APPENDIX B: VEGETATION SURVEY AND MAPPING REPORT

The vegetation of the Hunter Economic Zone (HEZ), Cessnock LGA, New South Wales.

Final Report

January 2004

Report to

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Abstract

A vegetation survey was undertaken within the Hunter Economic Zone (HEZ) near Cessnock, in the Hunter Valley of New South Wales. This parcel of land occupies approximately 3300 ha of open forest and woodland, and includes part of Werakata National Park (formerly Aberdare State Forest). Aerial photographic interpretation and a detailed ground truthing program were undertaken to produce a vegetation map of the area, showing the distribution of vegetation communities and their variants, following the terminology of the Lower Hunter and Central Coast Regional Environmental Management Strategy.

During the survey, five vegetation communities were delineated, although one of these (the Lower Hunter Spotted Gum Ironbark Forest) comprised the vast majority of the area. Several communities present are considered to be poorly conserved in the region, and consequently the HEZ site plays an important role in the protection of these vegetation types. Two vegetation communities (Kurri Sand Swamp Woodland and Hunter Lowlands Redgum Forest) are presently listed as Endangered Ecological Communities under the terms of the NSW *Threatened Species Conservation Act 1995*, while others are under consideration for potential listing. Considerable variation in the floristic composition of the Kurri Sand Swamp Woodland is evident in the area, and discussion is included in this regard. Populations of one Endangered (*Acacia bynoeana*), five Vulnerable (*Callistemon linearifolius, Eucalyptus parramattensis* subsp. *decadens, Eucalyptus glaucina, Grevillea parviflora* subsp. *parviflora, Rutidosis heterogama*) and three rare (*Eucalyptus fergusonii subsp. dorsiventralis, Grevillea montana, Macrozamia flexuosa*) plant taxa occur within the HEZ site, together with several other regionally significant species. Two new and undescribed eucalypt taxa (*Eucalyptus* sp aff *agglomerata* and *Eucalyptus* sp aff *camfieldii*) also occur within the site, and taxonomic studies on these are continuing with the National Herbarium of NSW.

The HEZ site is a botanically diverse parcel of land, with over 380 plant taxa currently recorded. Eucalypts in particular (including *Angophora, Corymbia* and *Eucalyptus*) number 29 species, which represents over 10% of the known species in New South Wales. Few other locations compare as favourably on a species-per-hectare basis for similarly sized areas.

Recommendations are made in relation to the conservation of plant taxa and vegetation communities within the HEZ site, and elsewhere around Cessnock.

[Cover shows *Eucalyptus glaucina, Rutidosis heterogama, Corymbia eximia* woodland, and *Acacia bynoeana*]

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1.0 Introduction

1.1 Background

The Hunter Economic Zone (HEZ) occupies 3300 ha of mostly dry sclerophyll forest in the Cessnock area of the Hunter Valley, New South Wales. It includes important examples of vegetation types once widely distributed in the lower Hunter Valley that have since been highly modified. It is planned that the proposed development of part of this land will represent the largest industrial site in New South Wales, and consequently it is imperative that comprehensive ecological studies be undertaken.

Previous vegetation studies in the area have provided a general background for strategic planning purposes, but further clarification and refinement is now required. This is emphasised when considering the diversity of native vegetation that is present in the Cessnock region. At least two vegetation communities listed on the NSW *Threatened Species Conservation Act 1995* as Endangered Ecological Communities (EEC's) occur in the area, as well as several threatened and rare plant species. There is also the potential for several other taxa or communities of significance to occur in the area.

This report presents the findings of a detailed vegetation survey and mapping program undertaken on behalf of Harper Somers O'Sullivan Pty Ltd, for the Hunter Economic Zone. It provides:

- a review of previous vegetation survey and mapping projects in the area;
- survey and mapping methodology for assessing the vegetation at HEZ;
- results of the survey, and implications for development; and
- input into a conservation strategy for the HEZ site.

1.2 Location and environmental setting

The HEZ site lies immediately south of the townships of Kurri Kurri and Abermain near Cessnock in the lower Hunter Valley (Figure 1). The Cessnock district comprises a mixture of urban, agricultural, mining, viticultural and bushland areas, including sizeable areas of public bushland (eg: Cessnock, Aberdare, Heaton, Pokolbin and Corrabare State Forests; Yengo, Watagan and Werakata National Parks; and Crown Reserves). The south-western corner of the HEZ site currently includes part of Werakata National Park. Mt Tomalpin is currently a Crown Reserve.

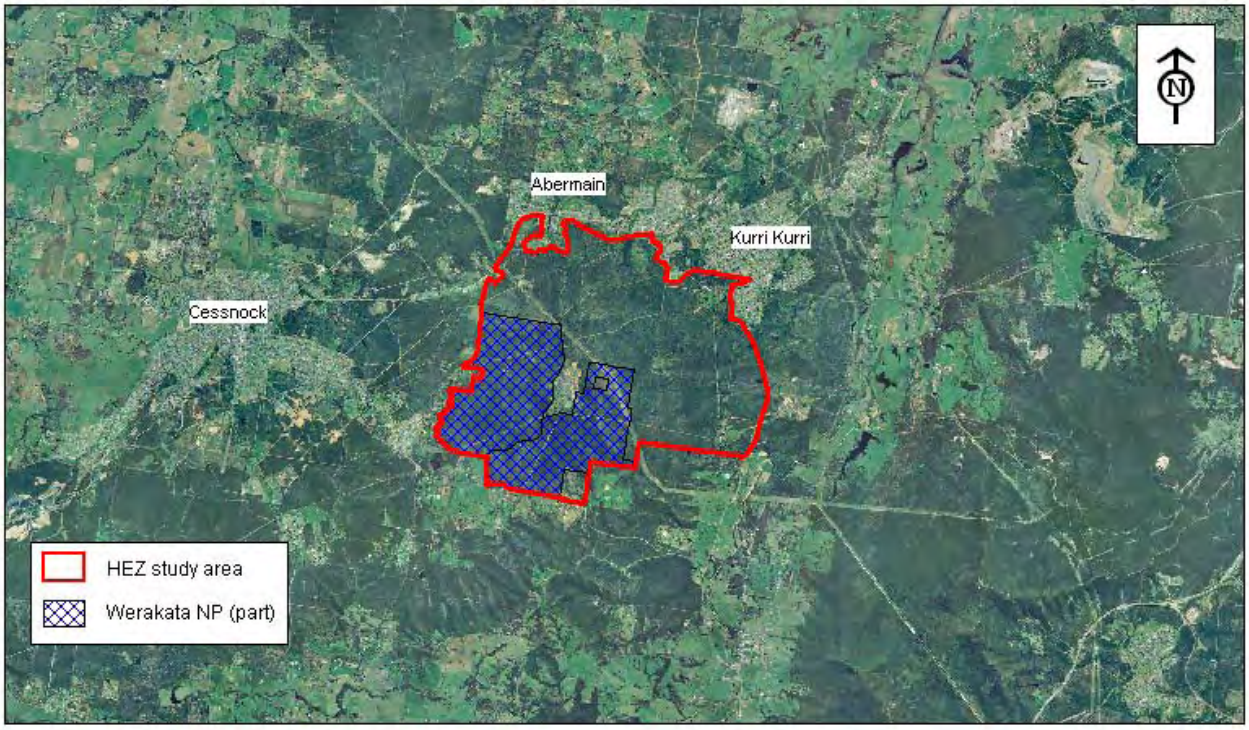

Figure 1 Location of the HEZ study area, showing Werakata National Park portion.

In the National context, the lower Hunter Valley lies within the Sydney Basin biogeographic region of Thackway & Cresswell (1995), and parts of the North Coast, Central Coast, South Coast, Central Western Slopes, Central Tablelands and Southern Tablelands botanical divisions of Anderson (1961). The Sydney Basin biogeographical region approximates the Sydney geological Basin, and stretches from around the upper Hunter Valley (Liverpool Range), to Port Stephens on the coast, and south to Batemans Bay on the south coast. The region covers approximately 36 655 km^2, and is composed of mesozoic sandstones and shales; dissected plateaus; forests, woodlands and heaths; skeletal soils, sands and podzolics (Thackway & Cresswell 1995). The six relevant botanical regions of Anderson (1961) imply that there is considerable botanical diversity throughout the region.

The Cessnock area falls within a warm temperate climatic zone, with warm wet summers and cool dry winters. Rainfall generally peaks in late Summer and early Autumn, with an annual average of 748 mm per year, although local variations due to topography are evident. Temperatures range from a daily average low of 4^o C in July and August, to a high of 30^o C in December and January (Bureau of Meteorology 2003). Table 1 summarises climatic data for Cessnock, the nearest weather station to the HEZ site (~8km to the west).

Table 1 **Annual average climatic data for Cessnock** (Source: Bureau of Meteorology 2003).

Factor		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Rainfall (mm)		79	88	78	66	59	60	45	40	42	55	59	76
Temperature (^{o} C)	Minimum	17	17	16	12	8	6	4	5	8	11	14	16
	Maximum	30	30	29	25	21	18	18	19	22	25	28	30

1.3 Previous land use and fire history

As a consequence of the comprehensive regional assessments (CRA's) carried out in New South Wales during the late 1990's, regional forest agreements (RFA's) were signed by State and Commonwealth governments for major forest areas of New South Wales. During this process, several broad forest ecosystems identified in the lower Hunter Valley were recognised as being poorly conserved (NPWS 1999). To assist in re-dressing this lack of conservation, portions of Cessnock and Aberdare State Forests were transferred to national park estate to create Werakata National Park, part of which lies within the current study area.

Much of the forest in and around Aberdare State Forest has been managed for timber production, principally ironbarks (mostly *Eucalyptus fibrosa*) and Spotted Gum (*Corymbia maculata*). As with many timber production forests, public access is not restricted, and consequently, illegal rubbish dumping, trail bike riding and car dumping by the local community have occurred for many years.

Aberdare State Forest was originally proclaimed in 1963, with additions made during the 1970's (EJE Group 1995). Prior to this, development of the area began with the exploitation of timber for use in local coal mines and the building industry. The construction of privately owned railway lines for transportation of coal in the early 1900's facilitated this practice. Several historical artifacts of significance apparently still remain in the area (EJE Group 1995).

An archeological investigation was undertaken of all state forests in the Morisset Forestry District by Kinhill Engineers (1995), as part of the environmental impact assessment process. This study found negligible evidence of occupation by Aboriginals for Aberdare State Forest, although there is a long history of European disturbance in the area which may have clouded remaining artifacts.

Due to the close proximity of the HEZ to the urban areas of Cessnock, arson has been a continuing problem for many years. It is likely that much of the area has been subjected to fire on average once every 2-3 years. During the Summers of 2000-2001 and 2002-2003, major fires occurred in several areas around Cessnock, including the HEZ.

1.4 Landforms, geology and soils

In general terms, the HEZ site comprises gently undulating-to-steep hills, with an elevational range of 20 to 201m ASL. The highest point in the local area is Mount Tomalpin, rising to an elevation of 201m ASL, located within a Crown Reserve. Drainage is directed into two sub-catchments of the Hunter River; northwards into the Swamp Creek catchment, and easterly into the Wallis Creek catchment. Hebburn Dam occurs on a tributary of Swamp Creek near Weston on the northern border of the site, and is a man-made dam used during previous mining activity.

Geologically, the HEZ site lies predominantly within the Branxton Formation (Maitland Group) of the Permian Sediments of the Hunter Valley, within the northern section of the Sydney geological basin (Rasmus, Rose, & Rose 1969). Soil landscapes in this area have been described and mapped by Kovac (1991) and Kovac & Lawrie (1991) at 1:250 000 scale. These authors map two soil landscapes for the site; Aberdare (ab; ~ 25% of the study area), and Neath (nh; ~75%). Aberdare landscapes (ad) comprise rolling low hills of Yellow (orange) Podzolic Soils on upper and mid slopes, Red Podzolics and Brown Podzolics on the steeper slopes, and Alluvial Soils (sands) in some drainage lines. Neath landscapes (nh) support gently undulating rises of grey Solodic soils in poorly drained areas associated with exposed coal seams, and Yellow Solodic Soils on the better drained lower slopes.

1.5 Previous botanical studies

Prior to the current work, preliminary vegetation survey and mapping of the HEZ site was undertaken by Ecotone Ecological Consultants (1999; 2000). This survey was broad in nature and was not required to assess the vegetation in great detail. The south-western corner of the site was included in the survey and mapping of Werakata National Park by Bell (2001a), which has been revised and added to in the current work. Binns (1996) completed two survey sites within what is now Werakata National Park, and one in Aberdare State Forest, as part of the Morisset Forestry District environmental impact process. This work involved survey of an area of approximately 112 000 ha incorporating fifteen State Forests. A total of 146 survey plots were undertaken across this area, representing a coverage of approximately 1 plot per 767 ha. Based on the two plots from the HEZ site, Binns (1996) determined that Grassy Sclerophyl Forest (MORf1: *Eucalyptus punctata, Corymbia maculata, Allocasuarina torulosa*; & MORf4: *Eucalyptus fibrosa, Corymbia maculata*) dominated the area.

In a major regional study, NPWS (2000a) has undertaken a survey, classification and modelling project for the Cessnock, Maitland, Newcastle, Lake Macquarie, Port Stephens, Wyong and

Gosford LGA area. Known as the Regional Environmental Management Strategy (REMS), this study attempted to define and model all vegetation within a 563 000 ha area, which included the HEZ site. Vegetation communities determined to be present within the site included Lower Hunter Spotted Gum-Ironbark Forest (Unit 17), Hunter Lowlands Redgum Forest (Unit 19), and Kurri Sand Swamp Woodland (Unit 35). Within these units, considerable variation occurs, as has been outlined by Bell (2001a) for Werakata National Park.

Other relevant studies in the area have involved specific small scale projects. Bell & Murray (2001) have examined the ecological significance of the Bow Wow Creek catchment in the Quorrobolong Valley, approximately 4km to the south-east of Werakata NP. This study provides useful distributional information on significant species, and also identifies a rainfall gradient occurring along the Broken Back Range which is reflected in the regional vegetation. Harper Somers O'Sullivan (2002; 2003) have also been examining land within and to the immediate east of the current site in relation to road infrastructure, and are preparing an Ecological Constraints Master Plan (ECMP) for the HEZ site (HSO in prog.).

Significant plant species present within the Cessnock LGA have been documented in Fallding & Bell (1996), and more recently in Murray & Bell (2002.). These listings have been based on the NPWS Wildlife Atlas database, augmented with unpublished and personal records, and provide background information to those species with some potential of occurrence within the HEZ site. Of particular interest is the recently discovered and highly endangered *Persoonia pauciflora*, which occurs within approximately 15 km of the site in similar habitat (Weston 1999). Table 2 summarises significant plant species known from within ~20km of the HEZ site.

Other regionally significant flora within this band include disjunct distributions of *Eucalyptus longifolia* and *Eucalyptus racemosa* in the Quorrobolong Valley (Bell & Murray 2001) and *Eucalyptus squamosa* in part of Aberdare State Forest (pers. obs.).

Table 2 Summary of significant flora from within a 20km radius band from the HEZ site. See Briggs & Leigh (1996) for explanation of status codes.

Species	Status	Location	Source
Eucalyptus castrensis	TSC S1	Singleton army base	pers. obs.
Persoonia pauciflora	TSC S1	North Rothbury	Weston (1999)
Callistemon linearifolius	TSC S2	Aberdare SF	Binns (1996)
		Werakata NP	Bell (2001a)
		Tomalpin area	HSO (2002; in prog)
Eucalyptus fracta	TSC S2	Pokolbin SF	NPWS Atlas
Eucalyptus glaucina	TSC S2	Werakata NP	Bell (2001a)
Eucalyptus parramattensis subsp. *decadens*	TSC S2	Mulbring Road, Mulbring	pers. obs.
		Tomalpin area	NPWS Atlas; HSO (2002; in prog)
		Werakata NP	Bell (2001a)
Eucalyptus pumila	TSC S2	Pokolbin SF	NPWS Atlas
Grevillea parviflora subsp. *parviflora*	TSC S2	Werakata NP	Bell (2001a)
		Tomalpin area	HSO (2002; in prog)
Tetratheca juncea	TSC S2	Heaton SF	Binns (1996)
		Sugarloaf Range	NPWS Atlas
Acacia "kulnurensis"	Rare ("2RC")	Aberdare SF	Bell & Murray (2001)
Callistemon shiressii	Rare (3RC-)	Bow Wow Creek catchment	Bell & Murray (2001)
Macrozamia flexuosa	Rare (2K)	Bow Wow Creek catchment	Bell & Murray (2001)
		Neath	Bell (1996)
		North Rothbury	Patrick (1999)
		Werakata NP	Bell (2001a)
		Tomalpin area	HSO (2002; in prog)
Eucalyptus fergusonii subsp. *dorsiventralis*	Rare (2RC-)	Murrells Rd, Heaton SF	Bell (2000)
		Summit Point, Heaton SF	Bell (2000)
		Bow Wow Creek catchment	Bell & Murray (2001)
Eucalyptus fergusonii subsp. *fergusonii*	Rare (2RC-)	North Rothbury	Patrick (1999)
Grevillea montana	Rare (2KC-)	Neath	Bell (1996)
		Singleton army base	pers. obs.
		Werakata NP	Bell (2001a)
		Tomalpin area	HSO (2002; in prog)

2.0 Methods

2.1 Survey design

Survey of the HEZ site was structured in such a way that existing data sources could be incorporated into the overall design. These included standard floristic plot sites undertaken by Binns (1996: 3 plots), and Bell (2001a: 7 plots), as well as other species lists and mapping of

Ecotone Ecological Consultants (1999) and HSO (unpubl. data). Two further plots were completed by NPWS (2000a) during the LHCCREMS project, however confidentiality agreements meant that this data was not available for the current work. Budgeting during the current project allowed for approximately 20 new survey sites, giving a total of over 30 sites to analyse. An audit of all existing data was carried out to ensure consistency of nomenclature and survey methods used.

2.2 Aerial photographic interpretation

Mapping of vegetation patterns present within the HEZ site was undertaken using colour aerial photographs examined under stereoscopic vision (Cessnock, 1:25000 scale, flown 2000). Photopatterns of differing texture and colour were marked onto clear acetate overlays, and then scanned and orthorectified into digital format. In addition, orthorectified digital photos (flown 1998) provided by the Land Information Centre were examined to refine polygon linework. Tracks and trails present within the area were also transferred from photographs to assist field survey and ground truthing.

2.3 Site selection

The selection of floristic survey sites was driven principally by the need to provide a highly accurate portrayal of the vegetation present. Consequently, study sites were placed in locations representative of observable variations in floristic and structural composition, following extensive field reconnaissance of the entire site. This methodology departs from the more typical approach, where sites are placed proportionally within an environmental stratification (such as soil landscape, elevation etc), as the available information on environmental attributes was not considered fine enough to surrogate for floristic variation. In addition, previous experience has shown that the vegetation around Cessnock is particularly complex, and more value can be achieved through strategically placed quadrats than those within an environmental stratification.

2.4 Floristic survey

Floristic survey was carried out within HEZ primarily between March and July 2003. Local familiarity with the vegetation occurring in the area assisted in the identification of most species that were not flowering or fruiting during this time. Despite this, a small number of species could not be confidently assigned to subspecies or varietal rank with certainty.

Survey methodology followed that outlined by Wilson *et al* (1997), which was also identical to that used by NPWS (2000a). It is also consistent with Cessnock Council's D.C.P. No. 56 *Flora and Fauna Survey Guidelines*. Within each 0.04 ha survey site, all vascular plant species present were

recorded and given a cover abundance rating, based on a modified Braun-Blanquet scale (see Walker & Hopkins 1990). Physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position, etc) were also recorded, and photographs were taken of the site for later reference. Voucher specimens of unknown or significant status were collected for later identification or lodgement with the National Herbarium in Sydney.

During field survey, general reconnaissance was also made over most of the area on foot and in 4WD vehicle, while moving between plots. During such reconnaissance, the distributions of vegetation community types were noted, while searches for significant plant species were also made. Cropper (1993) and Keith (2000) indicate that the detection of rare or threatened plant species is often best achieved through general traverses. Levels of disturbance, weed invasion and fire history of the area could also be assessed in this manner.

2.5 Data analysis and vegetation classification

Cluster analysis was performed on collected data using the *PATN* Statistical Analysis Package (Belbin 1995a, 1995b), following methodology undertaken in similar works (eg: Keith & Bedward 1999; Griffith, Wilson & Maryott-Brown 2000; NPWS 2000a). Belbin (1991) provides detailed discussion on how ecological data is analysed using this program.

Delineation of vegetation communities was planned to be undertaken as far as possible at the 0.7 level of dissimilarity, although reference to field notes collected during truthing exercises formed an important part of the analysis. At all times, familiarity with the field situation guided the classification process. Most vegetation classifications carried out using PATN clustering techniques delineate vegetation communities at the 0.6 to 0.8 dissimilarity levels wherever possible.

2.6 Vegetation mapping

Following floristic survey and cluster analysis of collected data, floristic vegetation communities were mapped for the whole of the HEZ site, based on the API layer previously prepared. Boundaries of floristic communities were determined using a combination of broad vegetation trends, cluster analysis of survey data, knowledge of the ground situation and re-examination of aerial photographs. The high number of tracks and trails present enabled detailed ground truthing of these floristic communities to then occur to a relatively high degree of accuracy. Refinements to the regional mapping of NPWS (2000a) were also undertaken as a by-product of this process.

