reserved in Warra National Park.

Key sites for conservation: Areas near Mount Mitchell and Portion 14, Parish of Hall are key locations for conserving this community, including sites 126, 128, 131, 255.

Community 16: Broad-leaved Stringybark (*Eucalyptus caliginosa*)-Forest Ribbon Gum (*Eucalyptus nobilis*)-Blakely's Red Gum (*Eucalyptus blakelyi*) Open Forest, Oban River (Fig. 25)

Equivalent in Hager and Benson (1994): EF413c; **Forest Type:** 160

Sample sites (5)**:** 139, 142, 144, 145, 267

Landform, substrate and soils: Slopes and ridges on granite substrate with sandy-loam soils.

Fig. 25. Community 16, *Eucalyptus nobilis-Eucalyptus caliginosa* open forest on ridges and slopes above the Oban River, 8 km east of Backwater.

Distribution: Oban River and Wards Mistake in the north-eastern section of the study area at elevations 1050–1270 m.

Extant area: native understorey: 824 ha; exotic understorey: 1 ha; **Total:** 825 ha

Estimated remaining extent of pre-European extent: 50%

Structure: Open forest, trees 15–20m high with mid-dense (30–50%) crown cover. Shrubs absent or very sparse, ground cover dense and dominated by grasses.

No. native species: 84; **Mean no. per site:** 36 +/- 6

No. exotic species: 4; **Mean no. per site:** 2 +/- 0.7

Common native species:

- Trees: *Eucalyptus caliginosa*, *Eucalyptus nobilis*, *Eucalyptus blakelyi*
- Shrubs: *Rubus parvifolius*, *Opercularia hispida*
- Ground cover: *Pteridium esculentum*, *Lomandra longifolia*, *Imperata cylindrica*, *Dichelachne micrantha*, *Cymbopogon refractus*, *Poa sieberiana*, *Glycine clandestina*

Indicator native species: *Cheilanthes distans*, *Plectranthus parviflorus*, *Cymbopogon refractus*, *Brachyscome tenuiscapa* var. *pubescens*

Common exotic species: *Hypochaeris radicata*

Variability: *Eucalyptus blakelyi* is present on the lower slopes. The understorey is consistently dominated by grasses.

Condition: Average. Extensive areas cleared on lower slopes and in valleys. Remnants grazed.

Threats: Clearing, grazing, logging and too-frequent fire threaten this community.

Threat status: Guyra: V(ii); **NSW:** V(ii)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 0; **Area reserved:** 0

Conservation status: Not reserved, mostly found on private land.

Key sites for conservation: Sites 139 and 142 on ridge on the eastern side of Oban River, and sites 144 and 145 on the ridge on the western side of the Oban River.

Community 17: Messmate (*Eucalyptus obliqua*)-Forest Ribbon Gum (*Eucalyptus nobilis*) Tall Open Forest (Fig. 26)

Equivalent in Hager and Benson (1994): EF475c; **Forest Type:** 152

Sample sites (35)**:** 16, 27, 42, 52, 56, 61, 107, 117, 130, 134, 135, 136, 137, 138, 150, 151, 152, 153, 154, 162, 165, 168, 169, 170, 173, 174, 210, 211, 212, 247, 257, 263, 266, 279, 280

Landform, substrate and soils: Mainly on protected eastern or southern slopes, occasionally extending onto ridges. Occurring most frequently on granite and leucogranite substrates but also acid volcanics with most often a sandy-loam soil.

Distribution: Mainly east of the Great Dividing Range where rainfall is higher than western areas. Occurs in Mount Duval Nature Reserve, on Little Duval and with a small stand in Boorolong Nature Reserve in the south-western section of the study area. Most common on Days Ridge and Mount Duncan in the north-eastern section of the study area. Also present on leucogranite at Mount Nobbler, Crown Mountain and 'Wattleridge'. Generally at elevations above 1300 m but its occurrences range from 1040–1400 m.

Extant area: native understorey: 2888 ha; exotic understorey: 5 ha; **Total:** 2893 ha

Estimated remaining extent of pre-European extent: 80%

Structure: Tall open forest, trees usually > 25 m high (up to 40 m at site 56 at 'Wattleridge'), crown cover dense (50–80%). Sparse small tree layer often present. Shrubs very sparse, ground cover mid-dense.

No. native species: 189; **Mean no. per site:** 31 +/- 9

No. exotic species: 29; **Mean no. per site:** 4 +/- 3

Common native species:

- Trees: *Eucalyptus obliqua*, *Eucalyptus nobilis*, *Eucalyptus radiata* subsp. *sejuncta*, *Banksia integrifolia* subsp. A
- Shrubs: *Rubus parvifolius*, *Leucopogon lanceolatus*, *Senecio* sp. E, *Lomatia silaifolia*
- Ground cover: *Acaena novae-zelandiae*, *Pteridium esculentum*, *Poa sieberiana*, *Geranium solanderi* var. *solanderi*, *Dichondra repens*, *Desmodium varians*, *Smilax australis*, *Wahlenbergia stricta*, *Galium ciliare*, *Hydrocotyle laxiflora*

Fig. 26. Community 17, *Eucalyptus obliqua-Eucalyptus nobilis* tall open forest occurs on protected aspects of a number of mountain ranges that receive higher rainfall than surrounding valleys. The understorey varies from mesic to dry, the latter shown here at site 135 on 'Mount View' Days Ridge, where *Lomandra longifolia* dominates.

Indicator native species: *Eucalyptus nobilis*, *Hydrocotyle geraniifolia*, *Asplenium flabellifolium*

Common exotic species: *Hypochaeris radicata*, *Cirsium vulgare*, *Trifolium repens*

Variability: This group could be divided into three subgroups based on the UPGMA analysis: 1. Sites on Mount Nobbler, Mount Duncan and Days Ridge which are high and wet and contain moist understorey species; 2. Those on the acid volcanics on and near Little Duval which contain a drier understorey; 3. Occurrences on the leucogranite north east of Backwater which contain a number of different understorey species normally found on poorer soils.

Condition: Generally good as this community occurs on high, steep hillsides that have not been totally cleared. Large remnants remain. Some areas have been heavily logged and grazed.

Threats: Isolated clearing continues (for example on the southern side of Mount Nobbler). Heavy logging is threatening the structure of the community in some places, such as Days Ridge. Grazing is less of a threat.

Threat status: Guyra: LC(i); **NSW:** LC(i)

Reservation code: Guyra: M; **NSW**: AC

No. reserves in study area containing this community: 3; **Area reserved:** 179 ha

Conservation status: Moderately well conserved. Represented in Warra National Park, Mount Duval Nature Reserve and Boorolong Nature Reserve.

Key sites for conservation: Other then the present reserves, areas suitable for protection include Little Duval, sections of Days Ridge and Mount Duncan, Mount Nobbler (site 162) and sections of 'Wattleridge'.

Community 18: Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*)-Wattle-leaved Peppermint (*Eucalyptus acaciiformis*) Open Forest on Granite (Fig. 27)

Equivalent in Hager and Benson (1994): EF515b; **Forest Type:** 111

Sample sites (20)**:** 18, 21, 48, 97, 121, 122, 123, 124, 125, 146, 147, 148, 149, 192, 193, 214, 268, 270, 272, 274

Landform, substrate and soils: Exposed plateaux, ridges and slopes mainly on granite substrates with sandy clay soils.

Distribution: Mainly restricted to the north-eastern section of the study area along Wards Mistake Road,

Fig. 27. Community 18 is often dominated by *Eucalyptus radiata* subsp. *sejuncta* with a stratum of small trees of *Banksia integrifolia* subsp. A. This shows site 274 north of the Sara River north west of Backwater on granite substrate.

between Backwater and Llangothlin Lagoon, Aberfoyle Road, Days Ridge and near Backwater, at elevations 1090–1400 m.

Extant area: native understorey: 6753 ha; exotic understorey: 308 ha; **Total:** 7061 ha

Estimated remaining extent of pre-European extent: 40%

Structure: Open forest, trees 15 m high, mid-dense to dense (30–80%) crown cover with a very sparse shrub layer and mid-dense to dense ground cover.

No. native species: 173; **Mean no. per site:** 33 +/- 10

No. exotic species: 26; **Mean no. per site:** 5 +/- 3

Common native species:

- Trees: *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus acaciiformis,* occasionally *Eucalyptus pauciflora, Banksia integrifolia* subsp. A
- Shrubs: *Rubus parvifolius*, *Senecio* sp. E
- Ground cover: *Poa sieberiana*, *Dichondra repens*, *Pteridium esculentum*, *Glycine clandestina*, *Geranium solanderi* var. *solanderi*, *Desmodium varians*, *Acaena novae-zelandiae*

Indicator native species: *Eucalyptus acaciiformis*

Common exotic species: *Hypochaeris radicata*, *Trifolium repens*, *Rubus ulmifolius*

Variability: Trees such as *Eucalyptus caliginosa and Eucalyptus dalrympleana* subsp. *heptantha* occur at some sites.

Condition: Varies from good to poor depending on the degree of clearing and grazing. Some roadside remnants are in excellent condition. Some remnants are heavily grazed, thinned and affected by dieback.

Threats: As this community mainly occurs on private land, further clearing and heavy grazing threaten some areas. Dieback affects isolated small patches of forest.

Threat status: Guyra: V(i); **NSW:** V(i)

Reservation code: Guyra: VP; **NSW:** P

No. reserves in study area containing this community: 0; **Area reserved :** 0

Conservation status: Not reserved.

Key sites for conservation: Sites 21 and 122 on road reserve along Wards Mistake Road; site 273 on 'Stonebrook', site 268 at Beesnest Hill on 'Sunnyside' (contains a good patch of the rare *Thesium australe*); Day Trig area.

Community 19: Wattle-leaved Peppermint (*Eucalyptus acaciiformis*)-Broad-leaved Stringybark (*Eucalyptus caliginosa*)-Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*) Open Forest on Sediments (Fig. 28)

Equivalent in Hager and Benson (1994): EF515b,e; Forest Type: 111
Sample site (3)**:** 24, 95, 183

Landform, substrate and soils: Undulating terrain composed of fine grain sedimentary rocks and clayey soils.

Distribution: Rockvale Road and Macleay Range, north-east of Armidale, at 1200 m elevation.

Extant area: native understorey: 489 ha; exotic understorey: 20 ha; **Total:** 509 ha

Estimated remaining extent of pre-European extent: 20%

Structure: Open-forest with trees 8–14m high with a 35–50% crown cover, shrubs sparse, dense ground cover dominated by grasses and forbs.

No. of native species: 63; **Mean no. per site:** 40 +/- 2

No. exotic species: 13; **Mean no. per site:** 6 +/- 2

Common native species:

- Trees: *Eucalyptus acaciiformis*, *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus caliginosa*
- Shrubs: *Allocasuarina littoralis*, *Acacia filicifolia*, *Ozothamnus diosmifolia*
- Ground cover: *Poa sieberiana*, *Themeda australis*, *Chrysocephalum apiculatum*

Indicator native species: NA

Common exotic species: *Hypochaeris radicata*, *Trifolium* species

Variability: Analysis revealed that this community shares many species with community 2 which also occurs on sediments in the area. Much of the forest is regrowth in variable sized patches.

Condition: Poor. Mostly cleared for agriculture and most remnants are grazed. Remnants along roadsides have better developed understoreys.

Threats: Further clearing, grazing of understorey, road-widening.

Threat status: Guyra: E(ii); **NSW:** E(ii)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 0; **Area reserved:** 0

Fig. 28. Community 19, *Eucalyptus acaciiformis* low open forest on sedimentary substrate near Rockvale Road east of Armidale. Only small remnants of this community remain. Floristically it has affinity to Community 2 — Broad-leaved Stringybark (*Eucalyptus caliginosa)* open forest on sediments.

Conservation status: Not reserved.

Key sites for conservation: Roadside remnants along Rockvale Road and Ebor Road. There may be better sites outside the study area.

Community 20: Heath Swamps on Leucogranite and Granite (Fig. 29)

Equivalent in Hager and Benson (1994): NA; Forest Type: 223

Sample site (5)**:** 4, 36, 51, 167, 171

Landform, substrate and soils: Valley swamps on leucogranite and granite acid-organic soils.

Distribution: North-east of Backwater and at Mount Duncan, at elevations 1200–1390 m.

Extant area: native understorey: 369 ha; exotic understorey: 0 ha; **Total:** 369 ha

Estimated remaining extent of pre-European extent: 80%

Structure: Open-closed shrubland/sedgeland, shrubs 1–2 m with 50–100% crown cover, with a dense sedgeland ground cover often growing in *Sphagnum* moss.

No. of native species: 92; **Mean no. per site:** 30 +/- 6

No. exotic species: 9; **Mean no. per site:** 20 +/- 4

Common native species:

- Trees: Generally absent, occasionally *Eucalyptus acaciiformis* present on margins.
- Shrubs: *Leptospermum gregarium*, *Baeckea gunniana*, *Lomatia fraseri*, *Hakea microcarpa*, *Epacris microphylla*, *Epacris breviflora*, *Banksia cunninghamii* subsp. A, *Callistemon pityoides*
- Ground cover: *Baloskion stenocoleus*, *Sphagnum cristatum* (a moss), *Lepyrodia anarthria*, *Gonocarpus micranthus*, *Schoenus apogon*, *Xanthorrhoea glauca* subsp. *glauca*

Indicator native species: *Baloskion stenocoleus*, *Sphagnum cristatum*, *Lepyrodia anarthria*, *Gonocarpus micranthus*, *Leptospermum gregarium*, *Callistemon pityoides*, *Hakea microcarpa*, *Baeckea gunniana*, *Epacris microphylla*, *Lomatia fraseri*

Common exotic species: None.

Variability: The density of the shrub layer varies between swamps due to hydrological differences or fire history, however the floristic assemblages are consistent.

Fig. 29. Community 20, heath swamp dominated by shrubs and sedges. These swamps occur on leucogranite near Backwater such as site 51 shown here in Kangaroo Gully.

Condition: Very good. Little disturbed by agriculture and not subject to heavy grazing.

Threats: Hobby farming activities in the Mount Mitchell and Sara River areas with some clearing, drainage and roadworks.

Threat status: Guyra: LC(ii); **NSW**: LC(ii)

Reservation code: Guyra: P; **NSW:** M

No. reserves in study area containing this community: 1; **area reserved:** 15 ha

Conservation status: Similar swamps are located in reserves outside the study area in the NET Bioregion, for example Bald Rock and Gibraltar Range National Parks. However, these swamps are poorly reserved in the study area with limited representation in Warra National Park.

Key sites for conservation: The reservation of the many swamps in portion 14, Parish Hall and on 'Wattleridge' would greatly improve the conservation status of this community.

Community 21: Mallee (*Eucalyptus codonocarpa*) and Heath on rocky outcrops on Leucogranite (Fig. 30)

Equivalent in Hager and Benson (1994): MA209a; **Forest Type:** 223, 225

Sample sites(6)**:** 5, 53, 59, 119, 166, 172

Landform, substrate and soils: Rocky ridges on leucogranite with skeletal, sandy soil.

Distribution: Restricted to the leucogranite outcrop north-east of Backwater including ridges near Paddys Gully, Mount Nobbler and Crown Mountain at elevations 1020–1400 m.

Extant area: native understorey: 241 ha; exotic understorey: 0 ha; **Total:** 241 ha

Estimated remaining extent of pre-European extent: 95%

Structure: Sparse (10–30%) crown cover of mallee or woodland, with mid-dense shrub layer interspersed with areas of bare rock, sparse ground cover.

