

**WORLD HERITAGE AND ASSOCIATIVE NATURAL
VALUES OF THE CENTRAL EASTERN RAINFOREST
RESERVES OF AUSTRALIA**

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By channels of coolness the echoes are calling
And down the dim gorge I hear the creek falling
It lives in the mountains where mosses and sedges
Touch with their beauty the bank and the ledges
Through breaks in the cedar and sycamore bowers
Struggles the light that is sweet to the flowers;
And softer than slumber and sweeter than singing,
The notes of the bell-birds are running and ringing.

‘Bellbirds’

by Henry Kendall

EXECUTIVE SUMMARY

This report reviews the World Heritage values of the Central Eastern Rainforest Reserves of Australia (CERRA) World Heritage Area. The assessment of World Heritage values is based on the criteria for World Heritage listing. CERRA was inscribed on the World Heritage list as a site with outstanding universal significance in terms of its natural heritage. The property satisfied three of the four possible criteria for the listing of a natural property.

The criteria for World Heritage listing have changed since the listing of CERRA, but this has little effect on this review because the changes generally amount to a re-arrangement of themes within the criteria for which the property is listed. This review identifies attributes, which demonstrate the values under each criterion. Threats to these attributes are identified and the condition of integrity is assessed.

World Heritage values

Criterion (i): *'be outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.'*

Values related to this criterion and key attributes supporting these values are as follows.

- **CERRA World Heritage rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana.**

Ecosystems demonstrating this value include subtropical, warm temperate and cool temperate rainforest types. Species, which support this value, include:

- Ferns from families having origins in Pangea, including tree ferns.
- All conifers and cycads, pre-Angiosperm groups with their ancestry in Gondwana. Hoop pine (*Araucaria cunninghamii*), a member of the most ancient section of *Araucaria*, is of particular importance.
- Early angiosperm lineages in Austrobaileyales and Magnoliids, which contribute to CERRA being a secondary centre of endemism for early angiosperm lineages that complements the Wet Tropics. Specific genera and families include *Trimenia*, Atherospermataceae, Monimiaceae, Lauraceae, Annonaceae, Eupomatiaceae, Aristolochiaceae, Piperaceae, Peperomiaceae and Winteraceae.
- Other Gondwanic families, demonstrating the early radiation of the flowering plants. Some of the important families include Proteaceae, Nothofagaceae, Casuarinaceae, Berberidopsidaceae, Myrtaceae, Eucryphiaceae, Cunoniaceae, Escalloniaceae and Pittosporaceae.
- A primitive group of the Corvidae, one of the two major groups of the world's true songbirds. The oldest members of this group include lyrebirds, bowerbirds, tree-creepers and the Rufous Scrub-bird.
- Other birds dating from Gondwana including the Pale-yellow Robin, thornbills, scrubwrens and gerygones.
- All frogs in families Myobatrachidae and Hylidae, families having Gondwanan origins.
- Reptiles with a long history in Australia including chelid turtles, Leaf-tailed Gecko and the Angle-headed Dragon.
- A range of invertebrates with origins in Gondwana. Examples are fresh-water crayfish, land snails, velvet worms, a number of beetle families including flightless carabid beetles, the Richmond Birdwing Butterfly and glow-worms.

- **CERRA World Heritage Area includes an outstanding range of ecosystems and taxa which demonstrate the origins and rise to dominance of cold adapted and dry adapted flora.**

Cool temperate rainforest, dry rainforest and wet sclerophyll ecosystems demonstrate this value. Members of the families Myrtaceae and Proteaceae are of particular importance; these families are today widespread in Australian ecosystems in cold and dry locations.

CERRA meets the conditions of integrity necessary for this criterion. However, the addition of other areas beyond the property would improve the integrity of the property by including a more complete

expression of the attributes. Threats to the values and the related attributes include inappropriate fire regimes, exotic plants, animals and diseases, disruption or change in gene flow as a result of rainforest fragmentation, die-back of vegetation, and localised damage from increased human visitation.

Criterion (ii): *be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.*

Values related to this criterion and attributes supporting these values are as follows.

- **CERRA WHA includes outstanding geological features associated with the erosion of shield volcanoes.**

Two shield volcanoes – the Tweed Shield Volcano and the Ebor Volcano contribute to this value. The Tweed Shield Volcano Caldera is possibly the best preserved erosion caldera in the world, notable for its size and age, and for the presence of a prominent central mountain mass and all three stages in the erosion of shield volcanoes – the planeze, residual and skeletal stages. The remnants of the Ebor Volcano represent the best example in eastern Australia of a radial drainage pattern related to a specific centre of eruption.

- **CERRA WHA includes significant centres of endemism where ongoing evolution of flora and fauna species is taking place.**

Ecosystems that are of particularly important as centres of endemism include cool temperate rainforest, subtropical rainforest, warm temperate rainforest, dry rainforest, wet sclerophyll forest, montane heathlands and rocky outcrops. The Border Ranges area is particularly important as a centre of endemism. Species groups demonstrating high levels of endemism include:

- Many Magnoliid genera, particularly Winteraceae, Atherospermataceae, Monimiaceae and Lauraceae.
- Genera in other Gondwanic families, including Proteaceae, Cunoniaceae, Euphorbiaceae, Escalloniaceae, Davidsoniaceae, Pittosporaceae, Myrtaceae, Elaeocarpaceae and Sterculiaceae.
- All fauna of low motility that occur in more than one isolated pocket of CERRA.
- Frogs such as *Phyloria* and the *Litoria pearsoniana* / *phyllochroa* complex that occur in scattered habitats along the Great Escarpment.
- Invertebrates such as snails, earthworms, fresh-water crayfish, velvet worms and carabid beetles show particularly high incidences of generic and species endemism

CERRA continues to meet the condition of integrity required for this criterion. Addition of rainforest remnants on the eastern side of the Tweed Shield and of Bellinger NP would increase the representation of the significant geological features associated with the Tweed Shield Volcano and the Ebor Volcano respectively. These geological features are massive and threats are generally absent. The ecosystems associated with the second value are affected by similar threats to those related to Criterion (i).

Criterion (iv): *'contain the most important and significant habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.'*

The value related to this criterion and the attributes supporting this value are as follows.

- **CERRA WHA includes the principal habitats of a large number of threatened species of plants and animals. These species are of outstanding universal value from the point of view of science and conservation, including relict and primitive taxa.**

Threatened species are most common in subtropical rainforest, warm temperate rainforest, wet sclerophyll forest, montane heathlands and rocky outcrops. There is a concentration of such species in the Border Ranges.

Over 200 rare or threatened species of plants occur in the CERRA property. Some 76 narrowly endemic rare or threatened plant species occur in the Border Ranges. Rare or threatened plant species are particularly common in groups such as *Cryptocarya*, *Endiandra*, *Tasmannia*, Proteacea, Myrtaceae and Euphorbiaceae. Some other groups of plants of interest to scientists are well represented also. Orchids are an example, with over 140 species in CERRA.

Some 90 rare or threatened vertebrate fauna occur in CERRA. These include the Marbled Frogmouth, the Eastern Bristlebird, *Philoria* spp., the Pouched Frog, barred frogs, the Parma Wallaby, the Yellow-bellied Glider, the Hastings River Mouse and the Golden-tipped Bat. While little attention has been given to the conservation of invertebrates and the recognition of rare or threatened invertebrates, several of the small number that have been recognised occur in CERRA. These include the Richmond birdwing butterfly and *Nurus brevis*, a flightless carabid beetle. A possible additional ecosystem value present in parts of CERRA is stygnofauna, fauna inhabiting groundwater environments.

The property continues to meet the requirements of integrity for this criterion but would benefit from additions to minimise edge effects. Threats are those identified for earlier criteria with the additional threat that the majority of the populations of a number of rare or threatened species, particularly those of warm subtropical rainforests on the Tweed Shield, occur outside the property.

Associative natural values

CERRA has, in addition to the values and attributes related to the criteria for which the property was listed, a number of other natural values that contribute to its global importance. These associative natural values of CERRA follow.

Criterion (iii): *'contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.'*

While the IUCN did not support the listing of CERRA under this criterion, it did accept that many of the elements of this criterion are present and should still be recognised in management. The major threat to this associative value is the intrusion of inappropriate development into the landscape. The property currently maintains its integrity with respect to this value.

Marginal swells are characteristic of all passive continental margins. The Australian marginal swells are outstanding and exceptional in having volcanics to allow the process to be dated.

This associative natural value was identified by the CRA World Heritage Expert Panel. A representative example of the significant features related to passive continental margins is exposed within the New England NP section of CERRA. This value is not threatened and its integrity remains intact.

Eucalyptus-dominated vegetation is an outstanding example on a continental scale of forest and woodland vegetation dominated by a single genus. This vegetation has evolved under stress, including conditions of high climatic variability, nutrient deficiency, and high fire frequency.

This is another associative natural value identified by the CRA World Heritage Expert Panel. Good examples of *Eucalyptus*-dominated vegetation and the varied boundaries and intergrades between that vegetation type and rainforest are present in CERRA. While this associative value retains its integrity, threats to it include inappropriate fire regimes, exotic plants and animals, localised dieback, and increased visitation.

Distribution of values

With the exception of attributes related to specific geological features, attributes related to the identified values are present within all of the groups of reserves in CERRA. An overview of the values present in each group of reserves is provided.

General information is also provided on those reserves listed in 1994 that were not included in the 1992 nomination.

The current boundaries of CERRA contain examples of all the values for which the property was listed but the inclusion of a number of other areas would improve the integrity of the property. The addition of significant areas of *Eucalyptus*-dominated vegetation is also discussed.

Management issues

CERRA is currently managed with inadequate knowledge of the distribution of plant and animal species within the constituent reserves and an inadequate understanding of basic ecological processes. Further data collection and research is a priority. Research work should also investigate the past history of the CERRA rainforests and the effects of past and current fragmentation on the rainforest biota and structure. A major gap in our knowledge is an understanding of the cultural history of the rainforests and landforms of CERRA. In particular, an understanding of the relationship between the Aboriginal people and these features is essential for sympathetic management of CERRA.

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1. INTRODUCTION

There has been an increased awareness in the past two decades of the importance of the remaining Australian rainforests. This recognition and public pressure has resulted in substantial changes in official policies regarding management of these forests and in their improved representation in conservation reserves. In 1985 the Australian Government recognised the importance of rainforests as part of the nation's natural heritage and nominated, with the assistance of the New South Wales Government, a suite of rainforest national parks and nature reserves within New South Wales for inclusion on the World Heritage List. These areas were listed in 1986 as the Australian East Coast Subtropical and Temperate Rainforest Parks World Heritage Site.

It was widely acknowledged that the initial listing of a number of reserves in New South Wales did not adequately encompass the diversity of the rainforests of Central Eastern Australia. The omissions included not only the 'missing half' to the north of the State border in Queensland but also other rainforest areas in northern New South Wales. These omissions were partially remedied with the nomination in 1992 of the existing World Heritage area and additional significant areas of rainforest in southern Queensland and additional small areas in northern New South Wales. The additional areas listed in northern New South Wales included a number of areas (i.e. some State Forest flora reserves and Oxley Wild Rivers National Park) that were not included in the 1992 nomination document. These areas were nominated in response to correspondence from the International Union for the Conservation of Nature and Natural Resources (IUCN – now known as the World Conservation Union) following the initial assessment of the nomination. The nominated areas and these additional areas in New South Wales were listed in 1994 as the Central Eastern Rainforest Reserves (Australia) World Heritage Site. This World Heritage property is referred to throughout this document as CERRA.

CERRA is a property composed of over 50 reserves ranging in area from eleven hectares to some 103 000 hectares. These reserves extend in a discontinuous arc from Barrington Tops near Newcastle to the Main Range west of Brisbane and cover a total of 366 514 hectares (307 284 ha in NSW and 59 230 ha in Queensland).

CERRA was inscribed on the World Heritage List as a site with outstanding universal significance in terms of its natural heritage. It satisfies three of the four possible criteria for the listing of a natural property, representing outstanding examples of the major stages of Earth's evolutionary history, of ongoing geological and biological processes, and of biological diversity. The values directly related to the criteria for which the property was inscribed on the World Heritage List – its World Heritage values – are not all present in all of the constituent reserves. Furthermore, since it was listed there is increased knowledge regarding the natural heritage values of the property, including its World Heritage values and the attributes contributing to them. Also, the definition of the World Heritage criteria under which the property was assessed has been reviewed and amended.

To date, the World Heritage values and attributes of CERRA have not been delineated for each of the reserves included, those values have not been updated since the property was nominated in 1992 and the attributes of the property have not been tested in relation to the present World Heritage criteria. The aims of the present project are to:

- derive a list of the outstanding universal values (World Heritage values) and associated attributes of CERRA from the 1985 and 1992 nomination documents;
- assess the relevance of these values with relation to the present World Heritage criteria;
- update information on the attributes contributing to the outstanding universal values of CERRA, including those relating to the eucalypt theme identified by the World Heritage Expert Panel convened as part of the Regional Forest Assessment process;
- investigate knowledge of the invertebrate fauna of CERRA to more fully delineate the World Heritage values and attributes of this group of animals;
- provide more detailed information on those reserves in New South Wales that were included in the 1994 listing but were not discussed in the 1992 nomination document;
- identify other reserves which should be included in World Heritage listing;
- provide a description of World Heritage values and attributes for the reserves included in CERRA;
- identify threats to the World Heritage values and assess the condition and integrity of the sites, and
- identify gaps in our knowledge of CERRA.

2. APPROACH

A review of literature associated with the property and the criteria for which it was listed was undertaken. This was supplemented by unpublished reports and papers provided by Environmental Protection Agency and Department of Natural Resources in Queensland, and National Parks and Wildlife Service in New South Wales.

Direct contact was made with a number of people having expertise on the property or sites within the property or with expertise related to the natural heritage of the subject landscapes and ecosystems.

Dr Geoff Williams undertook an investigation of values related to the invertebrate fauna. A search of published information within the taxonomic literature was undertaken. This was supplemented by extensive data collected during the Australian Museum's 'New South Wales Rainforest Terrestrial Invertebrate Survey', information provided by specialist taxonomists in response to data requests, and limited data extracted from the invertebrate collections of the Australian Museum. The results of Dr William's research have been published as a separate report (Williams 2002). Some summary information and directly relevant data from that report is included in the present report.

3. LOCATION AND COMPOSITION OF THE PROPERTY

CERRA is located, in the broad sense, between Brisbane in southeast Queensland and Newcastle in central eastern New South Wales. The property lies between the latitudes 27°45' S and 32° S. CERRA is a disjunct property and includes more than 50 reserves. The most southerly reserve in CERRA is Barrington Tops National Park and the most northerly is Main Range National Park.

The reserves within CERRA generally occur as an arc of disjunct occurrences of rainforest along the Great Escarpment. This 'archipelago of rainforest islands within a sea of sclerophyll forest' represents the major refugial stands of this vegetation type within central eastern Australia. While some of these reserves form contiguous chains and a number of groupings can be recognised, there is generally a very high boundary to area ratio within the property. The reserves range in size from eleven hectares to 102 820 hectares.

The current tenure of the reserves includes national parks, nature reserves, conservation parks, a flora reserve, forest reserves and small areas of other Crown reserves (Rabbit Board paddock reserves, prison purposes lands and road reserves). The majority of the reserves are managed in Queensland by the Queensland Parks and Wildlife Service (part of the Department of the Environmental Protection Agency) and in New South Wales by the National Parks and Wildlife Service. Map 1 shows the extent of the property; the sites included in CERRA and their areas are given in Table 1.

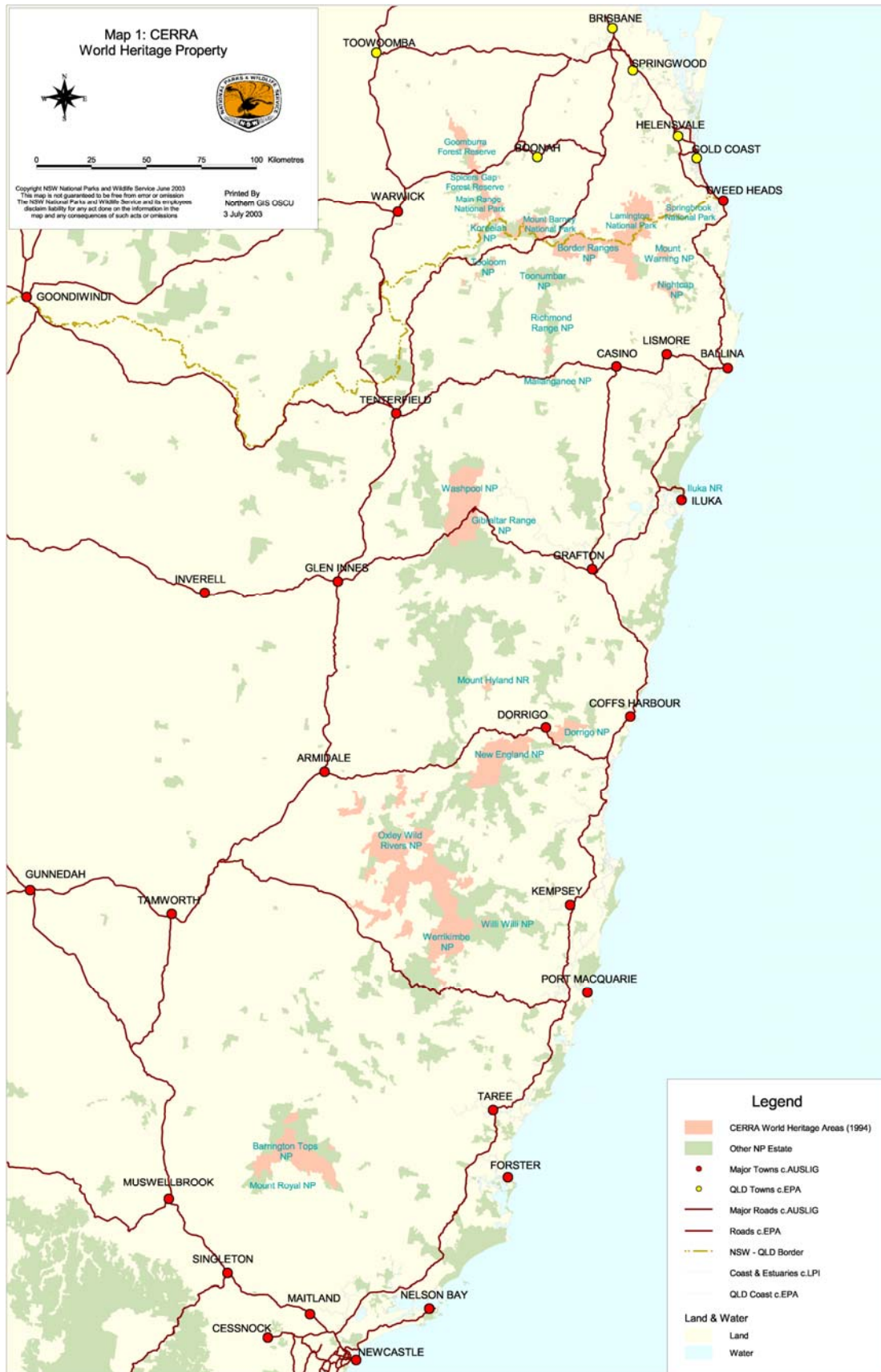


Table 1. Individual reserves included in CERRA

NEW SOUTH WALES			
National parks (managed by NSW National Parks & Wildlife Service (NPWS))			
Barrington Tops (part)	39 193 ha	Border Ranges (part)	31 508 ha
Cunnawarra (part)	270	Dorrigo (part)	7 885
Gibraltar Range (part)	17 273	Koreelah (part)	769
Mallanganee (part)	222	Mebbin (part)	11
Mt Clunie (part)	485	Mt Nothofagus (part)	650
Mt Royal (part)	230	Mt Warning	2 380
New England (part)	30 115	Nightcap (part)	4 945
Oxley Wild Rivers (part)	102 820	Richmond Range (part)	870
Tooloom (part)	1 665	Toonumbar (part)	1 225
Washpool (part)	27 715	Werrikimbe (part)	25 578
Willi Willi (part)	1 610		
Nature reserves (managed by NPWS)			
Captains Creek (part)	380	Iluka	136
Limpinwood	2 646	Mount Hyland	1 636
Mount Seaview	1 703	Numinbah	858
The Castles (part)	2 360		
Flora reserves (managed by State Forests of NSW)			
Amaroo	36		
<i>Total area in New South Wales</i>			307 284
QUEENSLAND			
National parks (managed by Queensland Parks and Wildlife Service (QPWS))			
Lamington	20 569	Main Range	17 794
Mount Barney (part)	10 831	Mount Chinghee	1 257
Springbrook (part)	2 480		
Conservation parks (managed by QPWS)			
Spicers Gap	6		
Forest reserves (managed by QPWS)			
Burnett Creek (part)	1 076	Emu Vale (part)	268
Gambubal (part)	2260	Gilbert (part)	84
Goomburra (part)	2 067	Spicers Gap (part)	257
Teviot (part)	390		
Rabbit Board paddock reserves (managed by the Darling Downs – Moreton Rabbit Board)			
R464 (Res 11.108)	26	R470 (Res 11.135)	40
R475 (Res 5740)	22	R489 (Res 929)	18
R603 (Res 3934)	36		
Reserves for prison purposes (managed by the Queensland Department of Corrective Services)			
R547 (Res 2678)	42	R932 (Res 12018)	6
Road reserves			
Various road reserves adjacent to the areas listed above			areas not calculated
<i>Total area in Queensland</i>			59 230

Total area: 366 514 ha

Tenure as at January 2003.