3.0 Results

3.1 Floristic survey

Twenty-one full floristic plots were completed during the survey, which when combined with the ten previously existing sites provided a total of thirty-one plots. Appendix 1 details the biophysical information for each site, and Figure 2 shows their locations.

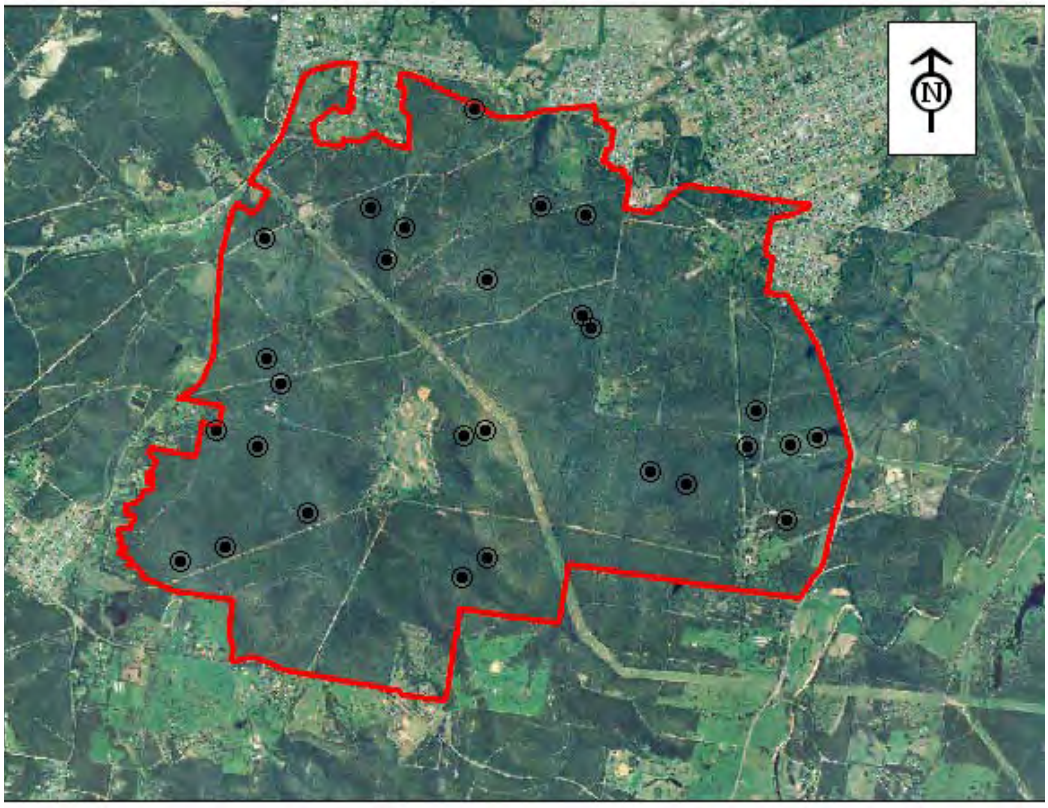

Figure 2 Location of floristic study plots, Hunter Economic Zone.

A total of over 380 plant taxa were recorded during the survey (Appendix 2). Nine rare or threatened plant species occur within the HEZ (Table 3), three of which (*Acacia bynoeana, Eucalyptus glaucina, Eucalyptus fergusonii* subsp*. dorsiventralis*) were recorded for the first time on the site during this study. The balance (*Callistemon linearifolius, Eucalyptus parramattensis subsp. decadens, Grevillea parviflora subsp. parviflora, Grevillea montana, Rutidosis heterogama, Macrozamia flexuosa*) have been previously recorded during other surveys of the site (Ecotone Ecological Consultants 1999, 2000; Bell 2001a; HSO 2002, in prog.). In addition, two eucalypt taxa (*Eucalyptus* sp aff *agglomerata* & *Eucalyptus* sp aff *camfieldii*) occur on the site which possibly represent new species. While these potential new species are not currently recognised as rare or threatened, they remain of some significance until further information is collected. All taxa considered of conservation significance are discussed in detail in Section 4.2 (and see HSO in prog.).

Table 3 Rare or Threatened plant taxa present on the HEZ.

Species	Status	Source
Acacia bynoeana	TSC S1	current study; HSO in prog.
Callistemon linearifolius	TSC S2	Ecotone 1999, 2000; Bell 2001a; HSO 2002, in prog
Eucalyptus glaucina	TSC S2	current study; HSO in prog.
Eucalyptus parramattensis subsp. decadens	TSC S2	Ecotone 1999, 2000; Bell 2001a; HSO 2002, in prog
Grevillea parviflora subsp. *parviflora*	TSC S2	Ecotone 1999, 2000; Bell 2001a; HSO 2002, in prog
Rutidosis heterogama	TSC S2	current study; HSO in prog.
Eucalyptus fergusonii subsp. *dorsiventralis*	2RC-	current study
Grevillea montana	2KC-	Ecotone 1999, 2000; Bell 2001a; HSO 2002, in prog
Macrozamia flexuosa	2KC-	Ecotone 1999, 2000; Bell 2001a; HSO 2002, in prog
Eucalyptus sp. aff agglomerata	new taxon	current study
Eucalyptus sp. aff camfieldii	new taxon	current study

3.2 Data analysis and delineated plant communities

Data analysis of collected floristic data proved extremely complex in parts of the HEZ site. The high level of intergrading vegetation types associated with the Kurri Sands landscape in particular meant that insufficient replicates could be sampled within the available budget. While variations within observable vegetation types could be identified in the field, statistical support could not be obtained with the available data. This scenario is not totally unexpected, as previous experience with vegetation occurring in the Cessnock area has shown that an unusually high density of study plots is required to clearly define floristic relationships.

An analysis using the Bray-Curtis association measure was undertaken, with an UPGMA strategy and the default PATN settings. The cluster analysis showed that at the 0.6 level of dissimilarity, 31 groups were evident (one group per site). At the 0.8 level of dissimilarity, twenty clusters eventuated (out of 31 sites), with only ten groups consisting of more than one site (and all but one of these comprised of only two sites). At the 0.9 level, broad community groupings eventuated, but the lack of replicates meant that some unusual pairings were evident (see Figure 3). Community delineations for this report have been made at the 0.9 level, although several variations have been discussed within these. Additional replicated survey plots are required to enable more meaningful interpretations of the data to be made, particularly within the highly variable and intergrading Kurri Sands Swamp Woodland and Lower Hunter Spotted Gum-Ironbark Forest (Units 35 & 17 respectively).

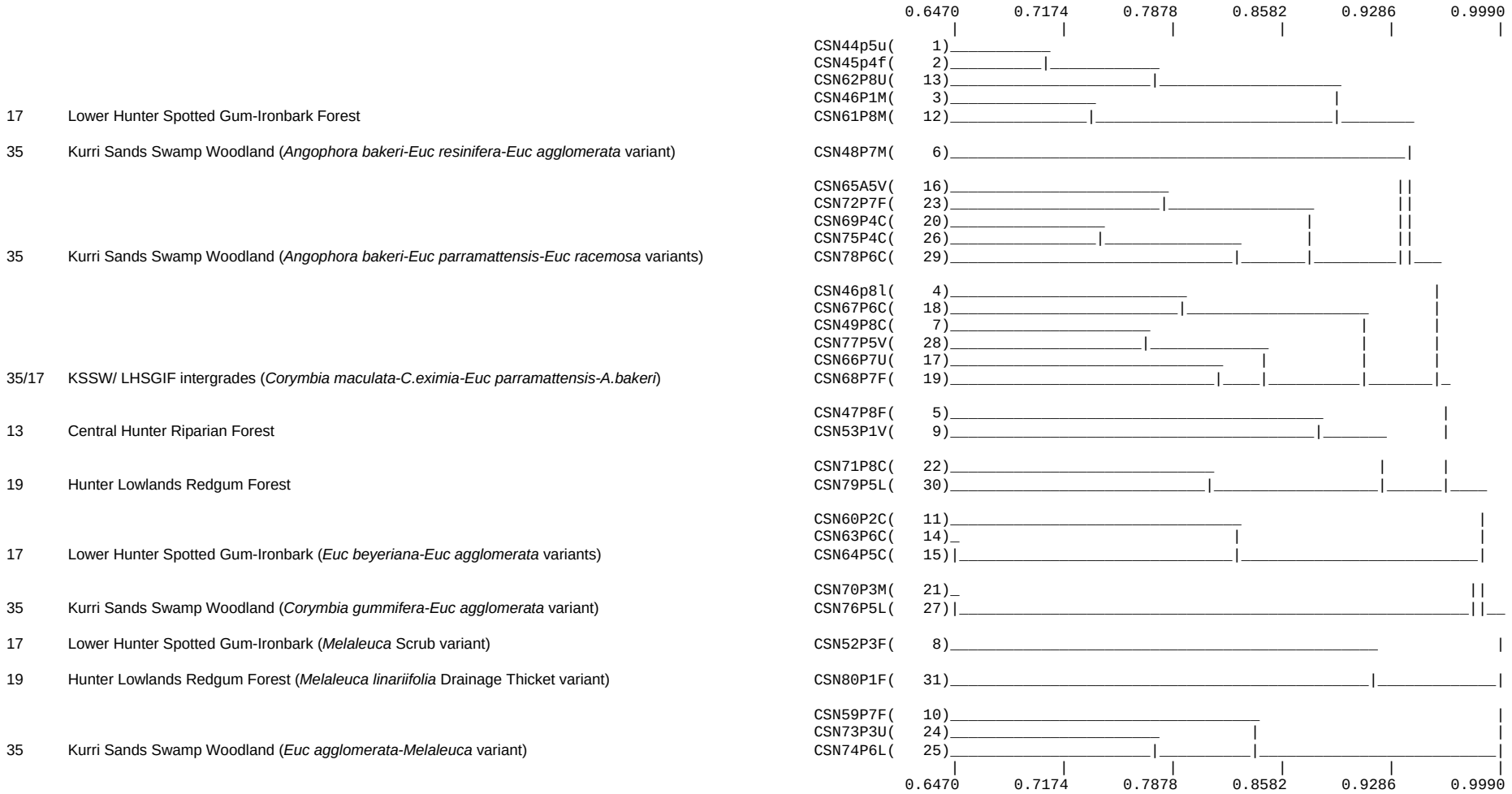

Figure 3 Site dendrogram produced through the PATN analysis, with clusters separated at ~0.9 level of dissimilarity.

As a consequence of this complexity, five vegetation communities have been delineated and described within the REMS framework (see NPWS 2000), but variations as observed in the field have also been described and mapped. As these variations have not been delineated in other studies in the Cessnock area (apart from parts of Werakata NP: Bell 2001), it is difficult to assess the conservation status of these with any confidence. It is likely that some of these variations will ultimately be recognised as more restricted and threatened than others, but ongoing studies are required.

Table 4 summarises the main features of the five vegetation communities identified, including the observable variations. Appendix 3 contains detailed profiles for all vegetation communities. A brief summary of each is provided below.

Unit 13: Central Hunter Riparian Forest
A variable community occupying narrow zones along tributaries of the major creeks, excluding the broader alluvial flats. Dominant canopy species include *Eucalyptus canaliculata, Angophora floribunda, Eucalyptus moluccana, Casuarina glauca* (in places), and various *Melaleuca* species. Variants occur based primarily on local soil type (sand vs clay).

Unit 17: Lower Hunter Spotted Gum-Ironbark Forest
Characterised by Spotted Gum (*Corymbia maculata*) and various Ironbarks (predominantly *Eucalyptus fibrosa*). Other canopy species include *Eucalyptus agglomerata* (atypical form), *Eucalyptus beyeriana, Eucalyptus punctata*, and a few restricted locations *Corymbia eximia*. Dominance by *Melaleuca nodosa* in the shrub layer is indicative of past disturbance in some areas.

Unit 19: Hunter Lowlands Redgum Forest
A community generally dominated by Redgums (*Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia, Eucalyptus glaucina*) and other species such as *Angophora floribunda, Eucalyptus punctata,* and occasionally *Eucalyptus crebra*. Understorey is grassy with scattered shrubs due to past disturbance. In some creek lines with impeded drainage, thickets of *Melaleuca linariifolia*, *Melaleuca styphelioides* and occasionally *Callistemon salignus* develop, over an understorey of sedges such as *Carex appressa* and grasses.

Unit 35: Kurri Sand Swamp Woodland
Kurri Sands Swamp Woodland is a highly variable vegetation type which comprises a number of observable combinations of canopy and understorey species. Most occur on sandy soils and support a range of heathy understorey plants, but others are present on claypans in close proximity to sand deposits. Canopy species present within the broader KSSW include *Angophora bakeri, Corymbia gummifera, Eucalyptus agglomerata, Eucalyptus resinifera, Eucalyptus parramattensis subsp. decadens, Eucalyptus fibrosa, Eucalyptus punctata, Eucalyptus racemosa,* and *Eucalyptus capitellata*. Scrub and heath variants are also present, where a stunted and widely spaced canopy of trees occurs.

Unit 46: Freshwater Wetlands
A few small wetland areas are present in the study area, most of which have been formed from man-induced activities. These have yet to be sampled in detail, but consist of at least two variants. The first occurs in drainage lines in the east where the construction of MR 195 has created wetlands dominated by *Baumea articulata* and *Philydrum lanuginosum*. The second is dominated by *Typha orientalis*, which colonises disused water storages such as dams.

Table 4 Summary of vegetation communities and variations, Tomalpin HEZ.

Unit	Community	Variation	Floristic plot
13	Central Hunter Riparian Forest	a) *Eucalyptus moluccana–Angophora floribunda–Eucalyptus punctata* Alluvial Clay Woodland	CSN47; CSN83; CSN90
		b) *Angophora floribunda – Eucalyptus punctata – Pteridium esculentum* Alluvial Sand Forest	CSN81
		c) *Angophora floribunda–Eucalyptus tereticornis* Elevated Riparian OF (Tomalpin amphitheatre)	[unsampled]
		d) *Casuarina glauca – Angophora floribunda – Melaleuca linariifolia* Riparian Forest	CSN53
		e) *Melaleuca styphelioides – Syncarpia glomulifera* Moist Riparian Forest	CSN65
17	Lower Hunter Spotted Gum-Ironbark Forest	a) *Eucalyptus fibrosa – Corymbia maculata – Eucalyptus punctata* Grassy Open Forest	CSN49; CSN61; CSN71
		b) *Eucalyptus beyeriana – Corymbia maculata* Grassy Open Forest	CSN62; CSN63
		c) *Corymbia eximia – Corymbia maculata – Eucalyptus fibrosa* Heathy Open Woodland	CSN66; CSN78
		d) *Eucalyptus fibrosa – Eucalyptus* sp aff *agglomerata* Open Forest	CSN60
		e) *Eucalyptus* sp aff *agglomerata-Eucalyptus punctataXcanaliculata–Corymbia maculata* Open Forest	CSN64
		f) *Eucalyptus canaliculata* Grassy Open Forest (Top of Mt Tomalpin)	[unsampled]
19	Hunter Lowlands Redgum Forest	a) *Eucalyptus tereticornis-Eucalyptus punctata-Angophora floribunda* Open Forest	CSN79
		b) *Melaleuca linariifolia-Melaleuca styphelioides* Drainage Thicket	CSN80
35	Kurri Sands Swamp Woodland	a) *Angophora bakeri – Eucalyptus racemosa – Eucalyptus parramattensis* Heathy Forest	CSN72
		b) *Eucalyptus parramattensis – Melaleuca* Claypan Dry Scrub Forest	CSN68; CSN74
		c) *Corymbia gummifera – Angophora bakeri – Eucalyptus* sp aff *agglomerata* Shrubby Open Forest	CSN70
		d) *Melaleuca decora – Melaleuca nodosa – Eucalyptus fibrosa* Scrub	CSN46; CSN52
		e) *Eucalyptus* sp aff *agglomerata – Eucalyptus resinifera - Melaleuca* Heathy Scrub Forest	CSN59; CSN73; CSN89
		f) *Angophora bakeri–Eucalyptus capitellata–Eucalyptus parramattensis* Heathy Woodland	CSN69; CSN77; CSN91
		g) *Leptospermum parvifolium-Melaleuca nodosa* Heath	CSN84
		h) *Xanthorrhoea fulva-Melaleuca-Leptospermum* Scrub	CSN82
		i) *Angophora bakeri – Eucalyptus resinifera – Eucalyptus* sp aff *agglomerata* Scrub Forest	CSN48; CSN59
		j) *Angophora bakeri – Eucalyptus punctata* Heathy Woodland	CSN67
		k) *Eucalyptus* sp aff *agglomerata – Eucalyptus punctata – Angophora bakeri* Shrubby Heath Woodland	CSN75; CSN76
46	Freshwater Wetlands	a) *Baumea articulata* Sedgeland	[unsampled]
		b) *Typha* Sedgeland	[unsampled]

3.3 Vegetation mapping

Mapping of floristic vegetation communities was undertaken after survey and analysis, and included an extensive ground truthing program in which all tracks and trails were traversed, and foot transects undertaken. In addition, GPS locational data of all mature tree species carried out by HSO from across the development zone provided the opportunity for a desktop truthing exercise to be undertaken, by overlaying tree species distribution with the vegetation map. Patterns in vegetation distribution throughout the Tomalpin HEZ are provided as Figure 4.

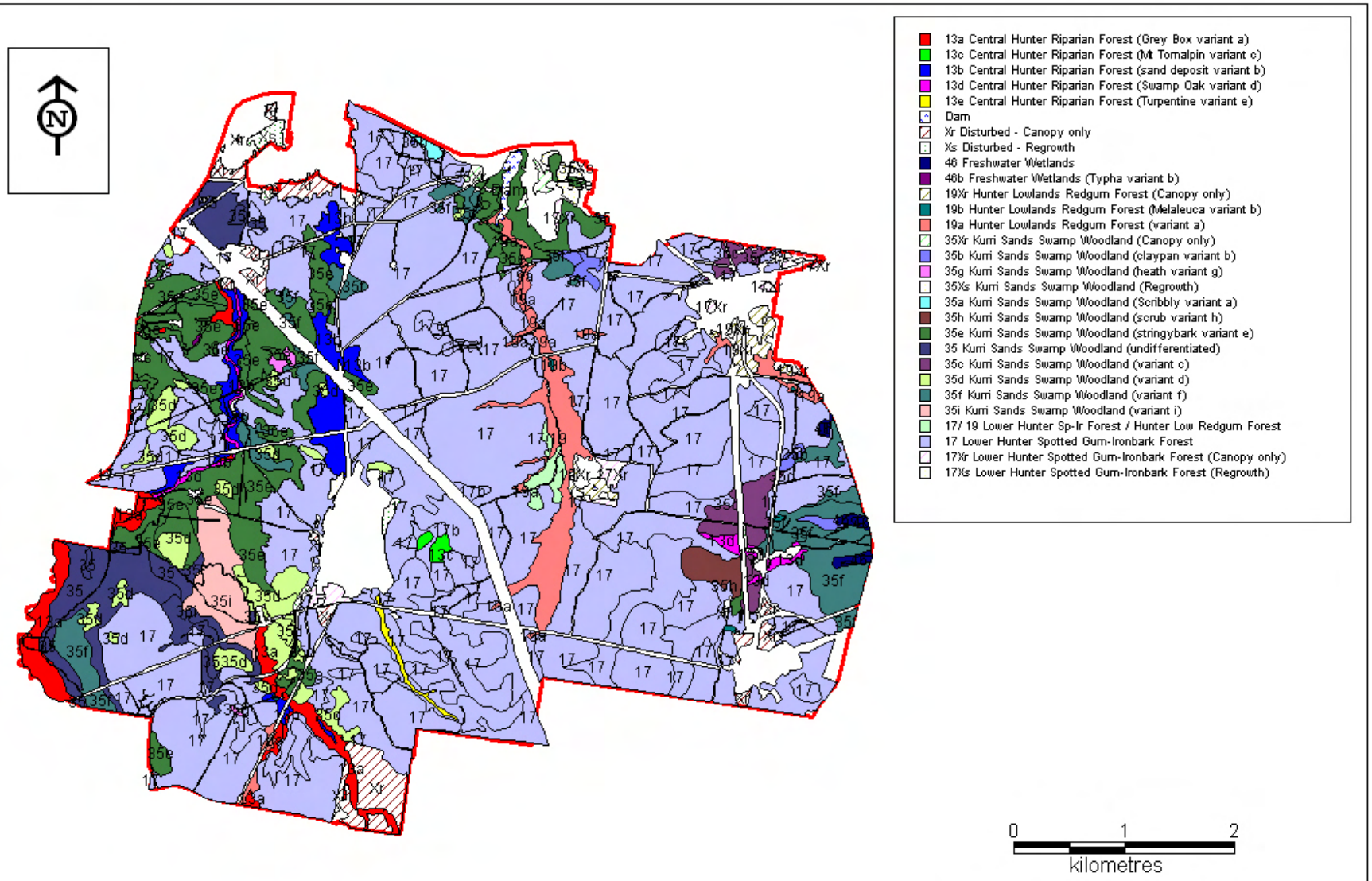

Figure 3 **Vegetation map of the HEZ site.**

4.0 Discussion and Conservation Significance

4.1 The Hunter Economic Zone flora

The Hunter Economic Zone supports a range of vegetation communities and flora species that are generally poorly reserved throughout the lower Hunter Valley. This fact has been previously recognised in relation to the vegetation contained within Werakata National Park (Bell 2001a). Survey and analysis undertaken for the current study has identified over three hundred plant taxa and five vegetation communities. Floristic variations within several of these have also been recognised, but formal recognition as sub-communities through statistical analysis has not been possible due to inadequate replicates. The HEZ site also plays an important role in the regional corridor linking sizeable areas of bushland from around Cessnock (including State Forest land), south to the Watagan Range (Bell & Murray 2001).