No. native species: 98; **Mean no. per site:** 29 +/- 6

No. exotic species: 1; **Mean no. per site:** -

Common native species:

- Trees: *Eucalyptus codonocarpa*, *Eucalyptus caliginosa*
- Shrubs: *Leptospermum novae-angliae*, *Platysace lanceolata*, *Mirbelia confertiflora*, *Leucopogon neo-anglicus*, *Kunzea obovata*, *Hovea beckeri*, *Hibbertia linearis*, *Dillwynia phylicoides*, *Brachyloma saxicola, Acacia falciformis*, *Allocasuarina littoralis*

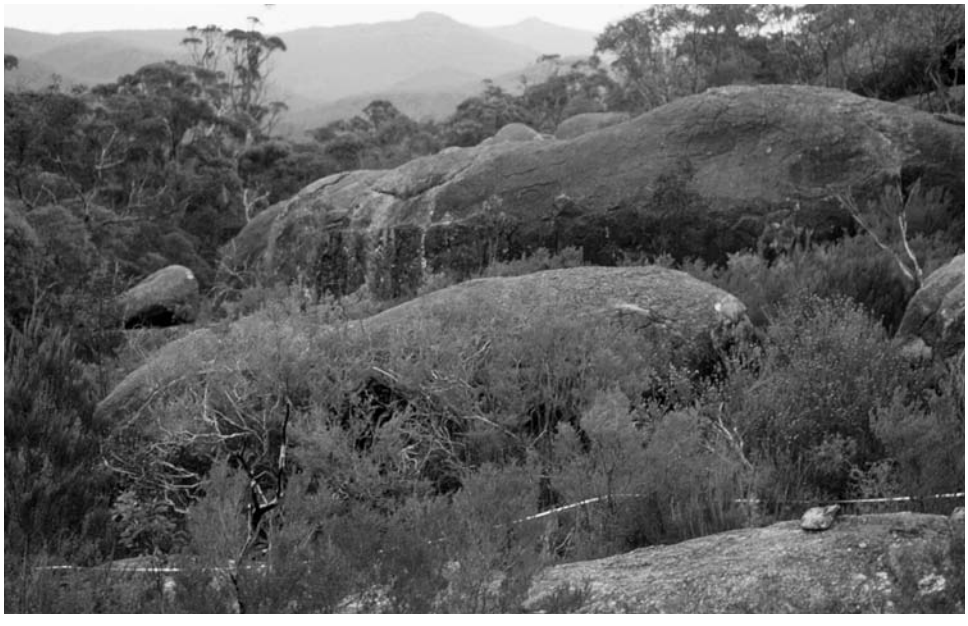

Fig. 30. Community 21, mallee and heath growing among leucogranite rocky outcrops at site 5 on the property Wattleridge north of Backwater.

- Ground cover: *Entolasia stricta*, *Lomandra longifolia*, *Lepidosperma gunnii*, *Patersonia glabrata*

Indicator native species: *Eucalyptus codonocarpa*, *Leucopogon neo-anglicus*, *Platysace lanceolata*, *Lepidosperma gunnii*, *Kunzea obovata*, *Hovea beckeri*, *Leptospermum novae-angliae*, *Acacia falciformis*, *Dillwynia phylicoides*, *Entolasia stricta*

Common exotic species: None.

Variability: Grades into community 11 along ridges. Some sites contain the mallee eucalypt *Eucalyptus codonocarpa*, others do not.

Condition: Very good. Due to its location on rocky ridges it has not been cleared or heavily grazed.

Threats: Hobby farm subdivision that could lead to increased disturbance and grazing by stock including goats.

Threat status: Guyra: LC(iii); **NSW:** LC(iii)

Reservation code: Guyra: P; **NSW:** AC

No. reserves in study area containing this community: 1; **Area reserved:** 4 ha

Conservation status: Sampled in Warra National Park and in other reserves north of the study area. If portion 14, Parish Hall and 'Wattleridge' were reserved this community would be well conserved.

Key sites for conservation: Sites on 'Wattleridge' and the adjoining portion 14, Parish of Hall.

Community 22: Narrow-leaved Peppermint (*Eucalyptus radiata* subsp. *sejuncta*)-Broad-leaved Stringybark (*Eucalyptus caliginosa*) Open Forest with dense shrubland on Leucogranite (Fig. 31)

Equivalent in Hager and Benson (1994): EF515e; **Forest Type:** 111

Sample sites (2)**:** 50, 132

Landform, substrate and soils: Flats on leucogranite with low nutrient, coarse, sandy soil.

Distribution: Restricted to between Paddys Gully Road and Sara River north-east of Backwater at an elevation of 1220 m.

Extant area: native understorey: 316 ha; exotic understorey: 0 ha; **Total:** 316 ha

Estimated remaining extent of pre-European extent: 95%

Structure: Open forest, trees 12 m high, mid-dense (30–50%) crown cover, with a closed (80%) cover of a tall shrub layer and a very sparse ground cover.

No. native species: 35

No. exotic species: None.

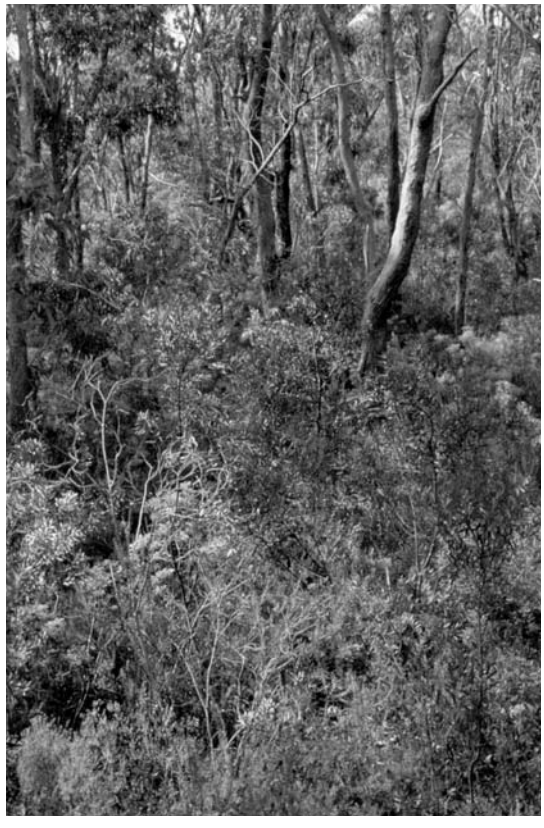

Fig. 31. Community 22 is composed of low open forest of *Eucalyptus radiata* subsp. *sejuncta* and *Eucalyptus caliginosa* with a dense shrub understorey. It is restricted to flats on leucogranite near Kangaroo Gully northeast of Backwater.

Common native species:

- Trees: *Eucalyptus radiata* subsp. *sejuncta*, *Eucalyptus caliginosa*
- Shrubs: *Leptospermum brevipes*, *Leptospermum novae-angliae*, *Mirbelia confertiflora*, *Rhytidosporum procumbens*, *Platysace ericoides*, *Petrophile canescens*, *Hibbertia riparia*, *Acacia buxifolia* subsp. *buxifolia*, *Persoonia cornifolia*, *Cryptandra scortechinii*, *Grevillea scortechinii* subsp. *sarmentosa*
- Ground cover: *Patersonia glabrata*, *Lepidosperma laterale*, *Entolasia stricta*, *Goodenia hederacea* subsp. *hederacea*

Indicator native species: (Only two sites, so illustrative only) *Cryptandra scortechinii*, *Petrophile canescens*, *Hibbertia riparia*, *Acacia buxifolia*, *Rhytidosporum procumbens*, *Hibbertia riparia*, *Choretrum pauciflorum*, *Patersonia glabrata*, *Lepidosperma laterale*

Common exotic species: None.

Variability: Consistent floristics.

Condition: Very good. No weeds and not heavily grazed.

Threats: Too-frequent fire (< 10 year intervals) and bulldozing of fire trails and any future subdivision of portion 14, Parish of Hall are the main threats to this community. While little of this plant community has yet been cleared it is threatened by hobby farming clearing.

Threat status: Guyra: LC(iii); **NSW:** LC(iii)

Reservation code: Guyra: VP; **NSW:** VP

No. reserves in study area containing this community: 0; **Area reserved:** 0

Conservation status: Rare plant community that is not reserved.

Key sites for conservation: Portion 14, Parish of Hall.

Community 23: New England Riparian Shrubland (Fig. 32) (not mapped due to the linear shape of this community)

Equivalent in Hager and Benson (1994): NA; **Forest Type:** NA

Sample sites (15)**:** 32, 39, 43, 49, 98, 127, 141, 218, 232, 241, 252, 271, 276, 281, 296

Landform, substrate and soils: Between or on the banks of watercourses on a range of substrates, growing on alluvial sand-loam or skeletal soils.

Extant area: NA because not mapped

Estimated remaining extent of pre-European extent: 30%

Distribution: Widespread along creeks and rivers in the study area at elevations 1000–1280 m.

Structure: Open to mid-dense tall shrubland often with overhanging trees, with a sparse to mid-dense ground cover.

No. native species: 215; **Mean no. per site:** 36 +/- 12

No. exotic species: 52; **Mean no. per site:** 10 +/- 8

Common native species:

- Trees: *Eucalyptus nova-anglica*, *Eucalyptus pauciflora*
- Shrubs: *Leptospermum polygalifolium* subsp. *transmontanum*, *Rubus parvifolius*, *Hakea microcarpa*
- Ground cover: *Lomandra longifolia*, *Adiantum aethiopicum*, *Epilobium billardierianum* subsp. *cinereum*, *Carex gaudichaudiana*, *Hydrocotyle tripartita*, *Poa labillardieri*, *Myriophyllum variifolium*

Indicator native species: *Leptospermum polygalifolium* subsp. *transmontanum*, *Adiantum aethiopicum*, *Epilobium billardierianum* subsp. *cinereum*, *Carex gaudichaudiana*, *Poa labillardieri*. The threatened *Callitris oblonga* subsp. *parva* occurs along some creeks on leucogranite

Common exotic species: *Hypochaeris radicata*, *Rubus ulmifolius*, *Conyza albida*, *Trifolium repens*, *Centaurium erythraea*, *Holcus lanatus*

Variability: Variation occurs in the structure and floristics depending on the substrate and depth of soil (creek bank compared to rocky river bed). It is a species rich community, as illustrated by 82 species being recorded at site 252 on the Gara River.

Condition: Varies depending on location. Sites on leucogranite on the Sara River are in good condition

Fig. 32. Community 23, riparian shrubland lines watercourses on various substrates. It is often dominated by *Leptospermum polygalifolium* subsp. *transmontanum*. This shows the vulnerable Pygmy Cypress Pine (*Callitris oblonga* subsp. *parva*) growing in Backwater creek.

containing few exotic species, whereas riverine vegetation in more disturbed landscapes contain a greater number of exotic species and are not buffered by adjoining natural vegetation.

Threats: Weed invasion (including blackberry) and pollution and sedimentation of watercourses due to over-clearing in catchments. Susceptible to river mining.

Threat status: NSW: Guyra: E (ii); **NSW** V(ii)

Reservation code: Guyra: VP; **NSW:** M

No. reserves in study area containing this community: 1; **Area reserved:** NA

Conservation status: Probably moderately well reserved or protected on a state and bioregional perspective, although subject to weed invasion. Protected in Warra National Park and along the Sara River in the study area. Riverine vegetation on higher nutrient soils such as basalt are more threatened and not reserved.

Key sites for conservation: Vegetated river courses in the study area, particularly the Sara, Gara and Aberfoyle Rivers. Site 49 at Stuttering Dick's Creek at Backwater contains a remnant stand of *Callitris oblonga* subsp. *parva*.

Community 24: Basalt Plateau Lagoons (Fig. 33)

Equivalent in Hager and Benson (1994): NA; **Forest Type:** NA

Sample sites (6)**:** 45, 47, 277, 278, 311, 312

Landform, substrate and soils: In closed depressions on an undulating, high, mostly basalt plateau with organic soils forming in the lagoons over deep chocolate loam soils. 18 of the 28 lagoons are small — 5 ha in size. Two are 450 ha. Lunettes are present on the eastern shore of some of the lagoons. The lagoons probably formed during the last ice age through the process of deflation, in a similar way to those on the Monaro tableland on the Southern Tablelands of NSW (Benson & Jacobs 1994).

Distribution: Centred on Guyra, on the higher parts of the basalt plateau from Llangothlin in the north to Armidale in the south, at elevations 1310–1350 m.

Extant area: native understorey: 1090 ha; exotic understorey: 0 ha; **Total:** 1090 ha

Estimated remaining extent of pre-European extent: 30%

Structure: Closed to mid-dense sedgeland and grassland on the shores of open water or extending across shallow or dry lagoons.

Fig. 33. Community 24, site 311 at Lagoon Farm is one the few basalt plateau lagoons that has not been drained. These lagoons contain a range of water plants including *Myriophyllum variifolium* (foreground) and the grass *Glyceria australis* (background).

No. native species: 33; **Mean no. per site:** 14 +/- 5

No. exotic species: 8; **Mean no. per site:** 2.3 +/- 1.4

Common native species:

- Trees: None.
- Shrubs: None.
- Ground cover: Water plants, sedges, forbs and grasses are present. *Potamogeton tricarinatus*, *Myriophyllum variifolium*, *Nymphoides geminata, Eleocharis acuta*, *Stellaria angustifolia*, *Pratia surrepens*, *Hydrocotyle tripartita*, *Juncus fockei*, *Epilobium billardierianum* subsp. *cinereum*, *Brachyscome radicans*, *Agrostis avenacea*, *Glyceria australis*

Indicator native species: *Potamogeton tricarinatus*, *Myriophyllum variifolium*, *Nymphoides geminata, Eleocharis acuta*, *Stellaria angustifolia*, *Pratia surrepens*, *Juncus fockei*, *Hydrocotyle tripartita*, *Brachyscome radicans*, *Agrostis avenacea*, *Glyceria australis*, *Ranunculus inundatus*, *Utricularia dichotoma*

Common exotic species: *Holcus lanatus*, *Juncus articulatus*

Variability: Variable, depending on depth of the lagoon and perhaps other factors. The native grass *Glyceria australis* dominated sites 277 and 278 at Mother of Ducks Lagoon and site 311 Lagoon Farm at the time of the survey, but was less common at other lagoons.

Condition: Those lagoons left undrained are in good condition and retain a variety of water plants, but most of the lagoons in the region have been drained or impounded.

Threats: A vulnerable plant community because most of the 28 lagoons that once existed in the study area (D. Bell pers. comm.) have been drained or impounded. Disrupted hydrology remains the main threat to the lagoons not protected in reserves. Grazing, agricultural pollution and uncontrolled recreational use may also threaten the vegetation.

Threat status: Guyra: E(ii); **NSW:** E(ii)

Reservation code: Guyra: P; **NSW:** P

No. reserves in study area containing this community: 2; **Area reserved:** 208 ha

Conservation status: Little Llangothlin and Mother of Ducks Nature Reserves protect sections of two of the lagoons.

Key sites for conservation: All remaining undrained lagoons should be protected and some previously drained ones could be restored. Site 311 at Lagoon Farm near Black Mountain is a key site for protection. This lagoon along with the surrounding Snow Gum woodland should be protected as a nature reserve or under a conservation agreement with the landholder.

Reservation status and sites of botanical significance

Table 4 lists the area and proportion of existing extent (based on 1989 aerial photographs) of each plant community in reserves in the study area. Only 0.72% of the study area is reserved. None of the 24 plant communities are currently adequately conserved, using the definitions of Hager and Benson (1994) or JANIS (1996). This is not surprising given that 74% of the vegetation has been cleared and only five small conservation reserves have been established. The proportion of cleared land is higher than for other parts of the New England Bioregion (Fig. 34), probably because a large part of the study area is composed of basalt-derived soil and undulating topography.

Table 5 lists the most significant locations for conservation. These have been selected based on the criteria of representativeness of a plant community, condition, size, the presence of rare, threatened or other significant species. These locations include publicly owned land including conservation reserves, roadsides and travelling stock reserves as well as private land.

Backwater

The most significant area for conservation is the leucogranite vegetation remnant near Backwater. Most of this is private land, but it includes public land along the Sara River and in Warra National Park. This is the largest intact vegetation remnant in the study area (Fig. 35) and contains the highest number of plant communities and rare plant species. Most of the communities on this leucogranite outcrop are in good condition, although some land clearing was occurring during the time of survey. Further clearing could threaten some of these communities.

The most critical portions of land for conservation in this area are portion 14, Parish of Hall, County of Clarke and the adjoining eastern vegetated part of portion 54, Parish of Coventry, County of Clarke on the property 'Wattleridge'. These areas contain eight of the 24 plant communities defined in this survey (communities 10, 11, 12, 15, 17, 20, 21, 22 and 23). The rare or threatened plant species *Callitris oblonga* subsp. *parva*, *Eucalyptus codonocarpa*, *Grevillea scortechinii* subsp. *sarmentosa*, *Persoonia procumbens*, *Eucalyptus camphora* subsp. *relicta*, *Daviesia elliptica*, *Muehlenbeckia costata*, *Monotaxis macrophylla*, *Thelionema grande*, *Leionema ambiens*, *Acacia brunioides* subsp. *brunioides* and *Pseudanthus divaricatissimus* are present on the leucogranite outcrop north and south of the Sara River.

On the northern side of the Sara River the Warra National Park was declared in 1999. It was previously part of Warra State Forest. The NSW National Parks and Wildlife Service has a national park proposal over the vegetated lands on the southern side of the Sara River including portion 14, Parish of Hall, and the eastern part of the property 'Wattleridge'. This land remains in private ownership but 'Wattleridge' has recently been purchased by the Guyra Aboriginal Land Council. Until this land is managed for conservation, hobby farm subdivision and development may threaten the integrity of the vegetation and compromise Warra National Park.