4. THE WORLD HERITAGE CRITERIA

4.1. THE CRITERIA

The natural heritage criteria for which the CERRA property was listed in 1986 and 1994 were:

- (i) *be outstanding examples representing the major stages of earth's evolutionary history. This category would include sites which represent the major 'eras' of geological history such as 'the age of reptiles' where the development of the planet's natural diversity can well be demonstrated and such as the 'ice age' where early man and his environment underwent changes;*
- (ii) *be outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment. As distinct from the periods of the earth's development, this focuses upon ongoing processes in the development of communities of plants and animals, landforms and marine and fresh water bodies. This category would include for example (a) as geological processes, glaciation and volcanism, (b) as biological evolution, examples of biomes such as tropical rainforests, deserts and tundra, (c) as interaction between man and his natural environment, terraced agricultural landscapes; and*
- (iv) *be habitats where populations of rare or endangered species of plants and animals still survive. This category would include those ecosystems in which concentrations of plants and animals of universal interest and significance are found.*

Since the inscription of CERRA on the World Heritage List, the IUCN World Heritage Committee has reviewed and amended these criteria. The above three criteria now read:

- (i) *be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;*
- (ii) *be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; and*
- (iv) *contain the most important and significant habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

While the current criteria are in many respects very similar to the previous criteria, there are several important differences. The current criteria (i) and (ii) still emphasise major stages of earth's history, and on-going ecological and biological processes respectively, but the theme of on-going geological processes in the development of landforms, and significant geomorphic or physiographic features is now generally removed from criterion (i) to criterion (ii), and criterion (ii) is more focussed on on-going processes in the development of ecosystems and communities. CERRA has been listed on the basis of both of these criteria and, while there has been some re-arrangement of themes within the criteria, this does not affect the validity of the listing.

The current criterion (iv) also reflects some change in emphasis. Both it and the criterion prior to review refer to the presence of rare or endangered / threatened plants and animals. The earlier criterion included this group plus plants and animals of universal interest and significance. However, the current criterion limits the threatened species to those of outstanding universal value from the point of view of science or conservation, but widens the scope of the criterion to include a consideration of biological diversity. While the net result of the changes to this criterion is a greater emphasis on total biodiversity, this also does not affect the validity of the nomination.

Both nominations of CERRA argued that the property was also eligible for listing under criterion (iii). At the time of nomination, this criterion read:

- (iii) *contain unique, rare or superlative natural phenomena, formations or features or areas of exceptional natural beauty, such as superlative examples of the most important ecosystems to man, natural features (for instance, rivers, mountains, waterfalls), spectacles presented by great concentrations of animals, sweeping vistas covered by natural vegetation and exceptional combinations of natural and cultural elements.*

Following the IUCN World Heritage Committee review this criterion now reads:

- (iii) *contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.*

These two versions of criterion (iii) are very similar, but with the addition of ‘aesthetic importance’ to the current criterion; the two versions can be regarded as essentially the same for the purposes of this report.

IUCN did not support the listing of the property under criterion (iii), but stated (IUCN 1993) that ‘there are, however, many elements of criterion (iii) present and these should still be recognised in management.’ Thus, while it has been acknowledged that values are present in CERRA relevant to criterion (iii), these are not listed natural values, and are referred to as ‘associative natural values’.

Properties must meet certain conditions of integrity if they are to be included on the World Heritage List. These conditions are set out in the Operational Guidelines for the Protection of World Cultural and Natural Heritage (World Heritage Committee 1997). The conditions of integrity required to be met for the criteria for which CERRA was listed include:

For criterion (i): *the sites should contain all or most of the key interrelated elements in their natural relationships.*

For criterion (ii): *the sites should have sufficient size and contain the necessary elements to demonstrate the key aspects of processes that are essential for the long-term conservation of the ecosystems and the biological diversity they contain.*

For criterion (iv): *the sites should contain habitats for maintaining the most diverse fauna and flora characteristic of the biographic province and ecosystems under consideration.*

4.2. VALUES AND ATTRIBUTES

It is important to clarify what is meant by the terms ‘World Heritage values’ and ‘World Heritage attributes’.

World Heritage values and attributes fall into a hierarchy. Values are subordinate to the World Heritage criteria against which a property is assessed for inscription on the World Heritage list. Values are not quantifiable – they cannot be directly monitored, measured or assessed.

By contrast, World Heritage attributes are more tangible. These are the features which contribute to the values. The attributes are quantifiable – they can be directly monitored, measured and assessed.

Consider, for example, the statement ‘Australia has outstanding examples of relict biota reflecting ancient Gondwanan biota’. This is a statement of values pertaining to criterion (i). Species such as Eastern Bristlebird and Antarctic Beech are examples of such relict biota and are attributes – their presence, populations and other features can be monitored, measured and assessed.

Therefore, a property such as CERRA has several World Heritage values that are statements of its particular significance as judged against the World Heritage criteria, and the property contains attributes that contribute to these values. In the case of disjunct properties such as CERRA, not all of these values and certainly not all of the attributes are necessarily present in all of the sites within the property.

The CERRA World Heritage Area is the result of two successful nominations of rainforest areas in central eastern Australia. The first nomination, in 1985, was not fully successful as it also nominated Mt Dromedary FR in southern NSW as a potential World Heritage area. The original 1985 nomination document was revised to reflect the outcomes of the nomination and the 1986 listing. This revised nomination document (Adam 1987) and the 1992 document (DASET 1992) are used as the basis for the present review. The

Justification section in each document (Chapter 7 in Adam (1987) and Chapter 5 in DASET (1992) outlines the nominated values and attributes of the property.

The two nomination documents complement each other. There is, as might be expected, much overlap between the two. Therefore, the later document restates much of the concise justification presented in the earlier document but includes additional justification, particularly regarding the importance of CERRA as a key area for conserving plant groups central to major stages in the Earth's evolutionary history.

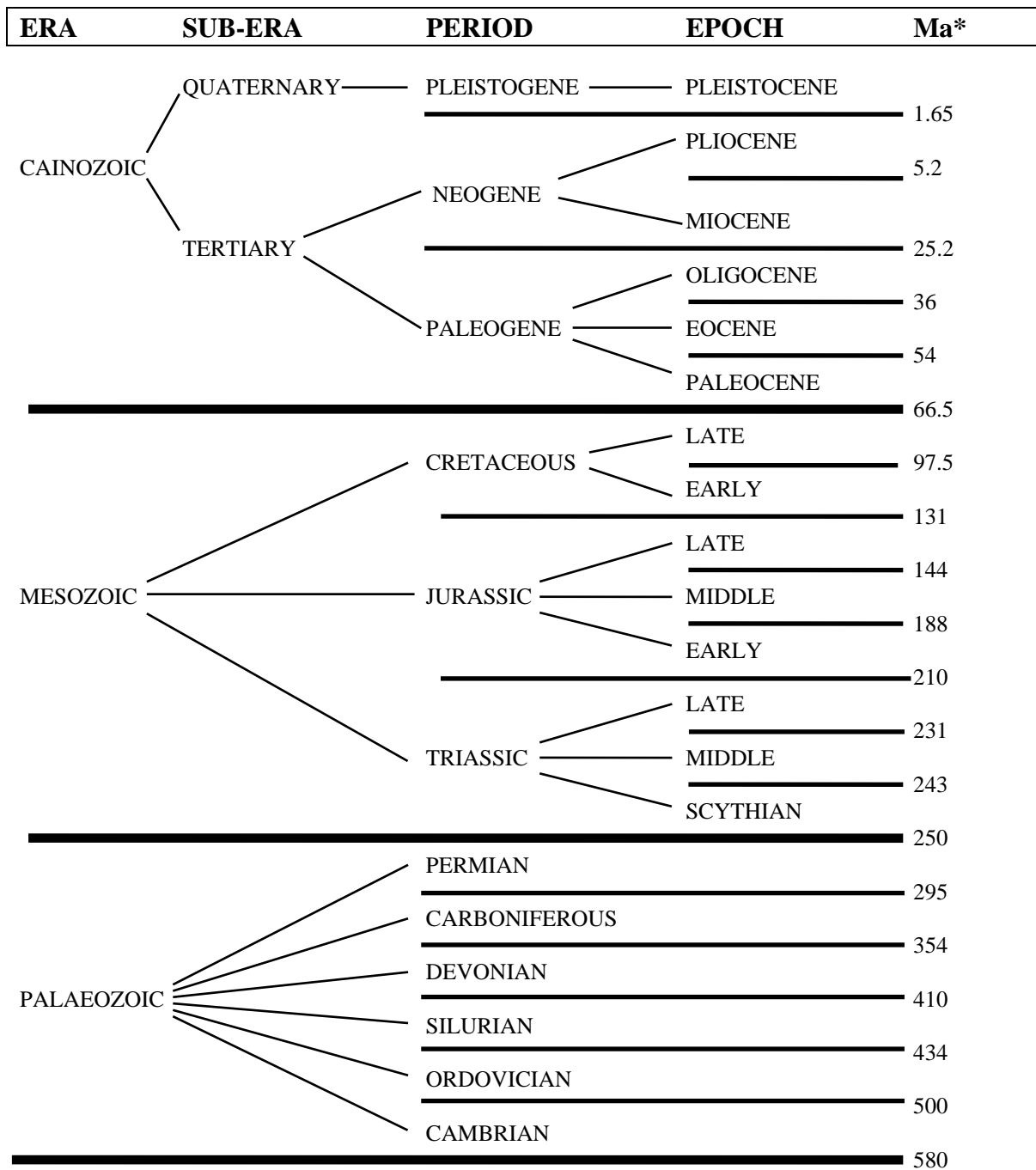
In the following three sections, for each of the three criteria for which CERRA is listed, the attributes as outlined in these two nominations are presented in turn; these follow a statement of the World Heritage value or values relevant to the criterion. The presentations differ in style because the original presentations differ significantly. The values and attributes are outlined comparatively concisely in Adam (1987). Those in DASET (1992) are, due to the nature of the data, more dissipated. Therefore, data drawn from Adam (see below) are most often in the form of direct quotes from the nomination. The only liberty that has been taken is the substitution of 'CERRA' in place of 'the nominated sites' and where appropriate to modify terms such as 'the subtropical rainforests of NSW'; CERRA is written in italics at such places to indicate that a substitution has taken place.

In a sense the two documents stress different levels of the hierarchy from values to attributes. Adam stresses the concepts and patterns that underlie the values. DASET includes many more of the specific attributes that establish these patterns.

Following the presentation for each criterion from each nomination is a brief summary of new information and comments related to this criterion which may affect these values.

Figure 1, a geological time scale from the beginning of the Palaeozoic Era to the Present, is included as an aid for the reader.

Figure 1. Geological time scale from beginning of the Palaeozoic era to the present



* Ma = millions of years ago

after DASET (1992)

5. WORLD HERITAGE VALUES AND ATTRIBUTES OF THE CENTRAL EASTERN RAINFOREST RESERVES OF AUSTRALIA – NATURAL HERITAGE CRITERION (i).

Criterion (i): ‘be outstanding examples representing major stages of Earth’s history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.’

The World Heritage values of the property related to this criterion are as follows:

- **CERRA WHA rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana.**
- **CERRA WHA includes an outstanding range of ecosystems and taxa which demonstrate the origins and rise to dominance of cold adapted / dry adapted flora.**

5.1. VALUES AND ATTRIBUTES BASED ON THE 1985 NOMINATION

The emphasis in the justification presented in this nomination (Adam 1987) for including the property under this criterion is on the central place that the central eastern rainforests have played in the origin and development of Australian rainforests. The argument is supported by data from the palaeobotanical record and the present distribution of taxa. Some of the most important points made are highlighted below.

Adam (1987) summarises some of the major findings based on the palaeobotanical record in relation to the origin and development of the Australian rainforests as follows:

- ‘There is evidence for a widespread relatively uniform flora across the whole supercontinent during the Cretaceous, before the start of break up of Gondwana (even taxa which are now regarded as basically Australian, such as *Casuarina*, were recorded in Africa in the Cretaceous).
- Towards the end of the Tertiary, increased aridity led to the decline of rainforest over much of the Continent and its restriction to wetter refugia along the Eastern Highlands. During the Tertiary there was widespread volcanic activity in Eastern Australia, leaving a legacy of dramatic scenery and areas of nutrient-rich soils. Most of the soils in eastern NSW are extremely nutrient-poor, and under climatic conditions marginal for rainforest development, it is unlikely that extensive subtropical rainforest stands could survive today except on the richer volcanic soils.
- Over the last two million years, a series of rapid (by geological standards) oscillations between moist and dry conditions have occurred, causing a further contraction in rainforest range and a further sifting of the flora. Nevertheless, in the moist phases, expansion of rainforest from the limited refugia which persisted during the driest periods has been vigorous.
- For the Early Tertiary, the possibility existed for migration between Australia and South America via Antarctica. The taxonomic links between Australian and South American cool and warm temperate rainforests may reflect such migration, or may indicate common origins in the pre break-up Pan-Gondwanan flora. Migration into Australia from the north may only have been readily possible in the last 15 Ma. Some rainforest species may have entered Australia in this period, but evidence in the fossil record of tropical/subtropical taxa prior to 15 Ma indicates that much of this floristic element was part of the Gondwanan flora which has evolved *in situ* in Australia.’

The evidence based on the present distribution of taxa shows that:

‘The taxonomic and ecological segregation of the three provinces (of Webb *et al.* 1984) can be used to support the argument that the three major floristic elements have largely developed independently, so that the subtropical rainforest types are distinct ecological entities with major taxonomic differences between their flora and both tropical and cool temperate rainforests.

‘Nowhere other than in eastern Australia is there such an extended transect (some 27 degrees of latitude) through a more or less continuous series of rainforest types. It stretches from tropical monsoonal and wet tropical rainforests in the northeast, through a range of moist and dry subtropical

rainforests and their transition with warm temperate types to cool temperate rainforests in montane habitats in coastal NSW and at lower altitudes in Victoria and Tasmania.

“In this unique transect, the rainforests of *CERRA* occupy a key position. **Here the wet subtropical broad-leaved rainforests have evolved many of their characteristic species.** It is only in the last decade or so that research on the Australian flora, and on the rainforest vegetation, has provided compelling evidence for the unique status of Australian subtropical rainforests. Reconstructions of past climate and vegetation types which allow the nature of subtropical rainforest to be re-assessed are still in their early stages. The extent of debate and scientific controversy about the derivation of the scleromorphic flora of Australia from an ancient moist closed forest, and about the immigration or evolution *in situ* of certain elements in the rainforest flora, indicate the international importance of *CERRA* rainforests as sites for future scientific investigation.

“However, it is clear that the subtropical rainforest in *CERRA* can no longer be regarded as a depauperate southern extension of tropical rainforest, with its southern boundary marking the limit of invasion by migratory Indo-Malayan species. **Rather it is possible to suggest that the subtropical rainforests of NSW *CERRA* may well represent the modern expression of the early Tertiary pan-Australian rainforest. This still has coniferous (*Araucaria*) relicts and habitats that allow possible glimpses of the early ecological relationships between rainforest and sclerophyll vegetation.** The survival of these vegetation types has been possible because of the diversity of suitable habitats within the moist mountainous regions of coastal *CERRA*. These habitats include a variety of geological substrates which allow the expression of climatic edaphic interactions favouring the survival of certain community types. When considered on a world scale, the subtropical rainforests of NSW (together with similar forests in southern Queensland) (*ie CERRA*) constitute a separate vegetation formation group. The *CERRA* rainforests, and associated forests, are unique in the southern hemisphere and the world.

“**The ancestry of the cool temperate rainforests of NSW and southeastern Qld stretches back to the time of Gondwana.** Hill (1984) has pointed out the floristic links between the present disjunct centres of occurrence of cool temperate rainforest in eastern Australia. Despite the overall floristic and structural similarity displayed by cool temperate rainforest, distinctive communities can be recognised. The *Eucryphia moorei* forests of southern NSW represent a unique floristic combination within the range of cool temperate rainforest, while the northern *Nothofagus moorei* rainforests of *CERRA* are a major subtype within the formation.

“***CERRA* contains the major part of the warm temperate rainforest in Australia, and its stands of this rainforest type demonstrate almost all the range of variation found in this community type.**

“The choice of sites (in *CERRA*) has been designed to provide examples of the major rainforest types and to sample the main geographical and habitat variations within each type. **There is good evidence to believe that the major rainforest areas in *CERRA* include the core areas of the refugia to which rainforest was restricted during the Quaternary dry phases, even if the exact localities of such cores are uncertain. Even relatively small rainforest patches, isolated from the larger areas, but which are protected from fire or which have survived as the result of a combination of particular ecological factors, may harbour narrowly endemic species, disjunct species or other relicts of great biogeographic significance. Included amongst the nominated sites, therefore, are refuge areas which have probably been vegetated continuously by some form of rainforest for at least 80 Ma.** This continuity of habitat, for both flora and fauna, means that in every sense the *CERRA* rainforests can be regarded as illuminating ‘major stages of the Earth’s evolutionary history’”.

5.2. VALUES AND ATTRIBUTES BASED ON THE 1992 NOMINATION

The justification presented in the second nomination (DASET 1992) for listing *CERRA* under criterion (i) is, as noted above, much more extensive and, in addition to supporting the justification outlined in Adam (1987), also outlines values at the level of additional individual taxa.

DASET (1992) argues that *CERRA* property represents outstanding examples of major stages in the Earth’s evolutionary history. In particular, the property preserves the following:

1. Some of the oldest elements of the world’s ferns from the Carboniferous period, representing the ‘Age of the Pteridophytes’;

2. One of the most significant centres of survival for araucarians, the most ancient and phylogenetically primitive of the world's conifers, representing the 'Age of the Conifers' in the Jurassic period;
3. An outstanding record of the 'Age of the Angiosperms' in that they contain
 - a secondary centre of endemism for primitive flowering plants originating in the Early Cretaceous, which complements the Wet Tropics of Queensland World Heritage Property,
 - the most diverse assemblage of relict angiosperm taxa representing the primary radiation of the dicotyledons in the mid-Late Cretaceous,
 - a unique record of the evolutionary history of Australian rainforests representing the 'golden age' of the Early Tertiary, and
 - a unique record of Miocene vegetation that was the antecedent of modern temperate rainforests in Australia;
4. An outstanding number of the oldest lineages of the Corvida, one of the two major groups of the world's oscine (true) songbirds that evolved in the Late Cretaceous;
5. Outstanding examples of other relict vertebrate and invertebrate fauna from ancient lineages linked to the break-up of Gondwana.

Attributes identified by DASET as contributing to each of these examples of major stages of the Earth's evolutionary history are summarised below.

1. The property conserves some of the oldest elements of the world's fern flora.

Ferns have existed in Australia for more than 350 million years. All seven of the 33 families of pteridophytes considered old enough to have been represented on Pangea occur in Australia, with the greatest generic diversity in CERRA and the Wet Tropics World Heritage areas. These are (genera and species known from within or close to CERRA follow the family name):

- Lycopodiaceae	<i>Lycopodium</i>	<i>L. deuterodensum</i> <i>L. laterale</i>
	<i>Huperzia</i>	<i>H. varia</i>
- Selaginellaceae	<i>Selaginella</i>	<i>S. brisbanensis</i>
- Ophioglossaceae	<i>Botrychium</i>	<i>B. australe</i>
	<i>Ophioglossa</i>	<i>O. pendulum</i>
- Marattiaceae	<i>Angiopteris</i>	<i>A. evecta</i>
- Osmundaceae	<i>Leptopteris</i>	<i>L. fraseri</i>
	<i>Todea</i>	<i>T. barbara</i>
- Schizaeaceae	<i>Schizaea</i>	<i>S. bifida</i>
- Gleicheniaceae	<i>Dicranopteris</i>	<i>D. linearis</i>
	<i>Gleichenia</i>	<i>G. dicarpa</i> <i>G. rupestris</i>
	<i>Sticherus</i>	<i>S. flabellatus</i> <i>S. lobatus</i>

The tree ferns in CERRA also have a long history. Members of Cyatheaceae and Dicksoniaceae, along with arborescent Osmundales, were an important component of fern-dominated Mesozoic vegetation. Living members of these two families occurring in CERRA include:

- Cyatheaceae	<i>Cyathea</i>	<i>C. australis</i> <i>C. cooperi</i> <i>C. cunninghamii</i> <i>C. leichhardtiana</i>
- Dicksoniaceae	<i>Dicksonia</i>	<i>D. antarctica</i> <i>D. youngiae</i>
	<i>Calochlaena</i>	<i>C. dubia</i>

2. The property is one of the most significant centres of survival for araucarians, the most ancient and phylogenetically primitive of the world's conifers.

Araucaria had a widespread distribution in Gondwana before the break-up of that continent about 130 million years ago. *A. cunninghamii* (a member of section *Eutacta*, the most primitive section of *Araucaria*) occurs within CERRA. *A. bidwillii* (section *Araucaria* of *Araucaria*) communities are best developed in Bunya Mountains NP, and this area, where species from both sections of *Araucaria* occur, is the most significant for the genus in Australia.

3. The property conserves an outstanding record of the ‘Age of the Angiosperms’ in that they contain representatives of primitive flowering plants, of the primary radiation of ‘higher’ dicotyledons, of the secondary radiation and modernisation of the floras, of the origin and rise of cold-adapted and dry-adapted floras.

3a. Primitive flowering plants.

The first phase of the evolution of the angiosperms was the evolution of the ‘lower’ Magnoliidae in the Early Cretaceous. Whereas the Wet Tropics WHA is outstanding for the conservation of relict primitive families of the Magnoliidae, **CERRA represents a secondary centre of endemism for primitive flowering plants originating in the Early Cretaceous that complements the Wet Tropics.**

Thirtytwo of the 377 extant families of flowering plants can be traced to the Cretaceous more than 66 Ma and only two or three families in the Magnoliales and Laurales are traceable to the Early Cretaceous. These are:

- Chloranthaceae
- possibly Austrobaileyaceae (a family confined to the Wet Tropics)
- **Winteraceae** - two genera occur in Australia. *Bubbia* is confined to the Wet Tropics. *Tasmannia* occurs from the Wet Tropics to southern NSW, with the greatest diversity being in CERRA where four species occur - *T. glaucifolia*, *T. insipida*, *T. purpurascens* and *T. stipitata*.