Eucalypt diversity

The HEZ study area supports a surprisingly high number of eucalypt species (29) within a relatively small area, which is indicative of the diversity of vegetation present (Table 5). Ironbarks in particular are represented by six taxa, with the likelihood of at least two further species (*Eucalyptus placita* and *Eucalyptus nubila*) also being present. When compared against the results of several other studies on the east coast of Australia, HEZ is a highly diverse area on a species-per-hectare basis (Table 6). Of the 262 recognised eucalypts in New South Wales, over 10% occur within the 3 300ha HEZ site. The area is therefore un-paralleled in the diversity of eucalypts presently documented within areas less than 15000 ha in size.

Stringybark complex

Within the HEZ study area, it is apparent that considerable integration and hybridisation is taking place between various stringybark taxa. While traditionally stringybarks have always been difficult to identify with certainty, there appears to be a number of intergrading characters at HEZ which suggest that several taxa are present and may be undergoing a process of hybridisation. Specimens of stringybark collected in the south-east, for example, show a strong resemblance to the vulnerable *Eucalyptus camfieldii*, a species generally restricted to the poor sandstone soils of the Hawkesbury Sandstones, but with other forms recently being recognised from the Norah Head-Forresters Beach and Tomago areas (Hill 2002; Hill 2003). A visit to the site by Ken Hill (eucalypt expert from the National Herbarium of New South Wales) confirmed that these specimens are strongly related to other coastal populations of what is broadly described as *Eucalyptus camfieldii*, but is now considered to be a distinct and separate entity (K. Hill, pers. comm.). Clarification of the likely identity of these specimens is currently underway.

Another stringybark that is widespread across the Tomalpin site is also thought to represent a new taxon. Specimens previously identified as atypical forms of *Eucalyptus agglomerata* (Bell 2001) were inspected on-site by Ken Hill, who believes them to represent a new species. Field experience in the lower Hunter area would suggest that this taxon is restricted to the wider Cessnock area, generally (but not always) within the wider Kurri Sands landscape. Within the constraints of the current project it has not been possible to adequately address these issues in detail, and studies will continue with the National Herbarium on taxonomic matters in the coming months.

Table 5 Eucalypts (including the genera *Angophora, Corymbia,* and *Eucalyptus*) within the HEZ study area.

Species	Occurrence in Tomalpin
Angophora bakeri	restricted to sand-based soils
Angophora floribunda	common in alluvial soils
Corymbia eximia	highly restricted; a few locations only
Corymbia gummifera	restricted to some sand-based soils
Corymbia maculata	widespread in clay-based soils
Eucalyptus acmenioides	occasional in clay-based soils
Eucalyptus amplifolia subsp*. amplifolia*	occasional in alluvial clays
Eucalyptus beyeriana	restricted; Mt Tomalpin only
Eucalyptus canaliculata	occasional, mainly riparian locations
Eucalyptus capitellata	scattered but widespread
Eucalyptus carnea	near the "horse paddock" in the centre of the area
Eucalyptus crebra	occasional in clay-based soils
Eucalyptus fergusonii subsp*. dorsiventralis* (ROTAP)	restricted; ridgeline south of Mt Tomalpin
Eucalyptus fibrosa	widespread in clay-based soils
Eucalyptus glaucina (TSC S2)	restricted; Chinamans Hollow Creek only
Eucalyptus globoidea	restricted; alluvial clay flats
Eucalyptus moluccana	restricted; a few scattered localities
Eucalyptus paniculata subsp*. paniculata*	scattered in clay-based soils
Eucalyptus parramattensis subsp*. decadens* (TSC S2)	widespread in sand-based soils
Eucalyptus punctata	widespread in clay-based soils
Eucalyptus punctata X canaliculata	widespread
Eucalyptus racemosa	far northern section near Chinaman's Hollow
Eucalyptus resinifera subsp*. resinifera*	restricted; sand-based soils
Eucalyptus siderophloia	common on clay-based soils
Eucalyptus sp. aff*. agglomerata* (probable new taxon)	common in all soils
Eucalyptus sp aff *camfieldii* (probable new taxon)	highly restricted; south-east on sand-based soil
Eucalyptus sparsifolia	very scattered in sandy soils
Eucalyptus tereticornis	common on alluvial clays
Eucalyptus umbra	occasional

Terrestrial orchid diversity

During botanical studies on the HEZ site to date, a total of twenty-four orchid species have been recorded. Previous studies have identified only *Dipodium punctatum, Cymbidium suave* and a *Microtis* sp. on the site (Ecotone Ecological Consultants 2000). As this group of plants have representatives that flower throughout the year in all seasons, the full diversity of orchid species, particularly terrestrial types, is yet to be realised. It is difficult, therefore, to consider the impacts of

any proposed development on the orchid flora. There is some potential that threatened orchid species may be present within the site, based on the habitat present. The vulnerable *Cryptostylis hunteriana*, for example, is a strong contender to inhabit the Kurri Sands Swamp Woodland, based on the similarity of floristics and soil types to other known habitats (see Bell 2001c). The new populations of *Acacia bynoeana* discovered in such habitat at HEZ lend weight to this contention, since both species occur in similar habitat on the Central Coast. Historically, Rupp (1969) lists around thirty species of terrestrial orchids for the Weston-Kurri area, and this work represents the only known published record of the orchids of this area. Immediately east of the HEZ, HSO (2003) has recorded a single plant of *Diuris* sp. aff. *dendrobioides* (Hunter Valley), which is described by Bishop (1996) as being a rare and vulnerable species restricted to a small portion of the Hunter Valley that should on no account be disturbed. This taxon is not listed on the *TSC Act 1995*.

Table 6 **Eucalypt diversity in various east coast locations, arranged in decreasing order of species per hectare.**

Location	No. Eucalypts	Area (ha)	Ha/ spp	Spp/ ha x 10 000	Source
Tingira Heights NR, Lake Macq.	8	16	2	5000	Bell 1998b
Pulbah Island NR, Lake Macquarie	7	69	10	1015	Bell 1998b
Awabakal NR, Lake Macquarie	13	245	19	531	Bell 1998a
Glenrock SCA, Newcastle	16	522	33	307	Bell 1998a
Garigal NP, northern Sydney	19	819	43	232	Sheringham & Sanders 1993
Clyde River NP, Batemans Bay	13	1 278	98	102	Douglas & Bell 2003a
HEZ	29	3 300	114	88	Current study
Tomaree NP, Port Stephens	13	2 266	174	57	Bell 1997a
Bimberamala NP, Batemans Bay	16	4 500	281	36	Douglas & Bell 2003b
Towarri NP, Cedar Brush NR & Wingen Maid NR, Upper Hunter	24	6 840	285	35	Hill et al 2001
Manobalai NR, Upper Hunter	12	4 500	375	27	Bell 1997b
Gardens of Stone NP, nr Mudgee	33	15 230	462	22	Washington 2001
Brisbane Water NP, Central Coast	22	11 000	500	20	Benson & Fallding 1981
Dharug NP, Central Coast	26	14 728	566	18	Clarke & Benson 1986
Barrington Tops/ Mt Royal NPs	41	67 530	1 647	6.07	Zoete 1998
Tenterfield SFMA	54	91 500	1 694	5.90	Binns 1995
Guy Fawkes NP, northern NSW	36	80 000	2 222	4.50	Austeco 2000
Coffs Harbour-Urunga SFMA	40	95 000	2 375	4.21	Tweedie et al 1995
Woronora Plateau	51	141 113	2 767	3.61	NPWS 2002a; Keith 1994; French et al 2000
Watagan Ranges	34	112 000	3 294	3.04	Binns 1996
Warragamaba Special Area	75	260 702	3 476	2.88	NPWS 2003
Yengo National Park	36	189 073	5 252	1.90	Bell et al 1993
Wollemi National Park	62	487 552	7 864	1.28	Bell 1998c
SE NSW Eden	66	800 000	12 121	0.83	Keith & Bedward 1999
Australian Alps	34	674 376	19 834	0.50	NPWS 2002b
SE Qld RFA study area	74	6 200 620	83 792	0.12	Bean et al 1998

Evidently, seasonal surveys for terrestrial orchid species should ideally be undertaken as a matter of course prior to any development of the HEZ.

4.2 Threatened & Rare taxa

During the course of survey work, several species of conservation significance were recorded, some of which confirm previous records for the site. In total, one endangered (*Acacia bynoeana*), five vulnerable (*Callistemon linearifolius, Grevillea parviflora* subsp. *parviflora*, *Eucalyptus glaucina, Eucalyptus parramattensis* subsp. *decadens, Rutidosis heterogama*), three rare (*Eucalyptus fergusonii* subsp*. dorsiventralis, Grevillea montana*, *Macrozamia flexuosa*) and several species of regional significance (see table later) were detected. Regional significance is based on the listing of species maintained by the Rare Plants Subcommittee of the Hunter Region Botanic Gardens (Bell, Peake, Tame, Simpson & Curran in prep.). In addition, two potential new species of eucalypt (*Eucalyptus* sp aff *agglomerata* & *Eucalyptus* sp aff *camfieldii*) were recorded. Specimens of all significant species have been lodged at the National Herbarium, Sydney. Note that further information on the occurrence of threatened and rare taxa within the HEZ is being investigated by Harper Somers O'Sullivan as part of the Ecological Constraints Master Plan (ECMP) process.

Endangered species

***Acacia bynoeana* Benth.**

During surveys for the present study four new populations of the Endangered *Acacia bynoeana* were discovered, confirming recent records of the species for the Cessnock area. Importantly, the populations at the HEZ appear to be quite sizeable, with rough estimates (based on previously reported densities; see Bell & Driscoll 2002; Bell & Driscoll in review) of more than 3000 plants. The determination of *Acacia bynoeana* as an Endangered species under the TSC Act 1995 states that most populations comprise 1-5 individuals, with perhaps 300-500 plants within the State. However, these estimates are almost certainly not based on field assessment, as recent studies have confirmed that most populations in the northern parts of the known range comprise at least 200 plants, occasionally up to 2000 plants (Bell & Driscoll in review). While detailed counts of the Cessnock populations have yet to be done, it is likely that similar trends will be apparent.

Of further interest in regard to the HEZ populations is the presence of *Acacia bynoeana* in previously undocumented habitat. A regional analysis of all known populations of this species is currently underway, with the aim of identifying suitable habitat for potential new populations in the wider region (Bell & Driscoll in prog.). The recent finds in vegetation broadly defined as Kurri Sands

Swamp Woodland infers that considerable areas of potential habitat exist in the wider Cessnock area.

Vulnerable species

***Callistemon linearifolius* (Link) DC.**

Spencer & Lumley (2002) indicate that *Callistemon linearifolius* occurs in dry sclerophyll forest on the coast and adjacent ranges chiefly from the Georges River to the Hawkesbury River on the Central Coast. It is a large shrub 3-4m in height with linear to linear-lanceolate leaves and bearing red flowers during Spring and Summer. This species is currently listed as Vulnerable (Schedule 2) on the NSW *Threatened Species Conservation Act 1995*, and carries a conservation risk code of 2RCi (Briggs & Leigh 1996).

Binns (1996) and Bell (2001a) had previously recorded *Callistemon linearifolius* from several locations in Aberdare State Forest/ Werakata NP. During the current survey, this species was recorded in several new locations, mostly within the understorey of Lower Hunter Spotted Gum-Ironbark Forest. Several additional records of the species within the HEZ have also been recorded by HSO staff, and estimates of over 4000 plants have been made for the HEZ area (Lucas Grenadier, pers. comm.). Both existing and new records of *Callistemon linearifolius* confirm that this species occurs within the North Coast botanical subdivision.

***Eucalyptus glaucina* Blakely**

Hill (2002) describes *Eucalyptus glaucina* as a tree to 30 m in height, locally frequent but sporadic in grassy woodland on deep moderately fertile and well-watered soils near Casino and from Taree to Broke. This species is currently listed as Vulnerable (Schedule 2) on the NSW *Threatened Species Conservation Act 1995*, and is also listed as 3VCa by Briggs & Leigh (1996). Populations of *Eucalyptus glaucina* are known from Selection Flat Flora Reserve on the NSW North Coast, where presumably more than 1000 individuals occur (Briggs & Leigh 1996), and also in part of Werakata National Park (Bell 2001a). In his survey of State Forests, Binns (1996) did not record *Eucalyptus glaucina* from anywhere within the Morisset forestry district, but suggested that if it did occur it would most likely be on the lower slopes or valley flats of Pokolbin State Forest.

Scattered individuals of *Eucalyptus glaucina* were recorded south of Kurri hospital, around Hebburn Dam, and near the “horse paddock” (DP1037092), where it occurs in Hunter Lowlands Redgum Forest with *Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia* and occasionally *Angophora floribunda*. As with most other occurrences of this species in the Hunter

Valley, most sites have been grazed in the past, leaving an open grassy understorey with only scattered shrubs. In a visit to the site, Ken Hill (National Herbarium of NSW) confirmed the identifications and indicated that there is a considerable amount of hybridisation occurring with *Eucalyptus tereticornis*, and that it would be a very difficult task to provide accurate population counts of the species without examining every tree, supported by genetic studies. Preservation of the species in this area would best be achieved through protection of the Hunter Lowlands Redgum Forest in which it occurs.

***Eucalyptus parramattensis* subsp. *decadens* L. Johnson & Blaxell**

Eucalyptus parramattensis is a small smooth barked tree, locally frequent in dry sclerophyll woodland on sandy soils in low, often wet sites (Hill 2002). Subspecies *decadens* is currently listed as Vulnerable on Schedule 2 of the NSW *Threatened Species Conservation Act 1995*, and apart from populations within Werakata NP, there are no other occurrences within dedicated conservation reserve (Murray & Bell 2002.). Extensive areas of this subspecies do occur on the Tomago Sandbeds north of Newcastle, this area acting as a psuedo-conservation reserve through its management as an emergency water supply by the Department of Land and Water Conservation (Bell & Fallding 2002).

Within the HEZ, *Eucalyptus parramattensis* subsp. *decadens* has a limited distribution linked to the Kurri Sand Swamp Woodland and its many variants. The distribution of this species within HEZ has been mapped by HSO (in prog). Although some areas of *Eucalyptus parramattensis* subsp. *decadens* are present within Werakata NP, the vast majority of the Kurri population of this taxon occurs outside of reserve (Bell 2001a).

Grevillea parviflora* R. Br. subsp. *parviflora

Grevillea parviflora is a low spreading dense to erect open shrub 0.3-1m tall, occurring from the north-western Sydney region to the Cordeaux-Appin area, in moist heath or woodland on clay soils (Olde & Marriot 1995; McGillivray 2000). Both subsp. *parviflora* and subsp. *supplicans* have been listed on the NSW *Threatened Species Conservation Act 1995*, the former as Vulnerable (Schedule 2). Subspecies *parviflora* (as it is currently circumscribed) was recorded within Werakata National Park by Bell (2001a), and is also known from Karuah Nature Reserve (Bell 2002). No other records are known from within conservation reserve in the Hunter Valley area, nor from elsewhere within its known distribution (NSW Scientific Committee 1998).

Research currently in progress is attempting to clarify the taxonomic position of *Grevillea parviflora* within the *Grevillea linearifolia* complex in the lower Hunter Valley and Central Coast (Driscoll & Bell in prog.). Numerous forms of what is currently described as *Grevillea parviflora* have been

examined, and it is likely that several new taxa within this group may be recognised. The HEZ forms an important component of this research, which is likely to continue for several more months.

Estimates of *Grevillea parviflora* subsp. *parviflora* s. lat. have been made by HSO Ecology staff for the entire HEZ site of over 3 million above ground stems (Lucas Grenadier, pers. comm.). A rhizome study carried out under license by HSO involved the excavation of 12 plants, resulting in an average of three above ground stems per plant, and ranging between two and eight stems. While the taxon is certainly common where it occurs, it is possible that true *Grevillea parviflora* in the strictest sense is quite rare.

***Rutidosis heterogama* Philipson**

Harden (1992) describes *Rutidosis heterogama* as occurring in heath and along disturbed roadsides, from Maclean to the Hunter Valley. This species was detected within the development zone at HEZ by a third party during the current study, and several new locations were subsequently discovered. On current knowledge, the eastern half of the HEZ site, including the 4(h) development and 7(b) conservation zones, appears to be a major stronghold for the species within the Hunter region. While many plants were evident in recently burnt sites where additional light was available, the species was still present in unburnt areas with moderate shrub cover. It also occurs well distant from established trails in undisturbed areas. Of interest is the occurrence of this species at HEZ in the Lower Hunter Spotted Gum-Ironbark Forest, a habitat differing to the heath described by Harden (1992). A recent population of this species discovered in the Wyong region also occurs within a Spotted Gum – Ironbark forest type (Bell & Driscoll, unpubl. data).

Rare species

***Eucalyptus fergusonii subsp. dorsiventralis* L. Johnson & K. Hill**

Eucalyptus fergusonii subsp. *dorsiventralis* is an ironbark tree to 25m in height, growing in dry sclerophyll forest on sandstone ridges, in the Wollombi Valley and the Wollemi Wilderness (Hill 2002). This species is currently listed by Briggs & Leigh (1996) with a conservation risk code of 2RC-, indicating a rare species with a geographical distribution of less than 100km, and with unknown population sizes in conservation reserves. The species is known from Wollemi National Park (Briggs & Leigh 1996; Bell 1998c) and Yengo National Park (Bell, Vollmer & Gellie 1993; Maryott-Brown & Wilks 1993), Pokolbin and Yango State Forests (Bell 1995; Binns 1996), and in the north-western sections of Heaton State Forest (Bell 2000). Bell (2001a) has suggested that the increase in records of this species from throughout the Hunter region warrants downgrading of the conservation risk code to 2RCa (adequately conserved).

Within the HEZ, *Eucalyptus fergusonii* subsp*. dorsiventralis* was recorded along the ridgeline south of Mt Tomalpin, within a form of the Lower Hunter Spotted Gum – Ironbark Forest.

***Grevillea montana* R. Br.**

Currently listed as a rare species by Briggs & Leigh (1996), with a conservation code of 2KC-, *Grevillea montana* is restricted to the southern rim of the Hunter Valley from Sandy Hollow to Kurri Kurri (Olde & Marriott 1994; Makinson 2002). In recent years, survey work in national parks and other pseudo-reserves (eg: Wollemi NP, Yengo NP, Myambat Logistics Company, Singleton Military Area) has revealed substantial populations which suggest the revision of this code to 2RCa (Bell 2001b).

Binns (1996) had previously indicated that this species occurs in both Cessnock and Aberdare State Forests, although there is no indication of population sizes at either location. During the survey of Werakata National Park, *Grevillea montana* was found to be abundant in most areas (Bell 2001a). In most cases, the favoured habitat appears to be the sandy clay loams supporting the Lower Hunter Spotted Gum-Ironbark Forest, although it also occurs in the Kurri Sand Swamp Woodland. The size of the populations present within Werakata NP confirm the suggested code revision (Bell 2001b). The species is also relatively abundant across the remainder of the HEZ.

***Macrozamia flexuosa* C. Moore**

Macrozamia flexuosa is a rare species currently listed with a conservation code of 2K (Briggs & Leigh 1996), and occurs generally from Bulahdelah to Lake Macquarie (Hill 1998). Little information is currently known about the presence of this species within reserves; however it is known from Glenrock SRA (Bell 1998a), Lake Macquarie SRA and Pulbah Island NR (Bell 1998b), Werakata National Park (Bell 2001a), and Karuah and Wallaroo Nature Reserves (Bell 2002). Surveys are also being undertaken at present for the species within Lake Macquarie Shire, and have resulted in some populations within Council reserves (Bell & Helman in prog.).

This species is distributed widely throughout the HEZ, where it occurs in the Lower Hunter Spotted Gum-Ironbark Forest, tending to predominate more in conglomerate-based soils.

New species

Eucalyptus sp aff agglomerata

In several locations across the HEZ site, specimens of stringybark trees occur which appear to have some affinities with *Eucalyptus agglomerata*. Such specimens have been previously treated

as atypical forms of *Eucalyptus agglomerata* (Bell 2001), but a recent visit to the site by Ken Hill (National Herbarium of NSW) has confirmed that a new species is involved. Similar examples have been observed in other locations around Cessnock, but insufficient information is currently available on population size and distribution. Hill (2003) suggests that this taxon may qualify as a threatened species after taxonomic and population studies are carried out.