Table 4: Area, threat and reservation status of the vegetation communities on Guyra 1: 100 000 sheet.

Plant Community	Estimated pre-European extent (ha) (approx.)	Estimated original rarity in NSW	Remaining extent (ha) (% pre-European extent)	Threat Status for study area	Area in reserves (ha) in study areas	% pre-European extent reserved	Reservation status for study area
1. *E. blakelyi-E. melliodora* Open Forest	33 000	Common	6612 (20)	E	1	0.003	VP
2. *E. caliginosa* Open Forest	17 000	Common	11 146 (65)	LC	443	2.4	P
3. *E. laevopinea* Open Forest	20 000	Common	10 084 (50)	NT	373	1.5	P
4. *E. banksii-E. laevopinea* Open Forest	500	Restricted	337 (70)	NT	13	2.7	P
5. *E. youmanii-E. andrewsii-E. nicholii-E. subtilior* Open Forest	22 000	Common	3330 (15)	E	0	0	VP
6. *E. viminalis-E. dalrympleana-E. pauciflora* Open -Tall Open Forest with a Grassy Understorey on basalt	44 500	Common	6643 (15)	E	17	0.04	VP
7. *E. stellulata-E. pauciflora* Low Open Forest or Low Open Woodland with a grassy understorey	18 000	Common	1819 (10)	E	27	0.15	VP
8. *E. nova-anglica* Woodland on basalt	7000	Common	345 (5)	CE	0	0	VP
9. *E. nova-anglica* Woodland on sediments	13 000	Common	1979 (15)	E	54	0.4	VP
10. *E. nova-anglica-E. pauciflora* Open Forest on granite and leucogranite	18 000	Common	4458 (25)	E	2	0.01	VP
11. *E. caliginosa-E. dalrympleana* Open Forest on leucogranite	7300	Common	4397 (60)	NT	56	0.76	VP
12. *E. campanulata* Open Forest on leucogranite	2500	Restricted	2118 (90)	LC	126	5.36	M
13. *E. laevopinea-E. nobilis* Open Forest on sediments	3000	Common	923 (30)	V	0	0	VP

Plant Community	Estimated pre-European extent (ha) (approx.)	Estimated original rarity in NSW	Remaining extent (ha) (% pre-European extent)	Threat Status for study area	Area in reserves (ha) in study areas	% pre-European extent reserved	Reservation status for study area
14. *E. radiata-E. nobilis-Hovea* sp. A Open Closed Forest	600	Rare	512 (90)	LC	0	0	VP
15. *E. nobilis-E. caliginosa* Open Forest on leucogranite	1400	Restricted	811 (60)	NT	115	8	M
16. *E. caliginosa-E. nobilis-E. blakelyi* Open Forest, Oban River	1700	Restricted	825 (50)	V	0	0	VP
17. *E. obliqua-E. nobilis* Tall Open Forest	3600	Common	2893 (80)	LC	179	5	M
18. *E. radiata-E. acaciiformis* Open Forest on granite	17 600	Common	7061 (40)	V	0	0	VP
19. *E. acaciiformis-E. caliginosa-E. radiata* Low Open Forest on sediments	2500	Restricted	509 (20)	E	0	0	VP
20. Heath Swamps on leucogranite and granite	500	Restricted	369 (80)	LC	15	3.26	P
21. *E. codonocarpa* and heath on rocky outcrops on leucogranite	250	Rare	241 (95)	LC	4	1.6	P
22. *E. radiata-E. caliginosa* Open Forest with dense shrubland on leucogranite	330	Rare	316 (95)	LC	0	0	VP
23. New England Riparian Shrubland	NA	Restricted	NA	E	NA	NA	VP
24. Basalt Plateau Lagoons	3000	Restricted	1000 (30)	E	208	7.00	M

Remaining extent is calculated from the GIS, while pre-European extent is estimated. The five conservation reserves in the study area also contain 271 ha of cleared land. Area of basalt lagoons (community 24) is inflated due to size of impoundment of Llanglothlin Lagoon. 'Original Rarity' is used to help define threat status. It refers to an estimation of the pre-European extent of the plant community in Australia: Common > 10 000 ha, Restricted 1 000 to 10 000 ha, and Rare < 1000 ha. The threat categories are based on IUCN (1999): CE = critically endangered, E = endangered, V = vulnerable, NT = near threatened, LC = least concern. Application of the threat codes is based on the proportion of the remaining extent to estimated pre-European extent (see text). Reservation codes are calculated by comparing extent reserved with the estimated pre-European extent in the study area: VP = very poor (< 1%), P = poor (1–5%), M = moderately well conserved (5–10%), AC = adequately conserved (10–25%), EC = exceptionally well conserved (> 25%). Riparian vegetation (community 23) was not mapped but threat and reservation estimates are provided. The extent of pre-European natural grasslands is also not included.

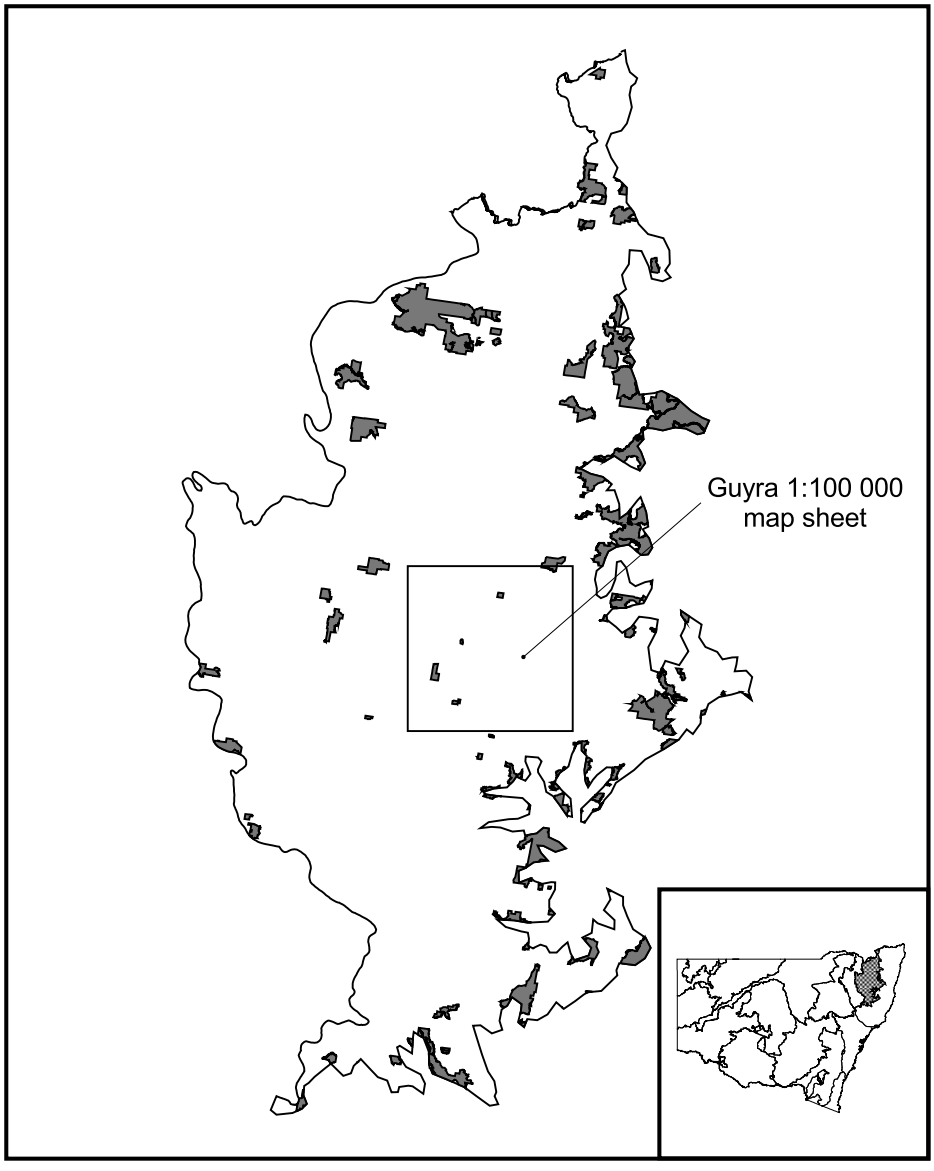

Fig. 34. Distribution of conservation reserves in the New England Tableland Bioregion. Only 0.72% of the study area is reserved compared to 7.5% for the Bioregion as a whole (data from NSW NPWS).

Table 5: Sites of botanical significance in the Guyra 1:100 000 map sheet area.

Justification criteria: T = contains rare or threatened plant species; S = contains plant species of regional significance; C = is in relatively good condition; M = is well fenced or easy to manage in other ways; D = contains high diversity of plant species; R = outstanding example of a plant community.

Locations or sites	Comm.	Location	Justification
Mother of Ducks Lagoon Nature Reserve	24	Mother of Ducks Lagoon, Guyra	T C M R
Little Llangothlin Nature Reserve	24, 6	Little Llangothlin Lagoon, Guyra	T C M R RAMSAR site
Boorolong Nature Reserve	2,3,4	North-west of Armidale	C M R
Mount Duval Nature Reserve	2,3,17	Mount Duval north of Armidale	C M D R
Warra National Park and Warra State Forest	10, 11, 12, 15, 17, 20, 21, 23	Sara River on leucogranite north of Backwater	T S C M D R
Portion 14 and Wattleridge and Sara River reserve.	10, 11, 12, 15, 17, 20, 21, 23	North of Backwater	T S C M D R
Parts of Days Ridge	2, 17, 18	20 km N/E of Guyra	C D R
Lagoon at 'Lagoon Farm' and adjoining ridge	24, 6	Black Mountain	C M D R
Avondale State Forest	13	Rockvale Rd east of Armidale	C M R
Mount Nobbler: sites 162, 163, 164	14, 17	North of Backwater	S C D R
6, 7	6	TSR New England Hwy Guyra	C R
10	6	Crown Reserve Ben Lomond	C M R
12, 13	5	Wandsworth Rd	T C R
14	5	TSR Tingha Rd	T C R
15, 191	9	Tingha Rd	C R
21	18	Wards Mistake Rd	C M D R
22	10	Wards Mistake Rd	C R
28, 113	1, 3	Thunderbolts Cave TSR	T C M D R
49	23	Stuttering Dicks Ck Backwater	T
67	9	Rockvale Rd	C R
80	4	Sunnyside Rd	S C M R
82	1	P 55 Thalgarrah	C R
84	1	Rockvale Rd TSR	S C M R
92	2	Eastview Rd	C R
93	9	Rockvale Rd Wollomombi River	C R
95	19	Rockvale Rd	C R
143	10	Oban River	C R
155	6	Baldersleigh Rd	T
175	2	Wandsworth Rd	C R
177	5	Happy Valley	T C R
180,181,182	5	Roadside reserves Aberfoyle Rd	T C D R
186, 187	6	New England Hwy TSR Ben Lomond Range	M C R
213	2	Little Duval	C R

Locations or sites	Comm.	Location	Justification
215	5	Wychwood near Fleetwood	T C M D
221	5	Old Armidale Rd	S C D R
223	1	Old Armidale Rd	C R
235	10	Granite Springs Oban River	R C S
268	18	near Beesnest Hill	T R
273	18	Stonebrook	C R
287, 288	5	west of Reedy Creek HS	S C D R
299, 306	4	Abington Ck	C R
309	2	Caer Timvil	C R

Avondale State Forest

Although the state forests in the area are not specifically reserved for conservation, they afford some protection to a number of plant communities (except for Armidale State Forest, which is pine plantation). Avondale State Forest contains stands of community 13 which is otherwise not protected on public land.

Days Ridge

This is located in the central-eastern section of the map sheet and contains remnant forests of *Eucalyptus obliqua-Eucalyptus nobilis* (community 17) and *Eucalyptus radiata* subsp. *sejuncta* (community 18). It is mainly private land and parts of it have been substantially logged.

Fig. 35. The largest vegetation remnant in the study area occurs on the leucogranite outcrop north-east of Backwater. This is a key area for conservation because it contains a rich species diversity, a number of rare plant species and a variety of plant communities.

Mount Nobbler

Located three km north-west of Backwater, this granite mountain contains some outstanding stands of community 17, *Eucalyptus obliqua-Eucalyptus nobilis* on protected slopes and community 14 *Eucalyptus radiata-Eucalyptus nobilis-Hovea* sp. A. Some of the footslopes have been recently cleared, even though the ground is rocky.

Happy Valley-Whans Road

The vegetation remnants in this area contained stands of the vulnerable species *Eucalyptus nicholii* and *Eucalyptus youmanii* in community 5 (for example, site 177). Most of this community has been cleared and recent clearing was noted during the survey. *Eucalyptus nicholii* also occurs in a stand of stringybark forest at site 215 west of Boorolong.

Reedy Creek

A stand of *Eucalyptus andrewsii*, *Eucalyptus prava* and *Eucalyptus laevopinea* is present west of Reedy Creek homestead on the steep, rocky hills on an acid volcanic substrate. This has been classified into community 5, although it could be separated from it. While it is restricted in the study area, it is more common to the west.

Travelling stock reserves and roadside reserves

Some of the most important vegetation remnants, containing vegetation that have not been continuously grazed, are located on TSRs or roadsides. These include TSRs along the New England Highway, Rockvale Road, Aberfoyle Road and the Guyra-Tingha Road. The dominant plant species on these TSRs and some sites of conservation significance are documented in Williams and Metcalfe (1991).

An important TSR is Thunderbolts Cave TSR at the Devils Pinch off the New England Highway. This contains a stand of community 1 (site 113) with *Eucalyptus youmanii* and *Pultenaea campbellii*, and regrowth community 3 with a rich diversity of species (site 28). One of the best examples of community 6 (Mountain Gum-Ribbon Gum on basalt) is in the Ebor and Aberfoyle road reserves near the Aberfoyle River (sites 180, 181 and 182). A good patch of community 6 is also found in a crown reserve (site 10) along Wandsworth Road, 3 km south-west of Ben Lomond.

Basalt lagoons

Two small nature reserves (Mother of Ducks and Little Llangothlin) protect parts of two lagoons on basalt (community 24). Little Llangothlin Nature Reserve is listed on RAMSAR as a wetland of international significance. Wetland vegetation of these lagoons remain inadequately reserved and vulnerable. Protection of the wetland on the property Lagoon Farm (site 311) would improve the conservation status of community 24.

Sites with regionally uncommon species

Some sites are important because they contain species that are restricted in their abundance in the study area. Examples include site 87 (Rockvale Road TSR) that contained a tableland occurrence of Grey Box *Eucalyptus moluccana*; sites 80 (Sunnyside Road) and 306 (Little Duval) contained a tufted grassy understorey dominated by the grass *Joycea pallida* and site 221 along the Old Armidale Road that contained the only record for the sedge *Caustis pentandra* in the survey. The recording of the ground orchid, *Caladenia cucullata* at site 133 on 'Wattleridge' was an extension of range for that species.

Other sites included important samples of a community and unusual species. For example, site 235 near the Oban River contained one of the few large stands of *Eucalyptus nova-anglica* encountered during the survey, as well as a northern extension of the grass *Poa clivicola*. Given the impacts of clearing and dieback on communities 8, 9 and 10, any reasonable remnants should be protected.

Discussion

The remaining natural vegetation on the Guyra map sheet is a composite of various sized remnants with different degrees of human-induced disturbance. Overall, the vegetation is a mosaic of grassy open forest and woodland, shrubby open forest, heaths, swamps and lagoons. The distribution of these major types of vegetation is largely determined by physiographic determinants — a combination of parent material and climatic factors. At a finer scale, local site elements such as topography and disturbance history play a modifying role. The largest and most 'natural' remnants occur on the poorest soils and roughest topography including the leucogranite country near Backwater. Most remnants on medium to high nutrient soils are moderately or severely disturbed, at least in their understorey. The tree canopies of plant communities 1–3, 6–10 and 18–19 are, in most cases, composed of secondary regrowth from episodes of clearing in the early 20th and late 19th centuries (Curtis 1989).

Sampling methods

Standards of vegetation survey are discussed in Benson (1995) and Keith and Bedward (1999). It is important that users of vegetation plot data or vegetation maps be aware of the rules that formed the basis of the gathering and interpretation of the data. Scale is one factor that can alter the intensity of survey and detail of mapping.