Other primitive families present in CERRA include:

- **Eupomatiaceae** - *Eupomatia* is the sole genus. CERRA is one of the few refugial areas where the *two* species - *E. bennettii* and *E. laurina* - occur.
- **Trimeniaceae** - *Trimenia* - *T. moorei* is restricted to CERRA and adjacent areas
- **Annonaceae** - *Ancana* and *Fitzlania* are closely related and represent an old evolutionary link with the original centre of diversification of the family.
- **Monimiaceae** is a Southern Hemisphere family and may be the most basal family of Order Laurales. CERRA and the Wet Tropics are the two major centres of diversity in Australia. Six genera occur in CERRA:
 - *Atherosperma* is monotypic and endemic to Australia. *A. moschatum* occurs in cool temperate rainforest from Gloucester Tops, in the southern part of CERRA, to Tasmania.
 - *Daphnandra* is a genus of six species endemic to Australia. CERRA is the centre of diversity of this genus, with three endemic species – *D. sp.A*, *D. sp.D* and *D. tenuipes* – and another species, *D. micrantha*, endemic to a small area adjacent to CERRA.
 - *Doryphora* is a genus of two species endemic to Australia. *D. sassafras* occurs from Nerang in south-east Queensland to Bega in southern NSW, including many CERRA sites; the second species is a Wet Tropics endemic.
 - *Hedycarya* is a genus of 25 species, two of which are endemic to Australia. *H. angustifolia* occurs from the Conondale Range in south-east Queensland to Bass Strait; the second species is endemic to the Wet Tropics.
 - *Palmeria* – *P. scandens*
 - *Wilkia* is a genus of about ten species endemic to Australia. Three species occur in CERRA; *W. austroqueenslandica* is endemic to the region, *W. huegeliana* and *W. macrophylla* are more widespread.
- **Lauraceae.** CERRA and the Wet Tropics are the two centres of endemism for this family in Australia. Eight genera occur in Australia; seven occur in CERRA. While the Wet Tropics is the major centre of endemism for *Beilschmiedia*, *Cinnamomum*, *Lindera* and *Litsea*, several allelopathic species of *Cinnamomum* (one species), *Cryptocarya* (seven species), *Endiandra* (four species) and *Litsea* (one species) are endemic to the CERRA region.
 - *Beilschmiedia* has two species in CERRA. *B. elliptica* is largely confined to the CERRA region; *B. obtusifolia* is more widespread.
 - *Cinnamomum* has two native species in CERRA. *C. virens* is largely confined to CERRA; *C. oliveri* is more widespread.

- *Cryptocarya* has 16 species within CERRA; eight species are endemic to the region of CERRA – *C. dorrigoensis*, *C. floydii*, *C. foetida*, *C. foveolata*, *C. meissneriana*, *C. nova-anglica*, *C. sclerophylla* and *C. williwilliana*.
- *Endiandra* has 11 species in CERRA; five are endemic to the region of CERRA – *E. crassiflora*, *E. floydii*, *E. globosa*, *E. hayesii* and *E. introrsa*.
- *Litsea* has two species in CERRA; one, *L. australis*, is endemic to the region of CERRA.
- *Neolitsea* has two species in CERRA.

3b. Primary radiation of ‘higher’ dicotyledons

The subclasses Rosidae and Hamamelidae diverged early after the first appearance of the Magnoliidae and formed major elements in the primary radiation of the higher dicotyledons. Whereas the Wet Tropics WHA conserves the greatest diversity of the most primitive flowering plant families (the subclass Magnoliidae), CERRA conserves the greatest diversity of primitive groups within the subclass Rosidae. (Apart from a key clade within Hamamelidaceae that survives in the Wet Tropics, relicts of the ‘Lower’ Hamamelidae have survived to a greater extent in the Northern Hemisphere.

Primitive families within the Rosales include (CERRA in brackets following the family name indicates that the CERRA area is the most significant area in the world for the family):

- **Cunoniaceae** (CERRA). This family is basal within the Rosidae. Genera occurring in CERRA include *Ackama*, *Aphanopetalum*, *Callicoma*, *Vesselowskyia*, *Ceratopetalum*, *Geissois*, *Pseudoweinmannia* and *Schizomeria*. *Eucryphia* is sometimes placed in its own family.
- **Escalloniaceae** (CERRA). This family is basal within the Rosidae. Genera occurring in CERRA include *Abrophyllum*, *Anopterus*, *Argophyllum*, *Corokia*, *Cuttsia*, *Polyosma* and *Quintinia*.
- **Pittosporaceae** (CERRA). This family is basal within the Rosidae. Genera occurring in CERRA include *Pittosporum*, *Hymenosporum*, *Bursaria*, *Citriobatus* and *Billardiera*.
- **Surianaceae** (CERRA). This Australian endemic family is represented in CERRA by the monotypic genus *Guilfoylia*.
- **Baueraceae** (CERRA). The genus *Bauera* is present in CERRA.
- **Davidsoniaceae** (CERRA). This endemic monogeneric Australian family is one of the most primitive of the Rosales. It is represented in the region of CERRA by two members of *Davidsonia*.
- **Proteaceae** is part of the Order Proteales, one of the four basal orders of the ‘Lower’ Rosidae. This is an ancient Gondwanic family, probably originating in the Early Cretaceous. While the Wet Tropics conserves the greatest diversity of primitive subfamilies, CERRA represents a secondary centre of endemism for the Grevilleoideae subfamily, particularly *Alloxylon*, *Floydia*, *Hicksbeachia*, *Lomatia*, *Macadamia*, *Orites*, *Stenocarpus*, *Telopea* and *Triunia*.
- **Akaniaceae** (CERRA) is a member of the Sapindales order, another of the basal orders of the ‘Lower’ Rosidae. It is a monotypic (*Akania bidwillii*) family endemic to the CERRA area.
- **Myrtaceae**, **Olacaceae**, **Loranthaceae** and **Sapindaceae** were first recorded from the Antarctic Peninsula, and later in Australia. Like Proteaceae, Myrtaceae is believed to have a Cretaceous origin in Gondwana, and rainforest-dwelling taxa gave rise to dry-adapted types that now dominate the Australian landscape.
- **Fagaceae (Nothofagaceae)** may represent either a transition between the ‘Lower’ Hamamelidae and the ‘Lower’ Rosidae or an early member of the ‘Higher’ Hamamelidae. *N. moorei* is the most basal surviving member of the subgenus *Menziesospora* and is a key element in the evolution and radiation of *Nothofagus* that is fundamentally linked with the development of cool temperate rainforests of the Southern Hemisphere. Nearly all of the extant areas of *N. moorei* - dominated cool temperate rainforest are included in CERRA.

3c. Secondary radiation and modernisation of the floras in the Early Tertiary.

The second radiation and modernisation of the angiosperm floras began in the Early Tertiary. The Cretaceous-Tertiary boundary sharply divides most of the world’s floras into an ancient, now largely extinct, Cretaceous flora from the modern, largely extant, floras originating in the Tertiary. A major extinction episode at the end of the Cretaceous (66 Ma) resulted in the extinction of an estimated 75% of all living species. The Australian region is one of the few areas which escaped these major extinction events, and it has been argued that present Southern Hemisphere rainforests are a better analogue of North American Late Cretaceous vegetation than modern Northern Hemisphere vegetation.

Key elements in the Australian Late Cretaceous vegetation (Proteaceae, *Nothofagus* and so on) continued to diversify in the Tertiary to a vegetation type that largely still survives today. Groups present in the Eocene include lauraceous magnoliids and members of the Proteaceae, Elaeocarpaceae and Myrtaceae. Many of the

plant taxa radiating in the Southern Hemisphere during the Late Cretaceous and Early Tertiary have characteristic relict distributions involving some or all of the landmasses of the western Pacific. Such taxa include Nothofagus, Monimiaceae, Elaeocarpaceae, Cunoniaceae, Escalloniaceae, Myrtaceae and Rutaceae.

Other families or genera appearing in the Australian fossil record in the Early Tertiary include:

- **Menispermaceae.** This family has a long Gondwanic history. *Carronia* is restricted to CERRA (*C. multiseptata*), the Wet Tropics (one species) and New Guinea (two species).
- **Euphorbiaceae.** The first appearance of the family was in Australia with *Austrobuxus* - type pollen. *Austrobuxus* is now represented in Australia by *A. swainii* (restricted to CERRA) and a species restricted to the Wet Tropics. *Fontainea* has eight species ranging from south-east Asia to Fiji; the greatest known species diversity is in lowland subtropical rainforests in south-eastern Qld and north-eastern NSW where four species occur.

The Dilleniidae subclass is probably not significantly distinct from the Rosidae, and many of the more primitive members of the subclass can be considered together with the 'Lower' Rosidae as members of the same complex conserved in CERRA.

The Dilleniales is the most primitive and isolated order in the subclass Dilleniidae and is most developed in Australia. The earliest known record of family **Ebenaceae** is from Australia, confirming the long history of this family in Gondwana.

The Malvales, also one of the more basal orders, has had a long history in Australia. Noteworthy families represented in CERRA include:

- **Elaeocarpaceae.** This is the most isolated and archaic family of the Malvales, and may be ancestral to the remainder of the order. It is likely that this family arose in the Cretaceous. Three of the four most primitive genera occur in Australia; two (*Aristotelia* and *Sloanea*) occur in CERRA and one in the Wet Tropics. The two Australian species of *Aristotelia* are the most primitive, and *A. australasica*, which is endemic to CERRA, is more basal than the Tasmanian species. The largest number of primitive species groups of *Sloanea* also occur in Australia; CERRA and the Wet Tropics are the two key centres of diversity and endemism.
Elaeocarpus is the largest and possibly most advanced genus in the family. More widespread in the past in Australia, the genus probably spread to south-east Asia, where it is most diverse today, in the Miocene. The two major refugia for the genus in Australia are CERRA and the Wet Tropics.
- **Sterculiaceae.** This is one of the most basal families of the Malvales. It has its greatest genetic diversity in Australia, with both subfamilies and all tribes represented; 11 of the 22 Australian genera are endemic and three are near endemic. CERRA and the Wet Tropics are the two major centres for the family in Australia. *Seringia*, a monotypic endemic, is, with the exception of one record from the Wet Tropics, restricted to CERRA. *Argyrodendron* is endemic to Australia and is a characteristic canopy of subtropical rainforests in CERRA. *Brachychiton* is virtually endemic, with all but one of the 31 species restricted to Australia. With four of the five classified Sections present, CERRA together with the Bunya Mountains contain the greatest number of *Brachychiton* lineages at the Sectional level. Species diversity is highest in arid environments; the genus radiated from mesothermal rainforests during the Late Tertiary and Quaternary.

In summary, CERRA is a major centre of endemism and diversity for the Rosidae-Dilleniidae, with a history dating back to the Late Cretaceous or Early Tertiary. Most occur in the subtropical rainforests of CERRA which contains the largest surviving occurrence of subtropical rainforest in Australia. The origins of this community type can be traced at least to the Early Tertiary.

The 'ecofloristic regions' of Webb *et al.* (1984) are distinct at the generic as well as the species levels reflecting long periods of isolation. Despite many shared taxa, a large number of genera are endemic to either the subtropical rainforests of CERRA (region A) or the tropical rainforests of the Wet Tropics (region B). CERRA and the Wet Tropics represent the two most significant although complementary centres of endemism for flora radiating during the Early Tertiary.

On a world scale, CERRA provides an unparalleled record within the subtropical climatic zone of rainforests originating in the Gondwanan Cretaceous but surviving the major extinction episode characterising the Cretaceous-Tertiary boundary.

CERRA contains the most latitudinally, and perhaps areally, extensive subtropical rainforests in the world. This subtropical rainforest, together with the mesotherm rainforests of the Wet Tropics of Queensland WHA, represents an important analogue of vegetation that was more widespread in the Late Cretaceous but that no longer survives in the Northern Hemisphere. They provide a unique record of the evolutionary history of Australia's rainforests in the Early Tertiary, when subtropical and tropical rainforests reached their zenith extending even to high latitudes. Thereafter followed a rapid transition at higher latitudes to cooler, temperate (microtherm) rainforests in the Oligo-Miocene.

3d. Origins and rise to dominance of cold-adapted and dry-adapted floras in the Late Tertiary.

The temperate rainforests of CERRA conserve remnants of a separate element of the Late Tertiary segregation of the Australian rainforests. This element, probably the closest analogue of the rainforests of the Oligocene, contains taxa that were also once widespread but that disappeared from the more southern regions now characterised by cooler temperate rainforest. On the basis of fossil data, Hill has suggested that the northern temperate rainforests such as are found in CERRA are ancestral to the southern temperate rainforests of Tasmania.

The cool temperate rainforests within CERRA are dominated by *Nothofagus moorei* and this species is possibly ancestral to *N. cunninghamii* which is a common dominant of southern temperate rainforests. Another species pair that may reflect similar segregation is *Anopterus macleayanus* in CERRA and *A. glandulosum* in Tasmania. Genera such as *Ceratopetalum* and *Quintinia* in CERRA are also key genera reflecting retreat from high latitudes of the more warm temperate elements characterising the Oligocene as cooling progressed.

During the mid-late Miocene, rainforest in Australia generally contracted dramatically in response to the marked decrease in precipitation and became restricted to the eastern margin of the continent. This period also saw the development of a well-marked dry season, which contributed to an increase in burning. The rainforests that extend in a discontinuous series of 'islands' along the east coast today are remnants of the forests that once covered much of the continent.

A drier rainforest dominated by *Araucaria* appears first in the pollen record in the Pliocene in northern NSW. There are significant areas of drier (humid and subhumid) rainforest within CERRA. Indeed, south-east Queensland is the present-day stronghold of this rainforest type (araucarian notophyll or microphyll vine forest) in Australia. The major remaining areas of araucarian rainforest are in the Bunya Mountains and, in CERRA, in Lamington and Border Ranges National Parks. The Bunya Mountains is outstanding for its rainforests dominated by *Araucaria cunninghamii* and *A. bidwillii*. The next most extensive area of araucarian rainforest is in Lamington NP, where only *A. cunninghamii* is found. Other areas occur as far south as New England NP.

Wet sclerophyll forests are another significant feature of CERRA. Wet sclerophyll forest was dominant in south-eastern Australia from at least the Late Tertiary.

Since their Gondwanan origins, Australia's rainforests have undergone many changes in floristic composition, and segregation of various types in response to cooling and drying has been a feature of their history. However, for some 50 million years two taxa, *Nothofagus* and *Araucaria*, were characteristic components. CERRA, specifically between the Macleay River and the Lamington Plateau, is the only part of Australia where rainforests containing both these genera survive, albeit generally within different floristic types. At least one community of *Nothofagus moorei* with emergent *Araucaria cunninghamii* occurs in CERRA - in the upper reaches of Running Creek in Lamington NP.

4. The property conserves an outstanding number of the oldest lineages of the Corvida, one of the two major groups of the world's oscine (true) songbirds that evolved in the Late Cretaceous

The montane and submontane areas of CERRA represent part of the Tumbanan zone, which is postulated to have provided habitat for the early rainforest fauna of Australasia from which dry-adapted species evolved and radiated. CERRA retains significant elements of the Tumbanan avifauna, as evidenced by the genera and, to a lesser extent, species shared between the rainforests of CERRA and those of the highlands of New Guinea, as well as an unparalleled proportion of the oldest lineages of the Australo-Papuan songbirds.

An outstanding number of the oldest lineages of the Corvida, one of the two major groups of the world's oscine (true) songbirds that evolved in the Late Cretaceous are present in CERRA; the Corvida probably originated in the Australian portion of Gondwana.

Oldest members of the Corvida are Australo-Papuan **Menuroidea**. CERRA is a refugial stronghold for this ancient relict group; nine of the 17 Australian species are found here, including two confined to the region, all of which are descendants of the oldest branches of the Australo-Papuan songbird tradition:

- **Treecreepers.** This group may have an isolated taxonomic position. There are seven species in two genera; six species are endemic to Australia and one to New Guinea. *Climacteris* has five species; all are Australian endemics; two – *C. erythrops* and *C. picumnus* – occur in CERRA. *Cormobates* includes two species, one Australian endemic and one endemic to Papua New Guinea; *C. leucophaeus* (White-throated Treecreeper) occurs in CERRA rainforests.
- **Lyrebirds.** The two species, *Menura alberti* (Albert's Lyrebird) and *M. novaehollandiae* (Superb Lyrebird), are endemic to Australia; *M. alberti* is essentially confined to CERRA.
- **Scrub-birds.** *Atrichornis* is a genus of two species, endemic to Australia; one, *A. rufescens* (Rufous Scrub-bird), is essentially confined to CERRA, and the other is in Western Australia.
- **Bowerbirds.** There are 18 species of bowerbirds. Nine species occur in Australia, including seven endemics. Three of the endemic species occur in CERRA – *Ailuroedus crassirostris* (Green Catbird), *Ptilonorhynchus violaceus* (Satin Bowerbird) and *Sericulus chrysocephalus* (Regent Bowerbird).

Other significant species include:

- the relict species *Orthonyx temminckii* (Logrunner) is restricted to the CERRA rainforests and the New Guinea highlands; the other Australian species in the genus is restricted to the Wet Tropics.
- an old endemic Australo-Papuan group including the thornbills (*Acanthiza*), scrubwrens (*Sericornis*) and gerygones (*Gerygone*), which are represented by rainforest species in eastern Australia, including CERRA, and in the mountains of New Guinea (with one species widely distributed through south-east Asia).
- *Tregallasia capito* (Pale-yellow Robin) is an endemic rainforest species. One subspecies is confined to the Wet Tropics, the majority of the habitat of the second, *T. capito capito*, is in CERRA.
- *Turnix* (button-quails) has 16 species, seven of which occur in Australia. Five of these occur in CERRA, including three Australian endemics. The Black-Breasted Button-quail, *T. melanogaster*, is the only rainforest-inhabiting button-quail in the world; it is recorded from several sites in CERRA.

5. The property conserves outstanding examples of other relict vertebrate and invertebrate fauna from ancient lineages linked to the break-up of Gondwana.

5a. Other vertebrates. CERRA is outstanding as a habitat for frogs, not only because of its great diversity of species but also as a habitat for species that represent relicts of a much more widespread distribution in Australia. Two of the four frog families in Australia are accepted as having Gondwanan origins:

- **Myobatrachidae.** CERRA includes 24 species from nine of the 19 genera:
 - *Assa* is a monotypic genus; *A. darlingtoni* is virtually restricted to CERRA and belongs to the most primitive subfamily, the Myobatrachinae.
 - *Adelotus* is a monotypic genus; *A. brevis* occurs within CERRA
 - *Kyarranus* is a genus of three species, *K. kundagungan*, *K. loveridgei* and *K. sphagnicolus*, all essentially confined to CERRA. There have been recent changes in the taxonomy of this group; see the comments and update section below.
 - *Lechriodus* includes four species, three in New Guinea and one, *L. fletcheri*, restricted to the central east coast of Australia, much of its distribution being within CERRA.
 - *Mixophyes* includes six species. The Australian central eastern coast is the centre of diversity. Four species occur in CERRA – *M. balbus*, *M. fasciolatus*, *M. fleayi* and *M. iteratus*; one species occurs in the Wet Tropics and one in New Guinea.
 - *Crinia*, *Limnodynastes*, *Pseudophryne* and *Uperoleia* are also represented in CERRA.
- **Hylidae.** This Gondwanan family is represented by the genus *Litoria* in CERRA; twenty species are recorded from the property.

Many of the **reptile** species found in CERRA are of significance in relation to the evolutionary history of Australia's reptiles. Groups with a long history in Australia include:

- **Chelid turtles.** Three species of this group occur in CERRA – *Chelodina longicollis* (Long-necked Tortoise), *Emydura signata* and *Elseya latisternum*

- **Diplodactyline geckoes.** The subfamily Diplodactylinae is endemic to the Australasian region and of likely Gondwanan origin. Six species in four genera are recorded from CERRA.
 - *Saltuarius* (formerly part of *Phyllurus*) has one species – *S. swaini* (*P. cornutus*) (Northern Leaf-tailed Gecko) – represented in CERRA.
 - *Diplodactylus* has one species present in the area – *D. vittatus* (Wood Gecko).
 - *Oedura* has three species in CERRA – *O. lesueurii* (Lesueur's Velvet Gecko), *O. robusta* (Robust Velvet Gecko) and *O. tryoni* (Southern Spotted Velvet Gecko)
 - *Underwoodisaurus* is represented in CERRA by *U. milii* (Thick-tailed Gecko)
- **Legless lizards.** The family Pygopodidae is endemic to Australia and New Guinea, and is possibly Gondwanic in origin. Four species in three genera – *Delma*, *Lialis* and *Pygopus* – are present in CERRA.
- **Agamid lizards.** This group has a long history in Australia and is possibly Gondwanic in origin. There is evidence that Australasian *Gonocephalus* and *Physignathus* had an Australian origin from a Gondwanan ancestor.
 - *Gonocephalus* has species in Australia, New Guinea and Asia; one of the two species in Australia is confined to CERRA – *G. spinipes* (Southern Angle-headed Dragon) – and the other to the Wet Tropics. Both Australian species are typically assigned to *Hypsilurus*.
 - *Physignathus* occurs in Australia and New Guinea, with one species – *P. lesueurii* (Eastern Water Dragon) – in Australia, including CERRA.

Several reptiles may be relicts of former much wider distributions:

- *Coeranoscincus*. A genus of two species; one (*C. reticulatus*) is largely restricted to CERRA and the other is largely restricted to the Wet Tropics.
- *Tropidechis carinatus* (Rough-scaled Snake) is confined to the central eastern coast with a disjunct occurrence in the Wet Tropics.

One of the three major groups of skinks in Australia, the *Egernia* group, probably originated in Australia more than 25 Ma. This group includes *Tiliqua* (one species in CERRA), *Cyclodomorphus* (two species in CERRA) and *Egernia* (six species in CERRA).

Some rainforest species also occur in heathlands. Heathlands arose in Gondwana and their evolution may parallel that of the rainforests; there is a close affinity between heathlands and rainforests in some parts of CERRA. Vertebrate species occurring in both habitats in CERRA include *Saltuarius swaini* (*Phyllurus cornutus*), *Ophioscincus truncatus*, *Calyptotis scutirostrum*, *Lampropholis challengerii*, *Saiphos equalis*, *Hemiaspis signata*, *Hoplocephalus stephensii* and *Tropidechis carinatus*.

5b. Invertebrates. The invertebrate fauna of CERRA has many links with the Gondwanan fauna.

Freshwater crayfish. The family Parastacidae is of likely Gondwanan origin, being confined to eastern Australia and South America. Euastacus is an Australian endemic genus with one species in the Wet Tropics and the remainder in coastal streams from south-east Queensland to Victoria. At least nine species are recorded from CERRA:

- *E. jagara* – Mistake Mountains
- *E. sulcatus* – Main Range, McPherson Range and Border Ranges
- *E. madae* – Springbrook NP
- *E. valentulus* – Springbrook NP
- *E. neohirsutus* – Dorrig NP
- *E. aquilus* – New England NP
- *E. spinosus* – Werrikimbe NP
- *E. polyetosus* – Barrington Tops
- *E. reductus* – Barrington Tops

Land molluscs. CERRA rainforests are important refugia for land molluscs, and have filled this role for a considerable time. Taxa present include Gondwanan elements such as Charopidae, Caryodidae, Cystopeltidae and Athoracophoridae, plus post-Miocene modern elements such as the Camaenidae and Helicarionidae.