Eucalyptus* sp aff *camfieldii

A small stand of stringybark trees in the east of the HEZ site on Kurri sands bear strong similarities to the vulnerable *Eucalyptus camfieldii*. Hill (2003) considers this population to represent either a new species with affinities to, or a new subspecies of, *Eucalyptus camfieldii*. He also suggests that the new taxon may in fact be more threatened than the classic *Eucalyptus camfieldii* from Hawkesbury Sandstone geologies near Sydney. Further taxonomic and distributional studies are required on this population, which Hill (2003) considers as urgent.

Other potential threatened or rare species

With continuing survey, it is considered reasonable that three additional threatened or rare species may occur within the HEZ:

- *Cryptostylis hunteriana* – a leafless saprophytic terrestrial orchid, flowering from November to February, currently listed as Vulnerable on the TSC Act 1995. Potentially suitable habitat occurs within the more sandy areas of the Kurri Sand Swamp Woodland.
- *Tetratheca juncea* – a leafless shrub difficult to detect when not in flower (predominantly Winter to Summer), and currently listed as Vulnerable on the TSC Act 1995. Potentially occurs within the dryer sand-based forms of the Kurri Sand Swamp Woodland.
- *Eucalyptus prominula* – a rare stringybark known from the hills around Cessnock, including Pokolbin State Forest (Binns 1996) and Corrabare State Forest (Bell 2001b). Currently carries a ROTAP code of 2KC- (but should be amended to 2RC-), and potentially may occur within Lower Hunter Spotted Gum – Ironbark Forest on sandstone ridges south of Mt Tomalpin.

Regionally significant species

A small number of additional taxa are present within the HEZ that are considered to be regionally significant in the Hunter Valley (Bell *et al* in prep.). These taxa are summarised in Table 7. None of these species are legally protected, nor require addressing under threatened species legislation. However, all contribute to the diversity of vegetation present in the Cessnock district.

Table 7 Regionally significant taxa (excluding listed threatened or rare species).

Species	Regional significance	Occurrence in HEZ
Acacia deanei subsp. deanei	range extension onto NC	south-western section
Acacia linifolia	uncommon on Permian	occasional in KSSW
Angophora bakeri	restricted distribution	widespread, broadly in KSSW
Babingtonia pluriflora	near southern limit of distribution	Swamp Creek
Callistemon pinifolius	range extension onto north coast	eastern section in KSSW
Corymbia eximia	near northern limit of distribution	central section, a few locations
Dianella prunina	uncommon	scattered
Diuris aurea	northern limit at Kurri Kurri	scattered
Eucalyptus canaliculata	near southern limit of distribution	mainly along creeklines
Eucalyptus carnea	southern limit	near the “horse paddock”
Eucalyptus racemosa	disjunct occurrence	extreme north of the area
Gompholobium inconspicuum	range extension onto NC	southern sections
Lomandra cylindrica	northern limit of distribution	throughout the area
Melaleuca erubescens	range extension onto NC	south-eastern portion; also northern section in headwaters of Hebburn Dam, at AMG 354836 6367131
Micromyrtus ciliata	range extension onto NC	south-western section on sand
Santalum lanceolatum	easterly extension of range	south-western section on sand

4.3 Significant vegetation types

Much of the vegetation within the HEZ supports vegetation of conservation significance, either through the presence of threatened or rare plant species, or Endangered Ecological Communities. Other vegetation types are considered regionally significant due to their general rarity, or their lack of adequate reservation in formal conservation reserves.

Unit 13: Central Hunter Riparian Forest

A few major streams within the HEZ support a vegetation type that is most closely identifiable with the Central Hunter Riparian Forest of NPWS (2000a). However, there are several floristic differences worthy of mention. Along parts of Swamp Creek, such as in the Neath portion of Werakata National Park, a deeply incised channel supports fringing *Casuarina glauca* with *Melaleuca styphelioides* and *Melaleuca linariifolia*, over an understorey which includes *Baumea*

juncea and *Phragmites australis*. The presence of *Casuarina* and *Baumea* here suggests a strong saline influence not evident elsewhere in the Park.

In other areas, small sandy alluvial rises adjacent to drainage lines support a vegetation characterised by *Angophora floribunda* and *Eucalyptus punctata*, over an understorey of species such as *Leptospermum trinervium, Pteridium esculentum, Banksia oblongifolia, Lomatia silaifolia* and *Imperata cylindrica* var. *major*. This type is currently recognised as a variant of the Central Hunter Riparian Forest, but possibly is more closely related to the Warkworth Sands Woodland EEC near Singleton. That EEC occurs on aeolian sand dunes associated with Wollombi Brook, and it is possible that the vegetation within HEZ is a scaled-down version associated with sandy deposition from the Kurri Sand deposits. Further survey and analysis is required to clarify the floristic relationships here, but until that time these sandy rises are considered at least regionally significant.

Unit 17: Lower Hunter Spotted Gum-Ironbark Forest

The Lower Hunter Spotted Gum-Ironbark Forest represents a vegetation type that was formerly quite widespread on the floor of the Hunter Valley (NPWS 2000a). Forests between Beresfield and Cessnock represent the core of its distribution, although much of this occurs in State Forest and has been managed for timber production for many years. Within the region, NPWS (2000a) have mapped an extant distribution of 26917ha, which represents a reduction of 59% of its former range. Under the criteria of Landsberg (2000), this vegetation type classifies as vulnerable due to a substantial decline in distribution (Criteria A).

Extensive areas of the HEZ study site support components of the Lower Hunter Spotted Gum-Ironbark Forest. This is particularly the case in the east of the site. Areas around Mt Tomalpin in the south-west support a different form of this community. Bell (2001a) has mapped approximately 1600 ha of this vegetation type for Werakata National Park, which plays a critical role in its conservation in the region. NPWS (2000a) report only 1873 ha of this community from all conservation reserves.

Unit 19: Hunter Lowlands Redgum Forest

Hunter Lowlands Redgum Forest has been identified as a regionally significant vegetation community by NPWS (2000a), and is listed as an Endangered Ecological Community under the NSW *TSC Act 1995*. Within the Tomalpin HEZ, Chinamans Hollow Creek catchment supports good examples of this community. As far as is known, Werakata National Park (with 7ha) represents the only formal conservation reserve protecting examples of this vegetation type in the region.

There is considerable variation within the Hunter Lowlands Redgum Forest, much of it related to soil drainage and disturbance history. Areas suffering from frequent fires tend to support a higher component of grass species, while in other areas shrubs such as *Bursaria spinosa* and *Melaleuca nodosa* are prevalent. In poorly drained depressions where runoff forms small billabongs and ponds, *Melaleuca linariifolia* thickets occur offering specialised fauna habitat. The latter areas are poorly represented in Werakata National Park.

Unit 35: Kurri Sand Swamp Woodland

The Kurri Sand Swamp Woodland [as delineated by NPWS (2000a)] was determined as an Endangered Ecological Community under the *Threatened Species Conservation Act 1995* in July 2001. The description of this community as listed in the TSC Act legislation includes a list of plant species which characterise the unit. When compared against several vegetation types present in the HEZ, there are clear differences in the dominant and component species which make including them within the TSC Act definition difficult. This issue has been raised previously in regard to the vegetation present within Werakata National Park (Bell 2001a). The overall description of the community in the determination, particularly its biophysical components, is generally consistent with the field situation, but there are important discrepancies. Bell (2001a) considered parts of the vegetation within Werakata NP as a variant of the Kurri Sands Swamp Woodland of NPWS (2000a), and mapped approximately 70 ha of this variant within the Park, and stated that nowhere was the Kurri Sands Swamp Woodland as defined in the TSC Act represented.

Survey as part of the current project has confirmed and extended the variations evident within the Kurri Sand Swamp Woodland alluded to in Bell (2001a). Several forms of what may be considered part of the KSSW are present within the HEZ, and indeed in the wider Cessnock-Kurri region. The floristic composition in all of these is heavily dependant on soil type (specifically the relative proportions of sand and clay) and the related drainage patterns. Table 8 summarises some of these main variations and relates them to biophysical characteristics.

The Kurri Sands Swamp Woodland and its variations show strong affinities to parts of the western Sydney vegetation. NPWS (2000b) describe and map the natural vegetation of the Cumberland Plain, where they identify four communities occurring on two different deposits of Tertiary alluvium. The distribution of these four communities is reportedly related to the extent of exposure of soils from three depositional phases, and local drainage conditions. Consequently, vegetation dominated by ironbarks (Castlereigh Ironbark Forest) occurs on soils with a high clay content, while more sandy soils support Scribbly Gum (Castlereigh Scribbly Gum Woodland). Typically, soils with a high clay content underlie sandy soil but tend to be exposed through erosion around

the edges of deposits. Poorly drained depressions support a swamp woodland (Castlereigh Swamp Woodland), while shallow deposits of Tertiary alluvium over shale soils, or localised concentrations of iron-indurated gravels, support a transitional forest (Shale Gravel Transition Forest). A fifth community with a sparse canopy but with a dense understorey of *Melaleuca nodosa* (Cooks River Clay Plain Scrub Forest) was included as a sub-unit of the Castlereigh Ironbark Forest.

Table 8 Variations observed within the Kurri Sands Swamp Woodland.

Variation	Substrate	Structure & situation	Floristic composition
A	White sand	Open forest with heathy understorey; higher crests, well drained sandy soil	*Eucalyptus racemosa, Angophora bakeri, Lambertia formosa*
B	Grey clay	Woodland with dense scrubby understorey; drainage depressions, generally around the edges of more sandy substrates	*Eucalyptus parramattensis subsp. decadens, Melaleuca decora, Melaleuca nodosa*
C	Sandy clay	Open forest;	*Corymbia gummifera, Angophora bakeri, Eucalyptus sp. aff. Agglomerata*
D	Clay	Closed scrub with scattered & stunted emergents; claypans	*Melaleuca nodosa, Eucalytpus fibrosa*
E	Clay	Open forest-woodland with dense heathy understorey; crests and slopes	*Eucalyptus sp aff. agglomerata, Melaleuca nodosa, Leptospermum parvifolium, Lambertia formosa*
F	Sandy clay +/- laterite	Open forest-woodland with a heathy understorey; broad crests	*Angophora bakeri, Eucalyptus capitellata, Eucalyptus parramattensis subsp. decadens, Banksia spinulosa, Xanthorrhoea glauca*
G	Sandy clay +/- laterite	Heath	*Leptospermum parvifolium, Melaleuca nodosa*
H	Grey sand	Dense, tall scrub with scattered emergents	*Xanthorrhoea glauca, Leptospermum polygalifolium, Melaleuca nodosa, Angophora bakeri, Corymbia gummifera*

Further survey and analysis is required in all areas outside of the HEZ supporting the TSC Act-defined Kurri Sands Swamp Woodland to more clearly understand floristic relationships. Until this is done, there is no way of confidently assigning conservation status levels to the variations described in this report, as no comparable data is yet available.

4.4 Comparison with REMS vegetation mapping

Classification and mapping of the vegetation within the HEZ has allowed direct comparisons to be made with the modelling undertaken during the LHCCREMS project (NPWS 2000a). The finer

scale of investigation allowable in the current study has greatly improved upon the LHCCREMS framework. The following points summarise these improvements:

- in general, the area is far more complex than the LHCCREMS mapping indicates;
- many small areas of heath and scrub have been omitted from the LHCCREMS mapping, an artifact of the API process employed;
- in general, the distribution of Hunter Lowlands Redgum Forest throughout most of the area as shown in the LHCCREMS mapping does not correspond with the ground situation, and includes several drainage lines which do not support it;
- the mapping of Lower Hunter Spotted Gum – Ironbark Forest is shown to cover much of the western parts of the site, which in fact supports variations of the Kurri Sands Swamp Woodland.

The main consequences of this revised mapping for the HEZ are that more of the Kurri Sands Swamp Woodland EEC is presently within the study area boundaries, and replace what is currently mapped as Lower Hunter Spotted Gum – Ironbark Forest. In addition, the mapping of variants within both of the main communities (Units 17 & 35) provides a start to a more comprehensive treatment of the vegetation patterns occurring in the Cessnock region, particularly in regard to the Kurri Sands Swamp Woodland EEC. From a conservation assessment perspective, it is difficult to address the variants of these communities, as they have not been delineated by NPWS (2000a), and their full extent in the region is unknown.

4.5 Management issues

Numerous trails and tracks are evident throughout the HEZ, and rationalisation of these should be undertaken to assist in the control of rubbish dumping, firewood collection, arson and weed dispersal. Trail bike riding is also a common occurrence, which promotes erosion to fire trails and creates a generally inhospitable and noisy environment. Due to the ready access by the local community, rubbish dumping and localised weed invasion from garden refuse is problematic in some areas.

5.0 Recommendations

Considering the extent and distribution of vegetation communities and significant plant species present within the HEZ, it is recommended that:

- areas north of the current Werakata NP boundary (Crown lands zoned 7b) be protected, preferably through addition to that park, in recognition of their important botanical value.
- the south-eastern portion immediately north of the Richmond Value Railway Museum be protected, in recognition of the KSSW variations present, the new *Eucalyptus* taxon, and the populations of *Acacia bynoeana*.
- investigation be carried out in areas around Cessnock for representative examples of all forms of the endangered Kurri Sand Swamp Woodland. A wider survey of the entire Kurri Sands vegetation is warranted in order to establish the number and extent of variations.
- targeted seasonal surveys be undertaken across the HEZ site, particularly the KSSW, for threatened terrestrial orchids.
- targeted searches be undertaken for threatened plant species in the wider Cessnock area, particularly *Acacia bynoeana*.

6.0 Acknowledgements

Thanks to Colin Driscoll for field assistance, Lucas Grenadier and other staff at Harper Somers O'Sullivan for logistical support and comments on an earlier draft of this report, and staff at the National Herbarium of NSW for plant identifications. Ken Hill from the National Herbarium also visited the site to assist in clarifying some of the eucalypt issues.

7.0 References

Anderson, R.H. (1961) Introduction. *Contribution from the New South Wales National Herbarium Flora Series*. 1-18: 1-15.

Austeco (2000) *Guy Fawkes River National Park Vegetation Communities*. Unpublished Report to NSW National Parks and Wildlife Service.

Bean, A.R., Sparshott, K.M., McDonald, W.J.F., & Neldner, V.J. (eds) (1998) *Forest Ecosystem Mapping and Analysis of South-eastern Queensland Biogeographic Region. Vegetation Survey and Mapping*. Report for Queensland CRA/RFA Steering Committee. Queensland Herbarium, Queensland Department of Environment & Heritage, and Environment Australia. Brisbane.

Belbin, L. (1991) The Analysis of Pattern in Bio-survey Data. Pp. 176-190 IN *Nature Conservation: Cost Effective Biological Surveys and Data Analysis*. Ed. by C. Margules and M. Austin. CSIRO, Canberra.

Belbin, L. (1995a) *PATN Pattern Analysis Package: Users Guide*. CSIRO Division of Wildlife Rangelands Research, Canberra.

Belbin, L. (1995b) *PATN Pattern Analysis Package: Reference Manual*. CSIRO Division of Wildlife Rangelands Research, Canberra.

Bell, S.A.J. (1995) *Assessment of ridgetop vegetation in compartments 380 – 384, Pokolbin State Forest*. Unpublished Report to North East Forest Alliance. October 1995.

Bell, S. (1996) *Flora Survey and Assessment: Construction of Access Road to Proposed Extensions of Cessnock Landfill, Cessnock*. Ecotone Ecological Consultants Pty Ltd. Report to Maunsell Pty Ltd. February 1996.

Bell, S.A.J. (1997a) *Tomaree National Park vegetation survey. A fire management document*. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter District). May 1997.

Bell, S.A.J. (1997b) *Vegetation Survey and Mapping of Crown Land, South of Manobalai Nature Reserve, Upper Hunter Valley*. Report to the Department of Land and Water Conservation and the NSW National Parks and Wildlife Service Upper Hunter District.

Bell, S.A.J. (1998a) *Glenrock SRA and Awabakal NR vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter District). August 1998.

Bell, S.A.J. (1998b) *Lake Macquarie SRA, Pulbah Island NR, and Tingira Heights NR vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Hunter and Central Coast Districts). April 1998.

Bell, S.A.J. (1998c) *Wollemi National Park vegetation survey. A fire management document*. Volumes 1 & 2. Eastcoast Flora Survey - Report to NSW National Parks and Wildlife Service (Upper Hunter District).

Bell, S.A.J. (2000) *Validation survey of REMS mapping, Lower Hunter and Central Coast*. Undertaken for NSW National Parks and Wildlife Service, CRA Unit.

Bell, S.A.J. (2001a) *The vegetation of Werakata (Lower Hunter) National Park, Hunter Valley, New South Wales*. Unpublished Report to NSW National Parks and Wildlife Service, Hunter Coast District.

Bell, S.A.J. (2001b) Notes on the distribution and conservation status of some restricted plant species from sandstone environments of the upper Hunter Valley, New South Wales. *Cunninghamia* 7(1): 1-12.

Bell, S.A.J. (2001c) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* (Orchidaceae) from the Central Coast of New South Wales. *Cunninghamia* 7(2): 195-204.

Bell, S.A.J. (2002) *Preliminary vegetation survey of Karuah and Wallaroo Nature Reserves, north of Newcastle, New South Wales*. Unpublished Report to NSW National Parks and Wildlife Service, Hunter Region. July 2002. Eastcoast Flora Survey.

Bell, S.A.J. & Driscoll, C. (2002) *Population size and habitat of the endangered* Acacia bynoeana *Benth. (Fabaceae: Mimosoideae) at Lake Macquarie SRA*. Eastcoast Flora Survey – Report to NSW National Parks and Wildlife Service, Lakes Area, Hunter Coast Region. May 2002.

Bell, S.A.J. & Driscoll, C. (in review) Population size, habitat and conservation status of the endangered *Acacia bynoeana* Benth. (Fabaceae: Mimosoideae) on the Central Coast of New South Wales. *Pacific Conservation Biology*

Bell, S.A.J. & Driscoll, C. (in prog.) Floristic and structural variations in habitat of the endangered *Acacia bynoeana* Benth. (Fabaceae: Mimosoideae) across its known geographical range.

Bell, S. & Fallding, M. (2002) *Tomago Sandbeds weed and bushfire risk management plan*. Report to Department of Land and Water Conservation.

Bell, S. & Helman, A. (in prog.) *Distribution and habitat of* Macrozamia flexuosa *C. Moore in Lake Macquarie Shire*. Lake Macquarie Research Grant No. 99/00 - 2

Bell, S. & Murray, M. (2001) *The ecological significance of Bow Wow Creek Gorge, Mulbring, Hunter Valley, New South Wales: a nationally significant site*. Eastcoast Flora Survey & Forest Fauna Surveys P/L – Report to Cessnock City Council.

Bell, S., Vollmer, J. & Gellie, N. (1993) *Yengo National Park and Parr State Recreation Area. Vegetation Survey for Use in Fire Management*. Report prepared for NSW National Parks and Wildlife Service. Unpublished.

Bell, S., Peake, T., Tame, T., Simpson, J., & Curran, T. (in prep.) Regionally significant plants of the Hunter Valley and Central Coast: a working register. Unpublished listing. Hunter Region Botanic Gardens.

Benson, J.S. & Fallding, H. (1981) Vegetation survey of Brisbane Water National Park and environs. *Cunninghamia* 1(1): 79-113.

Binns, D. (1995) *Flora survey, Tenterfield Management Area, Northern Region, New South Wales*. Tenterfield EIS Supporting Document No. 3. State Forests of New south Wales Research Division.

Binns, D. (1996) *Flora survey, Morisset Forestry District, Central Region, New South Wales*. Morisset Forestry District EIS Supporting Document No. 3. State Forests of New South Wales, Sydney.

Briggs, J.D. & Leigh, J.H. (1996) *Rare or Threatened Australian Plants*. CSIRO, Canberra.

Bureau of Meteorology (2003) Climatic data. [NSW Bureau of Meteorology web site]

Clarke, P.J. & Benson, D. (1986) *Vegetation survey of Dharug National Park*. Unpublished Report to NSW National Parks and Wildlife Service. National Herbarium of NSW, Royal Botanic Gardens.

Cropper, S.C. (1993) *Management of Endangered Plants*. CSIRO Publications, East Melbourne.

Driscoll, A.C. & Bell, S.A.J. (in prog.) A taxonomic review of the *Grevillea linearifolia* complex as it occurs in the Central and Lower North Coast of NSW, with particular reference to the threatened *Grevillea parviflora* subsp. *parviflora*.

Douglas, S.D. & Bell, S.A.J. (2003a) *Vegetation survey and mapping of Clyde River National Park, NSW South Coast*. Unpublished Final Report to NSW National Parks and Wildlife Service South Coast Region. ESP Ecological Surveys & Planning P/L & Eastcoast Flora Survey. April 2003.

Douglas, S.J. & Bell, S.A.J. (2003b) *Vegetation survey and mapping, Bimberamala National Park. NSW South Coast*. Unpublished Final Report to NSW National Parks and Wildlife Service, South Coast Region. ESP Ecological Surveys & Planning P/L & Eastcoast Flora Survey. January 2003.