The vegetation of the study area was sampled on the basis of stratifying the environmental variables of substrate, altitude and landform position. While inspections of rainfall and temperature maps on the NSW National Parks and Wildlife Service geographical information system indicated that rainfall and temperature broadly corresponds to altitude, there are some inconsistencies. For example, there is a marked rainshadow in the south-eastern corner of the study area near Bakers Creek and this variation was not taken into account in stratifying the sampling. It is likely there are inaccuracies in the geology mapping for the region therefore confounding some of the

assumptions about sampling major nutrient classes. Also, some plant communities were under-sampled due to the limitations of the LANDSAT-derived vegetation cover GIS layer (Roberts 1992) that was used in selecting sample sites. It identified forest or woodland with a canopy cover of greater than 20%. Therefore, scattered open woodland vegetation, including patches of New England Peppermint *Eucalyptus nova-anglica* (communities 8, 9 and 10), Ribbon Gum *Eucalyptus viminalis* (community 6), and small remnants of less than 5 hectares in area, were not mapped from the LANDSAT image. Although we modified the sampling design to cater for these deficiencies, open vegetation may still have been undersampled. An example is that the small remnants of community 6 were under-sampled in the southern part of the study area. Finally, vegetation remnants in areas distant from roads or tracks were less well sampled than vegetation near roads or tracks.

Classifications of vegetation through numerical analysis can be achieved by either sampling all species in plots or a subset of them. Recording all species takes more time than recording a subset of species. Alternatively, if the aim is to model certain species across a landscape there is advantage in maximising the number of sample plots by minimising the time to sample them ie. by recording a subset of species. Austin et al. (1999) used this strategy in modelling the pre-European distribution of tree and tall shrub species (> 1.5 m) in a survey of the Lachlan region in the NSW wheatbelt.

We recorded all species in plots because we considered that there were benefits of recording full floristic data. Only through the latter can relative rarity be assessed for the total vascular flora of a region. Also, the presence or absence of ground cover and shrub species can be important in determining floristic groupings in a numerical classification. Understorey species should not be underestimated when classifying vegetation.

Mapping scale

The selection of scale depends on the purpose but scale can have major implications for selecting units in the landscape for decision making (Pressey & Logan 1995). We mapped the vegetation of the Guyra 100 000 map sheet area at 1: 25 000 scale. This is a relatively fine scale for regional mapping (Benson 1995), but it was chosen to adequately represent the complexity of the patterns of vegetation, the small size of many vegetation remnants, and the size of properties in the Bioregion. This also matches the topographic map and aerial photographic coverage for the region.

The accompanying published Guyra vegetation map is at 1: 100 000 scale. Such a reduction in scale can lead to a loss of definition of vegetation remnants, and also an amalgamation of floristically classified polygons leading to increased heterogeneity of map units. While these simplifications have been minimised in the published map, vegetation assessments and planning should use the 1: 25 000 scale GIS version of the map. This provides a capacity for generating different map products because each polygon has multiple attributes (viz. type of vegetation, structure, degree of disturbance and understorey condition). Map coverages could be generated, for example, showing the distribution of exotic versus native understorey within certain targeted plant communities.

Plant community classification

Austin and Smith (1989) point out that the community concept of co-occurring species is most relevant to a particular landscape, or region, reflecting its patterns of environmental variables. This highlights the danger of applying a broad-based typology such as 'forest types' (Forestry Commission of NSW 1989) in describing or assessing vegetation in a local or regional context. Most of the 'forest types' that we intuitively attempted to match the plant communities to are much broader in their coverage of geographical distribution and botanical variation.

Understorey variation due to varying degrees of disturbance caused considerable noise in the UPGMA, data output. Some sites were placed into groups counter to intuition because of this variation. The nearest neighbour analysis helped to correct some of these apparent anomalies. This understorey variation caused by different histories of grazing in particular, highlights one limitation of using full floristic plot data to derive vegetation classifications in agricultural landscapes, compared to using it to classify vegetation in more natural landscapes such as conservation reserves. However, when a subset of the floristic data containing only tree species were subjected to UPGMA, the resulting classification was considered to be too simplistic.

The scope of a classification can be important in defining the number of plant communities. Our survey sampled all of the major formations of vegetation across the landscape. We classified one type of heath/mallee (community 21) growing on leucogranite outcrops near Backwater. In contrast, Hunter and Clarke (1998), who restricted their flora survey to vegetation on granitic outcrops in the New England Bioregion, defined three floristic groups on outcrops in the Backwater area.

Patch size also affects the recognition of plant community types. Hunter and Clarke (1998) defined a closed scrub community dominated by *Quintinia sieberi* and *Rapanea* spp. as occurring among leucogranite rock outcrops protected from frequent fire. We only observed this community once and due to its rarity and patch size relative to the scale of the work, it was not sampled nor mapped.

Limited sampling can also affect community classification. For example, an open forest dominated by *Eucalyptus prava* and *Eucalyptus andrewsii* occurs on acid volcanic ridges in a remnant on the western edge of the map sheet (sites 287–289). *Eucalyptus prava* is more common to the west and north-west of the map sheet. It is a canopy co-dominant of plant communities in Torrington State Recreation Area (Clarke et al. 1998) and in Kings Plain National Park (Hunter 2000).

Based on shared understorey species, our sampling grouped this forest into the western tableland stringybark-dominated plant community 5 which is dominated by *Eucalyptus youmanii*, *Eucalyptus andrewsii* and *Eucalpytus subtilior*. It is likely that with more sampling to the west a new plant community would be defined, including the *Eucalyptus prava*/*Eucalyptus andrewsii* sites 287–289.

Species patterns

Over 150 years of grazing, pasture improvement and clearing of forests has altered the species composition of the vegetation. This has particularly affected plant communities 1, 2, 3, 6, 7, 8, 9 and 19 which occur on high to medium nutrient soils and contain a grassy ground cover.

A number of upright perennial forbs occurring in these communities are regionally rare including *Eryngium ovinum*, *Eryngium vesiculosum*, *Podolepis jaceoides*, *Podolepis neglecta*, *Microseris lanceolata*, *Swainsona monticola, Geranium retrorsum* and *Velleia paradoxa*. Tremont (1994) found that tall herbacous plants are susceptible to being grazed out compared to low forbs with flat rosettes. She demonstrated that grazed treatments favoured annual species with reproductive organs at or near ground level between dominant tussocky grasses. Our survey demonstrated that prostrate-leaved forbs such as the introduced *Hypochaeris radicata* or the native *Cymbonotus lawsonianus* were common.

Most species were recorded a few times only. This pattern is similar to that documented in McIntyre et al. (1993) for herbaceous species in the Bioregion. McIntyre (1992) suggests that sparse species occurring in grassy woodlands or in derived native grasslands have been overlooked in threatened species listings. The redlist criteria developed by IUCN (1994) (under revision IUCN 1999) overcomes this to some extent, as susceptible species can be identified if they are declining.

The ubiquitous stringybark communities 2 and 3 are the most widespread plant communities in the study area. Both stringybark species *Eucalyptus caliginosa* and *Eucalyptus laevopinea* occur on various substrates and aspects but both species tend to grow on ridges or slopes rather than in valley bottoms. Since hybridisation between these species may occur, it is difficult to detect clear patterns in their distribution. Significant differences of distribution occur due to substrate and aspects. Broad-leaved Stringybark, *Eucalyptus caliginosa*, is widespread on siliceous sedimentary substrates in the south around Armidale, on siliceous acid volcanic substrate in the north-west of the study area, on granite and on leucogranite north of Backwater as a co-dominant in quite different floristic assemblages from those on sediments and acid volcanics. Silver-topped Stringybark, *Eucalyptus laevopinea*, tends to occur on steep, well drained, protected (south or east facing) slopes (sometimes enriched by basalt above). It also commonly occurs on acid volcanic, sedimentary and basaltic substrates but is less common on leucogranite and granite.

The databased survey data provides a basis for further analysis of species patterns and modelling of species distribution.

Modifications induced by European land use

A thorough account of the changes to the vegetation on the Northern Tablelands since European settlement is given in Curtis (1989), although much of his discussion deals with regions outside the Guyra 1: 100 000 map sheet study area.

Clearing, grazing and soil erosion

As early as the 1870s people were alarmed at the effect of clearing on the landscape. Mrs Charles Meredith (1844), referring to clearing near Sydney, wrote:

'The system of clearing here by the total destruction of every tree and shrub gives a most bare, raw and ugly appearance to a new place'.

Today, approximately 26% of the native tree cover remains in the study area. Much of this is regrowth forest after past clearing or logging (Nadolny 1995). Clearing has concentrated on the more fertile soils and flatter terrain. Relatively intact plant communities are 12, 13, 14, 15, 17, 20, 21 and 22. Most of these are confined to poor soils on leucogranite in the Backwater region. However, clearing of marginal agricultural lands on granite and leucogranite for hobby farms has continued up to the present.

The communities on higher nutrient soils (1, 3, 6, 7, 8, 9, 10, 19) are mostly cleared and remain as small remnants. The NSW land cover study by ERIC (1998) revealed that very little clearing (50 ha/year) took place in the study area between 1995–97. This was possibly due to low commodity prices for wool and meat.

Some communities are estimated to have been cleared to less than 20% of their original extent, for example Blakely's Red Gum-Yellow Box on sediments (community 1), Mountain Gum-Ribbon Gum on the Guyra basalt plateau (community 6), and communities 8 and 9 containing New England Peppermint. Furthermore, communities 1, 2, 8, 9, 10 and 18 have been extensively ringbarked in the past (Fig. 36) and affected by dieback.

Over-clearing and subsequent over-grazing has led to soil erosion in some places (Fig. 37). Gale et al. (1997) found that the deposition rate of soil into Llangothlin Lagoon accelerated after the introduction of stock by Europeans in the Guyra area in 1837. These authors postulate that much of the topsoil of the lagoon's catchment was eroded within 25 years of the arrival of Europeans.

Continuous grazing of most grassy woodland or forest remnants (communities 1, 2, 3, 6–10 & 19) has probably led to a depletion of the shrub understorey and a lack of regeneration of trees (Curtis 1989). Norton (1876) noted patches of wattle (*Acacia*) among white gums (*Eucalyptus viminalis* or *E. pauciflora*) and New England Peppermint near Glen Innes in the 1850s, and the Government botanist (Maiden 1898) noted *Acacia* as being common in the understorey in the region. During our survey wattle was rarely abundant in sample plots in the grassy woodland communities — although it was more common on roadsides or in travelling stock reserves that are not continuously grazed. Overall, wattle appears to have declined substantially since European settlement.

Many native grass and forb species have declined under high grazing pressure because of their growth habit or palatability. In extreme cases the natural ground cover has been completely altered through ploughing and sowing of exotic species creating an appearance of a manicured park (Fig. 38). Both Whalley et al. (1978) and McIntyre et al. (1993) report that stock grazing has produced a shift from tall tussocky grass species, such as *Themeda australis* and *Sorghum leiocladum*, to more prostrate, shorter species.

Fig. 36. Large areas for forest on the New England Tableland Bioregion have been ringbarked such as this stand of *Eucalyptus nova-anglica-Eucalyptus pauciflora* open forest (community 10) north of Backwater.

Fig. 37. Clearing of native vegetation followed by heavy grazing has led to gully erosion in some places such as this gully at the foot of Mount Hourigan.

Fig. 38. The ground cover in many forest remnants has been replaced by exotic species. This is illustrated here in this *Eucalyptus laevopinea* forest on basalt north-west of Armidale where the ground cover is dominated by the exotic grasses *Hordeum leporinum*, *Lolium perenne* and *Bromus* spp.

They note that less palatable native grasses such as *Poa sieberiana* may increase in the presence of grazing and the removal of competitors. Our survey data support this view as *Poa sieberiana* was the most common species recorded in the 312 sample plots.

Fragmentation

Clearing of two thirds of the woody vegetation along with episodes of dieback have yielded a fragmented landscape. However, the degree of fragmentation is generally less pronounced than that in the Western Australian and eastern Australian wheatbelts (see papers in Saunders et al. 1987). Studies on fragmentation show that when 50% of vegetation is cleared, connectivity between remnants is broken (Dawson 1994). When more than 70% of a landscape is cleared, the small patches of bush between larger remnants tend to disappear (Andren 1994). This leads to a significant decline in the population of some species because their dispersability across the landscape diminishes as distance between remnants increases (Andren 1994, Schwartz 1992).

The theory of island biogeography of species diversity in relation to habitat area and spatial arrangement of habitats (MacArthur & Wilson 1967) is more applicable when the matrix between habitat patches is distinct (Diamond 1981). It is postulated that habitat sensitive plant or animal species will not persist or cross altered countryside (Dawson 1994). However, some less sensitive species will. Native pasture and isolated trees commonly occur between vegetation remnants in the New England Bioregion. For this reason McIntyre and Barrett (1992) described the Bioregion as a variegated landscape because diffuse boundaries exist between forest remnants and pasture land

compared to the sharp boundaries encountered in crop lands or on oceanic islands. However, since we did not map native pastures or isolated clumps of trees less than one hectare in size, any use of the vegetation map for predicting the impacts of fragmentation on certain species need to take these limitations into account.

Assuming that some native species live in substantially modified habitats, vegetation management should not be restricted to preserving large remnants. Rather, the whole landscape should be managed sympathetically. Nevertheless, it is likely that species of animals and plants with low populations, low reproductive potential, poor dispersal mechanisms and large fluctuations in their populations would be most susceptible to extinctions in the most fragmented parts of the study area. These would include areas covered by communities 1, 5, 6, 7, 8, 9, 10, and 19 which have been reduced to less than 30% of their pre-clearing extent.

In a study of vegetation remnants near Armidale, Barrett et al. (1994) found that 104 of the 137 bird species recorded were threatened by fragmentation and structural change of the vegetation. Some bird species such as the Red-browed Treecreeper were restricted to large (> 400 ha) remnants, while other species were recorded in smaller remnants. Reid (1999) supported these findings for woodland bird species occurring on the Southern Tablelands of NSW. He found that size, complexity and spatial arrangement of vegetation remnants are critical factors for the survival of many woodland birds. Barrett et al. (1994) concluded that to protect what is left of the New England avifauna, vegetation remnants of various sizes need to be maintained, a range of tree age classes need to be present, and the understorey needs to be managed to encourage regrowth of shrubs. This may require the judicious use of fire to stimulate the germination of some shrubs species and controlling stock numbers to allow for their growth to maturity.

Enhancing corridors may allow species to recolonise areas through immigration (Diamond & May 1976) where stochastic events (fire, drought, flood, changes in herbivory or predation) may have led to their localised extinction.

Weeds

Invasive plants are not as critical a threat to native vegetation in the study area compared with other parts of eastern Australia. There are numerous pasture weed species. Some of these dominate the ground cover and invade forest remnants that adjoin pastures. Only a small proportion of the 146 exotic species recorded are 'problem' weeds. *Hypochaeris radicata* was the most commonly recorded exotic species.

The long lived shrub, Hawthorne (*Crataegus monogyna*), is a weed in some places —particularly near Armidale. The fruit of this species is dispersed by birds such as the Pied Currawong (Bass 1989). Privet (*Ligustrum vulgare)* has seeded into forest remnants close to settlements but is less abundant than Hawthorne. Blackberry (*Rubus ulmifolius*) invades riverine vegetation (community 23) by dispersing along watercourses. St John's Wort (*Hypericum perforatum)* is common in some disturbed pastures and forests such at site 29 along Sunnyside Road north of Armidale. Although we did not record African Love Grass *(Eragrostis curvula)*, it is present and increasing in abundance in the

Bioregion (C. Nadolny pers. comm.). It is becoming a major weed species in other places such as western Sydney and on the Southern Tablelands. Both *Hypericum perforatum* and *Eragrostis curvula* produce large quantities of small dispersible seeds and therefore may easily increase in abundance.

Dieback

Dieback is a complex phenomenon that has caused the death of millions of trees in rural areas of south-eastern Australia (Landsberg & Wylie 1988). The Northern Tablelands gained national attention in the late 1970s and 1980s due to a major episode of dieback that killed millions of trees (Nadolny 1988). Several studies on dieback have concentrated on the Northern Tablelands (for example Williams & Nadolny 1981, Mackay et al. 1984, Jones et al. 1990). Nadolny (1995) summarised the current viewpoints about the causes of dieback in the region:

- Defoliation by scarab beetles was a major cause of dieback on the Northern Tablelands in the 1970s–80s. It is postulated these beetles may have increased in numbers due to a combination of favourable climatic conditions, the existence of more feed for their larval stage in improved pasture, reduced predators such as birds, bandicoots and parasitic wasps and an increase in the nutrition of the foliage of trees due to livestock excrement and fertilizer;
- Drought can cause water stress in trees making them more susceptible to infections (White 1986);
- Fungal infections can occur in trees damaged by storms. Isolated trees in paddocks are more susceptible to storm damage;
- Increased soil salinity and water stress during drought.