Charopidae, in Australia, are confined to the rainforests of eastern Australia. CERRA, particularly the McPherson and Border Ranges, is a refugium of special significance. The genera *Ngairia*, *Hedleyoconcha* and *Setomedeia*, are remnants of old stock with origins in early Gondwanan biota.

- *Ngairia* has five species, three are largely restricted to CERRA:

- *N. levicostata* – known only from Cunninghams Gap in Main Range NP and a site to the south in Border Ranges.
- *N. dorrigoensis* – Main Range and Tamborine Mountain to Dorrigo and New England NPs.
- *N. corticicola* – Lamington NP, Dorrigo NP and the Big Scrub.
- *Hedleyoconcha* has a relictual distribution:
 - *H. delta* – central NSW to the Bunya Mountains, including some CERRA areas
 - *H. ailaketoae* – Mount Bellenden Ker in the Wet Tropics
 - *H. addita* – Lord Howe Island
- *Setomedeia* has a disjunct distribution in areas of rainforest between Dorrigo and north-east Queensland. *S. seticostata* is largely restricted to the moist temperate and subtropical rainforests of CERRA.

Velvet worms (Peripatus). Onychopora are a link between annelids (worms, leeches) and arthropods, and appear to have changed little in more than 400 million years. They occur on southern landmasses and are probably Gondwanan relicts. Less than 100 species are described worldwide with eight species from seven genera described in Australia. There may be more than 50 other species collected but not described in Australia. Two described species, *Ooperipatus oviparus* and *Euperipatoides leuckartii* occur throughout the CERRA region. There are undescribed species endemic to Lamington Plateau (one species), Mt Warning and Nightcap Range (one species), Gibraltar Range (two species), New England NP (one species), Banda Banda FR (one species) and Barrington Tops (three species).

Insects. Many relict and Gondwanan lineages are known from the CERRA rainforests, particularly from wet, cool montane rainforests:

- **Chinamyersiinae**, a small, primitive subfamily of **flat bugs**, is probably Gondwanan in origin, being confined to eastern Australia, New Zealand, New Caledonia and Vanuatu. *Kumaressa* is a genus of three species confined to Australia; the nearest relative is the monotypic *Tretocoris* of New Zealand. One species is confined to rainforest on three mountain tops in the Wet Tropics; the other two species are found in moist upland sites in CERRA:
 - *K. scutellata* – Lamington Plateau
 - *K. carraiensis* – Carrai Plateau (now partly within CERRA)
- **Peloridiidae**, a small family of primitive **moss bugs**, is probably Gondwanan in origin, being found only in eastern Australia, New Caledonia, New Zealand and South America. Two of the eight species in Australia are recorded from CERRA. *Hackeriella veitchi* is essentially confined to CERRA at high altitudes on the Main Range, McPherson Range and near Point Lookout in New England NP; the only other species in the genus is confined to a few mountain tops in the Wet Tropics.
- **Myerslopiini**, a relict, primitive tribe of **leafhoppers**, is found only in eastern Australia, New Zealand, New Caledonia, South America and Madagascar. It is represented in Australia by two species in the endemic genus *Myerslopella*. An undescribed species occurs in CERRA on Lamington Plateau; the second species is only found on mountain tops in the Wet Tropics.
- **Carabidae** has a history of at least 100 million years. CERRA rainforests and wet sclerophyll forests are particularly important for a group of flightless, ground-living **carabid beetles** with a long history in Australia and with affinities to taxa in New Zealand and New Caledonia. Genera restricted to CERRA include *Cratoferonia*, *Zeodera*, *Liopasa*, *Notolestus*, *Decogmus* and *Meonis*. Genera at the southern limit of their range include *Lieradira*, *Trichosternus*, *Mystropomus* and *Pamborus*. At their northern limit are two very important Gondwanan subfamilies, Broscinae and Migadopinae, and the genera *Eutrechus* and *Trechiella*. *Megadromus eborensis*, known only from New England NP is placed in the same genus of flightless carabid beetles as a New Zealand species; it forms a relict and primitive pair with *Trichosternus australasicus*, a species which probably belongs in *Megadromus* and which is only known from Barrington Tops. *Setalis*, a genus of three species of flightless carabid, has two species in CERRA and one in the Wet Tropics.
- *Anomoses hylecoetes*, the only member of the **primitive moth** family Anomosetidae, is essentially restricted to Lamington Plateau and the Border Ranges.
- **Lamingtoniidae** and **Rhinorhipidae**, families of **beetles**, are each known only from a single species restricted to rainforests on or near the Lamington Plateau and Border Ranges.

Spiders. CERRA provides habitat for several relict Gondwanan spider taxa. Fifty genera of infra-order Mygalomorphae ('trapdoor' spiders), the most primitive and ancient group of spiders, occur in Australia; 33 inhabit rainforest. Ten genera occur in CERRA, including *Homogona*, *Ixamatus*, *Xamiatus*, *Bymainiella* and *Australothele*, genera with their greatest species richness in the area.

Migas and *Heteromigas*, genera in family Migidae, are considered to be of Gondwanan origin. *Migas* occurs in Australia, New Zealand and New Caledonia, with *M. variapalpus* restricted to the Lamington Plateau; *Heteromigas* is confined to Australia.

Members of Araneomorphae ('true' spiders), the other infra-order of spiders present in Australia, which occur in CERRA include species in the family Gradungulidae, an extremely primitive relictual group recognised as among the world's most primitive 'true' species. The family is represented in CERRA by two or three species of *Tarlina*, a genus which is endemic to eastern Australia – *T. noorundi* in the Gibraltar Range-Werrikimbe area, *T. woodwardi* in south-east Queensland, including Main Range and Laminton, and an undescribed species from the Barrington Tops area; the remaining three species occur in the Wet Tropics (two species) and the lower Hastings River catchment. *Progradungula carraiensis*, an especially primitive member of the family, is known only from two caves in The Castles FR, a CERRA site. Two other families, Toxopidae and Cycloctenidae, also occur only in Australia and New Zealand and are probably very ancient Gondwanan groups. Family Pararchaeidae is confined to eastern Australia and New Zealand; the sole genus, *Pararchaea*, includes six described Australian species – four in Tasmania, one in the Wet Tropics and one in CERRA in Lamington NP.

Genus *Tasmanoonops* also shows a relict temperate distribution, with at least eight species in CERRA.

Terrestrial nemertines (ribbon worms) normally occur on oceanic islands; Australia being the only continent where they occur. Australian species belong to the endemic *Argonemertes*, a genus with four species. Three of the species occur in CERRA and two are restricted to the area – *A. australiensis* occurs at Lamington NP and between Canberra and Tasmania, *A. hillii* is known only from Lamington NP, Dorriggo and Barrington Tops, and *A. stocki* is known only from New England NP; the fourth species occurs in south-western Australia.

5.3. COMMENTS AND UPDATE

1. The Age of the Pteridophytes. The taxonomy of some of the fern flora within CERRA has changed in recent years (Harden 2000a). *Lycopodium laterale* is now transferred to *Lycopodiella lateralis*.

2. The Age of Conifers.

2a. Other Araucariaceae. Since the 1992 nomination, an extant member of a third genus of Araucariaceae has been discovered. The relictual *Wollemia nobilis* is known only from Wollemi NP to the south of CERRA (Jones *et al.* 1995). Members of the third genus, *Agathis*, occur in Australia in the Great Sandy region of southern Qld and in the Wet Tropics.

2b. Araucaria and community types. DASET (1992) note that *Araucaria cunninghamii* occurs in the araucarian (dry) rainforests of the nominated property, and that the association between *Araucaria* and *Nothofagus* is elsewhere only found in the Andes. *A. cunninghamii* occurs in a much wider range of rainforest types than this suggests. It also occurs within CERRA in simple notophyll vine forest (warm temperate rainforest) dominated by Coachwood (*Ceratopetalum apetalum*), and in subtropical floodplain and littoral rainforests beyond CERRA; indeed, the only rainforest type in the CERRA region in which this species does not occur is well-developed complex notophyll vine forest (subtropical rainforest). Association between *Nothofagus* and *Araucaria* occurs in CERRA in a number of places on the Tweed Range and McPherson Range in Border Ranges NP and Lamington NP. Beyond CERRA, but within the CERRA region, association of the two genera is fairly common in Eastern Dorriggo.

2c. Other conifers in CERRA. Apart from *Araucaria*, there are a number of other members of Coniferopsida (conifers) present in CERRA. These are members of the other two southern conifer families, Podocarpaceae and Cupressaceae, plant groups that were present during the 'Age of the Conifers'. They include:

- *Podocarpus elatus* (Plum Pine). The gymnosperm family Podocarpaceae is overwhelmingly southern hemisphere in distribution now and was so in the past (Hill 1995). *Podocarpus* is the largest genus with more than half the species in the family. The genus has a long history in Australia since the Cretaceous (Hill 1995, Hill and Brodribb 1999). *P. elatus* occurs in littoral, riverine and subtropical rainforest from Batemans Bay to Cairns, including some CERRA sites (Floyd 1989).

- *Callitris*, a member of family Cupressaceae, is confined to Australia and New Caledonia. The genus is closest to *Actinostrobus* of southwest Western Australia and *Fitzroyia* of Chile. Half the species of *Callitris* are restricted to the east coast of Australia, with a possible centre of diversity in the 'McPherson-Macleay Overlap' (Bowman & Harris 1995). (The 'McPherson-Macleay Overlap' area is central to CERRA).

Cupressaceae fossils occur from the Late Triassic. Remains of *Callitris* date from Cretaceous and Mid Tertiary. Xeric conditions in the Late Tertiary may have stimulated geographic expansion and species radiation in *Callitris* (Page & Clifford 1981). *Callitris* now occurs in all major Australian ecosystems with the exception of southeastern Australian mountains over 600m altitude and western Tasmania. Four species occur in CERRA – *C. macleayana*, *C. monticola*, *C. oblonga* and *C. rhomboidea*. A fifth species, *C. baileyi*, occurs in the Bunya Mountains and just outside the property at Koreelah Creek below Acacia Plateau. While most are open forest species, *C. macleayana* is typically found on the edges of, or extending into warm temperate rainforest (Floyd 1989). Fire sensitivity is a feature *Callitris* species share with many rainforest species.

2d. Cycads in CERRA. In addition to Class Coniferopsida, the other group that was common at this period in Earth's history is the members of Class Cycadopsida (the cycads). The two genera present in the CERRA region – *Lepidozamia* and *Macrozamia* – are both Australian endemics. While the latter is mainly present in drier sclerophyll forest, at least one species, *M. johnsonii*, occurs in wet sclerophyll forest and into araucarian rainforest margins outside CERRA but within the region. The second genus *Lepidozamia* is represented by two species – one, *Lepidozamia peroffskyana*, in the CERRA region and the other, *L. hopei*, in the Wet Tropics. *L. peroffskyana* occurs in wet sclerophyll forest and in rainforest margins.

3. The Age of the Angiosperms.

3a. Evolution of the Angiosperms. During the 1990s, reconstruction of the phylogeny of seed plants took a great step forward. Rapidly accumulating DNA sequences, in particular from the plastid gene *rbcL*, provided new and informative sets of data. Cladistic analysis of these data sets was also much improved, especially through development of phylogenetic theory and application to analysis of large data sets, and various methods for estimating the support for individual clades in the phylogenetic trees. In many cases the new knowledge of phylogeny revealed relationships in conflict with the then widely used modern classifications (e.g. Cronquist 1981; Thorne 1992; Takhtajan 1997).

Soltis *et al.* (2002) assembled a data set of four plastid (cpDNA) genes to explore the relationships among the five groups of extant seed plants (cycads, *Ginkgo*, conifers, Gnetales, and angiosperms) and to resolve conflicts between molecular data sets (reviewed by Doyle 1998). Their analyses concluded that the gymnosperms are sister to the angiosperms, and within the gymnosperms a conifer clade includes Gnetales as sister to Pinaceae. Cycads and *Ginkgo* are either successive sisters to this conifer clade (including Gnetales) or a clade that is sister to conifers and Gnetales; the preferred typology is that Gnetales are sister to *Pseudotsuga*.

There are a large number of differences in the stem lineages between gymnosperms and angiosperms, indicating that the pre-radiation of the angiosperms goes back much further in time than is currently indicated by fossil evidence of angiosperms (Peter Weston pers. comm.). McLoughlin (2001) argues that a pre-Cretaceous (and possibly even Triassic) origin for angiosperms is a strong possibility, but given the lack of fossil evidence any pre-Cretaceous angiosperms would appear to have had a relatively low importance in the general vegetation (McLoughlin 2001). Given that fossils of gymnosperms go back at least 350 million years, 'the birth of flowering plants could have occurred anytime between 140 million and 350 million years ago' (Cromie 1999).

Several proposed classifications for the families of flowering plants, based on DNA sequencing, have been developed recently (e.g. Angiosperm Phylogeny Group (APG) 1998, Soltis *et al.* 2002). Some of the discussion in DASET (1992) of primitive flowering plants and, in particular, the primary rise of 'higher dicotyledons' may require some modification in the light of recent work. It was generally believed at the time that the two CERRA nominations (Adam 1987, DASET 1992) were written that the higher dicotyledons developed from these primitive groups. A different interpretation, based on recent phylogenetic analyses, indicates that the evolution of the angiosperms was not monophyletic but

polyphyletic with at least six separate groups arising. The most recent product of APG (APG in press) is currently the most resolved phylogenetic system. The discussion below is based on that paper (see Figure 2). However, it should be understood that while there is currently broad agreement on the relationships between the major angiosperm groups and within most groups, the relationships among the major orders of monocots, core eudicots, and partly among the orders of rosids and asterids are still uncertain.

There is general agreement that *Amborella* (Amborellaceae) is sister to all other angiosperms. This family is represented by a single extant species of small tree in New Caledonia. This is the one remaining species of a lineage that first appeared more than 140 million years ago (Cromie 1999).

Nymphaeaceae is the subsequently diverging sister to the rest of the angiosperms.

Austrobaileyales were the next group to diverge. This order includes Austrobaileyaceae (*Austrobaileya*), Trimeniaceae (*Trimenia*) and Schisandraceae (*Illicium* and *Schisandra*). With the exception of *Amborella*, extant members of this group represent the earliest group of terrestrial angiosperms to appear.

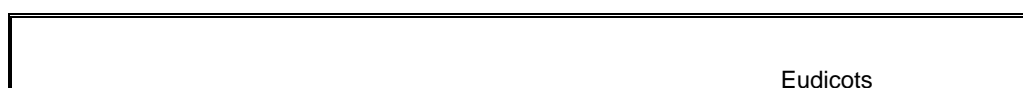
Magnoliids were the next group, after Austrobaileyales, to diverge. This clade comprises:

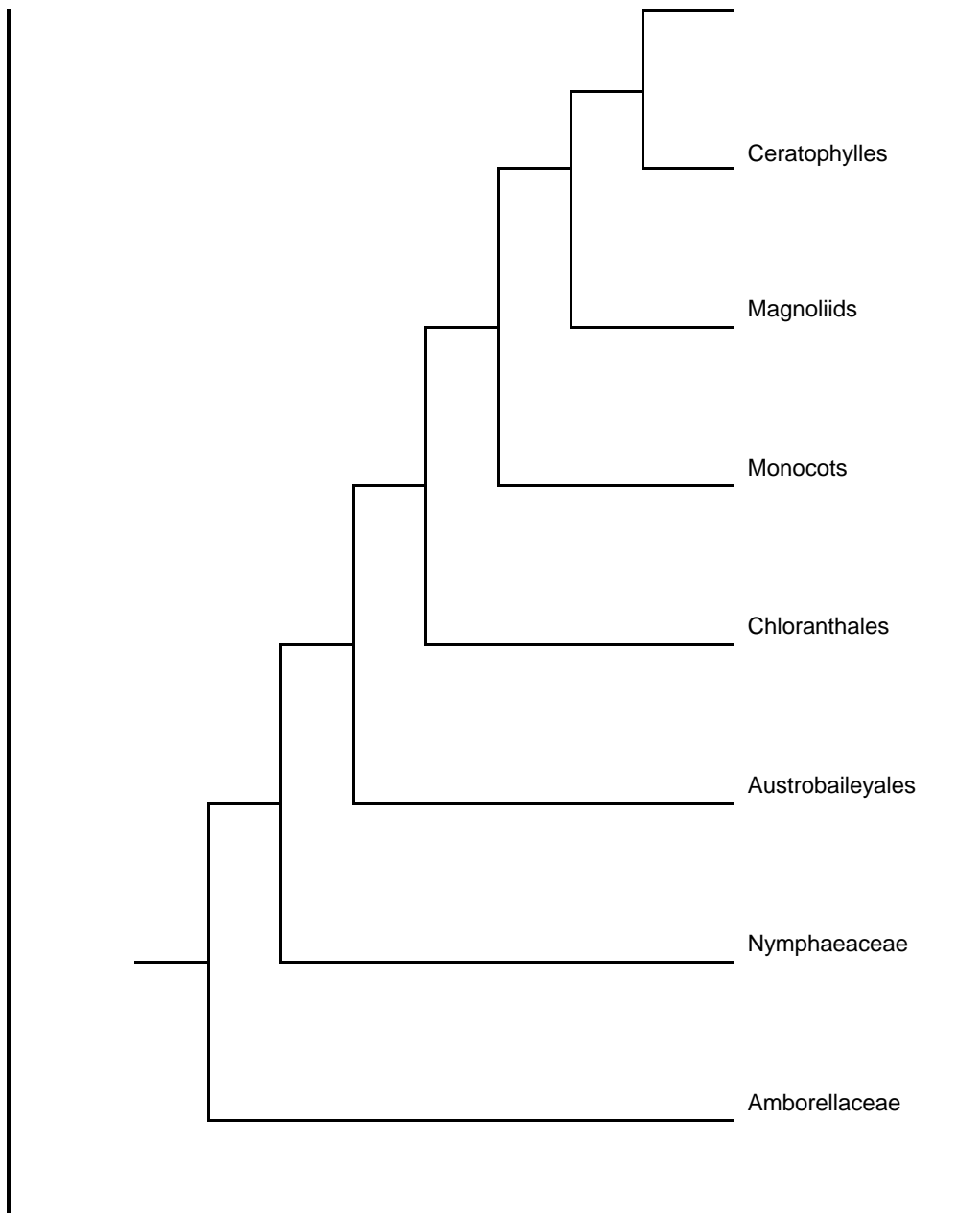
- Laurales – Atherospermataceae, Calycanthaceae, Gomortegaceae, Hernandiaceae, Lauraceae, Monimiaceae and Siparunaceae
- Magnoliales – Annonaceae, Degeneriaceae, Eupomatiaceae, Himantandraceae, Magnoliaceae and Myristicaceae
- Piperales – Aristolochiaceae, Hydnoraceae, Lactoridaceae, Piperaceae, Peperomiaceae and Saururaceae
- Canellales – Canellaceae and Winteraceae

While some (e.g. Soltis *et al.* 2000) place Chloranthaceae and the monocots with the magnoliids in the eumagnoliids, this is not generally accepted (APG in press). The position of Chloranthaceae requires further study. The root of the monocots requires clarification, but is close to the divergence of the magnoliids and must be prior to the emergence of the major group of dicotyledons, the eudicots.

While recent molecular work has established the basic structure of angiosperm phylogeny, knowledge of relationships between many basal clades of angiosperms, among major eudicot lineages, and many orders are unresolved. It must be emphasised that until a much more fully-resolved phylogenetic tree is available, there is an inadequate framework to begin to understand the details of morphological evolution of flowering plants (APG in press).

Figure 2. Preliminary phylogenetic tree of the angiosperms





after APG (in press)

Nevertheless, we do know that a number of lineages branched off early and have very few species, compared to the eudicots. Terrestrial members of these early-diverging groups include the Austrobaileyales and the Magnoliids, groups that have traditionally been regarded as primitive. While some members of these groups may retain primitive characters, more advanced characters are also present in some. Rather than being necessarily 'primitive', these groups are important because they are members of lineages that diverged at a very early stage from, and are entirely separate from, other angiosperms.

3b. The Austrobaileyales and Magnoliids. As noted above, these groups are no longer regarded as ancestral to 'higher' dicotyledons, but are separate lineages within the polyphyletic angiosperms.

The Austrobaileyales order includes Austrobaileyaceae (*Austrobaileya*), Trimeniaceae (*Trimenia*) and Schisandraceae (*Illicium* and *Schisandra*). No members of Schisandraceae are present in Australia, and the group is generally confined to the Northern Hemisphere. *Austrobaileya scandens*, a climber confined to the Australian Wet Tropics, is the only extant member of Austrobaileyaceae. *Trimenia* is a genus of six species from Australia, Melanesia, Fiji and New Caledonia. The genus is represented in CERRA by *T. moorei*, a vine species that occurs in association with *Ceratopetalum* warm temperate rainforests from Barrington Tops to the Queensland border.

The rainforests of CERRA contain representatives of the four orders within the Magnoliids – Laurales, Magnoliales, Piperales and Canellales. The Laurales and Magnoliales are sisters, and Canellales and Piperales are sisters.

Three of the seven families in the order Laurales – Atherospermataceae, Lauraceae and Monimiaceae – are present within the property, and a fourth – Hernandiaceae – occurs just outside the property. Members of these families and their distribution within CERRA have been discussed in DASET (1992). Monimiaceae formerly included a number of genera now transferred to Atherospermataceae. Members of Monimiaceae *s. str.* occurring in CERRA include *Palmeria*, *Hedycarya* and *Wilkea*. *Atherosperma*, *Doryphora* and *Daphnandra* are now transferred to Atherospermataceae. Susanne Renner (pers. comm. 2002) states that Atherospermataceae is unrelated to Monimiaceae and that Monimiaceae is closely related to Lauraceae and Hernandiaceae.

Two of the six families in the Magnoliales occur within CERRA – Annonaceae and Eupomatiaceae. DASET (1992) discusses these families. Within Annonaceae, *Ancana* is now included within the genus *Meiogyne*; the former *A. stenopetala*, endemic to the CERRA region, is now included in *M. stenopetala* subsp. *stenopetala*. CERRA is the southern limit for the family. Within *Eupomatia*, the sole genus in Eupomatiaceae, there are now three species recognised (Jessup 2002) – *E. laurina* from Gippsland to West Irian, *E. bennettii* from the CERRA region, and the newly described *E. barbata* from the Wet Tropics.