Ecotone Ecological Consultants Pty Ltd (1999) *Flora and fauna investigations and planning assessment for the Tomalpin Employment Zone, within Cessnock Local Government Area*. Unpublished Report to Harper Somers Pty Ltd and Cessnock City Council. February 1999.

Ecotone Ecological Consultants Pty Ltd (2000) *Additional flora and fauna investigations within Tomalpin Employment Zone - Supplementary Report*. Unpublished Report to Harper Somers Pty Ltd and Cessnock City Council. March 2000.

EJE Group (1995) *Morisset EIS European cultural heritage study*. Morisset Forestry District environmental impact statement, supporting document No. 9. State Forests of NSW.

Fallding, M. & Bell, S. (1996) *Wollombi vegetation and habitat plan*. Land & Environment Planning. Report to Cessnock City Council.

French, K., Pellow, B. & Henderson, M. (2000) Vegetation of the Holsworthy Military Area. *Cunninghamia* 6(4): 893-939.

Griffith, S.J., Wilson, R., & Maryott-Brown, K. (2000) Vegetation and flora of Booti Booti National Park and Yahoo Nature Reserve, lower North Coast of New South Wales. *Cunninghamia* 6(3): 645-715.

Harden, G.J. (1992) *Rutidosis*. Pp. 249-251 IN *Flora of New South Wales. Volume 3*. Revised Edition. Ed. by G.J. Harden. NSW University Press, Kensington.

Harper Somers O'Sullivan (2002) *Species Impact Statement for Stage 1: Road Infrastructure within the Hunter Economic Zone (HEZ)*. Prepared for HEZ Pty Ltd. October 2002.

Harper Somers O'Sullivan (in prog.) *Ecological Constraints Master Plan for the Hunter Economic Zone (HEZ)*. Prepared for HEZ Pty Ltd.

Hill, K.D. (1998) Cycadophyta. *Flora of Australia* 48: 597-661.

Hill, K.D. (2002) *Eucalyptus*. Pp. 96-164 IN *Flora of New South Wales. Volume 2*. Revised Edition. Ed. by G.J. Harden. NSW University Press, Kensington.

Hill, K.D. (2003) Eucalyptus camfieldii *in the Gosford – Wyong district*. Unpublished Report to Wyong Shire Council. March 2003.

Hill, L., Peake, T., Bell, S., & Raine, A. (2001) *The vegetation of Towarri National Park, Cedar Brush Nature Reserve & Wingen Maid Nature Reserve for fire management purposes*. Unpublished Report to NSW National Parks and Wildlife Service, Hunter District. Eastcoast Flora Survey.

Keith, D. (1994) Floristics, structure and diversity of natural vegetation in the O'Hares Creek catchment, south of Sydney. *Cunninghamia* 3(3): 543-594.

Keith, D.A. (2000) Sampling designs, field techniques and analytical methods for systematic plant population surveys. *Ecological Management & Restoration* 1(2): 125-139.

Keith, D.A. & Bedward, M. (1999) Native vegetation of the South East Forests region, Eden, New South Wales. *Cunninghamia* 6(1): 1-218.

Kinhill Engineers Pty Ltd (1995) *Morisset Forestry District EIS. An assessment of Aboriginal archeological sites*. Morisset Forestry District environmental impact statement, supporting document No. 8. State Forests of NSW.

Kovac, M. (1991) *Soil landscapes of the Singleton 1:250 000 sheet*. Soil Conservation Service of NSW: Sydney. [map]

Kovac, M. & Lawrie, J.W. (1991) *Soil landscapes of the Singleton 1:250 000 sheet*. Soil Conservation Service of NSW: Sydney. [report]

Landsberg J. (2000) *Draft Regulations to the Environment Protection and Biodiversity Conservation Act 1999 (Cth): Criteria for assessing the level of threat to ecological communities*. 10 March 2000.

Makinson, G.J. (2002) *Grevillea*. Pp. 32-66 IN *Flora of New South Wales: Volume 2*. Revised Edition. G.J. Harden (Ed.) (UNSW Press: Kensington).

Maryott-Brown, K. & Wilks, D. (1993*) Rare and endangered plants of Yengo National Park and adjacent areas*. Unpublished Report to NSW National Parks and Wildlife Service, Upper Hunter District.

McGillivray, D.J. (2000) Proteaceae 2, Grevillea*. Flora of Australia 17A:* 1-460*.*

Murray, M. & Bell, S. (2002) *Flora and fauna survey guidelines, Lower Hunter and Central Coast*. Report to Lower Hunter and Central Coast Regional Environmental Management Strategy.

National Parks and Wildlife Service (1999) *Forest ecosystem classification and mapping for the Hunter sub-region in the Lower North East Comprehensive Regional Assessment*. A project undertaken for the Joint Commonwealth NSW Regional Forest Agreement Steering Committee of the NSW Comprehensive Regional Assessments. Project Nos. NL 10/EH & NL 02/EH. CRA Unit, Sydney Zone NPWS. March 1999.

National Parks and Wildlife Service (2000a) *Vegetation Survey, Classification and Mapping: Lower Hunter and Central Coast Region*. A project undertaken for the Lower Hunter and Central Coast Regional Environmental Management Strategy, CRA Unit, Sydney Zone NPWS. April 2000.

National Parks and Wildlife Service (2000b) *The native vegetation of the Cumberland Plain, western Sydney – Technical Report*. New South Wales NPWS. April 2000.

NPWS (2002a) *The native vegetation of the Woronora, O'Hares and Metropolitan Catchments*. Unpublished Report, NSW National Parks and Wildlife Service, Hurstville.

NPWS (2002b) *Eucalypt species analysis for the NSW sections of the Great Escarpment and the Australian Alps protected areas (excluding Blue Mountains World Heritage Area).* Unpublished Report. NSW National Parks and Wildlife Service, Southern Directorate, Queanbeyan.

NSW National Parks and Wildlife Service (2003) *The native vegetation of the Warragamba Special Area*. *Parts A (Technical Report) & B (Vegetation Community Profiles).* Unpublished Report to Sydney Catchment Authority. NPWS Central Conservation Programs and Planning Division.

NSW Scientific Committee (1998) *Final Determination of* Grevillea parviflora *subsp.* parviflora*.* NSW Scientific Committee.

Olde, P.M. & Marriott, N.R. (1994) A taxonomic revision of *Grevillea arenaria* and *Grevillea obtusiflora* (Proteaceae: Grevilleoideae). *Telopea* 5 (4): 711-733.

Olde, P. & Marriott, N. (1995) *The Grevillea Book: Volume 3*. Kangaroo Press, Kenthurst.

Patrick, G. (1999) *Initial Flora Survey to Sample Potential habitat, Abundance and Distribution of the New Plant Species Persoonia 'North Rothbury'*. Report prepared for NSW National Parks and Wildlife Service. Ecotone Ecological Consultants.

Rasmus, P.L., Rose, D.M., & Rose, G. (1969) *Singleton 1:250 000 Geological Series (Sheet S1 56-1).* First Edition. NSW Department of Mines.

Rupp, H.M.R. (1969) *The Orchids of New South Wales*. (Facsimile Edition). Government Printer, New South Wales.

Sheringham, P.R. & Sanders, J.M. (1993). *Vegetation Survey of Garigal National Park and Surrounding Crown Lands.* Unpublished Report to NSW National Parks and Wildlife Service.

Spencer, R.D. & Lumley, P.F. (2002) *Callistemon*. Pp. 193-198 **IN** *Flora of New South Wales Volume 2*. Revised Edition. Ed by G.J. Harden. UNSW Press, Kensington.

Thackway, R. & Cresswell, I.D. (1995) (Eds) *An Interim Biogeographic Regionalisation for Australia: A Framework for Establishing the National System of Reserves*. Version 4. Australian Nature Conservation Agency: Canberra.

Tweedie, T.D., Bruskin, S., Chapman, W.S., & Heyward, R.W. (1995) *Flora survey, Urunga and Coffs Harbour Management Areas, Northern Region, New South Wales*. State Forests of NSW Research Division.

Walker, J. & Hopkins, M.S. (1990) Vegetation. Pp. 58-86 IN *Australian Soil and Land Survey Field Handbook*. Ed. by R. McDonald, R. Isbell, J. Speight, J. Walker and M. Hopkins. Inkata Press, Sydney.

Washington, H. (2001) *Vegetation survey of Gardens of Stone National Park*. Unpublished Report to NPWS Blue Mountains Region. Ecosolution Consulting, April 2001.

Weston, P.H. (1999) *Persoonia pauciflora* (Proteaceae), a new species from the Hunter Valley, New South Wales. *Telopea* 8(2): 159-164.

Wilson, P., Gott, M., & Schofield, M.J. (1997) *Vegetation mapping guidelines for reserve and conservation planning.* NSW National Parks and Wildlife Service, Environmental Survey & Research Division. May 1997.

Zoete, T. (1998) *Vegetation Survey of Barrington Tops and Mount Royal National Parks for use in Fire Management*. Prepared for NSW National Parks and Wildlife Service by WBM Oceanics Australia, Broadmeadow.

Appendix 1 Biophysical attributes of all sites

Site code	Soil landscape	Broad vegetation	AMG's	Elevation	Source
CSN44	aberdare	open forest	354200 6364200	175	Binns 1996
CSN45	neath	open forest	352980 6364610	65	Binns 1996
CSN46	neath	open forest	352450 6365390	35	Binns 1996
CSN46P1M	neath	scrub	352045 6364260	50	Bell 2001a
CSN47P8F	neath	open forest	351609 6364432	40	Bell 2001a
CSN48P7M	neath	open forest/scrub	352575 6363565	50	Bell 2001a
CSN49P8C	neath	open forest	351692 6363201	70	Bell 2001a
CSN52P3F	neath	scrub	352127 6365189	40	Bell 2001a
CSN53P1V	neath	open forest	352293 6364937	40	Bell 2001a
CSN60	neath	open forest	357315 6364645	40	current study
CSN61	neath	open forest	356206 6363990	50	current study
CSN62	aberdare	open forest/ woodland	354451 6364430	180	current study
CSN63	aberdare	open forest	354227 6364382	190	current study
CSN64	aberdare	open forest	354475 6363080	130	current study
CSN65	aberdare	open forest	354199 6362869	80	current study
CSN66	neath	open forest/ woodland	354471 6366028	50	current study
CSN67	neath	open woodland	355515 6366724	40	current study
CSN68	neath	open forest/ woodland	357966 6364365	35	current study
CSN69	neath	open forest/ woodland	357683 6364285	35	current study
CSN70	neath	open forest/ woodland	357230 6364257	35	current study
CSN71	neath	open forest	357643 6363474	50	current study
CSN72	neath	open woodland	354340 6367828	30	current study
CSN73	neath	open forest/ woodland	352115 6366460	40	current study
CSN74	neath	open forest/ woodland	351224 6363053	55	current study
CSN75	neath	open forest	355049 6366821	30	current study
CSN76	aberdare	open forest	353405 6366239	40	current study
CSN77	aberdare	open forest/ woodland	353593 6366578	45	current study
CSN78	neath	open forest/ woodland	356421 6366072	60	current study
CSN79	neath	open forest	355584 6365523	40	current study
CSN80	neath	thicket	355486 6365641	40	current study

Appendix 2 Species list – HEZ

Plant taxa recorded from the HEZ during 2000-2001 & 2003, based primarily on plot data. Species marked "*" represent non-indigenous taxa. Significant taxa are noted. Additional species have been gleaned from previous work and are noted.

CLASS FILICOPSIDA (Ferns)

ADIANTACEAE	
Adiantum aethiopicum	Common Maidenhair Fern
DENNSTAEDTIACEAE	
Pellaea falcata var. *falcata* [recorded by Ecotone 2000]	Sickle Fern
Pteridium esculentum	Bracken
SCHIZAEACEAE	
Schizaea dichotoma	
SINOPTERIDACEAE	
Cheilanthes austrotenuifolia	
Cheilanthes distans	
Cheilanthes sieberi subsp. *sieberi*	Poison Rock Fern

CLASS CYCADOPSIDA (Cycads)

ZAMIACEAE	
***Macrozamia flexuosa* (ROTAP 2K)**	**-**
Macrozamia reducta	-

CLASS MAGNOLIOPSIDA (Flowering Plants)
Subclass Magnoliidae (Dicotyledons)

ACANTHACEAE	
Brunoniella australis	
Brunoniella pumilo [recorded by Ecotone 2000]	-
Pseuderanthemum variabile	Pastel Flower
AMARANTHACEAE	
Alternanthera denticulata	Lesser Joyweed
APIACEAE	
Centella asiatica	
Hydrocotyle peduncularis	-
Platysace ericoides	Heath Platysace
Platysace lanceolata	-
Trachymene incisa subsp. *incisa*	Native Parsnip
ARALIACEAE	
Astrotricha obovata	-
Polyscias sambuccifolia	Elderberry Panax
ASCLEPIADACEAE	
Gomphocarpus fruticosus *	Cotton Bush *
ASTERACEAE	
Aster subulatus *	Wild Aster *
Brachycome multifida var. *multifida*	Cut-leaved Daisy
Bractenatha bracteata	Golden Everlasting
Calotis cuneifolia	Purple Burr-daisy
Cassinia uncata	
Chrysocephalum semipapposum	Clustered Everlasting
Conyza sp. *	Fleabane *
Epaltes australis	Spreading Nut Heads
Euchiton (Gnaphalium) involucratum *	Cudweed *

Euchiton (Gnaphalium) sphaericum *	Cudweed *
Facelis retusa *	-
Galinsoga parviflora	-
Helichrysum scorpioides	Button Everlasting
Hypochaeris radicata *	Catsear *
Laginifera gracilis	
Laginifera stipitata	
Olearia microphylla	
Olearia ramulosa	-
Ozothamnus diosmifolius	White Dogwood
***Rutidosis heterogama* (TSC Act S2)**	**-**
Senecio linearifolius [recorded by Ecotone 2000]	-
Senecio madagascariensis *	Fireweed *
Sonchus oleraceus *	Common Sow thistle *
Tagetes minuta *	Stinking Roger *
Taraxacum officinale *	Dandelion *
Vernonia cinerea var. *cinerea*	-
Vittadinia cervicularis var. subcervicularis	
BIGNONIACEAE	
Pandorea pandorana	Wonga Vine
CAMPANULACEAE	
Wahlenbergia communis	Tufted Bluebell
Wahlenbergia gracilis	Australian Bluebell
Wahlenbergia luteola	-
CASUARINACEAE	
Allocasuarina torulosa	Forest Oak
Casuarina glauca	Swamp Oak
CELASTRACEAE	
Maytenus silvestris	-
CLUSIACEAE	
Hypericum gramineum	St Johns Wort
CONVOLVULACEAE	
Dichondra repens	Kidney Weed
Polymeria calycina	Swamp Bindweed
DILLENIACEAE	
Hibbertia acicularis	Prickly Guinea Flower
Hibbertia aspera	Rough Guinea Flower
Hibbertia diffusa	-
Hibbertia elata [recorded by Ecotone 2000]	
Hibbertia empetrifolia	Trailing Guinea Flower
Hibbertia linearis	Showy Guinea Flower
Hibbertia obtusifolia	
Hibbertia pedunculata	-
Hibbertia scandens	
Hibbertia vestita	A Guinea Flower
DROSERACEAE	
Drosera auriculata	Sundew
Drosera peltata	Sundew
EPACRIDACEAE	
Astroloma humifusum	Native Cranberry Heath
Brachyloma daphnoides	
Epacris pulchella	NSW Coral Heath
Leucopogon juniperinus	
Leucopogon virgatus	A Beard-heath
Lissanthe strigosa subsp. *strigosa*	Peach Heath
Melichrus procumbens	Jam Tarts
Melichrus urceolatus	Urn Heath
Monotoca scoparia	Prickly Broom-heath
Styphelia triflora	-
Styphelia tubiflora	
EUPHORBIACEAE	
Breynia oblongifolia	Breynia
Glochidion ferdinandi var. *ferdinandi*	Cheese Tree
Phyllanthus gasstroemii	Spurge
Phyllanthus gunnii	

Phyllanthus hirtellus	Thyme Spurge
Phyllanthus occidentalis	
Phyllanthus virgatus	Wiry Spurge
Poranthera microphylla	-
FABACEAE	
Bossiaea heterophylla	Variable Bossiaea
Bossiaea obcordata	Spiny Bossiaea
Bossiaea rhombifolia subsp. *rhombifolia*	
Chorizema parviflorum	
Daviesia acicularis	
Daviesia genistifolia	Broom Bitter Pea
Daviesia squarrosa	
Daviesia ulicifolia	Gorse Bitter-pea
Desmodium brachypodum	
Desmodium rhytidophyllum	
Desmodium varians	Slender Tick-trefoil
Dillwynia retorta	Heathy Parrot Pea
Dillwynia sp. "trichopoda" (syn. Dillwynia parvifolia var. trichopoda)	
Glycine clandestina	Twining Glycine
Glycine microphylla	-
Glycine tabacina	
Gompholobium minus	
Gompholobium pinnatum	Pinnate Wedge-pea
Gompholobium uncinatum	Red Wedge-pea
Hardenbergia violacea	False Sarsparilla
Hovea linearis	Narrow-leaf Hovea
Indigofera australis	Austral Indigo
Jacksonia scoparia	
Mirbelia pungens	-
Mirbelia rubiifolia	-
Oxylobium pulteneae	Wiry Shaggy Pea
Podolobium ilicifolium	Native Holly
Pultenaea cunninghamii	-
Pultenaea villosa	-
GENTIANACEAE	
Centaurium spicatum *	Common Centaury *
GOODENIACEAE	
Dampiera stricta	Blue Dampiera
Goodenia bellidifola subsp. *bellidifolia*	
Goodenia hederacea subsp. *hederacea*	-
Goodenia heterophylla subsp. *heterophylla*	Variable-leaved Goodenia
Goodenia paniculata	
Goodenia rotundifolia	-
HALORAGACEAE	
Gonocarpus micranthus subsp. *ramosissimus*	
Gonocarpus tetragynus	Poverty Raspwort
Gonocarpus teucrioides	
Haloragis heterophylla	Variable Raspwort
LAMIACEAE	
Plectranthus parviflorus	
Westringia longifolia	
LAURACEAE	
Cassytha glabella forma *glabella*	Slender Devil's Twine
LINACEAE	
Linum marginale	
Linum trigynum *	
LOBELIACEAE	
Pratia purpurascens	White Root
LOGANIACEAE	
Logania pusilla	
LORANTHACEAE	
Amyema gaudichaudii	Mistletoe
Dendrophthoe vitellina	-
MALVACEAE	

Sida rhombifolia *	Paddys Lucerne *
MENISPERMACEAE	
Stephania japonica var. *discolor*	Snake Vine
MIMOSOIDACEAE	
Acacia binervata [recorded by Ecotone 2000]	Two-veined Hickory
Acacia brownii	Prickly Moses
Acacia buxifolia subsp. *buxifolia*	Box-leaved Wattle
***Acacia bynoeana* (TSC Act S1)**	**Bynoe's Wattle**
Acacia deanei subsp. *deanei*	Green Wattle
Acacia elongata var. *elongata*	Swamp Wattle
Acacia falcata	Sickle Wattle
Acacia fimbriata	
Acacia implexa	Hickory
Acacia irrorata subsp*. irrorata*	Green Wattle
Acacia kulnurensis ms	
Acacia linifolia	Flax-leaved Wattle
Acacia leiocalyx subsp. leiocalyx	
Acacia longifolia	Sydney Golden Wattle
Acacia parvipinnula	Silver-stemmed Wattle
Acacia spectabilis *	Mudgee Wattle *
Acacia ulicifolia	Prickly Moses
MORACEAE	
Ficus rubiginosa	Rusty Fig
MYOPORACEAE	
Eremophila debile	
MYRSINACEAE	
Rapanea variabilis	Muttonwood
MYRTACEAE	
Angophora bakeri	Narrow-leaved Ironbark
Angophora floribunda	Rough-barked Apple
Babingtonia pluriflora	-
Baeckea diosmifolia	
***Callistemon linearifolius* (TSC Act S2)**	**-**
Callistemon linearis	Narrow-leaved Bottlebrush
Callistemon pinifolius	-
Callistemon rigidis	
Callistemon salignus	
Corymbia eximia	Yellow Bloodwood
Corymbia gummifera	Red Bloodwood
Corymbia maculata	Spotted Gum
Eucalyptus agglomerata	Blue-leaved Stringybark
Eucalyptus amplifolia subsp. *amplifolia*	Cabbage Gum
Eucalyptus beyeriana	
Eucalyptus canaliculata	Large-fruited Grey Gum
Eucalyptus carnea	-
Eucalyptus capitellata	Brown Stringybark
Eucalyptus crebra	Narrow-leaved Ironbark
***Eucalyptus fergusonii* subsp*. dorsiventralis* (ROTAP 2RC-)**	**-**
Eucalyptus fibrosa	Broad-leaved Ironbark
***Eucalyptus glaucina* (TSC Act S2)**	**Slaty Red Gum**
Eucalyptus globoidea	White Stringybark
Eucalyptus moluccana	Grey Box
Eucalyptus paniculata subsp*. paniculata*	
***Eucalyptus parramattensis* subsp. *decadens* (TSC Act S2)**	**A Red Gum**
Eucalyptus punctata	Grey Gum
Eucalyptus punctata X canaliculata	
Eucalyptus racemosa	Snappy Gum
Eucalyptus resinifera subsp. *resinifera*	Red Mahogany
Eucalyptus siderophloia	Northern Ironbark
***Eucalyptus* sp. aff. *agglomerata* (new taxon)**	**-**
***Eucalyptus* sp. aff. *camfieldii* (new taxon)**	**-**
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus umbra	
Leptospermum parvifolium	Small-leaved Tea-tree
Leptospermum polygalifolium subsp. *cismontanum*	Lemon-scented Tea-tree
Leptospermum trinervium	Paperbark Tea-tree
Melaleuca decora	-
Melaleuca erubescens	
Melaleuca linariifolia	Snow-in-summer