In the study area dieback has most affected:

- Community 1: *Eucalyptus blakelyi-Eucalyptus melliodora* open forest on sediments around Armidale;
- Community 2: *Eucalyptus caliginosa* open forest in remnants east of Armidale along the Chandler Road. In other places stringybark trees were little affected by dieback;
- Community 8: *Eucalyptus nova-anglica* open forest on basalt (Fig. 18);
- Community 9: *Eucalyptus nova-anglica* open forest on sediments around Armidale and Boorolong. This has been the most affected community with whole valleys losing all of their trees (Williams & Nadolny 1981, Nadolny 1988);
- Community 10: *Eucalyptus nova-anglica-Eucalyptus pauciflora* woodland on granite and leucogranite near Backwater and along the Oban River;
- Community 18: *Eucalyptus radiata* subsp. *sejuncta-Eucalyptus acaciiformis* open forest on granite near Llangothlin, Rockvale Road, Days Trig and Wards Mistake.

Logging

Even where the vegetation has survived the initial phases of land clearing, continued logging has altered the structure of the forest and now few old trees remain. This is evident in state forests and on private forested land. Logging has particularly had an impact on communities 2, 3, 13 and 17. A recent trend towards wood heating in Armidale has led to increased cutting of trees for firewood and a resource depletion

Fig. 39. Subdivision and road construction on non-agricultural private land is threatening some of the largest vegetation remnants in the study area, such as this *Eucalyptus radiata* subsp. *sejuncta*-*Eucalyptus nobilis* (community 15) forest on leucogranite near site 34 at Mount Mitchell north of the Sara River.

(Wall & Reid 1993). This is impacting on plant communities that contain poor sawlog timber that had not previously been subject to sawlog extraction. An example of this is community 5 that occurs on acid volcanic substrates on the drier, western side of the study area.

Subdivision

One of the main threats to some of the larger vegetation remnants on rougher terrain composed of granite, acid volcanic or leucogranite substrates is subdivision for hobby farms. Areas around Mount Mitchell have been subdivided into 25 and 100 ha blocks with wide roads being pushed through some of the largest vegetation remnants in the study area (Fig. 39). The owners of these small bush blocks often clear part or all of them and introduce stock and other domestic animals. In contrast, some subdivision within a 20 km radius of Armidale may be having a positive effect on regeneration of plant communities 1, 2, 3 and 9 because grazing has been removed or limited.

Draining wetlands

Draining or impounding of lagoons has severely depleted the abundance of the wetland plant community 24. This could be considered a vulnerable plant community. Assessments by D. Bell (pers. comm.) reveal that only six of an original estimated 30 swamps in the study area remain in good condition. Most of these swamps occurred on the basalt plateau near Guyra, with a few near Armidale. Most have been

drained for conversion to pasture, some have been impounded to form dams for stock. One of the best remaining wetlands is Lagoon Farm near Black Mountain (Fig. 33). This wetland, along with the surrounding Snowgum woodland, ranks as one of the highest priority areas for conservation in the study area.

Changed fire regimes

Due to the degree of modification of the landscape, and a lack of documentation of past fires or Aboriginal burning practices, it is not possible to decipher precisely what were the pre-European fire regimes in the different plant communities in the study area. Presumably, moister forests with shrubby understoreys (for example, communities 17 and 18) would not have been subject to frequent fires. Some of the shrublands and dry sclerophyll forests on acid volcanic and leucogranite substrates may have been subjected to intense fires every 10–30 years. The grassy woodland communities may have been subjected to a mosaic pattern of less intense and relatively frequent burning by Aborigines.

Some plant species in the small, isolated remnants may have declined due to lack of burning. Grasses such as *Themeda australis* are known to respond well to fire (Lunt 1990). Many remnants are surrounded by improved pastures that rarely, if ever, burn. The isolation of remnants from larger stands of forest due to clearing has possibly led to a decrease in fire frequency. This may have affected populations species adapted to regenerate after fire (e.g. legumes). Intense fire can still occur in the larger remnants. Most of Warra State Forest (now partly reserved as Warra National Park) was burnt by an intense fire in January 1994 (NSW State Forests pers. comm.). This intense fire stimulated the germination of the rare species *Muehlenbeckia costata* and *Monotaxis macrophylla*.

Vegetation management

The remnant grassy woodland communities on more fertile soils are significantly influenced by grazing pressure and management of surrounding lands. The ground cover of New England Peppermint (communities 8, 9 & 10) and Ribbon Gum/ Mountain Gum (communities 6 and 7) remnants are often dominated by exotic pasture species and tree regeneration may be suppressed due to grazing pressure. There are few sites within these communities that contain a shrub layer. One aim of management should be to induce the germination of species of wattle through fire and protection from continuous grazing. Morgan and Terrey (1990) recommended the destocking of state forests in the region.

Some disturbances to native vegetation are direct and severe. These include impoundment of lagoons, clearing of woody vegetation and ploughing of native ground cover. These processes can be controlled through regulations, incentives and education. Other disturbances are more indirect and more difficult to control. For example, riparian vegetation (community 23) is being degraded through stock trampling river banks to access water, weeds invading via creeklines and changes in water quantity and quality due to the removal of vegetation in catchments and

pollution from a range of sources. Controlling these threats requires both catchment management (controlling pollution) and local management (piping water to stock in paddocks distant from creeklines).

Although some plant communities have been severely cleared, modified and fragmented in the study area, others still contain large numbers of remnants that are linked by corridors. The role of corridors has been subject to a large debate in the literature but most commentators consider corridors have a role in maintaining species in a landscape (see review by Dawson 1994). Management should aim to maintain these remnants as they form a source for 'natural' revegetation. Conservative land management (Nadolny 1995) of low grazing pressure and less pasture improvement would assist with restoring grassy forest and woodland communities. The cost-benefits of further pasture improvement in areas with poorer soils is questionable (Nadolny 1998). Sustainable agricultural practices that use a diversity of approaches to grazing and cropping may meet some of the requirements of protecting herbaceous plant species in the Bioregion (McIntyre 1994).

Revegetation through the planting of indigenous trees, shrubs and ground cover species is appropriate in areas that have been extensively cleared, degraded or severely affected by dieback (Barrett & Ford 1993). In the study area this mainly includes plant communities containing Blakely's Red Gum, Yellow Box and New England Peppermint as well as riparian vegetation. However, revegetation is a very costly solution, so if it is to be undertaken it should be based on the best information available. It should be undertaken in places where perhaps 80% of the vegetation has been cleared. While revegetation programs may never restore the vegetation and associated biodiversity to a pre-clearing form, some studies show that tree planting can increase biodiversity, probably due to habitat complexity. For example, Chilcott et al. (1997) recorded more microarthropod species in windbreaks than in open pasture. Revegetation may also redress the problem of dieback in plant communities where the remnant patch sizes are small and vulnerable, or the species themselves are inherently susceptible (Jones et al. 1990).

Revegetation should not simply target critical habitats or species, but should be undertaken with landscape processes in mind such as establishing corridors for wildlife movement, or increasing the size of existing remnants to increase the populations and viability of the species in them.

Conservation

The conservation and management of the natural biota is dependent on knowledge of the resource and ecosystem dynamics. This study has begun to address these aims by defining and mapping 24 plant communities and quantitatively correlating them with physical explanatory variables such as geology and altitude. Nationally, State or regionally rare or threatened species are listed and discussed. Sites of botanical significance are listed and proportions remaining of plant communities are estimated. These data can be used for planning the protection of key floristic elements in the landscape, but will not address fauna or abiotic values.

The five conservation reserves totalling 1904 ha managed by the NSW National Parks and Wildlife Service, account for 0.72% of the study area. Two reserves centre on deflation lagoons on the basalt plateau near the town of Guyra-Mother of Ducks Lagoon Nature Reserve (102 ha) and Little Llangothlin Nature Reserve (254 ha). Three forest conservation reserves were established as a consequence of the 1998 Comprehensive Regional Assessment of the forests of north-eastern NSW. They mainly sample stringybark communities. The former Warra Flora Reserve and Warra State Forest were subsumed into the Warra National Park (1918 ha). Most of this National Park falls on the Glen Innes map sheet to the north, with only 440 ha within the study area. Mount Duval State Forest was dedicated as the Duval Nature Reserve (243 ha) and Boorolong State Forest was dedicated as Boorolong Nature Reserve (865 ha).

The proportion of the study area reserved (0.7%) is less than one tenth for the New England Bioregion as a whole (7.5% in Pressey et al. in press and Benson 1999). Most of the area reserved in the NET Bioregion is located on its eastern edge bordering on the rugged terrain of the eastern escarpment with other reserves concentrated on granite or acid volcanic substrates in the west and north (Fig. 34). The central part of the bioregion is more extensively cleared and contains far less reserves. This highlights the need to address reservation at finer scales than bioregions, such as at the province or landscape level of classification used in Pressey et al. (in press) or at the plant community level (Benson 1989).

Of the 24 plant communities 16 are sampled in reserves in the study area. However, only four of these have more than 5% of their estimated pre-European extent reserved in the study area (Table 4). The remainder are very poorly or poorly reserved, with less than 5% of their pre-European extent reserved (Table 4). No communities are adequately reserved as defined in this paper (> 10% of pre-European extent protected). Some communities may have a different degree of reservation over their full range but cannot be established until their range is mapped. It is known, for example that community 17 (*Eucalyptus obliqua-E. nobilis*) is well protected in reserves such as Werrikimbee, Barrington Tops and Ben Halls Gap National Parks. Alternatively, the *Eucalyptus nova-anglica* communities 8–10 are known by the authors not to be well protected in reserves outside the study area.

There is little scope for conservation through reservation in areas where most of the vegetation remains in small, isolated remnants of varying vigour, although some TSRs provide scope for protecting reasonable-sized remnants (Williams & Metcalfe 1991). Only scattered remnants of communities 1–3, 6–10, 19 and 24 remain. For these communities it will not be possible to meet the JANIS (1996) criterion that 15% of the pre-European extent of ecological communities should be protected in conservation reserves. However, if the naturally vegetated part of 'Wattleridge' and portion 14 Parish Hall were reserved, this criterion could be met or exceeded for the leucogranite plant communities 11, 12, 14, 15, 20–22. This would enlarge the present Warra National Park and would also protect a large number of rare species. Other large patches of vegetation where reserves could be established include: Avondale State Forest, parts of Days Ridge, Mount Nobbler and areas on acid volcanic substrate near Reedy Creek.

Depending on their status outside the study area, plant communities 1, 6, 7, 8, 9, 10 and 24 are under long term threat and may warrant listing as endangered ecological communities under the NSW Threatened Species Conservation Act 1996. Certainly, further clearing of them should be discouraged.

The future of the native flora in this rural landscape will largely depend on appropriate management of private land and on public lands such as state forests, roadsides and TSRs. Five key conservation programs are required:

- controls on clearing and logging;
- pursual of conservation or property agreements over remnants on private land;
- management of the understorey in forest remnants including appropriate grazing and fire regimes;
- control of problem weed species;
- revegetation of over-cleared areas such as valley bottoms on the basalt plateau.

These programs could be designed and coordinated through a regional vegetation management plan under the NSW Native Vegetation Conservation Act. This study provides baseline data for the design and implementation of vegetation planning for the Guyra 1: 100 000 map sheet area. These data are also comprehensive enough to be incorporated into modelling procedures (Ferrier & Watson 1997) for single species restoration projects.

The future of the remnant vegetation in the 'variegated' landscapes of the New England Bioregion will largely depend on the attitudes of local people to landscape

Fig. 40. Important stands of roadside vegetation are being sign-posted by local governments in the study area. This helps to alert the public and council workers about the presence of this vegetation and can help to protect it from disturbances such as road widening.

management. There are some encouraging signs as more landholders discover the benefits of maintaining native vegetation cover (summarized in Gillespie 2000). The signposting of significant vegetation on public roadsides by Dumaresq Shire Council (Fig. 40) is an example of the active and positive role that local government and local communities can take in nature conservation.

Acknowledgments

We thank Michael Bedward for use of his unpublished nearest neighbour, homogeneity and fidelity analysis software. The National Parks and Wildlife Service's Armidale District and Geographical Information System unit supplied GIS data under a licence agreement that underpinned the sampling strategy. Mr Murray Ellis was of great assistance in this regard. Ms Dorothy Bell of the University of New England supplied information on the location and species composition of lagoons. Others who assisted with botanical advice included Mr Greg Roberts, Dr Sue McIntyre, Mr Peter Metcalfe and Dr Chris Nadolny. We are grateful to many botanists for assisting with plant identification including, Mr Rod Henderson (Queensland Herbarium), Mr David Jones (National Botanic Gardens, Canberra), and Ms Teresa James, Mr Bob Coveny and other botanists at the National Herbarium of NSW. Ms Marianne Porteners, Ms Barbara Wiecek, Ms Judy Scott and Mr Robert Denham assisted with the field work and Mr Peter Stricker and Mr Jeff Drudge assisted with digitising the vegetation map. Mr Chris Togher assisted with the final GIS production of the vegetation map. Special thanks to the many landholders we visited during the study, particularly to Mr Brian Humphries and Dr Judy Harris former owners of 'Wattleridge', who helped us with accommodation and showed extraordinary interest in the wildlife and natural landscapes of the region.

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Manuscript accepted 2 May 2000

Appendix 1. Plant species list with their occurrence in plant communities 1–24 for the Guyra 1: 100 000 map sheet.

Communities 6 & 7 are combined and community 8 was not sampled. The total of 889 taxa is composed of 664 taxa from 312 sites, 17 taxa recorded outside quadrats marked 'A', 43 taxa from NSW National Herbarium database marked 'B' (taxa not collected within the last 40 years are indicated by the year of the last collection), 119 taxa from the University of New England Herbarium (Department of Botany) database marked 'C', 3 orchid taxa from Peter Metcalfe (pers. comm.) marked 'D', 35 wetland taxa from Dorothy Bell (pers. comm.) marked 'E', 2 taxa from NSW NPWS ROTAP database marked 'F' and 6 rare species collected from the Backwater leucogranite by J.T. Hunter (pers. comm. 1996) marked 'G'. The Rare or Threatened Australian Plant list (Briggs & Leigh 1995) code is listed in parentheses: **E** = Endangered**, V** = Vulnerable; **R** = Rare; **K** = Poorly Known. Species listed under the NSW Threatened Species Conservation Act are coded: **e** = endangered, **v** = vulnerable. Introduced species are marked with an asterisk.