The order Piperales is represented by three of the six families – Aristolochiaceae, Piperaceae and Peperomiaceae. Aristolochiaceae is a family of 12 genera and about 475 species that are mainly tropical. The family is represented in the Australian indigenous flora by the genus *Pararistolochia*; 12 of the 30 species in the genus occur in Australia and all are endemic (Harden & Murray 2000). Two species occur in CERRA – *P. praevensis*, predominantly in warm subtropical rainforest from the Lismore area to south-eastern Queensland, and *P. laheyana*, a species of cool subtropical and cool temperate rainforests on the Mt Warning Shield. Piperaceae is a pantropical family with four genera and about 2000 species. Two genera and ten species occur in Australia, one species occurs in CERRA – *Piper novae-hollandiae*, a large climber of warm subtropical rainforests. Peperomiaceae is a family of tropical and subtropical region with four genera and about 1000 species worldwide. Two genera and eight species occur in Australia. Two species of *Peperomia* occur in CERRA – *P. leptostachya* and *P. blanda* var. *floribunda*.

One of the two families within Canellales is present in CERRA – Winteraceae. Members of this group have been discussed in DASET (1992).

3c. Primitive plant refugia. Adam (1992) has highlighted the importance of subtropical environments as refugia for plant families regarded as primitive:

“The families regarded as most primitive in present floras are not well represented anywhere in the fossil record, but the available evidence suggests that they were widespread in the late Cretaceous and early Tertiary. ... Such records, plus the early widespread distribution of families such as the Myrtaceae, are suggestive of a widespread, relatively homogenous, early angiosperm flora, for which Australia provides a refugium.

“The refugial status of primitive taxa is also apparent in their present distribution within Australia. Nix (1982) has demonstrated that the number of primitive genera within a region is correlated with the seasonality of climate: the highest numbers occurring in regions with low seasonality indices. It would appear that these primitive genera with a concentration of conservative traits survive best in those environments that retain climatic conditions that have persisted since at least the early Tertiary. Barlow and Hyland (1988) stressed the importance of the Great Escarpment in providing refugial conditions for primitive taxa since the early Tertiary. The major habitats for primitive taxa are complex and simple notophyll vine forests, rather than either mesophyll or microphyll forests, suggesting that subtropical environments may have been widespread for much of the Tertiary.”

This has immense implications for CERRA. CERRA encompasses the majority of subtropical environments in Australia where rainforest is present. CERRA can therefore be regarded as **the** core refugium for the Gondwanan notophyll rainforests. This is generally consistent with floristic analyses that indicates a primary split between the southern cooler (mesotherm/ microtherm) notophyll/ microphyll rainforests and the hotter (megatherm) mesophyll rainforests (Webb & Tracey 1981, Webb *et al.* 1984).

The subtropical environments within the Wet Tropics are confined to elevated plateaux and high mountains; it is anticipated that global warming would displace these environments from such locations with an attendant loss of taxa, including many of the primitive species which are dependant on such environments (Adam pers. comm.).

3d. Primary radiation of 'higher' dicotyledons. As discussed above in 3a, the radiation of the 'higher' dicotyledons can no longer be seen as the subsequent branching of a monophyletic tree from a base of 'primitive' magnoliids. On the contrary, the major group of dicots, the eudicots, represents a distinct lineage in a polyphyletic evolutionary tree. The relationships between major eudicot lineages and major orders are as yet unresolved, and there is an inadequate framework to begin to understand the details of the morphological evolution of flowering plants. Once this framework is resolved, this section of DASET (1992) will require updating. In the interim, an update is provided on those dicotyledon groups discussed in this section by DASET.

3e. *Nothofagus*. While the early diversification of the genus and its history within the major landmasses is now relatively well understood, the closest taxonomic affinities and place of origin of the genus are still uncertain (Hill & Dettmann 1996). Evolution of the genus during the early Campanian in southern high latitudes, where there is a macrofossil record of *Nothofagus* associated with possible fagaceous or betulaceous, is supported by the pollen evidence. However, it is possible that precursors of the *Nothofagus* were allied to early (Laurasian) members of the Betulae and evolved in Southeast Asia. Pollen records of the Betulae predate those of *Nothofagus* and are confined to the Upper Cretaceous of the Northern Hemisphere (Hill & Dettmann 1996).

3f. *Eucryphia*. *Eucryphia* is sometimes placed in the monogeneric Eucryphiaceae and sometimes in Cunoniaceae. A new species in the genus – *E. jinksii* – has recently been found to occur in CERRA, in one small area in Springbrook National Park (Forster & Hyland 1997). Recent work by Taylor and Hill (1996) supports the view that *Eucryphia* had a Gondwanic origin at least 50 million years prior to the disruption of Australia from Antarctica. The Australian species form a monophyletic group (they share a common ancestor which is a member of the same taxon), but the South American species are polyphyletic (that is, some of the members had quite distinct evolutionary histories). In addition to the species in CERRA there are four species of *Eucryphia* in Australia - two in Tasmania, one in southern NSW and one on Mt Bartle Frere in North Qld.

3g. *Vesselowskyia*. A member of Cunoniaceae, the genus was thought to have a single species in Australia occurring from the Hunter River to the Mount Chaelundi area (Floyd 1989). This species has been revised (Rozeffelds 2001) and two species are now recognised:

- *V. rubifolia*, from New England NP and Dorriggo area, and
- *V. venusta*, mostly from Barrington Tops, but also Bellangry and Mt Boss State Forests.

3h. *Akania*. Gadek *et al.* (1992) support the exclusion of *Akania* from the Sapindales and its inclusion within an expanded Capparales.

3i. Proteaceae. A new species of this family has recently been found growing on the Nightcap Range. The known population is confined to one creekline within Nightcap NP and the adjoining Whian Whian SF, but is just outside the section of Nightcap NP that is included in CERRA. The species, *Eidothea hardeniana*, is related to *E. zoexylocarya* which occurs in the Wet Tropics (Weston & Kooyman 2002). *Eidothea* falls within the subfamily Proteoideae as part of a trichotomy at the node above the base of the subfamily. One of the other two clades that branch from this node includes two subclades that span the Indian Ocean. If the Proteaceae really is a Gondwanan taxon (Weston & Crisp 1996), then these subclades date back to the rifting of Africa from the rest of Gondwana, about 100 million years ago, and the more basal *Eidothea* would be older than this (Weston & Kooyman 2002).

3j. Loranthaceae. This family is mentioned by DASET (1992). Barlow (1981a, 1984) provides more details of the origins and relationships of the family:

The primary basic chromosome number in family Loranthaceae, $x = 12$, is represented in South America in three genera, in two genera in New Zealand and in two genera (*Nuytsia* and *Atkinsonia*) in Australia. All of these genera show a number of apparently primitive characters, and appear to be relictual. The number $x = 12$ is also distributed from Australia to Southeast Asia in the several larger, more specialized

but fundamentally primitive genera of tribe Elytrantheae, including *Amylothea*, *Decaishina*, *Macrosolen* and *Lysiana*.

The basic number $x = 11$ occurs in two relict monotypic genera in New Zealand, in the small, primitive, temperate genus *Muellerina* in Australia, and perhaps in a small Chilean genera. The number $x = 10$ is known only from one monotypic genus from South America. The basic numbers $x = 11$ and 10 thus appear to be south temperate and relictual in their distribution. The pattern which emerges is therefore one in which an ancestral stock with $x = 12$ was widespread in the southern lands, and in which aneuploid reduction to $x = 9$ and 8 has preceded massive evolutionary radiation of the family in the tropics.

This pattern supports the argument that the Loranthaceae are part of the 'Paleoaustral' element. Even though mistletoes are highly specialized in terms of life form, they have probably had a long history in the southern lands. Their present distribution is consistent with their existence as part of the Gondwanan flora prior to the fragmentation of the southern supercontinent. The predominantly tropical nature of their present geographical and taxonomic distribution reflects the evolutionary responses that have followed the displacement and isolation of the southern continental plates.

Three genera in Australia (*Nuytsia*, *Atkinsonia* and *Muellerina*) are relictual in that they are remnants of the former Paleoaustral flora. *Nuytsia* is confined to Western Australia. *Atkinsonia* is confined to the Blue Mountains. *Muellerina* is a temperate genus of four species. It is a primitive and relictual genus that appears to have no close relatives:

- *M. celastroides* – Noosa to Victoria, open and closed forests of coast and ranges on various hosts but commonly on *Casuarina* and *Banksia*. It is recorded from CERRA.
- *M. eucalyptoides* – Kingaroy to Mt Gambier, in open forest of coast, ranges and slopes, usually on *Eucalyptus*.
- *M. myrtifolia* – Restricted to Darling Downs and McPherson Range, in mesic forest on *Croton*, *Parsonia* and *Pandorea*; apparently rare. Collections of the species include Killarney (near Border Gate), Acacia Creek (1906) and Gladfield, Qld (1890).
- *M. bidwillii* – Wide Bay, Queensland to ACT, in open forest and woodland, exclusively on *Callitris*

4. Origin and rise of cold-adapted and dry-adapted floras.

4a. *Nothofagus* and *Araucaria*. *Nothofagus moorei* communities with emergent *Araucaria cunninghamii* within CERRA are reported by DASET(1992) from one site – Running Creek - in Lamington NP. This community type also occurs at the adjacent Christmas and Gradys Creeks and nearby Brindle Creek, and also in the Dorrig/Dorrig area.

4b. *Eucryphia*. There is evidence that species of *Eucryphia* outside CERRA, which are dominants in cool temperate (microtherm) rainforests, have evolved in response to climatic deterioration from large-leaved ancestors of ever-wet, frost-free environments (Hill 1991). The CERRA representative, *E. jinksii*, may prove to be ancestral to, or more similar to the ancestor of, Tasmanian species such as *E. lucida* and *E. milliganii*.

5. Vertebrate fauna

5a. Faunal zones. The far northeastern region of New South Wales and southeastern Queensland is an area of great faunal richness, and this results from the diversity of habitats, vegetation communities, topography and geological history. These attributes in turn developed within a benign climate that facilitated the survival of relict taxa and speciation of others (CSIRO 1996). Three faunal elements – Tumbunan, Bassian and Torresian – are well represented in CERRA.

Tumbunan: an autochthonous element, being the subtropical notophyll rainforest biota which widely occurred across the Australian landscape during the mid-Tertiary. The two most significant refugial examples of this type are the Herbert-Daintree uplands of the Wet Tropics, and between the Richmond (NSW) and Mary (Qld) Rivers. Examples of the Tumbunan vertebrate fauna are Stephen's Banded Snake, Pouched Frog, barred frogs (*Mixophyes* spp.), Sooty Owl, Albert's Lyrebird, Rufous Scrub-bird, Logrunner and Brown Gerygone (CSIRO 1996).

Bassian: the temperate biota of southern Australia that occurs in sclerophyllous vegetation formations such as eucalypt forest, heath and shrub communities. The Bassian is widespread, includes Tasmania, and has an attenuated northern distribution along the Great Dividing Range with an isolated northern and relictual outlier on the Atherton Tablelands of northern Queensland (CSIRO 1996). Examples of the Bassian biota are the Common Eastern Froglet, Bearded Dragon, Eastern Tiger Snake, Crimson Rosella, Superb Fairy-wren, White-naped Honeyeater, Spotted-tailed Quoll, Greater Glider and Eastern Falsistrelle Bat (CSIRO 1996).

Torresian: the 'tropical' component that, in Australia, includes savannah and eucalypt-dominated vegetation. It extends southwards at low altitudes to at least the Hunter Valley of northern New South Wales. Examples of Torresian fauna occurring in the MMA are the Rocket Frog, Brown Tree Snake, Red-tailed Black Cockatoo, Forest Kingfisher, Red-backed Fairy-wren, White-throated Honeyeater, Common Planigale, Northern Brown Bandicoot, Grassland Melomys and Little Red Flying-fox (CSIRO 1996).

Less well represented are taxa from two additional zoogeographical groupings: the Irian, centred on the lowland mesophyll rainforests of New Guinea, and the Eyrean, that contains the endemic fauna of inland Australia (CSIRO 1996). Examples of Irian fauna are the Green Tree Frog, Rainbow Lorikeet, Scarlet Honeyeater and White-eared Monarch. Examples of the Eyrean fauna are Burton's Legless Lizard, Crested Pigeon, Galah, Little Corella and Striped Honeyeater. A number of the Eyrean taxa are recent colonisers of the MMA, probably as a result of post-European settlement and subsequent clearing of vegetation (CSIRO 1996).

However, taxonomic revision may result in some alteration of the distribution, taxonomic and biogeographical status of species and higher taxa (e.g. see *Litoria citropa* and *Saproscincus challengerii* complex), and this caveat applies to all faunal groups.

- 5b. 'Cryptic' frog taxa.** The forests of the eastern Australian coast and Great Dividing Range support a number of endemic hyliid frog radiations (e.g., *Litoria citropa* species-group) but several species have in recent decades disappeared or suffered a decline of former known abundance and distribution (e.g., *Litoria subglandulosa*) (Mahony *et al.* 2001).

Litoria daviesae has been newly described from the Upper Hunter to Hastings catchments of central-lower northern New South Wales (Mahony *et al.* 2001). This previously taxonomically and morphologically 'cryptic' species was formerly included in *Litoria subglandulosa*, but is distinguished by allozyme and mitochondrial DNA profiles, colour and adult body size. *Litoria daviesae* and *L. subglandulosa* are genetically well-differentiated sibling species with similar external morphology, but represent distinct evolutionary lineages (Mahony *et al.* 2001). *Litoria daviesae* is recorded from Werrikimbe National Park (holotype locality), Elands and the Ellenborough River (near Comboyne Plateau) and Barrington Tops National Park, at sites >400m elevation, and ranging from heath and open forest (at tableland localities) to wet sclerophyll forest and rainforest (escarpment localities). *Litoria subglandulosa* (*sensu lato*) is distributed from 'The Flags' near Walcha to Girraween National Park in south-east Queensland. It has disjunct populations usually occurring at elevations >600m, in a similar range of forest types to *L. daviesae*. In recent years *Litoria subglandulosa* has been recorded from Guy Fawkes National Park, Warra State Forest, Styx River State Forest, Gibraltar Range, Washpool National Park, Forest Lands and Spirabo State Forests and the Timbarra Plateau (Mahony *et al.* 2001). Although once common, no populations have been located in New England National Park since 1978, or further north in the headwaters of Oban and Henry Creeks. The recognition of the two distinct species emphasises the need to assess for the presence of 'cryptic' species in the wet forest anuran fauna (Mahony *et al.* 2001).

- 5c. *Kyarranus*/ *Philoria*.** *Kyarranus* is referred to as *Philoria* in NSW. Apart from *P. frosti* (a Victorian species), five species of *Philoria* are now recognised (Knowles *et al.* 2004): *P. kundagungan*, *P. loveridgei*, *P. pughi*, *P. richmondensis* and *P. sphagnicola*.

Several taxonomic problems remain. The species' identity of a number of populations around the periphery of the range of *P. pughi* and others that occur between populations of *P. kundagungan*, *P. loveridgei* and *P. richmondensis* are not resolved. These may be additional populations of the described taxa or may represent undescribed taxon (Knowles *et al.* 2004).

Within *P. sphagnicola*, there is evidence of two groups with relatively distinct genetic differences. Knowledge of geographic distributions and degree of genetic introgression is too incomplete to allow a full assessment of their taxonomic status (Knowles *et al.* 2004).

The extant species of *Philoria* are relicts of a once more widespread distribution as indicated by the fossil record. For example, *Philoria* was once found at Riversliegh (Tyler 1991).

5d. *Lampropholis challenger* is synonymous with *Saproscincus challenger* but records are best referred to *Saproscincus* ‘*challenger*’ complex because of the likely presence of similar species (Sadler *et al.* 1993). *Saproscincus* ‘*challenger*’, on the basis of allozymic and morphological variation, is recognised as a complex of 3 species (Sadler *et al.* 1993).

S. challenger, as redefined by Sadler *et al.* (1993), is confined to the McPherson Range region of southeast Queensland, and the hinterland of far northeastern New South Wales. Of the other two species described from the ‘*challenger*’ complex:

- *S. rosei* is distributed along the eastern edge of the Great Dividing Range and associated ranges of north-east New South Wales and south-east Queensland (e.g. McPherson, Tweed, Richmond);
- *S. galli* is distributed broadly, but within its known range (southern Queensland to Sydney, New South Wales), the species is recorded from a limited number of isolated localities (see Table 2).

In the eastern McPherson Ranges, *S. rosei* is restricted to montane rainforest. *S. rosei* has been recorded sympatrically with *S. galli* in the Dorrigo area, and with *S. challenger* and *S. galli* on the western edge of the McPherson Range. Some populations of individual species occur in relatively close proximity (i.e. <10 km) and, in some cases, populations of each species occur in ecological sympatry (Sadler *et al.* 1993).

Consequently, records from north-east New South Wales and south-east Queensland, previously given as *S. challenger*, may represent *S. challenger*, *S. rosei* or *S. galli*.

On the basis of genetic similarity, Sadler *et al.* (1993) recognised 2 subgroups within *S. rosei*: one from central-east and north-east New South Wales, the other from south-east Queensland. Included in the south-east Queensland subgroup are distinctive high altitude populations in the eastern Border Ranges.

Two genetic subgroups of *S. galli* were also distinguished (Sadler *et al.* 1993); one which was peculiar to the Dorrigo area, and the second occurring at some distance to the north and to the south. However, the two genetic populations are indistinguishable on the basis of morphological characteristics.

Table 2. Records for *Saproscincus challenger*, *S. rosei* and *S. galli* in or near CERRA

Taxa	Queensland records	New South Wales records
<i>Saproscincus challenger</i> ¹	Cunninghams Gap, Mt Tamborine	Border Ranges NP, Mt Warning NP, Nightcap NP, Yabba SF, Tooloom and Richmond Ranges
<i>Saproscincus galli</i> ²	Lamington NP	Border Ranges NP, Mt Warning NP, Wild Cattle Creek SF, Dorrigo NP
<i>Saproscincus rosei</i> ³	Mt Glorious, Lamington NP	Border Ranges NP, Washpool NP, Washpool SF, Gibraltar Range NP, Chaelundi SF, Dorrigo NP, Styx River SF, Werrikimbe NP, Mt Banda Banda FR, Barrington Tops

- (from Sadler *et al.* 1993).

¹ *Saproscincus challenger*: occurs from sea level to c. 500 m in rainforest.

² *Saproscincus galli*: in rainforest at low to mid (c. 500 m) altitudes.

³ *Saproscincus rosei*: restricted to montane rainforest.

Populations of *S. challenger* show little genetic variation across their range (Sadler *et al.* 1993).

Saproscincus oriarus is a newly described species, distributed along the coastal margin of northern New South Wales (Sadler 1998). Recorded localities are Byron Bay, Yuraygir National Park, Coffs Harbour, Sawtell, Limeburners Creek Nature Reserve (Big Hill) and Myall Lakes, in habitats including swamp

sclerophyll forest, *Melaleuca* forest, littoral rainforest and disturbed urban areas. Suitable habitat, within the species' known geographical range, occurs in CERRA at Iluka NR. Although *Saproscincus oriarus* has a broad north coast distribution the species is known by few individuals at any single locality and the overall scarcity of records suggests a limited distribution (Sadler 1998).

Saproscincus galli, described from Dorrigo by Wells and Wellington (1985), has been synonymised with *Saproscincus spectabilis* (Ingram 1994, see discussion in Shea & Sadler 1999) but Sadler *et al.* (1993) (also Ross Sadler pers. comm.) consider it a distinct species, separate from *Saproscincus challengerii*.

5e. Leaf-tailed Geckos. There are 12 species and 3 genera (*Orraya*, *Saltuarius*, *Phyllurus*) of 'leaf-tailed' geckos in eastern Australia, and the CERRA region spans the distribution of two genera, *Saltuarius* and *Phyllurus*. Nine of the 12 species are rainforest-wet sclerophyll forest obligates (e.g. in CERRA *Saltuarius swaini*, distribution Mt Tamborine in south-east Queensland to Bulahdelah north-east New South Wales).

Since 1975 morphological studies have resulted in the recognition of many new taxa of leaf-tailed geckos, including a new genus *Saltuarius* (Couper *et al.* 2000). Phylogenetic analyses, based on DNA sequences, demonstrate that *Saltuarius* is paraphyletic. *Saltuarius cornutus*, *S. salebrosus*, *S. wyberba* and *S. swaini* are a monophyletic sister group to the monophyletic genus *Phyllurus* (Couper *et al.* 2000).

Eight of the presently known 12 species have restricted geographical ranges, and a number are known from single localities, or are narrowly distributed and confined to small rainforest, or rainforest and heath, stands (Couper *et al.* 2000). This "distribution of 'leaf-tails' reflects the preservation of ancient taxa in relictual rainforest and elevated heath fragments in eastern Australia" (Couper *et al.* 2000).

Genetic analyses indicate a high divergence amongst leaf-tailed geckos, and that some significant differences remain to be clarified. The taxonomic status of '*Saltuarius wyberba*' populations in Chaelundi State Forest on the new South Wales north coast await definition, and additional leaf-tailed species (i.e. within '*Phyllurus caudiannulatus*') may exist in southern Queensland.

"It has been thought that Pleistocene ice age concentration of rainforest resulted in speciation among rainforest endemics, but the deep genetic divergence among leaf-tailed geckos precludes any role for Pleistocene speciation." (Couper *et al.* 2000).