Melaleuca nodosa	Honey Ball-myrtle
Melaleuca sieberi	Sieber's Paperbark
Melaleuca styphelioides	Prickly-leaved Ti-tree
Melaleuca thymifolia	Thyme Honey-myrtle
Micromyrtus ciliata	
Syncarpia glomulifera subsp. *glomulifera*	Turpentine
OCHNACEAE	
Ochna serrulata *	Ochna *
OLACACEAE	
Olax stricta	
OLEACEAE	
Ligustrum sinense *	Small leaved Privet *
Notelaea longifolia forma *longifolia*	Large Mock Olive
OXALIDACEAE	
Oxalis chnoodes	-
Oxalis perennans	Native Oxalis
PITTOSPORACEAE	
Billardiera scandens var. *scandens*	Apple Dumplings
Bursaria longisepala var. *longisepala*	-
Bursaria spinosa var. *spinosa*	Blackthorn
Citriobatus pauciflorus	
Pittosporum revolutum	Yellow Pittosporum
PLANTAGINACEAE	
Plantago debilis	Slender Plantain
Plantago lanceolata *	Lambs Tongue *
POLYGALACEAE	
Comesperma ericinum	
Comesperma sphaerocarpum	Broom Milkwort
PROTEACEAE	
Banksia oblongifolia	-
Banksia spinulosa var. *collina*	Hill Banksia
Conospermum taxifolium	
***Grevillea montana* (ROTAP 2KC-)**	**Mountain Grevillea**
***Grevillea parviflora* subsp. *parviflora* (TSC Act S2)**	**-**
Hakea laevipes	Broad-leaved Hakea
Hakea sericea	Bushy Needlebush
Hakea salicifolia [recorded by Ecotone 2000]	Willow-leaf Hakea
Hakea teretifolia	Dagger Hakea
Isopogon anemonifolius	Broad-leaf Drumsticks
Lambertia formosa	Mountain Devil
Persoonia linearis	Narrow-leaved Geebung
RANUNCULACEAE	
Clematis aristata	Old Mans Beard
RHAMNACEAE	
Pomaderris ferruginea	
ROSACEAE	
Rubus parvifolius	Native Raspberry
RUBIACEAE	
Galium gaudichaudii	
Galium propinquum	
Opercularia aspera	
Opercularia diphylla	-
Opercularia hispida	Stinkweed
Pomax umbellata	Pomax
Richardia humistrata *	Richardia *
RUTACEAE	
Boronia polygalifolia	
Correa reflexa var reflexa	Common Correa
SANTALACEAE	
Choretrum candollei [recorded by Ecotone 2000]	White sour Bush
Exocarpos cupressiformis	Cherry Ballart

Exocarpos strictus	Dwarf Currant
Santalum lanceolatum	
SAPINDACEAE	
Dodonaea triquetra	Hop-bush
SCROPHULARIACEAE	
Veronica plebeia	
SOLANACEAE	
Solanum nigrum *	Deadly Nightshade *
Solanum prinophyllum	-
STACKHOUSIACEAE	
Stackhousia vimineum	
STERCULIACEAE	
Lasiopetalum parviflorum	Rusty Petals
STYLIDIACEAE	
Stylidium graminifolium	
Stylidium lineare [recorded by Ecotone 2000]	Narrow-leaf Trigger Plant
THYMELIACEAE	
Pimelea linifolia subsp. *linifolia*	Slender Rice-flower
VERBENACEAE	
Lantana camara *	Lantana *
Verbena bonariensis *	Purple Top *
VIOLACEAE	
Hybanthus monopetalus	Slender Violet-bush
Viola hederacea	Native Violet
VITACEAE	
Cayratia clematidea	Slender Grape

CLASS MAGNOLIOPSIDA (Flowering Plants)
Subclass Liliidae (Monocotyledons)

ANTHERICACEAE	
Arthropodium minus	
Caesia parviflora var. *parviflora*	Pale Grass-lily
Laxmannia compacta	
Laxmannia gracilis	Slender Wire-lily
Thysanotus tuberosus subsp. *tuberosus*	Fringe Lily
Tricoryne elatior	
COMMELINACEAE	
Commelina cyanea	Scurvy Weed
Murdannia graminea	-
CYPERACEAE	
Baumea articulata	
Baumea juncea	Bare Twig-rush
Carex appressa	Tall Sedge
Carex inversa	
Carex longebrachiata	
Cyathochaeta diander	-
Cyperus difformis	Dirty Dora
Cyperus laevis	
Fimbristylis dichotoma	Common Fringe-rush
Gahnia aspera	Rough Saw-sedge
Gahnia radula	-
Lepidosperma gunnii	-
Lepidosperma laterale	Variable Sword-sedge
Lepidosperma viscidum	
Ptilothrix deusta	
Schoenus brevifolius	
HAEMODORACEAE	
Haemodorum planifolium [recorded by Ecotone 2000]	Bloodroot

HYPOXIDACEAE	
Hypoxis hygrometrica var. *hygrometrica*	Golden Weather-grass
IRIDACEAE	
Patersonia sericea	Silky Purple Flag
JUNCACEAE	
Juncus usitatus	Common Rush
LOMANDRACEAE	
Lomandra confertifolia subsp. *pallida*	A Mat-rush
Lomandra confertifolia subsp*. rubiginosa*	
Lomandra cylindrica	Needle Mat-rush
Lomandra filiformis subsp. *coriaceae*	Wattle Mat-rush
Lomandra filiformis subsp. *filiformis*	Wattle Mat-rush
Lomandra glauca	Pale Mat-rush
Lomandra longifolia	Spikey Mat-rush
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush
LUZURIAGACEAE	
Eustrephus latifolius	Wombat Berry
Geitonoplesium cymosum	-
ORCHIDACEAE	
Acianthus exertus	
Acianthus fornicatus	Pixie Caps
Caladenia caerulea	
Caladenia catenata	
Caleana major	Flying Duck Orchid
Calochilus robertsonii	
Cymbidium suave	Snake Orchid
Cryptostylis erecta	
Dipodium punctatum	Hyacinth Orchid
Diuris aurea	Golden Donkey Orchid
Diuris sulphurea	
Genoplesium fimbriatum	
Glossodia major	
Glossodia minor	
Lyperanthus suaveolens	
Microtis parviflora	
Prasophyllum sp.	
Pterostylis acuminata	Sharp Greenhood
Pterostylis concinna	
Pterostylis curta	
Pterostylis longifolia	
Pterostylis nutans	
Thelymitra ixioides	
Thelymitra "angustifolia" ms	
PHILYDRACEAE	
Philydrum lanuginosum	
PHORMIACEAE	
Dianella caerulea var. *assera*	Paroo Lily
Dianella caerulea var. *caerulea*	Paroo Lily
Dianella caerulea var. cinerascens [recorded by Ecotone 2000]	
Dianella longifolia var. longifolia [recorded by Ecotone 2000]	
Dianella prunina	A Flax Lily
Dianella revoluta var. *revoluta*	A Flax Lily
Dianella tasmanica	
POACEAE	
Agrostis aemula	Blowngrass
Agrostis avenacea var. avenacea	
Anisopogon avenaceus	Oat Spear Grass
Aristida ramosa var. *ramosa*	Three-awn Speargrass
Aristida vagans	Three-awned Spear Grass
Aristida warburgii	-
Austrodanthonia linkii var *fulva*	
Austrodanthonia longifolia	Long-leaf Wallaby Grass
Austrodanthonia setacea	
Austrodanthonia tenuior	Wallaby Grass
Austrostipa verticillata	Bamboo Grass
Axonopus affinis *	Carpet Grass *
Cortadiera selloana *	Pampass Grass *

Cymbopogon refractus	Barbed-wire Grass
Cynodon dactylon *	Common Couch *
Dichelachne micrantha	Short-hair Plume Grass
Digitaria parviflora	Small-flowered finger grass
Digitaria ramularis	-
Echinopogon caespitosus var. *caespitosus*	Tufted Hedgehog Grass
Echinopogon ovatus	Common Hedgehog-grass
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Eragrostis brownii	Brown's Love Grass
Imperata cylindrica var. *major*	Blady Grass
Joycea pallida	Red-anther Wallaby Grass
Microlaena stipoides var. *stipoides*	Weeping Grass
Oplismenus imbecillus	
Panicum effusum	
Panicum gilvum *	
Panicum pygmaeum [recorded by Ecotone 2000]	Pygmy Panic
Panicum simile	-
Paspalidium criniforme	-
Paspalidium distans	Bent Summer Grass
Paspalum dilatatum *	Paspalum *
Paspalum distichum	Water Couch
Phragmites australis	Native Reed
Poa affinis	
Poa sieberiana var. *sieberiana*	Fine-leafed Tussock Grass
Pseudoraphis ?spinescens	
Sarga leiocladum (syn. Sorghum leiocladum)	Wild Sorghum
Setaria gracilis *	Slender Pigeon Grass *
Sporobolus elongatus	Slender Rat-tails Grass
Themeda australis	Kangaroo Grass
Tetrahhena juncea	
POTAMOGETONACEAE	
Potamogeton tricarinatus	Floating Pondweed
RESTIONACEAE	
Hypolaena fastigiata	
TYHPACEAE	
Typha orientalis	
XANTHORRHOEACEAE	
Xanthorrhoea glauca subsp. *glauca*	Grasstree
Xanthorrhoea latifolia subsp. *latifolia* [recorded by Ecotone 2000]	Grasstree

TOTAL PLANT TAXA 382

Appendix 3 Community profiles

Background

Vegetation community profiles have been developed for the HEZ site, which have the aim of presenting important identifying information in an easy to understand format. The profiles are appended to the main body of the report, and are intended to exist as a stand-alone document if necessary. Each profile is based on detailed survey and mapping work and/or reconnaissance, and summarises all relevant information for that community. Communities have been delineated using the PATN Analysis Package (Belbin 1995a, 1995b), supported by ground truthing and backed by common sense. The concept behind these profiles is to enable the reader to recognise the different vegetation communities present. Photographs are included of each community, and represent the typical or characteristic form of that community. Variations within communities have only been pictorially presented in cases where images are available.

The Profiles

The following points should be noted in regard to the information presented in these profiles:

- *Community Name* - In most cases, community names have been chosen in keeping with those applied during the Lower Hunter & Central Coast REMS study (NPWS 2000). Complex floristic associations and terminology have been deliberately avoided.

- *Map Code* - The map code refers simply to the code used in the final floristic map.

- *REMS Classification* - Equivalent community names using the REMS classification (NPWS 2000) are included to enable consistency with this regional work.

- *Description* - Structural and floristic information is based on survey site data sheets and field reconnaissance, and presents the typical and most characteristic species for that community.

- *Rare and Threatened Species* - Known occurrences of rare or threatened plant species within a particular community are listed.

- *Relationship to other Communities* - Factors linking a particular vegetation community to other related communities are detailed, together with the major separating features between these communities.

- *Distribution* - The distribution of each community is provided in two categories: within HEZ, and in other areas outside of it but within the region. Also provided in this section are indications of the determining factors in the community's distribution, and the reliability of mapping for that community and potentially included units.

- *Conservation Significance* - The conservation significance of each vegetation community is provided at a Local, Regional and National level, based on currently available information and local knowledge. Local significance refers to a 50km radius around the Cessnock area; Regional significance to the Sydney Basin biogeographic region of Thackway and Cresswell (1995), while National significance is largely based on Specht *et al* (1995). In some cases, insufficient information is available to place communities within a conservation context. These instances are prefixed "?" to indicate uncertainties.

- *Threats* - Potential or currently known threats are listed for each community, particularly where these may be controlled in some way to prevent deleterious effects on the community.

- *Other Comments* - Any further comments considered relevant to particular communities are included in this section, such as the incidence of weed species, variations within a community, etc.

References

Belbin, L. (1995a) *PATN Pattern Analysis Package: Users Guide*. CSIRO Division of Wildlife Rangelands Research, Canberra.

Belbin, L. (1995b) *PATN Pattern Analysis Package: Reference Manual*. CSIRO Division of Wildlife Rangelands Research, Canberra.

Bell, S.A.J. (2001) *The vegetation of Werakata (Lower Hunter) National Park, Hunter Valley, New South Wales*. Eastcoast Flora Survey – Report to NSW National Parks and Wildlife Service, Hunter Coast District.

National Parks and Wildlife Service (2000) *Vegetation Survey, Classification and Mapping: Lower Hunter and Central Coast Region*. A project undertaken for the Lower Hunter and Central Coast Regional Environmental Management Strategy, CRA Unit, Sydney Zone NPWS. April 2000.

Specht, R.L., Specht, A., Whelan, M.B., and Hegarty, E.E. (1995) *Conservation Atlas of Plant Communities in Australia.* Centre for Coastal Management, Lismore, in association with Southern Cross University Press: Lismore.

Thackway, R. and Cresswell, I.D. (1995) *An Interim Biogeographic Regionalisation for Australia: A Framework for Setting Priorities in the National Reserves System Cooperative Program*. Australian Nature Conservation Agency, Canberra.

Central Hunter Riparian Forest Unit 13

REMS Classification: *? Central Hunter Riparian Forest (MU 13)*


Description
Central Hunter Riparian Forest represents a variable community that occupies narrow zones along tributaries of the major creeks in the area. Within the region this vegetation type has been largely disturbed or infiltrated with weed species. At HEZ, dominant canopy species include *Eucalyptus canaliculata, Angophora floribunda, Syncarpia glomulifera, Casuarina glauca* (in places), and various *Melaleuca* species. This vegetation most closely associates with the Central Hunter Riparian Forest as defined by NPWS (2000), although some floristic differences are apparent.

Structure
- **Tree** 10-25m, 20-40% cover
- **Small tree** 8-10m, 0-20% cover
- **Tall shrub** 4-6m, 60-70% cover
- **Shrub** 0.5-3m, 5-30% cover
- **Ground** < 0.5m, 90-100% cover

Floristics
- **Trees** *Angophora floribunda, Eucalyptus canaliculata, Eucalyptus moluccana, Eucalyptus fibrosa, Eucalyptus tereticornis, Syncarpia glomulifera*
- **Small tree** *Melaleuca decora, Melaleuca styphelioides, Melaleuca linariifolia, Acacia irrorata* subsp. *irrorata, Casuarina glauca*
- **Shrubs** *Bursaria longisepala var. longisepala, Lissanthe strigosa, Grevillea montana, Exocarpus strictus, Acacia longifolia, Bursaria spinosa, Melaleuca nodosa, Babingtonia pluriflora*
- **Vines** *Glycine clandestina, Glycine microphylla, Cassytha glabella forma glabella*
- **Herbs** *Hibbertia linearis, Lomandra longifolia, Pomax umbellata, Pratia purpurascens, Oxalis perennans, Pseuderanthemum variabile, Plantago debilis, Gonocarpus tetragynus*
- **Graminoids** *Themeda australis, Imperata cylindrica var. major, Aristida vagans, Dianella revoluta var. revoluta, Dichelachne micrantha, Austrodanthonia tenuior, Poa sieberiana* subsp. *sieberiana, Dianella caerulea var. cinerascens, Echinopogon ovatus, Eragrostis brownii, Austrostipa verticillata, Aristida ramosa var. ramosa, Sorghum leiocladum, Phragmites australis, Microlaena stipoides var. stipoides, Cymbopogon refractus, Entolasia marginata, Digitaria ramularis, Echinopogon caespitosus var. caespitosus*
- **Ferns** *Cheilanthes sieberi* subsp. *sieberi, Adiantum aethiopicum, Pteridium esculentum*
- **Sedges** *Gahnia aspera, Baumea juncea, Lepidosperma laterale*
- **Cycads** *Macrozamia flexuosa*
- **Orchids** *Pterostylis concinna, Pterostylis longifolia*

Rare or Threatened Species
- Undescribed species – *none recorded*
- NSW TSC Act species – *?Eucalyptus glaucina*
- Rare species – *Grevillea montana, Macrozamia flexuosa*

Relationship to Other Communities
Central Hunter Riparian Forest is closely related to the Hunter Lowlands Redgum Forest (Unit 19), through a sharing of canopy species such as *Eucalyptus tereticornis, Eucalyptus moluccana*, and *Angophora floribunda*, and several understorey species. However, Unit 19 generally does not support *Casuarina glauca* and *Eucalyptus canaliculata,* and occurs on flats and drainage depressions (not riparian zones). The levels of past disturbance shown in areas supporting both of these communities makes differentiation difficult. In Unit 19, redgum species (*Eucalyptus tereticornis, Eucalyptua amplifolia* subsp. *amplifolia, Eucalyptus glaucina*) clearly dominate, while these species are rare or absent in the Central Hunter Riparian Forest.

Distribution
Within HEZ
This vegetation type occurs along Swamp Creek and other major creeklines.

Outside of HEZ
Central Hunter Riparian Forest is relatively uncommon in the region, with most occurrences being heavily disturbed or modified through agricultural practices. NPWS (2000) have mapped 1187ha of this vegetation type in the region, with only 5ha in reserve.

Determining Factors
This vegetation type occurs as a fringing community along the banks of major streams, generally in areas of high exposure (flat to gently undulating land) on Permian clays.

Mapping Reliability & Included Units
This community has been mapped from aerial photographic interpretation and field reconnaissance, and is considered reasonably accurate.

Conservation Significance
- LOCAL - *Poor* (Werakata NP)
- REGIONAL - *Poor* (No reservation known)
- NATIONAL - *Poor* (No reservation known)

Threats
- *UPSTREAM PROCESSES* - this vegetation type is likely to be sensitive to upstream disturbances such as erosion and water pollution, which allow the introduction of exotic plant species.

Other Comments
The narrow bands of this community occuring along parts of Swamp Creek are in excellent condition. In these areas, the occurrence of *Casuarina glauca* and *Baumea juncea*, species normally associated with saline estuarine environments, is of interest.

Lower Hunter Spotted Gum-Ironbark Forest Unit 17

REMS Classification: *Lower Hunter Spotted Gum-Ironbark Forest (MU 17)*


Description
Lower Hunter Spotted Gum-Ironbark Forest represents a vegetation type characterised by Spotted Gum (*Corymbia maculata*) and various Ironbarks (predominantly *Eucalyptus fibrosa*). In the Cessnock area, other canopy species include *Eucalyptus agglomerata* (atypical form), and in some exposed locations *Corymbia eximia*. Historically, this vegetation type has been heavily logged throughout the lower Hunter Valley, and consequently canopy and understorey composition has been altered. Dominance by *Melaleuca nodosa* in the shrub layer is one indication of past disturbance.

Structure
- **Tree** 8-25m, 20-40% cover
- **Small tree** 3-12m, 5-40% cover
- **Tall shrub** 2-4m, 5-40% cover
- **Shrub** 0.5-2m, 20-60% cover
- **Ground** < 0.5m, 20-40% cover

Floristics
- **Trees** *Corymbia maculata, Eucalyptus fibrosa, Eucalyptus agglomerata* (atypical), [*Corymbia eximia* in some localised areas]
- **Small tree** *Bursaria spinosa*
- **Shrubs** *Grevillea montana, Daviesia ulicifolia, Bursaria longisepala var. longisepala, Lissanthe strigosa, Acacia elongata var. elongata, Astrotricha obovata, Melaleuca nodosa, Grevillea parviflora* subsp. *parviflora, Persoonia linearis, Leptospermum parvifolium, Isopogon anemonifolius, Podolobium ilicifolium, Acacia buxifolia, Hakea sericea, Syncarpia glomulifera* subsp. *glomulifera, Dillwynia retorta, Acacia ulicifolia*
- **Vines** *Cassytha glabella forma glabella, Hardenbergia violacea, Glycine clandestina*
- **Herbs** *Platysace ericoides, Phyllanthus hirtellus forma A, Pomax umbellata, Goodenia rotundifolia, Hibbertia vestita, Gompholobium uncinatum, Oxylobium pultenaea*
- **Graminoids** *Entolasia stricta, Aristida vagans, Dichelachne micrantha, Dianella revoluta var. revoluta, Eragrostis brownii, Panicum simile, Poa sieberiana* subsp. *sieberiana, Austrodanthonia longifolia, Lomandra filiformis* subsp. *coriacea, Imperata cylindrica var. major, Joycea pallida, Lomandra multiflora* subsp. *multiflora, Lomandra cylindrica, Lomandra confertifolia* subsp. *pallida, Lomandra filiformis* subsp. *filiformis, Anisopogon avenaceus, Themeda australis*
- **Ferns** *Cheilanthes sieberi* subsp. *sieberi*
- **Sedges** *Lepidosperma laterale*
- **Cycads** *Macrozamia flexuosa, Macrozamia reducta*
- **Orchids** -

Rare or Threatened Species
- Undescribed species – ?*Eucalyptus sp aff agglomerata*
- NSW TSC Act species – *Grevillea parviflora* subsp. *parviflora, Rutidosis heterogama*
- Rare species – *Eucalyptus fergusonii subsp dorsiventralis, Grevillea montana, Macrozamia flexuosa*

Relationship to Other Communities
The characteristic presence of *Corymbia maculata* and *Eucalyptus fibrosa* in the canopy of this community clearly distinguish this type from all other communities in the Park. In areas where the canopy is low, there may be some confusion with variants of the Kurri Sand Swamp Woodland (Unit 35), particularly in those areas where broad ecotones exist. In addition, areas with a disturbance history tend to support dense thickets of *Melaleuca nodosa* in the understorey, which again can be difficult to distinguish. Separation of the two communities is probably best achieved based on structure.