Botanical Name	**Plant Community Number (number of sites)**																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
BRYOPHYTES																						
Sphagnaceae																						
Sphagnum cristatum																		4				
PTERIDOPHYTES																						
Adiantaceae																						
Adiantum aethiopicum		1	2	1				1	1	1			1	1	10	1					11	
Aspleniaceae																						
Asplenium australasicum [A]															+							
Asplenium flabellifolium	2	5	9	1		4				1					19	4			1		3	
Azollaceae																						
Azolla filiculoides [E]																						
Blechnaceae																						
Blechnum cartilagineum										1					3							
Blechnum minus [B,1930]																						
Blechnum nudum															1						1	
Blechnum wattsii																					2	
Doodia aspera															3							
Doodia caudata			1						1	2				1	3						1	
Cyatheaceae																						
Cyathea australis [A]															+							

Botanical Name	Plant Community Number (number of sites)																				
	1	2	3	4	5	6/7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Davalliaceae																						
Davallia solida var. *pyxidata*										+					1				1			
Dennstaedtiaceae																						
Pteridium esculentum		10	7	3	3	17	1	8	13	12	1	2	9	5	33	18		1			8	
Dicksoniaceae																						
Calochlaena dubia										4			1		6							
Dicksonia antarctica											+				1							
Dryopteridaceae																						
Polystichum formosum						1																
Gleicheniaceae																						
Gleichenia dicarpa										1								2				
Isoetaceae																						
Isoetes muelleri [C]																						
Lindsaeaceae																						
Lindsaea microphylla										2												
Lindsaea linearis																				1		
Lycopodiaceae																						
Lycopodiella lateralis																		1				
Marsileaceae																						
Marsilea costulifera [E]																						
Marsilea hirsuta [C]																						
Marsilea mutica [C]																						
Ophioglossaceae																						
Botrychium australe								1					1			1						
Ophioglossum lusitanicum			1																			
Polypodiaceae																						
Pyrrosia rupestris						1				2			1		7	1			1			

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Psilotaceae																						
Psilotum nudum [c]																						
Sinopteridaceae																						
Cheilanthes distans		1	1											3								
Cheilanthes sieberi subsp. *sieberi*	12	8	18	2	8	2		2	1	2				3	2	1	1		2		3	
Pellaea nana	2	3	8		1	2								2	2						1	
GYMNOSPERMS																						
Cupressaceae																						
Callitris oblonga subsp. *parva* **(V, v)**													1								2	
ANGIOSPERMS																						
Acanthaceae																						
Brunoniella australis		1																				
Brunoniella pumilio										1												
Alismataceae																						
Damasonium minus [c]																						
Amaranthaceae																						
Alternanthera denticulata																					3	
Alternanthera sp. A	2		1																			
Anthericaceae																						
Caesia parviflora	+	1																				
Dichopogon fimbriatus	2	3	5	3	2	6	1	2	1			1			6	1	1	1				
Dichopogon strictus	1																1					
Laxmannia compacta [c]																						
Laxmannia gracilis			1																1			
Thysanotus tuberosus subsp. *tuberosus*	1						1	1														
Tricoryne elatior	2	1	2													1						
Apiaceae																						
**Ammi majus* [c]																						

Botanical Name	Plant Community Number (number of sites)																				
	1	2	3	4	5	6/7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Apiaceae cont.																						
**Berula erecta* [A]			+																			
Centella asiatica [E]																						
**Ciclospermum leptophyllum*																					1	
**Conium maculatum* [B]																						
Daucus glochidiatus	2	1	7			4							2	1	4							
Daucus glochidiatus form C		1																				
Daucus glochidiatus form F	1	2	1		1										1							
Eryngium ovinum [C]																						
Eryngium vesiculosum						1									7	5						
Hydrocotyle geraniifolia		1				1		2	1	1			3		18	8		1	1		2	
Hydrocotyle laxiflora	8	22	26	2	2	21	3	6	3	2			5	4	21	14	2	1			1	
Hydrocotyle peduncularis										1												
Hydrocotyle tripartita																1					9	4
Lilaeopsis polyantha																						1
Oreomyrrhis eriopoda		1	1											1	1	2						
Platysace ericoides									1	7		3	1		1				2	2		
Platysace lanceolata										1									4			
Trachymene anisocarpa								1		1			1		1				1			
Trachymene incisa subsp. *incisa*	1				2	2			2	3			3	1	2	4			2			
Araliaceae																						
Polyscias sambucifolia subsp. A		1		1					3	5		1	3		3	2			1			
Asphodeliaceae																						
Bulbine bulbosa	4	1	9		1	5	2	2	2				3	2	3							
Asteraceae																						
Ammobium alatum	2	1	2			8	1	1							1						4	
**Anthemis cotula* [C]																						
**Aster subulatus* [C]																						
**Bidens pilosa*						1																

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Asteraceae cont.																						
Brachyscome aculeata					1	1							1									
Brachyscome angustifolia var. *heterophylla*	4	5	4		2	1			2				1		1	2	1	1				
Brachyscome dissectifolia [C]																						
Brachyscome graminea [C]																						
Brachyscome heterodonta var. *heterodonta*	2	2																				
Brachyscome microcarpa		2	1	1	6	1			1	4	2	3	3	1	6	6					2	
Brachyscome nova-anglica		5	3	2		6		1	8	3			7		8	3			1		1	
Brachyscome procumbens	1	1	3	1											1							
Brachyscome radicans																						4
Brachyscome scapigera		1			1	1											1	1				
Brachyscome spathulata		2	5	1					1						4			1				
Brachyscome stuartii						1													2		1	
Brachyscome tenuiscapa var. *pubescens*		3			1			3	2	2				3	1	3			1			
Bracteantha bracteata		3				8		2	3	2			3		3	1	1	1			3	
Calotis cuneifolia	3	5	3	1		2											1					
Calotis dentex				1					1	1												
Calotis lappulacea [C]																						
**Carthamus lanatus* [C]																						
Cassinia compacta [C]																						
Cassinia laevis		1																				
Cassinia quinquefaria	6	7	8	2	1		1															
Cassinia uncata					2																	
Centipeda cunninghamii [E]																						
Centipeda minima [C]																						
Chrysocephalum apiculatum	6	6	1		4	4	2	3	6	5		2	7	2		2	3			1	1	
**Cirsium vulgare*	3	13	15		2	18	2	1					1		16	5	1	1			6	
**Conyza albida*	1	3	3		1	8		3	3				3	2	3	5					9	1
**Conyza bonariensis*	1														1							
**Conyza canadensis* var. *canadensis* [C]																						

Botanical Name	Plant Community Number (number of sites)																				
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Asteraceae cont.																						
Cotula australis	2	1	5																			
Craspedia variabilis		1				6	2					1	1	1	4	3		2				
**Crepis capillaris*	2			1		1		1							2						3	
Cymbonotus lawsonianus	4	8	12			2	3								1							
Euchiton gymnocephalus	6	22	21	3	4	7	1	2	6	3			7	1	15	10	1				4	
Euchiton involucratus						1							1									2
Euchiton sphaericus	1	2				2																
**Gamochaeta americana*	3							1	1												1	
**Gamochaeta spicata*	1		1			1	1									1					2	
Helichrysum rutidolepis									2	1			2		1						2	
Helichrysum scorpioides		1				1		1	1						2						1	
**Hypochaeris glabra*	1	5	6	1												1						
**Hypochaeris radicata*	13	36	36	6	15	20	6	9	11	6	2	1	9	5	29	20	3	2	1		13	
Lagenifera gracilis			1																			
Lagenifera stipitata	5	6	10		2	1		1		1					8	2						
Leptorhynchos squamatus subsp. A	3	2			1	3	2	1														
**Leucanthemum vulgare*			1		1	6	1	1													3	
Leucochrysum albicans var. *albicans*						1		1								1						
**Matricaria perforata* [c]																						
Microseris lanceolata	1	1				1																
Olearia alpicola [c]																						
Olearia argophylla															6	1						
Olearia cydoniifolia [c]																						
Olearia elliptica	1	3	3																			
Olearia erubescens				1	1																	
Olearia oppositifolia												2			5	1						
Olearia ramosissima		1							1	1												
Olearia ramulosa										1										1		
Olearia rosmarinifolia																					1	

Botanical Name	Plant Community Number (number of sites)																				
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Asteraceae cont.																						
Olearia viscidula	2	4	4	5	1		1								1	1						
Ozothamnus diosmifolius			2										1			1	2		1			
Ozothamnus obcordatus [C]																						
**Picris hieracioides*		1				2							1									
Podolepis hieracioides						1			1	1		1										
Podolepis jaceoides [C]																						
Podolepis neglecta [B]																						
Pseudognaphalium luteoalbum [E]																						
Rhodanthe anthemoides					2		1															
Senecio bipinnatisectus						2																
Senecio diaschides	1	3	2	1	2	5			2				1	1	2	2	1	1			1	
Senecio gunnii															1							
Senecio hispidulus var. *hispidulus*		2	2	1		1			1						3						1	
Senecio lautus subsp. *lanceolatus*													1								1	
Senecio linearifolius						1																
Senecio quadridentatus		1	2	3		1									1						1	
Senecio sp. E	1	7	8	2		4		1	2	4	1		9	3	23	12	1	1	1		2	
Sigesbeckia australiensis						1									2							
**Sigesbeckia orientalis*			1																			
**Silybum marianum* [C]																						
Solenogyne bellioides	2	4	4		1	1				1					1	2					2	
Solenogyne dominii		1					1															
Solenogyne gunnii		2	2												3	1						
**Sonchus asper* subsp. *glaucescens*	1	2	4			2		1													1	
**Sonchus oleraceus*	1		1																			
Stuartina muelleri [C]																						
**Taraxacum officinale*	4	14	16		1	12	2	1			1				9	6	1				3	
**Tripleurospermum inodorum*						1																
Triptilodiscus pygmaeus [A]	+																					

Botanical Name	Plant Community Number (number of sites)																					
	1	2	3	4	5	6/7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Asteraceae cont.																						
Vittadinia cervicularis var. *subcervicularis*			1																			
Vittadinia cuneata	4	3	8		1		1		1					2		1						
Vittadinia dissecta var. *hirta* [C]																						
Vittadinia muelleri	3						1															
**Xanthium spinosum* [E]																						
Bignoniaceae																						
Pandorea pandorana			2																			
Boraginaceae																						
Cynoglossum australe	3	6	7	1		8		3						1	3	2					1	
**Echium plantagineum* [C]																						
Myosotis australis	1				1																	
**Myosotis caespitosa*																					1	
**Myosotis discolor*																					1	
Brassicaceae																						
**Brassica rapa* subsp. *sylvestris* [C]																						
Cardamine gunnii						1																
Cardamine paucijuga																					2	
**Lepidium africanum*			2																			
Rorippa laciniata						1																
Rorippa nasturtium-aquaticum [E]																						
**Rorippa palustris* [B]																						
**Sisymbrium officinale*			3																			
**Sisymbrium orientale*						1																
**Turritis glabra* [C]																						
Burmanniaceae																						
Burmannia disticha [C]																						
Cabombaceae																						
Brasenia schreberi [E] **(R)**																						+

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Campanulaceae																						
Wahlenbergia communis			2			3	2															
Wahlenbergia gracilis	2	2	1	1		3			1	4			1	1	2		1				5	
Wahlenbergia graniticola		1			2	1			2				1								2	
Wahlenbergia littoricola	1				1																	
Wahlenbergia luteola	6	9	11		4	1									2	1	1				1	
Wahlenbergia planiflora subsp. *longipila*	3	3	8		1	1	1	2	1				1		1				1			
Wahlenbergia planiflora subsp. *planiflora*	13	8	2		2		1							1	1						1	
Wahlenbergia queenslandica	2	4	4	2	3	1	2			1			1									
Wahlenbergia stricta subsp. *stricta*	3	10	14		3	14	1	4	6				6	3	21	10	2	1			4	
Caprifoliaceae																						
**Lonicera japonica*																1						
Caryophyllaceae																						
**Arenaria leptoclados*						2																
**Cerastium fontanum* subsp. *vulgare*	1	5	6		2	8	2								4	1		1			2	
**Cerastium glomeratum* [C]																						
**Dianthus armeria*	1		1		1	2															2	
**Paronychia brasiliana*	7	20	15	1	1	2	1	1							4	5					1	
**Petrorhagia nanteuilii*	6	8	7		3	10	1										1				2	
**Polycarpon tetraphyllum*		3	4			1															1	
Scleranthus biflorus	12	26	22	3	3	13	2	7	1					2	10	14	1				3	
**Silene gallica*						2											1					
**Spergularia rubra* [B]																						
Stellaria angustifolia			3		1		1									1					4	5
**Stellaria media*		1	5		1										2							
Stellaria pungens	1	4	5	2		5									5						1	
Casuarinaceae																						
Allocasuarina littoralis									3	12			5	2	5	1	1	1	3	1		
Allocasuarina rigida subsp. *rigida*									1						1				1			
Casuarina cunninghamiana [C]																						

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Celastraceae																						
Maytenus silvestris		1								2					3							
Centrolepidaceae																						
Centrolepis strigosa [E]																						
Chenopodiaceae																						
Atriplex semibaccata [B]																						
**Chenopodium album* [B]																						
Chenopodium carinatum		1																				
Chenopodium pumilio [C]																						
Einadia hastata	4	6	7							1					1	1						
Einadia nutans	5	4	6	1		1	1															
Clusiaceae																						
Hypericum gramineum	12	18	13	1	7	10	3	7	5	1			5	1	6	15	3				2	2
Hypericum japonicum																						1
**Hypericum perforatum*	1																					
Colchicaceae																						
Wurmbea dioica			2																			
Commelinaceae																						
Commelina cyanea [C]																						
Convolvulaceae																						
**Convolvulus arvensis*						1																
Convolvulus erubescens	1		6			1																
Dichondra repens	18	36	34	3	9	15	4	2	2	1			3	5	26	19	2	2			5	
Dichondra sp. A			1																			
Crassulaceae																						
Crassula helmsii																					1	
Crassula sieberiana	3	7	14	1	1	4	1						1	4	2	4			1		2	

Botanical Name	Plant Community Number (number of sites)																					
	1	2	3	4	5	6/7	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Cyperaceae																						
Baumea nuda [B]																						
Baumea rubiginosa																		1			1	
Bulbostylis densa																					1	
Carex breviculmis	2	2	5		1			1		1		1	4	3	8	6		1				
Carex chlorantha																					1	
Carex fascicularis [B]																						
Carex gaudichaudiana						2							1		1						10	1
Carex incomitata			1			3									2	3			1		3	
Carex inversa	8	15	12	1	3	2	4	2	1							1	1				1	
Carex polyantha [C]																						
Carex tereticaulis																					1	1
Caustis pentandra					1																	
Cyperus difformis [C]																						
**Cyperus eragrostis*																			1			
Cyperus flaccidus [E]																						
Cyperus flavidus [E]																						
Cyperus gracilis		1																				
Cyperus gunnii [C]																						
Cyperus lhotskyanus																					1	
Cyperus lucidus																					5	
Cyperus sanguinolentus																					1	1
Cyperus sphaeroideus																					1	1
Eleocharis acuta																					2	6
Eleocharis dietrichiana																						1
Eleocharis gracilis																						1
Eleocharis pusilla [C]																						
Eleocharis sphacelata																					3	2
Fimbristylis dichotoma						1																
Gahnia aspera															1			1				

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Cyperaceae cont.																						
Gahnia sieberiana										+			1					1	1			
Isolepis cernua [B]																						
Isolepis fluitans [E]																						
Isolepis habra [E]																						
Isolepis hookeriana [E]																						
Lepidosperma gunnii									1	2									4			
Lepidosperma laterale			4	2					2	8			1	1	9			1	1	2	1	
Lepidosperma limicola																		1				
Lipocarpha microcephala [E]																						
Ptilothrix deusta																				1		
Schoenoplectus mucronatus																					1	
Schoenoplectus validus																					1	
Schoenus apogon	2		5		2	5	3	3	3				1	2	4	1		3			2	3
Scirpus polystachyus																					6	
Dilleniaceae																						
Hibbertia acicularis			1							3									2			
Hibbertia cistoidea							1															
Hibbertia linearis	11	14	16	5	13			1	4	6					2	4		1	4	2		
Hibbertia obtusifolia [C]																						
Hibbertia riparia	2	3			2			1	6	8	1					1		1	1	2		
Hibbertia rufa																		2				
Hibbertia serpyllifolia [C]																						
Hibbertia sp. B		2			1																	
Droseraceae																						
Aldrovanda vesiculosa [E] **(e)**																						+
Drosera burmannii [E]																						
Drosera peltata			3		3		1															
Drosera spatulata																		1				

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	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Elatinaceae																						
Elatine gratioloides																					2	
Epacridaceae																						
Brachyloma daphnoides	1	4			9			3	8	9						2					1	
Brachyloma saxicola										2								1	4	2		
Epacris breviflora																		3			2	
Epacris microphylla					1					1								4		1	3	
Epacris obtusifolia																		2				
Leucopogon biflorus			1		4																	
Leucopogon ericoides					1																	
Leucopogon fraseri		2	3				3	4	1							6	2					
Leucopogon lanceolatus var. *lanceolatus*		3	2	2				1	6	9	1	3	10		23	10			3			
Leucopogon melaleucoides [B]																						
Leucopogon microphyllus																			1			
Leucopogon muticus [C]																						
Leucopogon neo-anglicus																			4			
Leucopogon virgatus					1																	
Lissanthe strigosa	18	15	19	4	4	2	1				2				1	2	3					
Melichrus procumbens									2	3									2	1		
Melichrus urceolatus	10	14	10	3	11	2	1	1	5	2	1	1	5		1	1	1	1		1	1	
Monotoca scoparia		1		2	3			1	7	11		2	8		3	4		2	3	1	1	
Eriocaulaceae																						
Eriocaulon scariosum																		1			1	
Euphorbiaceae																						
Adriana tomentosa var. *tomentosa* [C]																						
Chamaesyce drummondii						1																
Monotaxis macrophylla [G] **(e)**																						
Phyllanthus subcrenulatus [C]																						
Phyllanthus virgatus	8	6	4			1	1	1	2				2			3					3	
Poranthera microphylla	11	22	21	5	12	13	2	6	10	12		3	10	2	12	13	3		1		4	
Pseudanthus divaricatissimus [G] **(R)**																						