5f. Significant birds. CSIRO (1996) lists the following bird species, from far north-east NSW and south-east Queensland as having special biogeographic or phylogenetic significance (text loosely quoted from that source):

- Australian Brush-turkey. Comprises, with *Aepyptodius* from upland New Guinea, a divergent ancient lineage of mound-building megapodes.
- Square-tailed Kite. Relictual endemic raptor with no established close relative.
- Red Goshawk. Divergent goshawk with no close relatives other than *Accipiter buergeri* from upland New Guinea (*A. buergeri* is now regarded as also belonging to *Erythrotriorchis*).
- Black-breasted Button-quail. Unique rainforest edge species in family more usually found in savannah and heath communities.
- Topknot Pigeon. No close relatives among Australo-Papuan fruit-eating pigeons.
- Glossy Black-Cockatoo. 'Derived' black cockatoo exhibiting unique modifications to lower mandible adapted to feed on seeds of certain Casuarinaceae.
- Australian King Parrot. Member of small derived long-tailed group of parrots of uncertain affinity, endemic to Australo-Papuan region.
- Channel-billed Cuckoo. Largest of brood-parasitic species with exceptionally large toucan-like bill.
- Sooty Owl. Relictual Tumbunan species, most divergent from tytonid owls.
- Marbled Frogmouth. May represent distinct relictual species endemic to rainforests of New South Wales – Queensland border region.
- White-throated Nightjar. Largest member of small divergent Australo-Papuan group of nightjars lacking bristled mouths.
- Albert's Lyrebird. One of two species in family Menuridae, root group of song birds.
- Rufous Scrub-bird. One of two species in Atrichornithidae, a sister root group of oscinine perching birds to the lyrebirds.
- Red-browed Treecreeper. Most geographically limited member of a root Australo-Papuan oscinine lineage with scansorial habits and modified syrinx.

- Eastern Bristlebird. Relictual member of root lineage ancanthizid warblers.
- Logrunner. Relictual member of root Australo-Papuan song bird lineage confined to Tumbunan rainforests. Fossil record dates to mid Tertiary.
- Crested Shrike-tit. Member of monotypic genus, and derived member of whistler family Pachycephalidae.
- White-eared Monarch. Unique Australian member of canopy-foraging group of monarch flycatchers known elsewhere only from Moluccas and islands in Banda Sea.
- Magpie-lark. One of a group of two giant ground-foraging, mud-nesting monarch flycatchers endemic to Australasia. Only other member found in upland New Guinea.
- Figbird. Of the two genera of Old World orioles, one is monotypic and comprises the Australian-centred figbirds which are strictly frugivorous and differ from other oriolids in their broad heads and bills and bare pink facial skin.
- Paradise Riflebird. The Australian-centred riflebird species are a root lineage of paradisaeine ‘birds of paradise’ that diverged in parallel with the radiation of this group in New Guinea.
- Regent Bowerbird. Root derivative of avenue-building bowerbirds, with only close relatives in hill forests of New Guinea. There are now 20 species of bowerbirds recognised worldwide.
- Mistletoebird. Single Australian representative of the palaeotropical family of flowerpeckers (Dicaeidae) (CSIRO 1996).

5g. Partial Migration in Landbirds. The Australian landscape is characterised by erratic availability of food resources, and great variation in climatic conditions, and the importance of rainfall to bird movement is well documented (Chan 2001). The eastern seaboard is a frequent migratory route within mainland Australia. An understanding of patterns of migration, including partial migration, has important ecological and conservation implications for managing and preserving bird species (Chan 2001), the maintenance of ecological processes (e.g., gene flow) within and between individual reserves, and the design of reserves more broadly. Conservation programs need to reflect an understanding of residency and migratory status, and the impact of off-reserve factors for landbirds that undertake some form of seasonal migratory movement or dispersal (Chan 2001).

About 40% of the landbirds (472 spp.) breeding in Australia exhibit some degree of migration (Chan 2001). This figure can be broken down into c. 44% (155 spp.) for non-passerines and c. 32% (317 spp.) for passerine species, and the available evidence suggests that landbird populations with mixed resident-migratory elements are prevalent throughout much of Australia. Altitudinal migration is probably common (Eastern Spinebill *Acanthorhynchus tenuirostris* regularly ascends the higher parts of New England NP in winter), but regular east-west migration is probably uncommon (Chan 2001). Significantly, nocturnal migration is common, and migratory landbirds often move *through* vegetation, not above it (Chan 2001). Few Australian species are known to winter >1000 kilometres from their breeding grounds, and this limited movement is a phenomenon that seems characteristic of Southern Hemisphere birds. The seasonal dispersal of birds that undertake some migration does not reach any further than the Tropic of Capricorn (Chan 2001), and in this regard the chain of north-south CERRA world heritage reserves occupies a significant length of the eastern seaboard migration pathway for upland and forest dependent migratory landbirds. However, CERRA does not include significant lowland areas and the clearing of lowland forests places resource constraints on altitudinal migrants within CERRA.

5h. Eastern Bristlebird. The Eastern Bristlebird *Dasyornis brachypterus* (Pardalotidae) is a ‘cover-dependent’ and ‘fire-sensitive’ species, and suitable dense low vegetation cover is a prerequisite for the species to survive in reserves (Baker 2000) and, to maximise the expansion and conservation of Eastern Bristlebird populations, fire should be excluded from habitat (Baker 2000).

The Eastern Bristlebird is recorded from south-east Queensland/ north-east New South Wales, southern New South Wales and the New South Wales/ Victorian border, and throughout its range occurs in a wide range of vegetation communities (e.g. rainforest, open eucalypt forest, shrubland, swamps, woodland and ‘mallee’). However, its habitat specialisation is ‘undergrowth’ (Baker 2000).

Conservation of terrestrial bird populations is dependent upon the retention of vegetation communities with particular structural and floristic attributes, and understorey species are dependent upon certain cover characteristics, and may be adversely impacted by fragmentation of habitat (Baker 2000). Baker (2000) found at Barren Grounds Nature Reserve, southern New South Wales, that the density of Eastern Bristlebird populations in ‘old habitat’ was 2.5 – 5 times that of young post-fire habitat, and found

evidence that the species would avoid recently burnt regenerating low vegetation, preferring unburnt vegetation stands.

The Eastern Bristlebird is a fire sensitive species, potentially threatened by frequent fire regimes, and fires have been responsible for, or implicated in, the extinction of local populations (including those in south-east Queensland and north-east New South Wales). Fire sensitive bird species tend to be “ground-dwelling, cover dependent, poor fliers, poor dispersers or low in fecundity” and are more likely to be killed or injured by fire rather than flee ahead of smoke or fire fronts (Baker 2000).

5i. Logrunners. Logrunners (Orthonychidae: *Orthonyx* spp.) are a small relictual family (Norman *et al.* 2002) of uncertain affinities, restricted to the rainforests of eastern Australia and New Guinea. They possess a number of notable biological and anatomical attributes, such as the unique pelvic girdle and leg architecture that facilitates their specialised foraging behaviour (i.e. sideways kicking to flick away leaves, twigs etc.) on the forest floor (Joseph *et al.* 2001).

The Southern Logrunner *Orthonyx temminckii*, from the subtropical rainforests of eastern Australia, is usually treated as conspecific with the logrunners of New Guinea’s montane rainforests (Joseph *et al.* 2001). However, Joseph *et al.* (2001) found that the Australian and New Guinea populations, on the basis of mitochondrial DNA sequence outcomes, are “deeply divergent”, and their morphological similarities were “almost certainly due to retention of ancestral plumage character states”. Joseph *et al.* (2001) consider the Australian and New Guinea populations to represent separate species, and the New Guinea species (*O. novaeguinae*) has been divided into three subspecies. As now constituted, *Orthonyx* consists of *O. temminckii* (central NSW to southern Queensland), *O. spaldingi* (northern Queensland) and *O. novaeguinae* (Papua New Guinea and West Papua). In *O. novaeguinae* there is a “deep phylogenetic break in the distribution of mtDNA diversity” between populations in north-west West Papua, the Snowy Mountains and south-eastern highland populations, and that “the magnitude of the break suggests that, ... vicariance has operated to fragment these birds’ populations at least since the beginning of the Pleistocene if not considerably earlier in the Plio-Miocene” (Joseph *et al.* 2001).

5j. ‘Leapfrog’ distribution of Sooty Owls and Logrunners. Results from nuclear and mitochondrial DNA sequencing, recently undertaken by Norman *et al.* (2002), indicate that sooty owls (*Tyto*) and logrunners (*Orthonyx*), two groups with broadly similar disjunct distributions, exhibit significantly different spatial and temporal histories in the rainforests of Australia and New Guinea. Additionally, the results of this work refute recent ancestry as an explanation of geographical distribution patterns, and suggest that distribution patterns may have arisen from complex evolutionary events that may involve a “combination of selection and drift in sooty owls and convergence or retention of ancestral characteristics in logrunners” Norman *et al.* (2002).

Disjunct distribution patterns, sometimes termed ‘leapfrog’ patterns, are known for several groups of birds (e.g. sooty owls, logrunners, ground-thrushes (*Zoothera* spp.), riflebirds (*Ptiloris* spp.)), found in rainforests along the eastern coastal region of Australia, and in New Guinea. Such species are comprised of populations that are separated by intervening, phenotypically distinct ones, and such patterns of geographical variation are widely recorded in montane forest birds (Norman *et al.* 2002).

Two general hypotheses have been formulated to explain ‘leapfrog’ distributions:

1. “phenotypic similarity of terminal populations is due to their more recent common ancestry with long distance dispersal or vicariance involved to explain the evolution of their disjunct distributions”;
2. “the leapfrog pattern results from unequal rates of phenotypic change among populations” (see discussion in Norman *et al.* 2002).

The results of mtDNA and nDNA sequencing question the separation of sooty owls into 3 taxa (i.e., *Tyto tyto tenebricosa* (central Queensland to south-east Australia), *T. t. arfaki* (New Guinea), *T. multipunctata* (north Queensland)) and the complex is best considered a single taxon *Tyto tenebricosa* (Norman *et al.* 2002). These results also strongly supported the distinction of *Orthonyx temminckii* (Queensland, New South Wales) and *O. novaeguinae* (New Guinea), and their separation from *O. spaldingi* (north Queensland) (Joseph *et al.* 2001, Norman *et al.* 2002).

“The phylogenetic relationships and depths of divergences identified [by Norman *et al.* 2002] illustrate that rates of molecular and morphological evolution are decoupled in both the logrunner and sooty owl

complexes. This is a common phenomenon in molecular studies of birds ... and cautions against the exclusive use of phenotypic characters when making taxonomic assessments" (Norman *et al.* 2002).

There is marked differentiation in the depth of sooty owl and logrunner lineages. This is not due to variation in rate of DNA evolution, and logrunners appear to be a more ancient radiation than sooty owls, and this is consistent with the fossil record (Norman *et al.* 2002). Miocene fossils are known for logrunners from Australia, but unknown for sooty owls. Logrunners appear to be an old Australo-Papuan endemic group with fossils widely known from eastern Australia indicating that their present isolated distribution is a result of contraction and fragmentation of rainforest habitat. By comparison, sooty owls are a cosmopolitan genus more recently arrived in Australo-Papuan rainforests. Although occupying broadly similar distributions to logrunners, sooty owls are not rainforest specialists or obligates, their ecological range extending into eucalypt-dominated vegetation. This habitat plasticity exhibited by sooty owls possibly contributed to preventing significant evolutionary divergence among populations, and may have buffered the group against the impacts of Plio-Pleistocene habitat fragmentation - the intervening non-rainforest vegetation facilitating interpopulation dispersal and gene flow (Norman *et al.* 2002).

5k. Rufous Scrub-bird. The Rufous Scrub-bird *Atrichornis rufescens* (Atrichornithidae) is confined to vegetation dominated by rainforest, wet sclerophyll forest and wet forest ecotones in the CERRA World Heritage Area and is listed as Vulnerable on the New South Wales *Threatened Species Conservation Act* 1995. Historical records suggest that the species was once abundant in lowland rainforest of the Richmond-Tweed district, and that the destruction of lowland rainforest throughout much of New South Wales resulted in the elimination of Rufous Scrub-birds that may have occurred more widely in these communities. Additional impacts of fire regimes, logging and predation by foxes and cats have been suggested as factors leading to decline in population levels and contraction and fragmentation of the species over its previous range (Shane Ruming pers. comm., Ferrier 1984, 1985). The Rufous Scrub-bird is a cryptic species, its most suitable protective, foraging and nesting habitat being patches of dense groundcover (including shrub understorey layers), one metre in height, with a moist microclimate and an accumulation of leaf litter within rainforest or wet sclerophyll forest (Shane Ruming pers. comm., Ekert 2000, Ferrier 1984, 1985).

The species is subject to a six year monitoring program (1999-2004) being undertaken by NSW NPWS, the project's overall aim being to determine whether there are changes in abundance of populations in north-east New South Wales over the period of investigation (Shane Ruming pers. comm.). In 1999, 370 monitoring sites were established within the five known subpopulations in New South Wales, and these sites were centred in the Border Ranges, Gibraltar Range, New England, Werrikimbe and Barrington Tops National Parks. To date, Rufous Scrub-birds have been recorded from all subpopulations, with specific records from Border Ranges, Mebbin, Gibraltar Range, Barool, New England, Oxley Wild Rivers, Carrai, Willi Willi, Werrikimbe and Barrington Tops National Parks. Trends in preliminary monitoring data indicate that the southern subspecies (*Atrichornis rufescens ferrieri*), found at Barrington Tops, Werrikimbe and New England National Parks, is probably more numerous than the northern subspecies (*Atrichornis rufescens rufescens*), which occurs at Washpool and the Border Ranges (Shane Ruming pers. comm.).

5l. Black-breasted Button-quail. Survey for this species in Queensland in 1992 and 1993 indicates that the species is now found in 13 isolated groups from Kalpower in the north to Border Ranges in the south (Flower *et al.* 1995). It also confirmed the presence of this species at several CERRA sites in south-east Queensland, including Spicers Gap, Green Mountains and Palen Creek State Forest. The species generally occupies drier rainforests in southern Queensland, ranging from 'Bottle tree scrubs' to dry rainforest with Hoop Pine emergents and littoral thickets on sand.

The presence of the species at Palen Creek was considered significant as similar habitat occurs across the State border and continues in a series of closed forests down the Richmond Range. These drier areas of rainforest bordering the wetter rainforests of the Border Ranges were thought to represent considerable potential habitat for Black-breasted Button-quail (Flower *et al.* 1995). A review of all records and surveys for the species in New South Wales has subsequently been undertaken. No evidence was found that the species is currently present in north-east New South Wales and the validity of earlier records of the species in the state is questioned (Milledge 1999).

5m. Mammals. While both nominations comment on the diversity of the mammalian fauna of CERRA, neither highlights the group as including species which have Gondwanan affinities or origins. Archer *et*

al. (1994) discuss the evidence for the first appearances of mammalian groups in Australia following the Cretaceous diversification of angiosperms, which resulted in the adaptive radiations of mammals between the Late Cretaceous and Early Palaeogene.

There are twelve groups of ordinal distinct endemic Australian mammals. Ten have extant representatives:

1. Monotremes – since Early Cretaceous in Australia and Early Palaeocene in Patagonia. Marsupials dispersed from North America to South America in the Late Cretaceous or Early Palaeocene, and dispersed to Australia prior to late Eocene; oldest Australian marsupial fossils are 55Ma.
 2. Marsupial dasyuromorphians (dasyures, numbats and thylacines) – from Early Eocene
 3. Bandicoots (bilbies, ordinary and forest bandicoots) – from Early Eocene, distinct prior to Australia's separation from Antarctica.
 4. Marsupial moles – from Early Miocene
 5. Diprotodontians (koalas, wombats, possums, kangaroos) – from Late Oligocene
- Placentals:
6. Bats – from Early Eocene. Plesiomorphic bats were present in Australia at least 10 million years before separation of the continent from Antarctica; an Asian archipelago source is supported. It is not clear when Megachiropteran bats dispersed to Australia from south-east Asia; they are unrepresented in Tertiary deposits in Australia.
 7. Whales – from Oligocene
 8. Rodents – from Early Pliocene
 9. Sirenians – from Late Tertiary
 10. Carnivores (dingoes) – from mid-Holocene; (seals) – from Late Pleistocene

Therefore, all monotremes and marsupials are of Gondwanan origin and provide added support for criterion (i). The Plesiomorphic bats were also present in Australia in Gondwanan times but may not be of Gondwanan origin.

5n. Dasyurids. Small dasyurid marsupials (e.g. *Antechinus*, *Sminthopsis*, *Phascogale*) are potentially important pollinators of a range of native plant taxa in sclerophyll vegetation communities, and the evidence in support of the role of *Antechinus* spp. as pollinators, especially of *Banksia* spp., is compelling (Goldingay 2000).

Antechinus subtropicus is newly described from the subtropical rainforests of south-east Queensland and north-east New South Wales, and is recorded from CERRA or nearby localities at Cunninghams Gap, Lamington Plateau, Mt Glorious, Mt Tamborine, Upper Tallebudgera Valley (Queensland), and Mebbin NP, Whian Whian SF and Border Ranges NP (New South Wales) (Van Dyck & Crowther 2000). This species has a greater palatal fenestration (perforation) than most other Dasyuridae and the extremely large palatal vacuities distinguish it from all other *Antechinus* (Van Dyck & Crowther 2000).

The taxonomic status of *A. stuartii* – *A. flavipes* populations in eastern Australia is uncertain owing to the taxonomic variation and lack of reliable diagnostic characters between species. Reappraisal of interpopulation variation and respective taxonomic status of eastern populations attributed to these species is required (Dickman *et al.* 1998, Van Dyck & Crowther 2000). Interestingly, the tropical species *A. adustus* is morphologically and ecologically closer to the southern species, *A. stuartii* and *A. agilis*, than to its geographical nearest relative in the species complex, *A. subtropicus* (Van Dyck & Crowther 2000). The view that *Antechinus* 'stuartii' is one of eastern Australia's most common native mammals, and consequently of low conservation significance, may need urgent re-evaluation due to the likelihood that a number of distinct taxa are currently 'hidden' under a broader 'stuartii' species complex (Van Dyck & Crowther 2000).

5o. Possums. The Phalangeridae are the most diverse and wide-ranging of the possum families, and comprise about 20 species distributed in Australia and New Guinea. The genera *Ailurops*, *Phalanger*, *Spilocuscus* and *Strigoscuscus* are restricted to northern Australia and New Guinea, but the genera *Trichosurus* (brush-tailed possums) and *Wyulda* (scaly-tailed possums) are confined to Australia (Osborne & Christidis 2002). The CERRA phalangerid fauna comprises *Trichosurus caninus* and *T. vulpecula*, which Flannery (1994) placed in the subfamily Phalangerinae, tribe Trichosurini. The Trichosurini, more broadly, encompasses *Trichosurus* (3-5 spp. dependent upon recognition of species), *Wyulda* (1 sp.) and *Strigoscuscus* (2 spp.). Phylogenetic analysis indicates three lineages within the Phalangerinae: 1.

Spiloglossus, 2. *Phalanger* and 3. *Trichosurus*-*Wyulda*, and this is congruent with the results of other molecular studies (Osborne & Christidis 2002). *Phalanger*-*Spiloglossus* and *Trichosurus*-*Wyulda* are estimated to have diverged about 25Ma. Mitochondrial dehydrogenase subunit 2 gene (ND2) and micro-complement fixation of albumin data indicate *Trichosurus* and *Wyulda* to have diverged 8-11Ma but fossil evidence from the Riversleigh deposits suggests *Wyulda* was already present in the Australian fauna by the middle Miocene (16.6-10.4Ma) (see Osborne & Christidis 2002 for discussion). *Trichosurus* is the only phalangerid possum genus occurring in southern and temperate Australia (Lindenmayer, Dubach & Viggers 2002). It appears to have been present in temperate Australia since at least the Miocene. Although the biogeographic reasons for the separation of some taxa (i.e. *T. caninus*, *T. cunninghami*) remain to be clearly determined, similar taxonomic separations are recorded for hylid frogs, rock-wallabies, dasyurid marsupials (*Antechinus*) and invertebrates (see Lindenmayer *et al.* 2002).

There is considerable variation among populations of *Trichosurus caninus*, however, "unequivocal morphological and genetic differences exist between northern and southern populations" (Lindenmayer *et al.* 2002, Lindenmayer *et al.* 1995). Only the form distributed from central coastal New South Wales to central Queensland is now retained as *T. caninus* (Short-eared Possum) and the southern (Victorian) form is now considered a distinct species, *T. cunninghami* (Mountain Brushtail Possum) (Lindenmayer *et al.* 2002). There is a possible geographic overlap between the two species in southern New South Wales, but the exact boundary between the two species has yet to be established. The type of *Trichosurus caninus* was originally collected "in the country of beyond the Hunter River" (Lindenmayer *et al.* 2002) and, as now constituted, is a phalangerid arboreal possum with disjunct populations in wet sclerophyll forest and subtropical rainforest. The related *T. vulpecula* is generally absent from dense wet forest communities (How 1978). Lindenmayer *et al.* (2002) could find no evidence that observed morphological patterns in populations, historically assigned to *T. caninus* at their study sites (which in, or adjacent to CERRA, comprised Allyn River Forest Park, Byrangerie Reserve and Whian Whian State Forest), are due to elevation (climate), competition or predation influences, and that other unknown factors appear to be responsible for the divergence of ancestral stock.

5p. *Miniopterus schreibersii* 'complex'. The genus *Miniopterus* is comprised of outwardly similar species, occurring in Africa, Europe and extending into Australasia. Two species, *Miniopterus australis* and *M. schreibersii*, occur in Australia. Recent studies of skull morphology and mitochondrial DNA sequence data have shown that there are three distinct lineages within the Australian Eastern Bent-wing Bat *Miniopterus schreibersii* populations (Cardinal & Christidis 2000). Cardinal and Christidis (2000) assign these to three endemic subspecies: *Miniopterus schreibersii orianae* from northern Australia, *M. s. bassanii* from western Victoria and eastern South Australia, and *M. s. oceanensis* from eastern Australia, extending south from Queensland, along the east coast of New South Wales and into central Victoria. The distribution of *M. s. oceanensis* through Victoria includes all the central Victorian wintering sites. The exact zone of division separating *M. s. bassanii* and *M. s. oceanensis* is unclear and awaits further study. The outcomes derived from the investigations undertaken by Cardinal & Christidis (2000) yielded no support for assigning Queensland populations to *M. s. orianae* from northern Australia. MtDNA sequences from the 3 Australian forms of *Miniopterus schreibersii* differed by 3-4% from each other, and by >10% from the second Australian species *M. australis*. The New Guinea population of *M. schreibersii* differed by some 5-6% from the Australian *Miniopterus schreibersii* taxa. Ten percent in the level of genetic character divergence is typical for differentiation of *Miniopterus* species. Consequently, the level of divergence between the Australian forms of *M. schreibersii* is insufficient to raise the taxa to species rank (Cardinal & Christidis 2000). The name *Miniopterus schreibersii blepotis* has been used for the Australian east coast form, but this subspecies name is based upon type material from Java and in view of the genetic integrity of the endemic Australian forms it is inappropriate to retain *blepotis* for the Australian fauna (Cardinal & Christidis 2000).