Distribution
Within HEZ
This vegetation type represents the most widespread community in the area, and covers sizeable areas of the eastern portion of the site.

Outside of HEZ
Lower Hunter Spotted Gum-Ironbark Forest is relatively widespread throughout the central and lower Hunter Valley areas, although many areas have been cleared or modified. This type merges with the Coastal Foothills Spotted Gum-Ironbark Forest in the Quorrobolong area. NPWS (2000) have mapped 26 917ha of this type within the region.

Determining Factors
Within HEZ, this vegetation type occurs on Permian-based yellow-brown or grey-brown clay soils on most ridges and slopes in the east.

Mapping Reliability & Included Units
This community has been mapped from aerial photographic interpretation and field reconnaissance, and is considered accurate. There may be some inclusion of scrub variants of Kurri Sand Swamp Woodland (Unit 35) in some areas where a broad ecotonal zone exists.

Conservation Significance
- LOCAL - *Poor* (Werakata NP)
- REGIONAL - *Poor* (No reservation known)
- NATIONAL - *Poor* (No reservation known)

Threats
- *FIRE* - inappropriate fire regimes may adversely affect this community, with frequent (<3 years) firing dramatically simplifying understorey vegetation.

Other Comments
On some exposed crests where sandstone outcropping occurs, species such as *Corymbia eximia, Corymbia gummifera, Isopogon anemonifolius,* and *Acacia buxifolia* form a variation of the typical form of this community. Although survey was undertaken here, sufficient distinction could not be made to lift this variant to community status.


Hunter Lowlands Redgum Forest Unit 19

REMS Classification: *Hunter Lowlands Redgum Forest (MU 19)*


Description

Along the major creeklines associated with drainage flats, Hunter Lowlands Redgum Forest occurs. The majority of this community has been subjected to light grazing in the past, and consequently the understorey has been reduced largely to grasses and herbs with scattered shrubs. Redgums (*Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia, Eucalyptus glaucina*) characterise this community, with other species such as *Eucalyptus punctata, Eucalyptus crebra, Eucalyptus moluccana,* and *Angophora floribunda* also present. In places, this community forms broad ecotonal bands with the surrounding Lower Hunter Spotted Gum – Ironbark Forest (Unit 17), and extends up some gentle lower slopes. In drainage depressions within this area, thickets of *Melaleuca linariifolia* and *Melaleuca styphelioides* occur over a sedge understorey.

Structure

- **Tree** 18-20m, 40-50% cover
- **Small tree** -
- **Tall shrub** 3-6m, 5-15% cover
- **Shrub** 1-2m, 5-40% cover
- **Ground** < 0.5m, 80-90% cover

Floristics

- **Trees** *Eucalyptus tereticornis, Eucalyptus amplifolia* subsp. *amplifolia, Eucalyptus glaucina, Eucalyptus punctata, Eucalyptus crebra, Eucalyptus moluccana, Angophora floribunda*
- **Small tree** *Melaleuca decora, Acacia irrorata* subsp. *irrorata, Melaleuca linariifolia, Melaleuca styphelioides, Acacia parramattensis*
- **Shrubs** *Exocarpus strictus, Grevillea montana, Callistemon linearis, Acacia ulicifolia, Pultenaea cunninghamii, Daviesia ulicifolia, Melaleuca nodosa*
- **Vines** *Cassytha glabella forma glabella*
- **Herbs** *Hypoxis hygrometrica var. hygrometrica, Helichrysum scorpioides, Veronica cinerea var. cinerea, Pratia purpurascens, Desmodium varians, Laxmannia gracilis, Dichondra repens, Pomax umbellata, Polymera calycina, Opercularia hispida, Hibbertia linearis, Murdannia graminea, Goodenia rotundifolia, Haloragis heterophylla, Phyllanthus virgatus, Oxalis perennans, Hydrocotyle peduncularis*
- **Graminoids** *Microlaena stipoides var. stipoides, Aristida vagans, Eragrostis brownii, Paspalidium distans, Echinopogon ovatus, Entolasia stricta, Austrodanthonia longifolia, Dianella caerulea var. caerulea, Lomandra confertifolia* subsp. *pallida, Panicum simile*
- **Ferns** *Cheilanthes sieberi* subsp. *sieberi*
- **Sedges** *Fimbrostylis dichotoma, Lepidosperma laterale*
- **Cycads** -
- **Orchids** -

Rare or Threatened Species

- Undescribed species – *none recorded*
- NSW TSC Act species – *Eucalyptus glaucina*
- Rare species – *Grevillea montana*

Relationship to Other Communities
Hunter Lowlands Redgum Forest is closely related to the Central Hunter Riparian Forest (Unit 13), through a sharing of canopy species such as *Eucalyptus tereticornis, Eucalyptus moluccana*, and *Angophora floribunda*, and several understorey species. However, Unit 13 generally also includes *Casuarina glauca* and *Eucalyptus canaliculata,* and is restricted to immediate riparian zones (not flats and drainage depressions). The levels of past disturbance shown in areas supporting both of these communities makes differentiation difficult. In the Hunter Lowlands Redgum Forest, redgum species (*Eucalyptus tereticornis, Eucalyptua amplifolia* subsp. *amplifolia, Eucalyptus glaucina*) clearly dominant with *Eucalyptus puncata*, while these species are rare or absent in Unit 13.

Distribution
Within HEZ
This vegetation type occurs principally in the Chinamans Hollow Creek and its tributaries, but other smaller occurences are present alsewhere.

Outside of HEZ
NPWS (2000) have mapped 4856ha of their Hunter Lowlands Redgum Forest (MU 19) remaining in the region, with only 100ha in reserve. This vegetation type as described by NPWS (2000) is not a tight community, and can be highly variable and difficult to define in some places.

Determining Factors
Hunter Lowlands Redgum Forest occurs in open depressions and drainage flats on clay-based Permian Sediments, adjacent to relatively major creeklines.

Mapping Reliability & Included Units
This community has been mapped from aerial photographic interpretation and field reconnaissance, and is considered reasonably accurate. Boundaries can be difficult to define in areas where it merges with the surrounding Lower Hunter Spotted Gum-Ironbark Forest (Unit 17).

Conservation Significance
- LOCAL - *Poor* (Werakata NP)
- REGIONAL - *Poor* (No reservation known)
- NATIONAL - *Poor* (No reservation known)

Threats
- Grazing and clearing of this community has historically occurred throughout its range, and these threats remain where areas lie adjacent to agricultural lands.

Other Comments
Boundaries of this community can be difficult to define with certainty, as broad ecotonal zones exist in places with the surrounding Lower Hunter Spotted Gum – Ironbark Forest (Unit 17). This community is listed as an Endangered Ecological Community on the NSW *TSC Act 1995*.

Kurri Sand Swamp Woodland Unit 35

REMS Classification: *Kurri Sand Swamp Woodland (MU 35)*


Description
Much of the western sections of the HEZ site support vegetation equating to the Kurri Sand Swamp Woodland (Unit 35) described by NPWS (2000), although significant differences in floristic composition are evident. In these areas, the canopy is variously dominated by *Angophora bakeri, Eucalyptus racemosa*, *Eucalyptus agglomerata* (atypical), *Eucalyptus parramattensis* subsp. *decadens* and *Corymbia gummifera*. Understorey vegetation is dominated by a range of shrubs typical of sand environments, but with clay species such as *Melaleuca nodosa* also prominent in some parts. Several variants have been recognised within this community, however insufficient sampling of these means that true relationships are clouded.

Structure
- **Tree** 5-12m, 10-40% cover
- **Small tree** -
- **Tall shrub** 1.5-3m, 10-80% cover
- **Shrub** 0.5-1.5m, 20-70% cover
- **Ground** < 0.5m, 10-60% cover

Floristics
- **Trees** *Angophora bakeri, Eucalyptus racemosa, Eucalyptus resinifera* subsp. *resinifera, Eucalyptus agglomerata* (atypical), *Eucalyptus parramattensis* subsp. *decadens, Corymbia gummifera*
- **Small tree** *Melaleuca sieberi, Melaleuca decora*
- **Shrubs** *Banksia oblongifolia, Banksia spinulosa var. collina, Dillwynia retorta, Leptospermum trinervium, Acacia ulicifolia, Leptospermum polygalifolium* subsp. *cismontanum, Leucopogon virgatus, Isopogon anemonifolius, Bossiaea heterophylla, Monotoca scoparia, Melaleuca nodosa, Lambertia formosa, Melichrus procumbens, Hakea dactyloides, Melaleuca thymifolia, Exocarpus strictus, Hakea sericea, Callistemon linearis, Styphelia triflora, Leptospermum parvifolium, Hibbertia acicularis*
- **Vines** *Cassytha glabella forma glabella, Mirbelia rubifolia*
- **Herbs** *Platysace ericoides, Dampiera stricta, Drosera auriculata, Hibbertia vestita, Helicrysum scorpioides*
- **Graminoids** *Lomandra cylindrica, Lomandra glauca, Anisopogon avenaceus, Entolasia stricta, Aristida warburgii, Eragrostis brownii, Xanthorrhoea glauca* subsp. *glauca*
- **Ferns** -
- **Sedges** *Gahnia radula, Lepidosperma gunnii*
- **Cycads** -
- **Orchids** *Acianthus fornicatus*

Rare or Threatened Species
- Undescribed species – *Eucalyptus* sp aff *camfieldii; Eucalyptus* sp aff *agglomerata*
- NSW TSC Act species – *Acacia bynoeana, Eucalyptus parramattensis* subsp. *decadens, Grevillea parviflora* subsp. *parviflora*
- Rare species – *Grevillea montana*

Relationship to Other Communities
In general, Kurri Sand Swamp Woodland is distinctly different to all other vegetation within HEZ, although transitional vegetation types can be difficult to discern. The canopy combination of *Angophora bakeri, Eucalyptus resinifera* subsp. *resinifera,* and *Eucalyptus agglomerata* (atypical) does not occur in other communities, and localised occurences of *Eucalyptus parramattensis* subsp. *decadens* and *Eucalyptus racemosa* do not occur elsewhere. The dense *Melaleuca* version of this type may be considered similar to parts of the Lower Hunter Spotted Gum – Ironbark Forest (Unit 17), but the presence of *Eucalyptus parramattensis* subsp. *decadens* in the former distinguishes the two. There is much variation within the Kurri Sands Swamp Woodland, and defining all differences between this vegetation type and others is perhaps premature.

Distribution
Within HEZ
This vegetation type occurs predominantly in the western half of the site, although drainage lines in the east also support it.

Outside of HEZ
NPWS (2000) have indicated that 2195ha of their Kurri Sand Swamp Woodland (MU 35) remains in the region, and they map only 46ha in reserve (ie: Werakata NP). This figure should be amended to 70ha after the mapping of Bell (2001). Kurri Sand Swamp Woodland is restricted to the Kurri-Cessnock-Maitland area, and the true extent of the many variations within it remain unknown.

Determining Factors
Kurri Sand Swamp Woodland occurs generally on level to slightly undulating Tertiary sand deposits where drainage is relatively free-flowing. Some variants, however, occur on soils with a higher clay content.

Mapping Reliability & Included Units
This community has been mapped from aerial photographic interpretation and field reconnaissance, and is considered accurate.

Conservation Significance
- LOCAL - *Poor* (Werakata NP)
- REGIONAL - *Poor* (No reservation known)
- NATIONAL - *Poor* (No reservation known)

Threats
- *FIRE* – frequent fire regimes may dramatically alter the current floristic composition of this community.

Other Comments
Vegetation within this community does not conform readily to that described by NPWS (2000), but in essence the major components are present. NPWS (2000) do not satisfactorily described the many variants present within this complex, as soil drainage within this type dictates the floristic composition of differing stands. In some areas where soils are particularly clayey, understorey vegetation is dominated by *Melaleuca nodosa*. In more sandy areas, this species is far less prominent and *Leptospermum trinervium* and *Leptospermum polygalifolium* dominate.


Freshwater Wetlands Unit 46

REMS Classification: Freshwater Wetland Complex *(MU 46)*


Description **No plot data**

A few small pockets of Freshwater Wetland occur in the study area, mainly associated with abandoned farm/ mining dams or as a result of road construction. In the former case, *Typha orientalis* wetlands generally occur, while in the latter wetlands dominated by *Baumea articulata* and *Philydrum lanuginosum* occur. No floristic survey has yet been undertaken in these types, and it is likely that these areas are more complex than described here. There is considerable variation in wetland vegetation throughout the region, and it is difficult to understand the inter-relationships between the various forms at present.

Structure

- **Tree** -
- **Small tree** -
- **Tall shrub** -
- **Shrub** 0.5-2m, 5-10% cover
- **Ground** < 0.5m, 70-100% cover

Floristics

- **Trees** -
- **Small tree** -
- **Shrubs** *Melaleuca thymifolia, Leptopsermum juniperinum*
- **Vines** -
- **Herbs** -
- **Graminoids** *Typha orientalis, Phragmites australis*
- **Ferns** -
- **Sedges** *Baumea articulata, Philydrum lanuginosum*
- **Cycads** **-**
- **Orchids** -

Rare or Threatened Species

- Undescribed species – *none recorded*
- NSW TSC Act species – *none recorded*
- Rare species – *none recorded*

Relationship to Other Communities

Freshwater Wetlands are distinct from all other vegetation types, both floristically and structurally.

Distribution

Within HEZ

Small pockets occur adjacent to MR 195 near Pelaw Main, and other abandoned dams occur in proximity to old farmlands or mining leases.

Outside of HEZ

NPWS (2000) have mapped 3773ha of their Freshwater Wetlands (Unit 46) remaining in the region, with only 658ha in reserve.

Determining Factors
Freshwater Wetlands occur on heavy clay subsoils in areas of no drainage, or in cases where drainage is severely impeded.

Mapping Reliability & Included Units
This community has been mapped from aerial photographic interpretation and field reconnaissance, and is considered accurate.

Conservation Significance
- LOCAL - *Poor* (No reservation known)
- REGIONAL - *Moderate* (several small coastal reserves)
- NATIONAL - *?Adequate* (?No reservation known)

Threats
- Alterations to drainge regimes will impact on this community.

Other Comments
Considerable additional survey and analysis is required within wetland complexes in the lower Hunter Valley to ascertain inter-relationships and to more clearly define the various communities and sub-communities that appear to be present.

APPENDIX C: FAUNA SPECIES LISTS

EXPECTED FAUNA SPECIES LIST

Below are tabulated lists of fauna species (separated into class guilds) that could be *reasonably* expected to be found within the study area at some time. Such an approach has been taken given the unlikelihood to record *all* potentially occurring species within an area during formal fauna surveys (due to seasonality of certain species, climatic limitations, crypticism etc).

Family sequencing and taxonomy follow for each fauna class:

Birds – Christidis and Boles (1994).

Herpetofauna - Cogger (2000).

Mammals - Strahan (ed) (1995) and Churchill (1998).

Known and Expected Bird List

Appendix Key:

= introduced species
? = species not confirmed beyond doubt
(C) = listed as CAMBA species
(J) = listed as JAMBA species
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
✓ = Species recorded within the study area.
(E) = listed as Endangered in NSW.
(V) = listed as Vulnerable in NSW.
(EE) = Species listed under the Commonwealth EPBC Act as Endangered
(EM) = Species listed under the Commonwealth EPBC Act as Migratory

Family	*Scientific Name*	Common Name	Recorded
Casuariidae (Emus)	*Dromaius novaehollandiae*	Emu	✓
Megapodiidae (Mound Builders)	*Alectura lathami*	Australian Brush-turkey	
Phasianidae (Quails, Pheasants and Fowls)	*Coturnix pectoralis*	Stubble Quail	✓
	Coturnix ypsilophora	Brown Quail	✓
Anatidae (Swans, Geese and Ducks)	*Anas castanea*	Chestnut Teal	
	Anas gracilis	Grey Teal	✓
	Anas platyrhynchos	*Mallard	
	Anas superciliosa	Pacific Black Duck	✓
	Aytha australis	Hardhead	✓
	Chenonetta jubata	Australian Wood Duck	✓
	Cygnus atratus	Black Swan	
Podicipedidae (Grebes)	*Tachybaptus novaehollandiae*	Australasian Grebe	✓
Anhingidae (Darters)	*Anhinga melanogaster*	Darter	
Phalacrocoracidae (Cormorants)	*Phalacrocorax carbo*	Great Cormorant	✓
	Phalacrocorax melanoleucos	Little Pied Cormorant	
	Phalacrocorax sulcirostris	Little Black Cormorant	✓
	Phalacrocorax varius	Pied Cormorant	
Pelecanide (Pelicans)	*Pelecanus conspicillatus*	Australian Pelican	✓
Ardeidae (Herons, Bitterns and Egrets)	*Ardea alba*	Great Egret (C,J, EM)	✓

Family	*Scientific Name*	Common Name	Recorded
	Ardea ibis	Cattle Egret (C,J, EM))	✓
	Ardea intermedia	Intermediate Egret	✓
	Ardea pacifica	White-necked Heron	
	Egretta garzetta	Little Egret	
	Egretta novaehollandiae	White-faced Heron	✓
	Nycticorax caledonicus	Nankeen Night Heron	
Threskiornithidae (Ibises and Spoonbills)	*Platalea flavipes*	Yellow-billed Spoonbill	✓
	Platalea regia	Royal Spoonbill	✓
	Threskiornis molucca	Australian White Ibis	✓
	Threskiornis spinicollis	Straw-necked Ibis	
Ciconiidae (Storks)	*Ephippiorhynchus asiaticus*	Black-necked Stork (E)	
Accipitridae (Hawks, Kites and Eagles)	*Accipiter fasciatus*	Brown Goshawk	✓
	Accipiter cirrhocephalus	Collared Sparrowhawk	
	Accipiter novaehollandiae	Grey Goshawk	✓
	Aquila audax	Wedge-tailed Eagle	✓
	Aviceda subcristata	Pacific Baza	✓
	Circus approximans	Swamp Harrier	
	Circus assimilis	Spotted Harrier	
	Elanus axillaris	Black-shouldered Kite	✓
	Haliaeetus leucogaster	White-bellied Sea-Eagle (C, EM)	
	Haliastur sphenurus	Whistling Kite	✓
	Hamirostra melanosternon	Black-breasted Buzzard (V)	✓
	Hieraaetus morphnoides	Little Eagle	✓
	Lophoictinia isura	Square-tailed Kite (V)	
Falconidae (Falcons)	*Falco berigora*	Brown Falcon	✓
	Falco cenchroides	Nankeen Kestrel	✓
	Falco longipennis	Australian Hobby	✓
	Falco peregrinus	Peregrine Falcon	✓
	Falco subniger	Black Falcon	✓
Rallidae (Crakes, Rails and Gallinules)	*Fulica atra*	Eurasian Coot	✓
	Gallinula philippensis	Buff-banded Rail	
	Gallinula tenebrosa	Dusky Moorhen	✓
	Porphyrio porphyrio	Purple Swamphen	✓
	Porzana fluminea	Australian Spotted Crake	
	Porzana pusilla	Baillon's Crake	
	Porzana tabuensis	Spotless Crake	
	Rallus pectoralis	Lewin's Rail	
Turnicidae (Button-Quail)	*Turnix pyrrhothorax*	Red-chested Button-quail	
	Turnix varia	Painted Button-quail	✓
Jacanidae (Jacanas)	*Irediparra gallinacea*	Comb-crested Jacana (V)	
Charadriidae (Lapwings, Plovers and Dottrels)	*Erythrogonys cinctus*	Red-kneed Dotterel	
	Elseyornis melanops	Black-fronted Dotterel	
	Vanellus miles	Masked Lapwing	✓
Laridae (Gulls and Terns)	*Chlidonias hybrida*	Whiskered Tern	
	Larus novaehollandiae	Silver Gull	
Columbidae			✓