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Fabaceae																						
Acacia brownii				1																		
Acacia brunioides subsp. *brunioides* **(R)**																			1			
Acacia buxifolia subsp. *buxifolia*					4																	
Acacia dawsonii		1																				
Acacia dealbata	5	5	9		4	13		2		1					5	6					1	
Acacia falciformis		1	2		1				2	5			3	1		1			4			
Acacia filicifolia	1	2	4						10	4			9		7	2	2			1	2	
Acacia fimbriata										2					5						3	
Acacia gunnii					5				1													
Acacia implexa	7	9	5	1		1									4	1	1					
Acacia irrorata [c]																						
Acacia leucolobia									1	1										2		
Acacia melanoxylon						2									1	1					1	
Acacia neriifolia					1																	
Acacia penninervis					1																	
Acacia rubida				1	4			1		2											1	
Acacia siculiformis	1							1														
Acacia stricta [c]																						
Acacia ulicifolia					1					3			1						1			
Acacia venulosa					3																	
Acacia viscidula [c]																						
Aotus subglauca									5	1									1	1		
Aotus subglauca var. *subglauca*					1			1		1			1					1				
Bossiaea neo-anglica									1	5			1							1		
Bossiaea prostrata				1																		
Bossiaea rhombifolia subsp. *rhombifolia*																			2			
Bossiaea scortechinii	1	2			4			1	10	9		2	3			2			1	1		
Crotalaria mitchellii subsp. *laevis*								1	1													
Cullen tenax		1				4																

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Fabaceae cont.																						
**Cytisus scoparius* [C]																						
Daviesia acicularis [C]																						
Daviesia elliptica [A] **(R)**									+													
Daviesia genistifolia	1	1				1																
Daviesia latifolia	1	3	1		5																	
Daviesia ulicifolia [A]		+																				
Desmodium brachypodum	4	6	2	2		1			1					2	2	3	1					
Desmodium varians	18	19	29	3	6	10	4	6	5	5		1	7	3	24	17	2				1	
Dillwynia juniperina [B]																						
Dillwynia phylicoides						1			6	4			1		1	1		2	4	1	1	
Dillwynia sieberi		2	1		1	3										2					1	
**Genista monspessulana*						1																
Glycine sp. nov.																					1	
Glycine microphylla [B]																						
Glycine clandestina	10	32	33	5	6	20	1	8	8	8	1	1	9	5	33	17	1	1	1		3	
Glycine tabacina	1	2	1			2			1							1						
Gompholobium huegelii					1	2			1	1												
Hardenbergia violacea	5	9	9	4	12	3		1	8	12	2	3	5	2	8	5	2		1			
Hovea beckeri										3									4	1		
Hovea lanceolata																			1			
Hovea linearis	2	2	2		7	5		1	9	2		1	5		1	4					1	
Hovea sp. A									2	4		2	1							1		
Indigofera adesmiifolia	1	1	3										2		1							
Indigofera australis	1	4	6	3	4	1			1		1				6	1	2					
Jacksonia scoparia	5	2	1						4	2			1	1							1	
Lespedeza juncea subsp. *sericea*	3	4	1			6	2	2	1					1		1					4	
Lotus australis	1	1	1			2																
**Lotus corniculatus*																					1	
Mirbelia confertiflora									2	4									4	2	1	
Pultenaea altissima										1			1									

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Fabaceae cont.																						
Pultenaea campbellii **(V, v)**	1	3			5																	
Pultenaea microphylla	6	7	2			9	2	2	1	1						4		2				
Pultenaea myrtoides																		1				
Sphaerolobium minus																		1				
Swainsona galegifolia [C]																						
Swainsona monticola [A]		+																				
Swainsona oroboides [C]																						
Swainsona parviflora		+			1		1															
Swainsona sericea			1					1														
**Trifolium arvense*	3	6	1		2	4	1	1													2	
**Trifolium campestre*	4	3	7		2	6	2	1									1					
**Trifolium glomeratum*	6	3	9		1	6	1							1	1		1				2	
**Trifolium pratense*						2															1	
**Trifolium repens*	7	18	13	1	6	18	2	5						2	15	16	2	1			8	2
**Trifolium striatum* [E]																						
**Vicia sativa* subsp. *angustifolia*					+	2																
**Vicia sativa* subsp. *sativa*																					1	
Zornia dyctiocarpa var. *dyctiocarpa*	1															1						
Gentianaceae																						
**Centaurium erythraea*	5	5	5	2	3	5	1	4	1	1			2		6	4					8	
Centaurium spicatum [C]																						
**Centaurium tenuiflorum*	1						1															
Geraniaceae																						
**Erodium moschatum* [C]																						
Geranium homeanum		1																				
Geranium potentilloides								+										2				
Geranium retrorsum [E]																						
Geranium solanderi var. *grande*																1						
Geranium solanderi var. *solanderi*	18	36	36	3	6	23	2	5	2				9	4	31	17	3	1			7	

Botanical Name	Plant Community Number (number of sites)																					
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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Goodeniaceae																						
Dampiera stricta [C]																						
Goodenia bellidifolia subsp. *argentea*		+							1													
Goodenia bellidifolia subsp. *bellidifolia*	1				7				1	1								1			1	
Goodenia gracilis	1			+																		
Goodenia hederacea subsp. *hederacea*	5	7	4		8	3		3	13	16	2	2	7	1	3	7	3	1	3	2	1	
Goodenia macbarronii [B, 1917] **(V, v)**																						
Goodenia pinnatifida	1																					
Scaevola hookeri																		1			1	
Velleia paradoxa [B]																						
Haemodoraceae																						
Haemodorum planifolium									2	1												
Haloragaceae																						
Gonocarpus micranthus							1											3			2	
Gonocarpus micranthus subsp. *ramosissimus*																		1				
Gonocarpus tetragynus	2	9	4		9	3	2	6	12	13	1	1	8	2	6	9		1	1	1		
Gonocarpus teucrioides	1	1	1	1	1			1	2	1			1		2	3			2		1	
Haloragis heterophylla	8	4	8		2	3	3	1	1							8	2				4	
**Myriophyllum aquaticum*																					1	
Myriophyllum crispatum																					1	
Myriophyllum lophatum [C]																						
Myriophyllum simulans [B]																						
Myriophyllum variifolium																					8	6
Myriophyllum verrucosum [C]																						
Hydrocharitaceae																						
Vallisneria gigantea																					3	
Hypoxidaceae																						
Hypoxis hygrometrica var. *splendida*							1	1								+					1	

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Iridaceae																						
Patersonia fragilis [C]																						
Patersonia glabrata									2	7		2			1			1	3	2		
Patersonia sericea								1	3	9			1					1				
**Sisyrinchium iridifolium* [E]																						
**Sisyrinchium* sp. A [E]																						
Juncaceae																						
**Juncus articulatus*																					1	3
Juncus australis						1															3	
**Juncus bufonius* [B]																						
Juncus continuus															1						1	
Juncus falcatus [B]																						
Juncus filicaulis	3	1	4		1	1	4	1													1	2
Juncus flavidus																					1	
Juncus fockei																					1	4
Juncus holoschoenus [C]																						
Juncus homalocaulis	3							1														
Juncus laeviusculus subsp. *laeviusculus* [A]																			+			
Juncus ochrocoleus [B]																						
Juncus planifolius	1																					
Juncus prismatocarpus																					3	
Juncus sandwithii [B]																						
Juncus subsecundus	3	1	4		2		2														1	
Juncus usitatus						1	1														6	
Juncus vaginatus																						1
Luzula densiflora	3	9	13		3	8	3	3	1				2	1	9	11		1	1		1	
Luzula flaccida															1							
Juncaginaceae																						
Triglochin procera																					2	

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Lamiaceae																						
Ajuga australis	5	8	6	1	2	10	1		1	1			3	1	5	7					2	
Lycopus australis [C]																						
**Marrubium vulgare*	1	1	3			1									1						1	
Mentha satureioides	6	9	14	1		3	1	1					1		1	4	1					
**Mentha* x *piperita*																					2	
Plectranthus parviflorus	2		1											3	1				1			
Prostanthera nivea [B]																						
Prostanthera scutellarioides																			2			
**Prunella vulgaris*						1															6	
Scutellaria humilis		1	3																			
Lauraceae																						
Cassytha glabella					2																	
Cassytha pubescens					1																	
Lemnaceae																						
Lemna trisulca [C]																						
Spirodela punctata [E]																						
Lentibulariaceae																						
Utricularia australis																						1
Utricularia dichotoma																		1			1	3
Linaceae																						
Linum marginale [B]																						
Lobeliaceae																						
Isotoma axillaris													+						1			
Isotoma fluviatilis																					1	1
Lobelia gibbosa									1													
Pratia purpurascens													1		2	1						
Pratia surrepens																					2	4

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Loganiaceae																						
Logania albiflora															2	1					1	
Lomandraceae																						
Lomandra elongata [C]																						
Lomandra filiformis subsp. *coriacea*	4	3	5	5	7				5	1			1			2						
Lomandra filiformis subsp. *filiformis*			2		1	1			3	3			5		1				1	1		
Lomandra glauca					1																	
Lomandra longifolia	2	6	6	2		4		5	8	12	1	3	8	5	30	12	1	1	4	1	12	
Lomandra multiflora subsp. *multiflora*	6	4	5	2	4	3	2	3	3	4	2	2	6	3	4	2			1		1	
Loranthaceae																						
Amyema miquelii	3					2				2					1	1						
Amyema pendulum subsp. *pendulum*	6	1	2	1	1	2			1										1			
Muellerina eucalyptoides [C]																						
Luzuriagaceae																						
Eustrephus latifolius			1			1				1		1	2	2	7							
Geitonoplesium cymosum			1										1									
Lythraceae																						
Lythrum hyssopifolia [E]																						
Lythrum salicaria [A]																+						
Malaceae																						
**Cotoneaster franchetii*								2							1							
**Crataegus monogyna*			2			1																
**Malus domestica*		1						1														
Malvaceae																						
**Modiola caroliniana*			1				1														1	
**Pavonia hastata* [C]																						
Menyanthaceae																						
Nymphoides geminata																						3
Nymphoides montana [C]																						

Botanical Name	Plant Community Number (number of sites)																					
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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Myrsinaceae																						
Rapanea variabilis															1							
Myrtaceae																						
Angophora floribunda		3	5			1																
Baeckea gunniana									1									5		1	1	
Baeckea omissa													1								1	
Callistemon pallidus													2									
Callistemon pityoides																		3				
Calytrix tetragona																			1			
Eucalyptus acaciiformis		1							1	1						9	2	2	2		3	
Eucalyptus amplifolia subsp. *sessiliflora*										1												
Eucalyptus andrewsii					6														1			
Eucalyptus banksii				6	2	1																
Eucalyptus blakelyi	19	6	4		2		1	1						2								
Eucalyptus bridgesiana	3	6	8	2	1																	
Eucalyptus caliginosa	8	40	4		8	1			12	7			8	5	5	8	3		2	1	4	
Eucalyptus cameronii										3					2	2			1			
Eucalyptus campanulata										15					1							
Eucalyptus camphora subsp. *relicta* [B] **(V, e)**																						
Eucalyptus codonocarpa **(R)**																			3			
Eucalyptus dalrympleana subsp. *heptantha*		6	7	1	9	8	3	3	10			1	1		1	7	1				4	
Eucalyptus laevopinea	9		38	8	9						2			1	5	2						
Eucalyptus melliodora	18	14	13																			
Eucalyptus michaeliana [C] **(R)**																						
Eucalyptus moluccana	1	1																				
Eucalyptus nicholii **(V, v)**					3																	
Eucalyptus nobilis		2	1			2			1	3	2	2	7	3	24	3			1		1	
Eucalyptus nova-anglica	1	2			1	5	6	8					2		1	3		1			7	
Eucalyptus obliqua						1				1			2		26			1				

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	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Myrtaceae cont.																						
Eucalyptus pauciflora			1			14		6	2				1		1	7		1			6	
Eucalyptus prava					3																	
Eucalyptus radiata subsp. *sejuncta*		1	1		2	1			4	6	2	3	6		13	15	3			2		
Eucalyptus subtilior					2																	
Eucalyptus stellulata						9		5														
Eucalyptus viminalis		6	3	1		11																
Eucalyptus youmanii **(R)**	4				8																	
Kunzea obovata									1										4	1		
Kunzea parvifolia	1				1		+															
Leptospermum arachnoides [C]																						
Leptospermum brevipes	2				4			1	1	1									2	2	3	
Leptospermum gregarium	1				1			1								1		5			1	
Leptospermum minutifolium [C]																						
Leptospermum novae-angliae									1									2	6	2	1	
Leptospermum polygalifolium subsp. *transmontanum*			1		1			2	1	1			2		1	1					15	
Najadaceae																						
Najas tenuifolia [E]																						
Nyctaginaceae																						
Boerhavia dominii [C]																						
Oleaceae																						
**Ligustrum sinense*																1						
**Ligustrum vulgare*		1																				
Notelaea linearis									2	6					2				1	1	3	
Notelaea microcarpa					1																	
Notelaea sp. A [A]												+										
Onagraceae																						
Epilobium billardiereanum subsp. *cinereum*		4	3	1	1	8	1	4	1					1	1						10	3
Epilobium billardiereanum subsp. *hydrophilum*								1													1	
Epilobium gunnianum [E]																						

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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Onagraceae cont.																						
Epilobium hirtigerum [E]																						
**Oenothera glazioviana* [C]																						
Orchidaceae																						
Acianthus exsertus													3		2							
Acianthus sp. aff. *exsertus* [D]																						
Bulbophyllum elisae									1						2				1			
Caladenia cucullata										1												
Caladenia fuscata												2	1		1	1						
Caleana minor					1																	
Calochilus campestris [C]																						
Calochilus gracillimus [B]																						
Calochilus robertsonii					1																	
Chiloglottis trapeziformis [C]																						
Corybas fimbriatus [C]																						
Dendrobium fairfaxii														1	3				1			
Dendrobium pugioniforme																			1			
Dipodium atropurpureum [B]																						
Dipodium punctatum [A]		?+																				
Dipodium variegatum			1																			
Diuris abbreviata						7						1				2						
Diuris dendrobioides						1																
Diuris pedunculata [C] **(E, e)**																						
Diuris punctata [B]																						
Diuris sulphurea [C]																						
Eriochilus cucullatus [C]																						
Gastrodia sesamoides [C]																						
Genoplesium nudum [C]																						
Glossodia major [C]																						
Microtis unifolia						1		1								1					1	

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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Orchidaceae cont.																						
Orthoceras strictum																1						
Prasophyllum brevilabre [C]																						
Prasophyllum odoratum [C]																						
Pterostylis abrupta [C]																						
Pterostylis alata [C]																						
Pterostylis cycnocephala [B]																						
Pterostylis fischii [C]																						
Pterostylis longifolia													1			1						
Pterostylis mutica			1												+							
Pterostylis obtusa [C]																						
Pterostylis parviflora [C]																						
Pterostylis praetermissa									1													
Pterostylis rufa			1																			
Pterostylis sp. aff. *obtusa* [D]																						
Pterostylis sp. aff. *abrupta* [D]																						
Pterostylis truncata [C]																						
Spiranthes sinensis subsp. *australis*								1														
Thelymitra ixioides var. *ixioides*																		1				
Oxalidaceae																						
Oxalis exilis	6	11	13			4	2						1			1	1				2	
Oxalis perennans	5	2	4			2	1														1	
Oxalis radicosa	1	7	5	3	12		1	2	7	1			5		2	7	1				1	
**Oxalis thompsoniae*		1	3												1							
Papaveraceae																						
**Argemone ochroleuca* subsp. *ochroleuca* [B]																						
Phormiaceae																						
Dianella caerulea		2											1		2		1				2	
Dianella longifolia						1									1							
Dianella revoluta var *vinosa*	1		2						11	3			3		2	1						

Botanical Name	Plant Community Number (number of sites)																				
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Phormiaceae cont.																						
Dianella tasmanica										3									2			
Stypandra glauca										2												
Thelionema grande [G] **(R)**																						
Phytolaccaceae																						
**Phytolacca octandra*										1					+							
Pittosporaceae																						
Billardiera scandens var. *scandens*		2	2	1	1	1		1	6	9		2	6	1	13	5			1		1	
Bursaria longisepala [C]																						
Bursaria spinosa	11	8	20	2		1		6	4	2			4	1	11						5	
Rhytidosporum procumbens		1			4				2	1										2	1	
Plantaginaceae																						
Plantago debilis						1																
Plantago gaudichaudii	7	6	3	1	1	4	2	1	1				2	2		1					1	
Plantago hispida	1	9	13	1	1	1	1		1	1			1	1	2						1	
**Plantago lanceolata*	8	9	2			6	3	1	1								2				4	
**Plantago scabra* [C]																						
Plantago varia [C]																						
Poaceae																						
Agrostis aemula							1															
**Agrostis capillaris*						1																
Agrostis avenacea var. *avenacea*		1				5	1														7	5
**Aira cupaniana*															1							
**Aira elegantissima*	5	4	12		7	3	4	3								1						
**Aira provincialis*		3				+																
Amphibromus nervosus																						1
Amphibromus pithogastrus [E]																						
Amphibromus sinuatus [C]																						
**Anthoxanthum odoratum*	3	6	8		2	7	3	2							9	8		1			2	1