The approximate genetic equidistance of the three Australian *M. schreibersii* lineages, and that of the investigated New Guinea taxon, suggests divergence occurred at about the same time. And there is no evidence to support successive divergence from New Guinea (Cardinal & Christidis 2000). Cardinal and Christidis (2000) propose that vicariance barriers may explain present distribution patterns of *M. schreibersii*. Basing the rate of mammalian cytochrome-*b* evolution at around 2% per million years, they estimate that the Australian taxa, and that of New Guinea, separated about 1.5 to 2 million years ago, with the post-Pleistocene sea barrier formed by the Torres Strait enabling divergence between Australian and New Guinean stock. Within Australia, Cardinal and Christidis (2000) suggest that the Carpentarian barrier between the Northern Territory and Queensland, which influences movement of groups such as birds, may account for differentiation of continental *Miniopterus schreibersii* forms. The availability of

suitable caves also strongly influences distribution and possible divergence, and the original extent of geographical separation of Australian *Miniopterus schreibersii* taxa may have been considerably reduced by human activities (i.e. provision of mine shafts as surrogate caves), and this may allow future integration of presently genetically-differentiated taxa (Cardinal & Christidis 2000).

5q. Native Rodents. *Pseudomys novaehollandiae* is known to interbreed with *P. delicatulus* from southern Queensland, being impossible to distinguish by conventional means (S. Van Dyck pers. comm.).

5r. Dingoes. New England National Park and surrounding forested crown lands are recognised as an area of significant dingo habitat. Preliminary DNA assessments of dingo/wild dog tissue collected from capture/release surveys in this area indicate that the New England National Park CERRA reserve supports or sustains pure dingos (Brad Nesbitt NSW NPWS pers. comm.).

6. Invertebrate fauna

The two World Heritage nominations (Adam 1987, DASET 1992) provide relatively little information on the contribution of invertebrates to the World Heritage values of CERRA. As part of the present project, Dr Geoff Williams undertook a review of a cross-section of the invertebrate taxa of the CERRA, highlighting the origins, diversity and level of endemism of the taxa (Williams 2002). Therefore, Williams (2002) provides the most up-to-date assessment of the contribution of invertebrates to the World Heritage criteria. That document should be recognised as part of the current review of World Heritage values and attributes; only the most important summary statements are included in this report.

Williams (2002) provides strong support for the important Gondwanan legacy present in the invertebrate fauna of the property. In summarising the data derived from the taxonomic and biogeographic information acquired during this project, Williams makes four major generalisations. Two are relevant to this criterion:

- The CERRA region, loosely defined as that area extending north from the Barrington Tops into southeast Queensland, is a significant zoogeographic refugium in terms of the evolution of Australian invertebrate taxa. Examples occur extensively within the taxa listed in the Appendix and discussed in the Overview. Particular examples are the terrestrial snail family Charopidae, the freshwater snail family Hydrobiidae, the beetle taxa Adeliini, Cyphaelini, Coprini, Denticollinae, Rutelinae, Melolonthinae, Lucanidae, flightless beetles in the family Carabidae, the fly family Drosophilidae and dolichopodid subfamily Sciapodinae, parastacid crayfish, aradid bugs, the Onychophoran family Peripatopsidae and mygalomorph spiders.
- The CERRA region includes a high proportion of taxa with 'Gondwanan' or 'Old Southern Endemic' affiliations. This group includes taxa with relatives on other Gondwanan landmasses such as South America, Africa and the Indian subcontinent, and those restricted to Australasia. Some taxa are restricted to Australia but with close relatives in either New Caledonia or New Zealand, but not both. Within known ranges, individual taxa can be widespread or relictual. Examples of 'southern' fauna exist across all taxonomic levels - from species to that of subphylum. Notable higher taxonomic rank examples are the megascolecid earthworms, mygalomorph and amphetid spiders, harvestmen in the family Acropsopilionidae, the mite family Pheroliodidae, and the terrestrial snail families Athoracophoridae, Charopidae, Cystopeltidae and Rhytididae. The insects are well represented, and include the beetle family Phloeostichidae and tribes Pamborini, Migadopini, Adeliini, Epistomentini and Stigmoderini, flies in the family Pelecorhynchidae, the subfamily Arachnocampinae and the tribe Pangoniini, the moth families Hepialidae and Micropterigidae, the 'birdwing' butterfly genus Ornithoptera, the hemipteran bug families Idiostolidae and Peloriidae, the neuropteran lacewing subfamilies Kempyninae and Stenosmylinae, ambrositine and hyptiogastrine wasps, and the plecopteran families Austroperlidae, Eustheniidae and Griptopterygidae.

These findings support the identified value statement for criterion (i): CERRA WHA rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana. The report (Williams 2002) also highlights invertebrate attributes of this value that complement the identified floral and vertebrate faunal attributes.

5.4. INTEGRITY

To be listed on the World Heritage List, a property must meet certain conditions of integrity. The condition of integrity required to be met for criterion (i) is:

The sites should contain all or most of the key interrelated elements in their natural relationships.

CERRA does contain most of the key interrelated elements (attributes) which together constitute the World Heritage values related to this criterion. The sizes of the ecosystems in which these attributes occur are generally sufficient to ensure that they are not threatened as a whole. However, there are other areas beyond the property, the addition of which would improve the integrity of the property by including a more complete expression of the attributes (see Section 12).

5.5. DISTRIBUTION

The numerous areas of rainforest, both large and small, scattered in an extended arc through central eastern Australia, make contributions to this criterion. While it is not feasible that all members of this subtropical ‘archipelago of habitat’ are included in the property, the sites in the property are representative of and do include most of the attributes. The ocean of predominantly *Eucalyptus*-dominated vegetation in which the rainforest archipelago is situated also contains some of the attributes. It also provides an important contextual framework for the continuing history of biotic evolution on the continent; the particular World Heritage values of these autochthonous ecosystems are now recognised (see Section 8).

5.6. THREATS

Existing threats to rainforest vegetation and constituent plant and animal species include:

- **Inappropriate fire regimes.** Rainforest species and vegetation are generally fire sensitive, but rainforest often abuts fire prone vegetation or is embedded in a landscape that is susceptible to fire events. Therefore fire management must be crafted to suit both the individual rainforest patch and the ecology of the surrounding landscapes (Bowman 2000).
- **Exotic plant species.** Pest plant species which are significant because of the extent of their distribution within rainforest or because of the severity of their impact include species such as Madeira Vine (*Anredera cordifolia*), Cat’s Claw Climber (*Macfadyena unguis-cati*), Balloon Vine (*Cardiospermum grandiflorum*), Asparagus vines (*Asparagus* spp.), Camphor Laurel (*Cinnamomum camphora*), Privets (*Ligustrum* spp.), Bitou Bush (*Chrysanthemoides monilifera*), Lantana (*Lantana camara*), Mistflower (*Eupatorium riparium*) and Crofton Weed (*E. adenophorum*).
- **Exotic animal species.** Pest animal species of concern include Feral Pigs (*Sus scrofa*), Cattle (*Bos taurus*), Foxes (*Vulpes vulpes*) and Cats (*Felis catus*). The impact of the feral honeybee on the reproductive ecology of rainforest plants requires investigation (Geoff Williams pers. comm.).
- **Dieback** of vegetation associated with canopy damage, incursion of cold air, snow or salt, exotic plant incursions and fungal pathogens.
- **Disruption to gene flow** or changes in the pattern of gene flow in plants and animals as a result of rainforest fragmentation.
- **Decline in populations of native frogs** as a result of fungal pathogens and possibly exacerbated by air-borne pollutants, climatic change and increased ultraviolet radiation.
- **Localised damage** due to increased visitation at some sites.

Potential threats include:

- clearing of vegetation;
- introduction of new exotic plants and animals or spread of existing feral species;
- introduction of new plant or animal pathogens;
- species loss and re-assemblages due to rapid climatic changes precipitated by human impacts on planetary processes; impacts associated with warming attributed to ‘Greenhouse Gases’ have been documented (Holmes 1999); and
- increased visitation and associated infrastructure.

Rainforest areas, such as designated wilderness areas, where natural processes are allowed to proceed without interference from human activities are very important as baseline areas against which the success or

otherwise of management can be measured. Such areas may also act as recruitment areas for regeneration in the wake of human-induced perturbations.

6. WORLD HERITAGE VALUES AND ATTRIBUTES OF THE CENTRAL EASTERN RAINFOREST RESERVES OF AUSTRALIA – NATURAL HERITAGE CRITERION (ii).

Criterion (ii): be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.

Statements of the World Heritage values relevant to this criterion are:

- **CERRA WHA includes outstanding geological features associated with the Tweed Shield, including its size, age and erosional landforms.**
- **CERRA WHA includes significant centres of endemism where ongoing evolution of flora and fauna species is taking place.**

6.1. VALUES AND ATTRIBUTES BASED ON THE 1985 NOMINATION

It is argued by Adam (1987) that the sites within the property meet this criterion on two grounds: as examples of important biomes, and as sites where significant continuing evolution of the biota may be occurring.

1. Examples of important biomes

The world's rainforests are a great storehouse of genetic diversity – perhaps half of all species are denizens of rainforest. Even before reduction by Europeans, Australia's rainforest was only a small proportion of the world's total. Because of the extended isolation there has been a long period available for the evolution of endemic taxa. It has been estimated that Australian rainforests may contain 5% of the world's rainforest species.

The different rainforest types in Australia have long geological histories as separate entities in Australia and much of their biota has evolved *in situ*.

Australia is one of the major centres of distribution for cool temperate rainforest. Floristically and faunistically there are relationships at family and generic level between cool temperate rainforest in South America, New Zealand and Australia, reflecting the probable widespread occurrence of some form of cool temperate moist forest in Gondwana but, given the long isolation of the three regions, all are distinct at the species level.

Warm temperate rainforest is a rainforest type with a distinctive structure and a tendency to dominance by a few canopy species. Major samples of this forest type are included in the property, including the largest single stand dominated by *Ceratopetalum apetalum* in existence.

Australian subtropical rainforest is a distinct biome with a long evolutionary history and, as such, is a rainforest type of world significance. The sites display much of the variation shown within subtropical rainforest in Australia and provide the habitat for a great diversity of organisms.

Dry rainforest probably evolved from ancestral subtropical rainforest in response to increasingly dry climatic conditions. These structurally and floristically distinctive forests may illuminate the processes by which much of the characteristically Australian biota evolved from rainforest ancestors. The sites contain major examples of dry rainforest communities.

The sites occupy an important segment in the continuum of rainforest types in Australia, and contain outstanding examples of four rainforest types.

The sites also contain substantial areas of eucalypt-dominated wet and dry sclerophyll forest and sclerophyll woodland. These biomes are unique to Australia. The eucalypt communities of the property provide a representative sample of much of the biota of eastern Australia.

2. A chain of islands – opportunities for continued biological evolution

Rainforest stands in Australia can be regarded as forming an archipelago, albeit of islands within a sea of sclerophyll communities. The present geographic separation of the ... major centres of rainforest ... is not an artefact of European clearance but is the consequence of the fragmentation of a once more widespread rainforest cover in response to climatic changes.

The different rainforest types are associated with different environmental conditions, the present distribution of which determines the degree of disjunction between stands. Thus the conditions appropriate for the survival of cool temperate rainforest are found over very limited areas widely separated from one another, with no possibility of there being small outlying stands between the main centres of distribution. On the other hand, the environment of subtropical rainforest is more extensive and suitable conditions for subtropical rainforest are also found in numerous limited areas between the major stands.

The distances between the major groups of rainforest sites are at least potentially barriers to the migration of species between regions. Depending on the effectiveness of these barriers to the movement of genetic material between site groups, and the length of time they have been in place, the evolution of genetic divergence of taxa between sites may have occurred. The effectiveness of the separation between the site groups is likely to vary between taxa. Maintenance of small stands may be vital if nomadic movement of (fruit eating) birds is to continue.

Many species are found in a large number of sites. This core of widespread species reflects the previous occurrence of more extensive rainforest, and, at least for some of the vertebrates, the continuing potential for many species to move between sites. There are also an appreciable number of species with extremely disjunct distributions or which are locally restricted endemics. The degree of genetic divergence between disjunct populations of a species, or between local populations of a widespread species, cannot be assessed in the absence of studies of variation below the species level in Australian rainforest taxa. However, it is likely that the fragmentation of Australian rainforests continues to be an important factor in the evolution of the biota.

The rainforests of the property can be regarded as an archipelago within the larger chain of rainforest islands stretching from New Guinea to Tasmania. Although within the context of this large arc the rainforests of the property are characterised by their own assemblage of species and vegetation types there are many taxonomic links between them and, on the one hand, Tasmania, and on the other, the Wet Tropics. In the case of vertebrates, many of these links are at species level although for vascular plants they are mostly at generic level.

The sites are evidence of the importance of the geological changes which have fragmented the distribution of rainforest in Australia. The sites show the range of vegetation-environment interactions found under present conditions. The disjunct distribution of species between sites, and the occurrence of local endemics, provide an indication of the importance of ongoing evolutionary processes. While individual groups of sites are important in their own right, comparison of the differences and similarities between all the groups provides a powerful illustration of the interaction over geological time of geological and evolutionary processes.

6.2. VALUES AND ATTRIBUTES BASED ON THE 1992 NOMINATION

The 1992 document argues that CERRA meets criterion (ii) on two grounds: it represents examples of significant sites where both ongoing geological processes and biological evolution are occurring.

1. Ongoing geological processes

Mt Warning Caldera is an outstanding example of ongoing geological processes. Considering its age of about 20 million years, it is possibly the best preserved erosion caldera in the world. It is notable for its size and age, for the presence of a prominent central mountain mass and for the erosion of the caldera floor to basement rock.

All three stages in the erosion of shield volcanoes - the planeze, residual and skeletal stages - are present in the Mount Warning complex. The planeze stage is represented in Border Ranges, Lamington and Springbrook National Parks.

The remnants of the Ebor volcano which include New England and Dorrigo National Parks also provide an outstanding example of ongoing erosion of a shield volcano. This represents the best example in eastern Australia of a radial drainage pattern related to a specific centre of eruption.

2. Ongoing biological evolution

2a. Vegetation

Australia is unique in having rainforests that are living models of the fossil vegetation, thereby providing an unparalleled opportunity for studying the ongoing evolution of plant communities as distinct from flora. This is because Australia has the only rainforest ecosystems for which there are closely matching macrofossils of entire plant assemblages or communities. A number of factors have contributed:

- Australia escaped the major extinction episodes experienced in the Northern Hemisphere at the Cretaceous-Tertiary boundary
- Australia was isolated for the major period of evolution of its forests so that mixing with other continental floras has been relatively recent and limited to the most northern parts of Australia
- Ancient palaeoclimates reflecting different stages in the evolution of Australia's forests have been preserved in eastern Australia as a result of northward drift of the continent compensating for global cooling that was initiated in the Oligocene.

CERRA provides the best known physiognomic equivalents of the widespread mesotherm rainforest of the 'golden age' in the Early Tertiary of Australia and of the nascent cool temperate rainforests developing in the Oligocene which were ancestral to the present-day rainforests of Tasmania. Because the rainforests of CERRA are unique living models of fossil vegetation they provide an outstanding benchmark for the study of ongoing biological evolution of plant and animal communities of Gondwanan origins.

2b. Flora

The flora and fauna of CERRA provide outstanding examples of ongoing evolution of individual taxa that complement the significance of the property for the evolution of vegetation communities.

The plant families of interest have had a long history of evolution in Australia with fossils detectable in the Cretaceous or Early Tertiary. CERRA is a key centre of endemism and diversity for the Southern Hemisphere families of Winteraceae, Monimiaceae and Lauraceae of the Magnoliidae, Proteaceae, Cunoniaceae, Euphorbiaceae, Escalloniaceae, Davidsoniaceae, Pittosporaceae, Myrtaceae and Sapindaceae of the Rosidae, as well as Elaeocarpaceae, Sterculiaceae and Ebenaceae of the Dilleniidae. These families belong to basal orders of the major subclasses of dicotyledons representing the primary and secondary radiations of flowering plants; that is, CERRA is a key centre for the origin and spread of the earliest members of a number of plant families which made up the first and second waves of the spread of the flowering plants.

The rainforests of CERRA were much more widespread during the Tertiary. The individual areas within CERRA are equivalent to separate islands, resulting largely from climatic changes that caused the contraction of much more widespread rainforest communities to more favourable, moist, elevated sites. Allopatric speciations associated with these disjunctions and with disjunctions from Wet Tropics (and southern areas) will be a major basis of ongoing evolution for this Gondwanan flora. Differences at the varietal level are already recognised. (*Davidsonia pruriens*, for example, has one variety in the CERRA region and one in the Wet Tropics, and there are significant chemical differences between disjunct occurrences of *Endiandra introrsa*).

2c. Vertebrate fauna

One example of relatively recent evolution of species can be seen within the **frog** genus *Pseudophryne* in the Pliocene. The three species in CERRA – *P. bibroni*, *P. major* and *P. coriacea* – are thought to have diverged, as a result of allopatric speciation, in the Pliocene.

The relict frog genus *Kyarranus/Philoria* is largely restricted to CERRA, with different species occurring in different parts of property.

Northern populations of the eastern bristlebird (*Dasyornis brachypterus*) in CERRA and populations in southern NSW/Vic may have differentiated sufficiently to be regarded as separate subspecies.

2d. Invertebrate fauna

Overlap and intergradation of different faunal elements in CERRA is seen in the insect fauna, where there is evidence for ongoing evolution. Within the Border Ranges area, apparent hybridisation is reported in members of the ant genus *Rhytidoponera*, *intergrades*, hybrids are seen where the ranges of two closely related species of dung beetles (*Onthophagus australis* and *O. nurubuan*) overlap, and character displacement is reported in the ant genus *Pristomyrmex*.

Two major mountain systems within the ‘McPherson-Macleay Overlap’ region – the Tweed Shield Volcano Complex and the Main Range Complex – have acted as separate centres of speciation and distributional refugium during the evolutionary history of the insects of the region. Main Range includes many species, such as the flightless carabid beetle *Trichosternus vigorsi*, which have apparently dispersed northwards along the Great Escarpment when rainforest was more extensive and which are absent from the Tweed Volcano Complex. Many southern elements, such as the flightless carabid *Cratoferonia phylarchus*, find their northern limits in the Mistake Mountains, while many northern elements, such as *Trichosternus renardi*, find their southern limit in the same locality. There is a faunal interchange zone between the two mountain complexes extending from Levers Plateau across the Mount Barney - Mount Ballow Complex to Wilsons Peak. For example *Trichosternus vigorsi*, which occurs on Main Range, extends as far east as Levers Plateau but is replaced by the related species, *T. subvirens*, on Lamington Plateau.

The Border Ranges area is the site of complex radiation and diversification of the flightless carabid genera *Trichosternus*, *Castelnaudia* and *Nurus*.

The araneomorph spider genus, *Tasmanoonops*, illustrates the effect of disjunct wet mountain habitats on speciation – *T. complexus* and *T. parvus* occurs on Lamington Plateau, *T. mysticus* in Nightcap NP, *T. dorrigi* occurs only at Dorrigi NP, *T. ripus* in New England NP, *T. elongatus* in New England NP and Carrai Plateau, and *T. parinus* and *T. pinus* at Barrington Tops.

6.3. COMMENTS AND UPDATE

There have been relatively few studies undertaken to date of genetic and/or morphological variations within CERRA and in particular of variation and speciation driven by the fragmentation of rainforest areas during periods of climatic perturbation and the subsequent isolation of rainforest taxa in moist refugia. Recent work in the Wet Tropics of North Queensland probably leads the world in this field. Most of this work has been done on animals.

The results of work in the Wet Tropics has many implications for CERRA, particularly as many of the rainforest areas in the CERRA region are, in contrast to the main Wet Tropics area, disjunct even under climatic regimes, such as are now present, which are favourable for rainforest. The result is that there are probably many ‘evolutionary significant units’ (historically isolated and independently evolving groups of populations) (Moritz 1994) for many species within CERRA. In some cases, the long periods of isolation may have resulted in changes which merit recognition at the varietal or species level.

Perhaps the most important point to be emphasised is that all extant stands of rainforest in the CERRA region conserve a genetic heritage that is the result of the environmental sifting of lineages that have evolved from Gondwanic stock. Each stand is therefore likely to be unique, and each represents a specific glimpse into the past history of rainforest. Furthermore, each stand is the possible source of novel adaptations that in time may translate into new varieties or species. It is therefore impossible to dismiss parts of CERRA as being

less important than others. With respect to ongoing processes such as evolution it is important to maintain the integrity of the whole of the property and indeed areas beyond the listed reserves. To this end, it is, on one hand, essential to maintain connectivity within evolutionary significant units, and, on the other, important to protect the small, disjunct areas which, dependant largely on vagility, may be stepping-stones for some species and centres of speciation for others.

1. Flora

1a. Significant plant families. Current understanding of the phylogeny of the flowering plants differs significantly from the phylogeny accepted in the past. In particular, the arguments advanced in DASET (1992) regarding the evolution of the angiosperms require some modification as it is now generally accepted that the angiosperms are polyphyletic and not monophyletic as was believed in the past. Unfortunately, angiosperm phylogeny is still partially unresolved and until a more complete understanding is available it is premature to speculate on many aspects of the evolution of the group (see section 5.3.3.a.).

Nevertheless, CERRA does include representatives from angiosperm lineages such as the Austrobaileyales and the Magnoliids that diverged from most other angiosperms relatively early in the evolution of angiosperms. In addition CERRA is also recognised as a key centre of endemism and diversity of a number of other recognised Southern Hemisphere (Gondwanan) families. These families, on the basis of fossil evidence, can be recognised as having had a long history of evolution in Australia. The families identified by DASET (1992) in this regard have been noted above in Section 6.2.2.b. Several families should be added to this list; these include several families discussed in DASET (1992) as support for listing CERRA under criterion (iii), plus families identified as supporting criterion (i). A more complete and partially annotated list is provided below.