Family	*Scientific Name*	Common Name	Recorded
(Pigeons and Doves)	*Columba livia*	Rock Dove #	
	Columba leucomela	White-headed Pigeon	
	Streptopelia chinensis	Spotted Turtle-Dove #	✓
	Chalcophaps indica	Emerald Dove	
	Phaps chalcoptera	Common Bronzewing	✓
	Phaps elegans	Brush Bronzewing	
	Ocyphaps lophotes	Crested Pigeon	✓
	Geopelia striata	Peaceful Dove	✓
	Geopelia humeralis	Bar-shouldered Dove	✓
	Leucosarcia melanoleuca	Wonga Pigeon	✓
Cacatuidae (Cockatoos)	*Calyptrohynchus funereus*	Yellow-tailed Black-Cockatoo	✓
	Calyptorhynchus lathami	Glossy Black-Cockatoo (V)	✓
	Cacatua roseicapilla	Galah	✓
	Cacatua tenuirostris	Long-billed Corella	✓
	Cacatua sanguinea	Little Corella	✓
	Cacatua galerita	Sulphur-crested Cockatoo	✓
	Callocephalon fimbriatum	Gang-gang Cockatoo	✓
Psittacidae (Parrots)	*Trichoglossus haematodus*	Rainbow Lorikeet	✓
	Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	
	Trichoglossus concina	Musk Lorikeet	✓
	Glassopsitta pusilla	Little Lorikeet	✓
	Alisterus scapularis	Australian King Parrot	✓
	Lathamus discolor	Swift Parrot (E, EE)	✓
	Platycercus elegans	Crimson Rosella	✓
	Platycercus eximius	Eastern Rosella	✓
	Neophema pulchella	Turquoise Parrot (V)	✓
	Psephotus haematonotus	Red-rumped Parrot	✓
Cuculidae (Old World Cuckoos)	*Cuculus saturatus*	Oriental Cuckoo (C,J, EM)	
	Cuculus pallidus	Pallid Cuckoo	✓
	Cacomantis variolosus	Brush Cuckoo	✓
	Cacomantis flabelliformis	Fan-tailed Cuckoo	✓
	Chrysococcyx basalis	Horsfield's Bronze-Cuckoo	✓
	Chrysococcyx lucidus	Shining Bronze-Cuckoo	✓
	Eudynamys scolopacea	Common Koel	✓
	Scythrops novaehollandiae	Channel-billed Cuckoo	✓
Centropodidae (Coucals)	*Centropus phasianinus*	Pheasant Coucal	✓
Strigidae (Hawk Owls)	*Ninox strenua*	Powerful Owl (V)	✓
	Ninox connivens	Barking Owl (V)	
	Ninox boobook	Southern Boobook	✓
Tytonidae (Barn Owls)	*Tyto alba*	Barn Owl	
	Tyto novaehollandiae	Masked Owl (V)	✓
	Tyto tenebricosa	Sooty Owl (V)	✓
Podargidae (Frogmouths)	*Podargus strigoides*	Tawny Frogmouth	✓
Caprimulgidae (Nightjars)	*Eurostopodus mystacalis*	White-throated Nightjar	
Aegothelidae (Owlet-nightjars)	*Aegotheles cristatus*	Australian Owlet-nightjar	✓
Apodidae (Typical Swifts)	*Hirundapus caudacutus*	White-throated Needletail (C,J, EM)	✓

Family	*Scientific Name*	Common Name	Recorded
	Apus pacificus	Fork-tailed Swift (C,J, EM)	
Alcedinidae (True Kingfishers)	*Alcedo azurea*	Azure Kingfisher	✓
Halcyonidae (Kingfishers and Kookaburras)	*Dacelo novaeguineae*	Laughing Kookaburra	✓
	Todiramphus sanctus	Sacred Kingfisher	✓
Meropidae (Bee-eaters)	*Merops ornatus*	Rainbow Bee-eater (J,EM)	✓
Coraciidae (Typical Rollers)	*Eurystomus orientalis*	Dollarbird	✓
Menuridae (Lyrebirds)	*Menura novaehollandiae*	Superb Lyrebird	
Climacteridae (Australo-Papuan Treecreepers)	*Cormobates leucophaeus*	White-throated Treecreeper	✓
	Climacteris erythrops	Red-browed Treecreeper	
	Climacteris picumnus victoriae	Brown Treecreeper (V)	✓
Maluridae (Fairy-Wrens and Emu-Wrens)	*Malurus cyaneus*	Superb Fairy-wren	✓
	Malurus lamberti	Variegated Fairy-wren	✓
	Stipiturus malachurus	Southern Emu-wren	
Pardalotidae (Pardalotes, Scrubwrens, Thornbills)	*Pardalotus punctatus*	Spotted Pardalote	✓
	Paradalotus striatus	Striated Pardalote	✓
	Sericornis frontalis	White-browed Scrubwren	✓
	Chthonicola sagittata	Speckled Warbler (V)	✓
	Smicrornis brevirostris	Weebill	✓
	Gerygone mouki	Brown Gerygone	✓
	Gerygone olivacea	White-throated Gerygone	✓
	Acanthiza pusilla	Brown Thornbill	✓
	Acanthiza reguloides	Buff-rumped Thornbill	✓
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	✓
	Acanthiza nana	Yellow Thornbill	✓
	Acanthiza lineata	Striated Thornbill	✓
	Hylacola pyrrhopygia	Chestnut-rumped Heathwren	
Meliphagidae (Honeyeaters)	*Anthochaera carunculata*	Red Wattlebird	✓
	Plectrhyncha lanceolata	Striped Honeyeater	✓
	Anthochaera chrysoptera	Brush Wattlebird	
	Philemon corniculatus	Noisy Friarbird	✓
	Philemon citerogularis	Little Friarbird	
	Xanthomyza phrygia	Regent Honeyeater (E, EE, EM)	✓
	Manorina melanophrys	Bell Miner	✓
	Manorina melanocephala	Noisy Miner	✓
	Meliphaga lewinii	Lewin's Honeyeater	✓
	Lichenostomus chrysops	Yellow-faced Honeyeater	✓
	Lichenostomus leucotis	White-eared Honeyeater	✓
	Lichenostomus melanops	Yellow-tufted Honeyeater	✓
	Lichenostomus fuscus	Fuscous Honeyeater	✓
	Lichenostomus penicillatus	White-plumed Honeyeater	✓
	Melithreptus brevirostris	Brown-headed Honeyeater	✓
	Melithreptus lunatus	White-naped Honeyeater	✓
	Melithreptus gularis gularis	Black-chinned Honeyeater (V)	✓
	Entomyzon cyanotis	Blue-faced Honeyeater	✓
	Lichmera indistincta	Brown Honeyeater	✓

Family	*Scientific Name*	Common Name	Recorded
	Phylidonyris novaehollandiae	New Holland Honeyeater	✓
	Phylidonyris nigra	White-cheeked Honeyeater	✓
	Acanthorhynchus tenuirostris	Eastern Spinebill	✓
	Grantiella picta	Painted Honeyeater (V)	
	Myzomela sanguinolenta	Scarlet Honeyeater	✓
	Epthianura albifrons	White-fronted Chat	
Eopsaltriidae (Robins)	*Microeca fascinans*	Jacky Winter	✓
	Petroica multicolor	Scarlet Robin	✓
	Petroica phoenicea	Flame Robin	
	Petroica rosea	Rose Robin	✓
	Eopsaltria australis	Eastern Yellow Robin	✓
Pomatostomidae (Australo-Papuan Babblers)	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (V)	✓
Cinclosomidae (Quail-thrushes and allies)	*Psophodes olivaceus*	Eastern Whipbird	✓
	Cinclosoma punctatum	Spotted Quail-thrush	✓
Neosittidae (Sittellas)	*Daphoenositta chrysoptera*	Varied Sittella	✓
Pachycephalidae (Whistlers, Shrike-tit and Shrike-thrushes)	*Falcunculus frontatus*	Crested Shrike-tit	✓
	Pachycephala pectoralis	Golden Whistler	✓
	Pachycephala rufiventris	Rufous Whistler	✓
	Colluricincla harmonica	Grey Shrike-thrush	✓
Dicruridae (Monarchs, Fantails and Drongo)	*Monarcha melanopsis*	Black-faced Monarch	
	Myiagra rubecula	Leaden Flycatcher	✓
	Myiagra inquieta	Restless Flycatcher	✓
	Grallina cyanoleuca	Magpie-lark	✓
	Rhipidura rufifrons	Rufous Fantail	✓
	Rhipidura fuliginosa	Grey Fantail	✓
	Rhipidura leucophyrs	Willie Wagtail	✓
	Dicrurus bracteatus	Spangled Drongo	
Campephagidae (Cuckoo-shrikes and Trillers)	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	✓
	Coracina papuensis	White-bellied Cuckoo-shrike	✓
	Coracina tenuirostris	Cicadabird	✓
	Lalage sueurii	White-winged Triller	
Oriolidae (Orioles and Figbird)	*Oriolus sagittatus*	Olive-backed Oriole	✓
	Sphecotheres viridis	Figbird	
Artamidae (Woodswallows, Butcherbirds and Currawongs)	*Artamus leucorynchus*	White-breasted Woodswallow	
	Artamus cyanopterus	Dusky Woodswallow	✓
	Cracticus torquatus	Grey Butcherbird	✓
	Cracticus nigrogularis	Pied Butcherbird	✓
	Gymnorhina tibicen	Australian Magpie	✓
	Strepera graculina	Pied Currawong	✓
Corvidae (Crows and allies)	*Corvus coronoides*	Australian Raven	✓
Cororacidae Mud-nesters	*Corcorax melanorhamphos*	White-winged Chough	✓
Ptilinorhynchidae (Bowerbirds)	*Ptilonorhynchus violaceus*	Satin Bowerbird	✓
Motacillidae (Old World Wagtails and Pipits)	*Anthus novaeseelandiae*	Richard's Pipit	

Family	*Scientific Name*	Common Name	Recorded
Passeridae (Sparrows, Weaverbirds, Waxbills and allies)	*Passer domesticus*	House Sparrow #	
	Taeniopygia guttata	Zebra Finch	
	Taeniopygia bichenovii	Double-barred Finch	✓
	Stagonopleura guttata	Diamond Firetail (V)	
	Neochmia modesta	Plum-headed Finch	
	Neochmia temporalis	Red-browed Finch	✓
	Lonchura castaneothorax	Chestnut-breasted Mannikin	
Dicaeidae (Flowerpeckers)	*Dicaeum hirundinaceum*	Mistletoebird	✓
Hirundinidae (Swallows and Martins)	*Hirundo neoxena*	Welcome Swallow	✓
	Hirundo nigricans	Tree Martin	✓
	Hirundo ariel	Fairy Martin	✓
	Cheramoeca leucosternus	White-backed Swallow	
Sylviidae (Old World Warblers)	*Cincloramphus mathewsi*	Rufous Songlark	
	Acrocephalus stentoreus	Clamorous Reed Warbler	✓
	Cisticola exilis	Golden-headed Cisticola	
Zosteropidae (White-eyes)	*Zosterops lateralis*	Silvereye	✓
Sturnidae (Starlings and allies)	*Sturnus vulgaris*	Common Starling #	✓
	Acridotheres tristis	Common Myna #	✓

Known and Expected Mammal List

Appendix Key: # = introduced species (E) = listed as Endangered in NSW.
? = species not confirmed beyond doubt (V) = listed as Vulnerable in NSW.
(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable
✓ = Species recorded within the study area.

Sub-Class	Family Name	*Scientific Name*	Common Name	Recorded
Protehria (Monotremes)	Tachyglossidae (Echidnas)	*Tachyglossus aculeatus*	Short-beaked Echidna	✓
Marsupalia (Marsupials)	Dasyuridae (Dasyurids)	*Antechinus flavipes*	Yellow-footed Antechinus	✓
		Antechinus stuartii	Brown Antechinus	
		Antechinus swainsonii	Dusky Antechinus	
		Dasyurus maculatus	Tiger Quoll (V)	
		Phascogale tapoatafa	Brush-tailed Phascogale (V)	
		Planigale maculata	Common Planigale (V)	
		Sminthopsis murina	Common Dunnart	✓
	Peramelidae (Bandicoots and Bilbies)	*Isoodon macrourus*	Northern Brown Bandicoot	
		Peremeles nasuta	Long-nosed Bandicoot	✓
	Phascolarctidae (Koala)	*Phascolarctos cinereus*	Koala (V)	✓
	Vombatidae	*Vombatus ursinus*	Common Wombat	✓
	Petauridae (Wrist-winged Gliders)	*Petaurus breviceps*	Sugar Glider	✓
		Petaurus norfolcensis	Squirrel Glider (V)	✓
		Petaurus australis	Yellow-bellied Glider (V)	✓
	Pseudocheiridae (Ringtail Possums)	*Pseudocheirus peregrinus*	Common Ringtail Possum	✓
	Acrobatidae (Feathertail Glider)	*Acrobates pygmaeus*	Feathertail Glider	
	Phalangeridae (Brushtail Possums and Cuscuses)	*Trichosurus vulpecula*	Common Brushtail Possum	✓
	Macropodidae (Wallabies and Kangaroos)	*Macropus giganteus*	Eastern Grey Kangaroo	✓
		Macropus robustus	Common Wallaroo	✓
		Macropus rufogriseus	Red-necked Wallaby	✓
		Wallabia bicolor	Swamp Wallaby	✓
	Pteropodidae (Flying-foxes, Fruit-bats and Blossum-bats)	*Pteropus poliocephalus*	Grey-headed Flying-fox (V, EV)	
		Pteropus scapulatus	Little Red Flying-fox	
	Rhinolophidae (Horseshoe-bats)	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	
	Emballonuridae (Sheathtail-bats)	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat (V)	
	Molossidae (Freetail-bats)	*Mormopterus norfolkensis*	East-coast Freetail-bat (V)	✓
		Mormopterus sp.1	Little Freetail-bat	
		Mormopterus sp.2	Freetail-bat	✓
		Nyctinomus australis	White-striped Freetail-bat	✓
	Vespertilionidae (Vespertilionid Bats)	*Miniopterus australis*	Little Bentwing-bat (V)	✓
		Miniopterus schreibersii oceanensis	Eastern Bentwing-bat (V)	✓
		Nyctophilus geoffroyi	Lesser Long-eared Bat	✓
		Nyctophilus gouldii	Gould's Long-eared Bat	✓

Sub-Class	Family Name	*Scientific Name*	Common Name	Recorded
		Chalinolobus dwyeri	Large-eared Pied Bat (V)	
		Chalinolobus gouldii	Gould's Wattled Bat	✓
		Chalinolobus morio	Chocolate Wattled Bat	✓
		Falsistrellus tasmaniensis	Eastern Falsistrelle (V)	✓
		Myotis adversus	Large-footed Myotis (V)	✓
		Scoteanax orion	Eastern Broad-nosed Bat	✓
		Scoteanax rueppellii	Greater Broad-nosed Bat (V)	✓
		Scotorepens greyii	Little Broad-nosed Bat	
		Vespadelus darlingtoni	Large Forest Bat	
		Vespadelus regulus	Southern Forest Bat	
		Vespadelus pumilus	Eastern Forest Bat	✓
		Vespadelus vulturnus	Little Forest Bat	✓
Eutheria (Non-Flying Placental Mammals)	Muridae (Murids)	*Hydromys chrysogaster*	Water Rat	
		Melomys burtoni	Grassland Melomys	
		Mus musculus	House Mouse #	✓
		Pseudomys novaehollandiae	New Holland Mouse	✓
		Rattus fuscipes	Bush Rat	
		Rattus lutreolus	Swamp Rat	✓
		Rattus norvegicus	Brown Rat #	✓
		Rattus rattus	Black Rat #	✓
	Canidae (Dingo and Fox)	*Canis familiaris*	Dog #	✓
		Canis familiaris dingo	Dingo	
		Vulpes vulpes	Red Fox #	✓
	Felidae (Cat)	*Felis catus*	Feral Cat #	✓
	Leporidae (Rabbit and Hare)	*Oryctolagus cuniculus*	European Rabbit #	✓
		Lepus capensis	Brown Hare #	✓
	Equidae (Horse and Donkey)			✓
		Equus caballus	Horse #	✓
	Suidae (Pig)	*Sus scrofa*	Pig #	✓
	Bovidae (Horned Ruminants)	*Bos taurus*	Cow #	✓
		Capra hircus	Goat #	✓
	Cervidae (Deer)	*Cervus timorensis*	Rusa Deer #	✓

Known and Expected Reptile List

Appendix Key:

(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable

(E) = listed as Endangered in NSW.

(V) = listed as Vulnerable in NSW.

✓ = Species recorded within the study area.

Family Name	*Scientific Name*	Common Name	Recorded
Chelidae (Tortoises)	*Chelodina longicollis*	Long-necked Tortoise	✓
Gekkonidae (Geckoes)	*Diplodactylus vittatus*	Wood Gecko	✓
Agamidae (Dragons)	*Amphibolurus muricatus*	Jacky Lizard	✓
	Physignathus lesuerii	Eastern Water Dragon	✓
	Pogona barbata	Eastern Bearded Dragon	✓
Pygopodidae (Legless Lizards)	*Lialis burtonis*	Burton's Snake Lizard	
	Pygopus lepidopus	Common Scaly-foot	
	Delma plebeia	Leaden Delma	
Varanidae (Monitors)	*Varanus gouldii*	Gould's Monitor	
	Varanus varius	Lace Monitor	✓
Scincidae (Skinks)	*Carlia tetradactyla*		✓
	Cryptoblepharus virgatus	Wall Lizard	✓
	Ctenotus taeniolatus	Copper-tailed Skink	✓
	Ctenotus robustus	Striped Skink	✓
	Cyclodomorphus casuarinae	She-oak Skink	✓
	Egernia cunninghamii	Cunningham's Skink	
	Egernia major	Land Mullet	
	Egernia modesta		
	Egernia striolata	Tree-crevice Skink	
	Egernia saxatilis	Black Rock Skink	
	Egernia whitii	White's Skink	✓
	Eulamprus quoyii	Eastern Water Skink	✓
	Eulamprus tenuis	Barred-sided Skink	✓
	Lampropholis delicata	Grass Skink	✓
	Lampropholis guichenoti	Garden Skink	✓
	Lygisaurus foliorum	Tree-base Litter-skink	
	Morethia boulengeri	South-eastern Morethia	
	Pseudomoia platynota	Red-throated Skink	
	Saiphos equalis		
	Saproscincus mustelinus	Weasel Skink	
	Tiliqua scincoides	Eastern Blue-tongued Lizard	✓
Typhlopidae (Blind Snakes)	*Ramphotyphlops bituberculatus*	Prong-snouted Blind Snake	
	Ramphotyphlops weidii	Brown-snouted Blind Snake	
	Ramphotyphlops nigrescens	Black Blind Snake	
Boidae (Pythons)	*Morelia spilota*	Diamond Python	
Colubridae (Tree Snakes)	*Boiga irregularis*	Brown Tree Snake	
	Dendralaphis punctulata	Green Tree Snake	✓
Elapidae (Venomous Snakes)	*Furina diadema*	Red-naped Snake	
	Acanthopis antarcticus	Death Adder	
	Cacophis krefftii	Dwarf Crowned Snake	
	Cacophis squamulosus	Golden Crowned Snake	
	Demansia psammophis	Yellow-faced Whip Snake	✓
	Furina diadema	Red-naped Snake	
	Hoplocephalus bitorquatus	Pale-headed Snake (V)	

Family Name	*Scientific Name*	Common Name	Recorded
	Hoplocephalus stephensii	Stephen's Banded Snake (V)	
	Notechis scutatus	Eastern Tiger Snake	✓
	Pseudonaja textilis	Eastern Brown Snake	
	Rhinoplocephalus nigrescens	Eastern Small-eyed Snake	
	Vermicella annulata	Bandy Bandy	
	Hemiaspis signata	Black-bellied Swamp Snake	
	Pseudechis porphyriacus	Red-bellied Black Snake	✓
	Rhinoplocephalus nigrescens	Eastern Small-eyed Snake	✓

Known and Expected Frog List

Appendix Key:

(EV) = Species listed under the Commonwealth EPBC Act as Vulnerable

(E) = listed as Endangered in NSW.

(V) = listed as Vulnerable in NSW.

Data Source:

✓ = Species recorded within the study area.

Family Name	*Scientific Name*	Common Name	Recorded
Hylidae (Tree Frogs)	*Litoria aurea*	Green and Golden Bell Frog (E, EV)	
	Litoria brevipalmata	Green-thighed Frog	✓
	Litoria caerulea	Green Tree Frog	
	Litoria chloris	Red-eyed Green Tree Frog	
	Litoria dentata	Bleating Tree Frog	✓
	Litoria fallax	Eastern Dwarf Tree Frog	✓
	Litoria latopalmata	Broad-palmed Frog	✓
	Litoria lesueuri	Lesueur's Frog	✓
	Litoris nasuta	Rocket Frog	
	Litoria peronii	Peron's Tree Frog	✓
	Litoria phyllochroa	Green Leaf Tree Frog	
	Litoria tyleri	Tyler's Tree Frog	✓
	Litoria verreauxii	Verreaux's Frog	✓
Myobatrachidae (Ground Frogs)	*Crinia signifera*	Common Eastern Froglet	✓
	Crinia tinnula	Wallum Froglet (V)	
	Limnodynastes dumerilli	Eastern Banjo Frog	✓
	Limnodynastes ornatus	Ornate Burrowing Frog	✓
	Limnodynastes peronii	Striped Marsh Frog	✓
	Limnodynastes tasmaniensis	Spotted Grass Frog	✓
	Pseudophryne coriacea	Red-backed Toadlet	
	Pseudophryne bibronii	Brown Toadlet	✓
	Uperoleia fusca		✓
	Uperoleia laevigata	Smooth Toadlet	✓