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Poaceae cont.																						
Aristida acuta																1						
Aristida calycina	3	1						3	3	3				3					1		2	
Aristida jerichoensis var. *subspinulifera*	5	3	4		4		1		1	2							1					
Aristida ramosa		4	6	2																	1	
Aristida ramosa var. *ramosa*	1	1	1																			
Aristida vagans		3	1		2	1										1	1					
Austrodanthonia bipartita [B]																						
Austrodanthonia caespitosa	1	1	1						2	2												
Austrodanthonia carphoides [B, 1931]																						
Austrodanthonia eriantha [B, 1947]																						
Austrodanthonia induta					1	1																
Austrodanthonia laevis	6	6	1	2	3	2							1			1	1				2	
Austrodanthonia monticola	1																					
Austrodanthonia penicillata		1				1																
Austrodanthonia pilosa var. *pilosa*	1		2	3				1	1				1		1	4					1	
Austrodanthonia racemosa var. *obtusata*	1	5	2	1												1						
Austrodanthonia racemosa var. *racemosa*	7	3	9		2	3	1	3	2				2		3	3					2	
Austrodanthonia richardsonii			1																			
Austrodanthonia tenuior		1	1		1				4	1			1					1			3	
Austrofestuca eriopoda [B]																						
Austrostipa densiflora					1																	
Austrostipa nodosa			2																			
Austrostipa pubescens										2											1	
Austrostipa rudis		1								1						1						
Austrostipa rudis subsp. *nervosa*	2	13	4	1	1	2		4	1		1		1	2	3	4					3	
Austrostipa rudis subsp. *rudis*	1		3		1																	
Austrostipa scabra subsp. *falcata*	3	4	2																			
Austrostipa scabra subsp. *scabra*			1																			
Austrostipa setacea [B, 1934]																						

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Poaceae cont.																						
Austrostipa verticillata			1																			
Bothriochloa biloba [F, 1955] **(V, v)**																						
Bothriochloa decipiens [C]																						
Bothriochloa macra	12	11	9	4	2	1	1	1						2		2					1	
**Briza minor*	3		3		3		3														1	
**Bromus alopecuros* [C]																						
**Bromus brevis*			3			2	1								1	1						
**Bromus cartharticus*																					1	
**Bromus diandrus*			1			1																
**Bromus hordeaceus*	1	1	8		1	5	1	1							1	2					3	
Bromus molliformis	1				1	2									2							
Capillipedium parviflorum									1													
**Cenchrus incertus* [C]																						
Chloris truncata						1																
**Chloris ventricosa*			1																			
Cymbopogon refractus	3	7	8	2	2	1	1	1	3	2				5		1					1	
Cynodon dactylon		2				1								1	2	3					1	
Cynodon incompletus [B]																						
**Cynosurus cristatus*	2																					
**Cynosurus echinatus*	1					1																
**Dactylis glomerata*	1	2	2			1	1								1							
Deyeuxia acuminata										2												
Deyeuxia brachyathera										1											1	
Deyeuxia gunniana									5	1								1			1	
Deyeuxia imbricata																		1			1	
Deyeuxia parviseta					1					1												
Deyeuxia parviseta var. *parviseta*					1			1	6	6		1	4		2	2		1		1	2	
Deyeuxia quadriseta													1									
Dichanthium sericeum	1																					

Botanical Name	Plant Community Number (number of sites)																					
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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Poaceae cont.																						
Dichelachne crinita	1	1	2			2		1								2					3	
Dichelachne inaequiglumis			1		1	1		2					2			2					1	
Dichelachne micrantha	11	20	12	5	9	4	1	4	12	10		2	6	5	9	4		1	1		2	
Dichelachne parva																		1				
Dichelachne rara		2	1		1	1		1								1					1	
Digitaria breviglumis									1						1							
Digitaria diffusa									1													
Digitaria ramularis										1											1	
**Echinochloa crus-galli* [C]																						
**Echinochloa esculenta* [C]																						
Echinopogon caespitosus var. *caespitosus*	4	2	2	1	6	1		1		1			1	1	3	3			1		1	
Echinopogon intermedius		2	3		2	3		3	2	2			1		5							
Echinopogon mckiei	2	3	2			2	1	3	2				1		1	2					2	
Echinopogon nutans var. *nutans*	1	4	3				1	3					2		2	2						
Echinopogon ovatus		2	11		1	2		1	1				1	1	2	1		2			2	
**Ehrharta calycina* [C]																						
**Ehrharta erecta* [C]																						
**Eleusine tristachya*			1																			
Elymus scaber	9	14	24	3	7	7	2	1	2	1			1		5	3					4	
Entolasia stricta			1		1	1			3	12		1	3		3	3	1		6	2	5	
Eragrostis benthamii			1					1	1												5	1
Eragrostis brownii [C]																						
**Eragrostis cilianensis* [C]																						
**Eragrostis curvula* [C]																						
Eragrostis leptostachya	6	4	1											1								
Eragrostis molybdea [C]																						
Eragrostis parviflora [C]																						
Eragrostis trachycarpa [E]																						
Festuca asperula [B]																						
**Festuca elatior*	4	1	1		1	6		1							2	2	1				4	

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	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Poaceae cont.																						
**Festuca pratensis*		1				2	1								1		1				1	
Glyceria australis																						3
Glyceria latispicea [C]																						
Hemarthria uncinata var. *uncinata*						1															1	2
**Holcus lanatus*					1	5	1	4								2		1			7	4
**Hordeum hystrix*		1																				
**Hordeum leporinum*		1	2																			
**Hordeum marinum*			1			1																
Imperata cylindrica var. *major*	2	3	4		2	3		5	11	9			8	5	15	8			1		6	
Isachne globosa													1								5	
Joycea pallida				1	1	1				3												
**Lolium perenne*	2	2	2		1	2	1	1							1						1	
Microlaena stipoides var. *stipoides*	2	10	13	2	5	3	1	2	2	3			1		9	5	1				3	
**Nassella trichotoma* [B]																						
Panicum effusum									1													
**Panicum gilvum* [E]																						
Panicum obseptum [E]																						
**Paspalum dilatatum*						1	1									1					5	
**Paspalum distichum*																					1	
Pennisetum alopecuroides	1					3															4	1
**Pennisetum villosum* [C]																						
**Phalaris aquatica*		3	2			2																
**Phleum pratense* [B]																						
Phragmites australis																					2	
**Poa annua* [C]																						
Poa clivicola								1														
Poa costiniana					1	3		1														
Poa labillardierei			3		4	7	2	2	2						1	2	1				8	
**Poa pratensis*																1					1	
Poa sieberiana	18	38	34	5	7	13	3	6	5	12	2	3	10	4	32	20	2	1	3		7	

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	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Poaceae cont.																						
Sacciolepis indica [C]																						
Sorghum leiocladum	4	3		1	1	5	1	1	2	1						5					3	
Sporobolus creber	2	5	3				1	2	2												1	
Themeda australis	13	10	9	2	7	15	4	8	12	8		1	6	2	6	11	3	1			6	
**Vulpia bromoides*		2	1		3	7		1								1					2	
**Vulpia myuros*	5	7	17		1	5	2	1							2	6	1	1			1	
Polygalaceae																						
Comesperma ericinum [C]																						
Comesperma retusum																		2				
Comesperma volubile [C]																						
Polygala japonica		1				3							1	1		1						
Polygonaceae																						
**Acetosella vulgaris*		7	2		1	9		5	1						5	3					3	
**Fallopia convolvulus* [C]																						
Muehlenbeckia costata (ms) [G] **(K)**																						
Persicaria decipiens																					6	
Persicaria hydropiper																					1	
Persicaria lapathifolia [C]																						
**Persicaria maculosa* [E]																						
Persicaria prostrata																					1	
**Polygonum arenastrum*			1																			
Rumex brownii	9	24	25			6	3	2						2	5	6					6	
**Rumex conglomeratus*																						1
**Rumex crispus*																						1
Portulacaceae																						
Neopaxia australasica [B]																						
Potamogetonaceae																						
Potamogeton crispus [C]																						
Potamogeton ochreatus																					4	1

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Potamogetonaceae cont.																						
Potamogeton perfoliatus																					1	
Potamogeton tricarinatus																						4
Primulaceae																						
**Anagallis arvensis*	2		1														1					
Proteaceae																						
Banksia cunninghamii subsp. A									1	3					1			4		2		
Banksia integrifolia subsp. A									9	10		3	9	1	19	12		2	1		3	
Banksia marginata [B]																						
Grevillea juniperina								3													2	
Grevillea ramosissima [B]																						
Grevillea scortechinii subsp. *sarmentosa* **(V, v)**									2	4									2	2	1	
Hakea dactyloides									1										1	1		
Hakea eriantha										7		1	1		6							
Hakea microcarpa																		4			6	
Lomatia fraseri						3		3	1		1				2	2		4			3	
Lomatia silaifolia		1		1	5			1	6	17		3	5	2	11	1		2	2	1		
Persoonia cornifolia					3			2	11	11		2	8		4	3			1	2	2	
Persoonia oleoides													1									
Persoonia procumbens **(R)**									6	2			2							1		
Petrophile canescens									3	5								1		2		
Ranunculaceae																						
Clematis aristata		1	2										1		8	1					1	
Clematis glycinoides var. *glycinoides*	1	3	10	2		3							1	1	5	3						
Ranunculus inundatus																						3
Ranunculus lappaceus	3	6	7	2	1	13	2		2				3		11	4	2					
Ranunculus sp. A																					1	
Restionaceae																						
Baloskion fimbriatum[B]																						
Baloskion stenocoleum																		5		1	4	

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Restionaceae cont.																						
Empodisma minus																		1				
Lepyrodia anarthria																		4			1	
Rhamnaceae																						
Cryptandra amara var. *amara*			1																		1	
Cryptandra amara var. *longiflora*	1					1		1													1	
Cryptandra lanosiflora [G] **(R)**																						
Cryptandra propinqua [C]																						
Cryptandra scortechinii						1													1	2		
Discaria pubescens [C] **(R)**																						
Pomaderris andromedifolia [A]		+																			+	
Pomaderris eriocephala [A]	+																					
Pomaderris lanigera															1							
Pomaderris nitidula																					2	
Rosaceae																						
Acaena agnipila [B]																						
Acaena novae-zelandiae	3	20	27	1	2	13	1	8	2				5	3	24	17	2	1			5	
Acaena ovina	2	13	10	1	1	10	4	1								1	1				3	
**Potentilla recta* [B]																						
**Pyracantha angustifolia*																						
**Rosa rubiginosa*	6	14	10		2	7	3	2								5						
Rubus parvifolius	5	9	11	1	2	19	3	9	8	3			9	5	32	18	1				8	
**Rubus ulmifolius*		9	6		2	11	2	1							6	12		1			9	
**Sanguisorba minor* subsp. *muricata*																					1	
Rubiaceae																						
Asperula charophyton [A] **(R)**																						+
Asperula conferta	12	10	14		2	16	5	3	1					1	1	4	1				6	
Asperula gunnii																		2				
Coprosma hirtella [A]															+							
Galium binifolium			1		1																	

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Rubiaceae cont.																						
Galium ciliare	4	10	11	2		14		2	2	1			7	1	21	11					4	
Galium gaudichaudii		2	12	3	1	1				1			2		2	4						
Galium liratum															1						1	
Galium migrans	2	3	5												1	1						
Galium propinquum		7	9	3	2	1					1	1	3	1	2	1	1				1	
Leptostigma reptans [E]																						
Opercularia aspera	9	5	5	5	3		2		1		1		4		1	3	1					
Opercularia hispida	1	3	5	1	2			1	9	9			4	4	7	6	1				1	
Pomax umbellata									2	12			2		1							
Rutaceae																						
Boronia algida [C]																						
Boronia anemonifolia var. *anemonifolia*																			2			
Boronia anethifolia [C]																						
Boronia microphylla					1																	
Boronia polygalifolia	1		1																			
Correa reflexa var. *reflexa*	1				2					4		1			2				1			
Leionema ambiens [G] **(R)**																						
Phebalium squamulosum [C]																						
Zieria cytisoides										1												
Zieria fraseri subsp. B										1									1			
Zieria laevigata [C]																						
Zieria smithii subsp. A																			1			
Salicaceae																						
**Salix babylonica*																					1	
Santalaceae																						
Choretrum pauciflorum									6									1		2		
Exocarpos cupressiformis	1	1		2		5			1	2					2	1	1					
Exocarpos strictus		1				2																
Santalum obtusifolium															1							
Thesium australe **(V, v)**						4										1						

Botanical Name	Plant Community Number (number of sites)																				
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Sapindaceae																						
Dodonaea boroniifolia [C]																						
Dodonaea viscosa subsp. *angustifolia*		1								1									1			
Dodonaea viscosa subsp. *angustissima* [C]																						
Dodonaea viscosa subsp. *spatulata*					1				1	3					1				1		1	
Scrophulariaceae																						
Derwentia arcuata						1		1	1	3			1		1	1						
Derwentia derwentiana subsp. *derwentiana*															2						1	
Euphrasia orthocheila [F] **(R)**																						
Glossostigma diandrum [E]																						
Gratiola nana [B]																						
Gratiola peruviana									1												5	
Limosella australis [B]																						
**Linaria pelisseriana* [E]																						
Mimulus gracilis [E]																						
**Verbascum thapsus* subsp. *thapsus*	3	7	8	1	2	6				1											3	
**Verbascum virgatum* [B]																						
**Veronica arvensis*																					1	
Veronica calycina	7	22	27	3	11	7	1	4	5	3			7	1	18	15		1			2	
Veronica gracilis [B]																						
Veronica notabilis [C]																						
**Veronica peregrina*					1																	
Veronica plebeia	8	11	5	1	1	3	1						1	3	3	2	2	1	1			
**Veronica serpyllifolia* [A]																+						
Veronica sp. C																					1	
Smilacaceae																						
Smilax australis						4			1	1		2	1		22	5		1			1	
Solanaceae																						
**Datura stramonium* [C]																						
Solanum aviculare					1																	

Botanical Name	Plant Community Number (number of sites)																				
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Solanaceae cont.																						
Solanum brownii						2							1		1							
**Solanum nigrum*		2				1		1							1			1				
Solanum opacum		2	1			3									2							
Solanum prinophyllum		1				1				1					2	2					1	
Stackhousiaceae																						
Stackhousia monogyna	3	5	2				1									1						
Stackhousia viminea	2	1	2		2	1				3			2			1			2			
Stylidiaceae																						
Stylidium graminifolium					5	1	1	5	12	7		1	4		1	2		2	2	1	1	
Thymelaeaceae																						
Pimelea curviflora var. *divergens*	8	7	11			3	1									1						
Pimelea glauca						1	1			1												
Pimelea ligustrina																					2	
Pimelea linifolia										1												
Pimelea linifolia subsp. *linifolia*	1	1	1		3	8		3	3	4								1	2	1	3	
Typhaceae																						
Typha domingensis [c]																						
Typha orientalis																					2	
Urticaceae																						
Urtica incisa	2	11	15		1	3									1						3	
Verbenaceae																						
**Verbena bonariensis*																					3	
Violaceae																						
Hybanthus monopetalus		8	4	1	9	6	1	1	1				1		2	5			1			
Hymenanthera dentata						4							1		1	1					2	
Viola betonicifolia	7	14	11	2	2	16	2	1	5	1			8	2	10	8	2		1		2	
Viola caleyana																					5	

Botanical Name	Plant Community Number (number of sites)																					
	1	**2**	**3**	**4**	**5**	**6/7**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
	(23)	(40)	(41)	(8)	(17)	(21)	(7)	(9)	(13)	(18)	(4)	(3)	(10)	(5)	(35)	(20)	(3)	(5)	(6)	(2)	(15)	(6)
Violaceae cont.																						
Viola hederacea	1		1		2	1				1			5		13	3		1			4	
Viola hederacea form d				1											1							
Winteraceae																						
Tasmannia stipitata [A]															+							
Xanthorrhoeaceae																						
Xanthorrhoea glauca subsp. *glauca*		1	2		3													2				
Xyridaceae																						
Xyris gracilis subsp. *gracilis*													+					1				
Xyris operculata																		1				