Fern and fern allies:

- Lycopodiaceae
- Selaginellaceae
- Ophioglossaceae
- Marattiaceae
- Osmundaceae
- Schizaeaceae
- Gleicheniaceae
- Cyatheaceae
- Dicksoniaceae

Cycads:

- Zamiaceae

Gymnosperm families:

- Araucariaceae
- Podocarpaceae
- Cupressaceae

Families within the Austrobaileyales and Magnoliids:

- Trimeniaceae – basal sister family to most angiosperms (APG in press)
- Atherospermataceae – a number of genera previously in Monimiaceae are now included in this family
- Lauraceae
- Monimiaceae
- Winteraceae
- Annonaceae – high generic but low species diversity, indicating relict distribution on the continent
- Eupomatiaceae
- Aristolochiaceae
- Peperomiaceae
- Piperaceae

Other families:

- Proteaceae – now placed in order Proteales within a grade at the base of the Eudicots; possibly originated in Mid Cretaceous (Hoot & Douglas 1998)
- Nothofagaceae – possibly originated in Late Cretaceous (Hill & Dettman 1996)
- Casuarinaceae – fossil evidence in Australia from the Early Palaeocene (Specht & Specht (1999)
- Berberidopsidaceae – a family of two genera (*Berberidopsis*, *Streptothamnus*) and three species from Australia and South America; one genus (*Streptothamnus*) and two species (*B. beckleri*, *S. moorei*) endemic to Australia; formerly placed in Flacourtiaceae (APG in press). Both endemic species occur in CERRA (Harden 2000) and *B. beckleri* is essentially confined to the CERRA region.
- Restionaceae – fossil evidence in Australia from the Late Palaeocene (Specht & Specht 1999)
- Myrtaceae
- Olacaceae
- Loranthaceae
- Cunoniaceae – fossil evidence from Late Palaeocene, possibly originated in Late Cretaceous (Barnes *et al.* 2001).
- Escalloniaceae
- Pittosporaceae
- Surianaceae
- Baueraceae
- Euphorbiaceae
- Sapindaceae
- Menispermaceae
- Elaeocarpaceae
- Sterculiaceae
- Ebenaceae
- Akaniaceae – family endemic to the CERRA region
- Petermanniaceae – family endemic to the CERRA region
- Doryanthaceae – Australian endemic family, one species endemic to CERRA region

1b. *Atherosperma*. This genus is now included in the family Atherospermataceae (see Section 5.1.3.3.b). Shapcott (1994) examined *A. moschatum*, a species that occurs in cool temperate rainforest at Gloucester Tops within CERRA and at Wentworth Falls in the Blue Mountains and in Victoria and Tasmania:

“The NSW stands sampled (Gloucester Falls and Wentworth Falls) were considerably divergent in their genetic composition compared to the other stands sampled. The morphology of *A. moschatum* plants at these sites was also very distinctive and considerably different from all southern sites. Combined, these attributes suggest that the NSW populations warrant taxonomic revision. It has previously been suggested by Schodde (1969), that they should be regarded as a distinct subspecies. As *A. moschatum* is currently regarded as a monotypic genus, the distinct nature of the NSW populations is significant. The NSW stands were clearly most closely related to the Victorian stands, since they shared several allelic variants which were absent or rare in Tasmanian stands.

“There may have been as few as 40 and unlikely to be more than 100 generations passed in *A. moschatum* populations since the last glacial cycle. Therefore, all *A. moschatum* populations may still be affected by such population reductions/founder effects and not be expected to have reached equilibrium (Lande 1988, Whitlock and Cauley 1990). The question then arises as to whether long-lived species will ever reach genetic equilibrium due to the fast pace of other environmental changes, especially at the hands of humans.

“The NSW populations have probably been isolated for a very long time, and there is both genetic and morphological evidence of their divergence.” (Shapcott 1994)

1c. *Actephila* (Euphorbiaceae). Shapcott (1998) investigated *A. lindleyi*. Preliminary tests show that the morphological variation between populations is matched by genetic variation at the enzyme and chromosome levels (for example, there were big differences between populations from Mount Glorious, Border Ranges and Lismore). Thus, taxonomic revision and conservation of the species should take this into account.

1d. *Fontainea* (Euphorbiaceae). Study of the genetic variation in *F. australis* (Rossetto *et al.* 2000), a species confined to CERRA and a few nearby sites, indicates that the Limpinwood Nature Reserve population represents a novel genotypic combination. The population clusters strongly with the related *F. rostrata* and is genetically distinct from other *F. australis* populations. Whether the population represents

pure *F. rostrata* or whether introgression with *F. australis* has occurred, this population is a new and distinct management unit; the nearest known *F. rostrata* population is 300 km to the north (Rossetto *et al.* 2000).

1e. *Triunia* (Proteaceae). Shapcott (2002) studied the genetic variation in *Triunia youngiana*, a rainforest shrub largely confined to the CERRA region, and *T. robusta*, an endangered species confined to a few sites on the Sunshine Coast, north of Brisbane. It was found that *T. robusta* has significantly more genetic diversity within populations than the more common *T. youngiana*. There was also more genetic differentiation between the *T. robusta* populations, which occur in close proximity, than between the more separated *T. youngiana* populations, indicating more gene flow between populations of *T. youngiana* than between populations of *T. robusta*. Surprisingly, the Big Scrub population of *T. youngiana* clustered with the Dorrigo population and not with the Terania Creek population, which clustered with the Border Ranges population. All the New South Wales populations that were investigated clustered separate to the Green Mountains (Lamington NP) population (Shapcott 2002).

1f. *Elaeocarpus*. A study has recently been undertaken of the genetic variation in three species of *Elaeocarpus*, a member of the Gondwanan family Elaeocarpaceae (Rossetto *et al.* in press, in prep. a, in prep. b). *E. grandis* (*E. angustifolius* in Queensland) is a widespread species ranging from Kempsey to at least the Wet Tropics and occurring in several CERRA sites from Gibraltar Range NP and north. The species showed less than expected genetic variation between the disjunct sites in New South Wales.

E. williamsianus is an endangered species with nine populations, one of which is just within CERRA. The species was shown to be genetically distinct at all sites but all stems at each site are clonal, with the exception of one site where two clones occur.

E. sp. 'Rocky Creek' is also considered endangered and is confined to the Nightcap and Koonum Ranges, just outside of CERRA. The species shows considerable genetic variation within its populations but there are distinct differences between the populations on the two mountain ranges.

2. Vertebrate Fauna

2a. *Litoria pearsoniana*. The population genetics of the wet forest frog species *Litoria pearsoniana* have been investigated by McGuigan *et al.* (1998). This showed that the genetic population structure of *L. pearsoniana* is best described by a subpopulation model with little, if any, contemporary gene flow among the rainforest isolates, but limited genetic differentiation within isolates.

The study was carried out in south-east Queensland and far north-east New South Wales. It suggests that suitable wet forest habitat contracted to two major refugia in this region, probably during the Pliocene (2-5 Ma). The molecular data suggest one putative refugium in the Conondale or D'Aguilar Ranges and the other to the south of the Brisbane River valley in the Border Ranges/ Scenic Rim area.

2b. *Litoria citropa* species-group. The *Litoria citropa* species-group comprises several small- to medium-sized frogs, distributed from central-east Queensland to eastern Victoria. These occur in a variety of stream-associated habitats along the Great Dividing Range (Donnellan *et al.* 1999). Historically there has been difficulty in determining the distribution and identity of individual frog species encountered during frog surveys in northern New South Wales, and the taxonomic status of *Litoria barringtonensis*, for example, remains unsettled. A number of species lack suitable external morphological diagnostic characters to assign some populations with certainty to specific taxa. This has implications for assessing the status of 'species' listed under the NSW *Threatened Species Conservation Act* 1995 (e.g. *L. piperata*).

Donnellan *et al.* (1999) undertook molecular genetic investigations (allozyme electrophoresis and nucleotide sequencing of a mitochondrial gene) of samples that encompassed observed morphological and geographical variation in smaller members of the *L. citropa* complex. This work exposed the existence of a wide allozyme and mitochondrial nucleotide diversity in a taxonomically unresolved species (Species 'C'). Species 'C' (possibly assignable to *Litoria barringtonensis*, but requiring further and more detailed confirmation) can be divided into at least four 'evolutionary significant units' (ESUs) that "replace each other in a linear sequence from north of the Hunter Valley in New South Wales to the Kroombit Tops in central Queensland" (Donnellan *et al.* 1999).

Donnellan *et al.* (1999) identified a possible zone of hybridisation (encompassing in part Washpool National Park) between the southernmost pair of ESU's in northern New South Wales, though the authors note that alternative hypotheses of retention of ancestral polymorphisms and independent mutation events may be responsible for observed genetic traits. The sympatric occurrence of *Litoria phyllochroa* and Species 'C' in central and mid-coastal areas of New South Wales (e.g. at Bellinger River) questions the reliability of previously published records for species within the complex (Donnellan *et al.* 1999). Considering the status of the four ESUs in Species 'C', Donnellan *et al.* (1999) state that each "should be considered a separate entity for the implementation of conservation policies as they are connected by such low levels of gene flow that they are functionally independent and each ESU encompasses a diversity of genotypes that are not adequately represented in any other ESU. The degree of genetic differentiation among these ESUs reflects the disjunct distribution of this riverine species in south-east Queensland ... and presumably in north-east New South Wales."

2c. *Philoria*. DASET (1992) identifies *Kyarranus* (part of *Philoria* in NSW) as a genus of three species that is largely restricted to CERRA and where each species occurs in different parts of the property. Recent work in NSW (Knowles *et al.* 2004) has led to the recognition of five species in this group within the CERRA region:

- *P. kundagungan* – Main Range NP, Beaury SF and Koreelah SF
- *P. loveridgei* – the rainforest block including Lamington NP, Border Ranges NP, Mt Warning NP and Nightcap NP
- *P. pугhi* – Billilimbra SF, Forestland SF, Washpool NP, Gibraltar Range SF, Gibraltar Range NP, Girard SF, Spirabo SF
- *P. richmondensis* – Yabba NP, Dome Mountain FR, Bungdoozle FR
- *P. sphagnicola* – Mt Hyland NR, Dorrigo NP, New England NP, Mt Boss SF, Werrikimbe NP, Mt Seaview NR, Mt Banda Banda, Brooklana SF, Marengo SF, Mistake SF, Never Never SF, Nulla Five Day SF, Oakes SF, Ramornie SF, Styx River SF, Wild Cattle Creek SF

The identity of species in several areas where the ranges of recognised species overlap remains unclear, and as yet unrecognised taxa may occur within the group (Knowles *et al.* 2004).

2d. *Eulamprus*. Sadler (1998) has recognised within the widespread *Eulamprus murrayi* (Conondale Ranges to Barrington Tops) a second species, *E. tyroni*. This species occurs only on the Lamington Plateau and the Tweed Range. The two species are sympatric on some sites (such as Brindle Creek), but are generally separated altitudinally.

2e. *Scrubwrens*. The Australo-Papuan genus *Sericornis* (Pardalotidae) 'scrubwrens' is principally rainforest-associated throughout its range, but individual species exhibit variation in foraging behaviour and habitat specialisation. Three species, *Sericornis citreogularis* (Yellow-throated Scrubwren), *S. frontalis* (White-browed Scrubwren) and *S. magnirostris* (Large-billed Scrubwren) are recorded from the CERRA region. *Sericornis citreogularis* is almost totally rainforest dependent, *S. frontalis* is found in rainforest, temperate forest, secondary growth and low coastal vegetation, and *S. magnirostris* is found in rainforest and wet sclerophyll forest (Joseph & Moritz 1993).

Previous appraisals based on plumage characters (e.g., Diamond 1969, Keast 1978) have aligned *Sericornis frontalis* with the tropical species *S. beccarii* and *S. magnirostris* with the tropical species *S. keri*. However, using allozyme electrophoresis Christidis *et al.* (1988) found that *S. frontalis* was closely related to *S. keri* and that *S. magnirostris* was very close to, possibly hybridising in some instances with, *S. beccarii*. *Sericornis frontalis* and *S. keri* probably diverged from a common ancestor (recent relative to the age of the genus), and separation of *S. magnirostris* and *S. beccarii* may also have been recent (see Joseph & Moritz 1993). The outcomes reached by Christidis *et al.* (1988) have significant consequences for the interpretation of the biogeography and origin of ecological variation in *Sericornis* species.

Mitochondrial DNA analyses grouped scrubwrens from mainland eastern Australia into two subgroups; *Sericornis beccarii* and *S. magnirostris*, and *S. frontalis* and *S. citreogularis* with *S. keri* (Joseph & Moritz 1993). This outcome supported and extended previous (e.g. Christidis *et al.* 1988) "reinterpretation of morphological and ecological shifts in the [genus]. This suggests considerable plasticity and parallelism in the plumage characters previously used to associate species. The low divergence and close relationship between montane rain-forest specialist *keri* and the widely distributed generalist *frontalis* demonstrate the capacity for evolutionarily rapid and dramatic shifts in habitat use. This contrasts with the assumption of

fixed habitat preference that underlies refuge-based models of diversification of rain-forest fauna” (Joseph & Moritz 1993).

MtDNA sequence divergence among *Sericornis* species is very high, with most values between species being >10% (Joseph & Moritz 1993), but divergence within species is low (0-3%). The marked degree of mtDNA sequence difference within the genus highlights the great antiquity of *Sericornis* radiation (c. 5-10 m.y.a.) and the level of interspecific “genetic distance for allozymes [is] large in comparison with other bird genera” (Christidis *et al.* 1988, Joseph & Moritz 1993).

In the light of a strongly corroborated phylogeny of *Sericornis*, Joseph & Moritz (1993), reviewed morphological and ecological development in the genus (see also foundation comments of Christidis *et al.* 1988). Plumage patterning appears capable of rapid evolutionary change, but morphometric change may be more conservative “in that it is mostly congruent with phylogeny” (Joseph & Moritz 1993). For the three CERRA species there is a dichotomy between the larger bodied, longer legged *citreogularis-frontalis* (including *S. keri*) and *magnirostris* (plus *beccarii*), and this is paralleled on the basis of their allozyme phylogeny (Christidis *et al.* 1988) and foraging behaviour. However, there is divergence in habitat specialisation with the related *S. frontalis* and *S. keri* being the most different; *keri* being restricted to montane tropical rainforests and *frontalis* is a widespread habitat generalist. The other member of the subgroup, *S. citreogularis*, is also mostly restricted to rainforests, and rainforest is the likely ancestral habitat for this subgroup (Christidis *et al.* 1988, Joseph & Moritz 1993). Joseph & Moritz (1993) cautions that the capacity for marked shifts in habitat specialisation exhibited by *Sericornis* species may have important consequences for our ability to interpret past climate change and habitat distribution impacts on the distribution of species.

“One view holds that a species’ habitat preference is fixed, so that its geographical range will track historical changes in habitat distribution. This assumption underlies efforts to predict past ranges from palaeoclimatological data and, more generally, models of diversification of rain-forest fauna within Plio-Pleistocene refuges. An alternative view is that differentiation along present-day environmental gradients is sufficient to explain biological diversity in tropical rain-forests” (see Joseph & Moritz 1993).

Under a ‘refuge’ model species such as *Sericornis frontalis* that lack fixed habitat specialisations should not exhibit intraspecific phylogeographical structure consistent with reduction in rainforest extent. Using a ‘gradient’ model “phylogeographical structure should be independent of habitat specialisation and instead be a function of dispersal ability, generation time and present selection pressures” (Joseph & Moritz 1993).

2f. Non-volant mammals. Winter (1997) matches hypothetical distributions of non-volant mammals in the Wet Tropics to Late Quaternary climatic changes. It presents evidence that post-glacial dispersal and vicariant phases played as important a part in determining the present-day distribution of species as the dramatic vicariant event at the height of the glacial period. The discussion of dispersal of non-volant mammals in relation to glacial and post-glacial environments has relevance to CERRA. It is argued that Wet Tropics endemic species were confined to one or other of the glacial refugia and subsequently dispersed, that another vicariant phase took place for cool-adapted species during the warm and wet of the late post-glacial, determining the present day upland population isolates and that species shared with south-eastern Australia arrived during the early post-glacial period.

2g. Eastern Bristlebird. While the 1992 nomination suggests that populations of this species in CERRA and those in southern New South Wales and Victoria may have differentiated sufficiently to be regarded as separate subspecies, genetic studies have shown that the populations are not genetically different, and there appears to be no genetic diversity in the species at all.

3. Invertebrate fauna

A major generalisation identified by Williams (2002) which is relevant to this criterion is as follows:

- There is a substantial level of endemism within the fauna. This is very high at the species and genus level, and many of these are currently known from only single localities or from geographically restricted ranges within the CERRA region. Instances of generic and species endemism are particularly high in the snail families Hydrobiidae and Charopidae, the earthworm family Megascolecidae, the crayfish family Parastacidae, the subphylum Onychophora, and the spider

suborder Mygalomorphae. Examples within the insects are the fly families Dolichopodidae, Platystomatidae, Exeretonevridae, Pelecorhynchidae and Tipulidae, the beetle tribes Onthophagini and Scarabaeini, the beetle family Carabidae and subfamily Melolonthinae, australembiid webspinners, cicadelloid and meziprine Hemiptera, oecophorine moths, and the lacewing family Hemerobiidae and the subfamily Kempyninae. The beetle family Rhinorhidae, and the mite family Platymeridae, are restricted to the CERRA region.

Further information on these and other attributes related to this criterion is contained in Williams (2002).

6.4. INTEGRITY

The condition of integrity required for this criterion is:

The sites shall have sufficient size and contain the necessary elements to demonstrate the key aspects of the processes that are essential for the long-term conservation of the ecosystems and the biological diversity they contain.

The property contains a major portion of the Tweed Shield Volcano remnants and the most significant geological features associated with this volcanic landform. The addition of rainforest remnants on the eastern side of the shield would increase the integrity of this aspect of the property by including more samples of the residual stage of erosion and some examples of the skeletal stage of erosion.

New England and Dorrigo National Parks contain important remnants of the Ebor Volcano. Addition of the Bellinger River National Park would add a section of the volcanic landform linking the two listed areas. There is only limited scope for increasing the representation of the radial drainage system that flows north and west on the Dorrigo and Ebor Plateaux as most of this relatively flat country is cleared. A notable exception is the 'Misty Valley' addition to New England National Park.

DASET (1992) notes that in relation to important biomes, the property 'contains the major occurrences of significant rainforest types within the region' and that the property conserves the most important floristic elements. This remains the case.

With respect to ongoing evolution, DASET (1992) argues that the legislative protection afforded to the property ensures the continuance of natural biological processes, essentially undisturbed by human interference. Since the listing of the property, the recognition and dedication of wilderness in a number of the NSW sites increases this protection.

6.5. DISTRIBUTION

The geological features related to the Tweed Shield Volcano are largely confined to the Tweed Shield Volcano Group of reserves (see Section 9). New England and Dorrigo National Parks include significant sections of the Ebor Volcano.

Ecosystems related to ongoing evolution are distributed throughout the property. While the condition of integrity includes a requirement for 'sufficient size', even very small rainforest areas may be important for genetic novelty and therefore ongoing evolution, particularly if they are disjunct. Small stands may also act as stepping stones for the movement of genetic material within an Evolutionary Significant Unit. A particular stand may perform both functions for different taxa.

6.6. THREATS

Most of the geological and geomorphic features relevant to this criterion are massive and the attributes are relatively insensitive to human impacts. They may be threatened by damage during the construction of visitor facilities or by damage by visitation if, for example, human use leads to erosion.

The ecosystems relevant to this criterion are essentially the same as those relevant to criterion (i) and are subject to the same threats. A threat related specifically to ongoing evolution is the loss of genetic variation due to past clearing of rainforest areas and the fragmentation of remaining areas, particularly in the lowlands.

Global warming poses a threat to some cool temperate rainforest ecosystems by reducing or locally eliminating the climatic envelopes within which the constituent species are able to establish. Changes in frequency and intensity of wildfires associated with global warming are possible threats to all rainforest ecosystems in the property.

7. WORLD HERITAGE VALUES AND ATTRIBUTES OF THE CENTRAL EASTERN RAINFOREST RESERVES OF AUSTRALIA – NATURAL HERITAGE CRITERION (iv).

Criterion (iv) contain the most important and significant habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The World Heritage value relevant to this criterion is:

- **CERRA WHA includes the principal habitats of a large number of threatened species of plants and animals. These species are of outstanding universal value from the point of view of science and conservation, including relict and primitive taxa.**

7.1. VALUES AND ATTRIBUTES BASED ON THE 1985 NOMINATION

The sites include a number of rare and endangered species, not just in rainforest but also in other habitats.

By virtue of including both northern and southern limits of *Nothofagus moorei* forest, the nominated sites also include the distribution limits of species restricted to this forest type. Moreover, the two regions at the limits of *Nothofagus* – Border Ranges and Barrington Tops – are also, or close to, the limits of a number of species from subtropical rainforest.

The Border Ranges area is a centre of species diversity for several taxonomic groups (birds, marsupials, frogs and snakes). The listed sites in this region encompass all the major habitats and so include much of this species diversity.

The occurrence within the sites of a number of “primitive” species is of considerable scientific interest and provides evidence for the historical continuity of rainforest.

7.2. VALUES AND ATTRIBUTES BASED ON THE 1992 NOMINATION

CERRA provides the principal habitat for many threatened species of plants and animals of outstanding universal significance. In addition, there are many rare species that can be considered potentially vulnerable to extinction.

The rainforests in Australia survive as an archipelago of ‘islands’ along the Great Escarpment, isolated largely by sclerophyll vegetation and cleared land. Sites within CERRA represent ‘islands’ largely within the mesotherm core area, whereas the Wet Tropics of Queensland WHA represent the megatherm and Tasmania the microtherm core areas. Rainforests in CERRA survive largely only on sections of the Great Escarpment receiving adequate rainfall and nutrient enrichment from Tertiary volcanism.

There survives in Australia a wide range of plant and animal lineages with origins in Gondwana, many representing isolated endpoints of formerly diverse lineages surviving largely or entirely within CERRA.

1. Flora

There are within CERRA many species of outstanding value to science and conservation and vulnerable to extinction. More than 170 species of rare or threatened plants are recorded from CERRA

There is an overall high level of biological diversity, with 170 families, 695 genera, 1625 species of vascular plants recorded from CERRA. About 150 species in 100 genera are essentially restricted to the property.

Nothofagus moorei is of particular note. It is a member of an ancient, relict genus, one of three species of the genus in Australia, and is essentially restricted to CERRA.

Border Ranges is outstanding with respect to narrowly endemic species. One hundred of the 150 species essentially restricted to CERRA are restricted to, or have the major proportion of their occurrence, in the Border Ranges; three quarters of the latter group are rare or threatened (53 rare, 17 vulnerable, 6 endangered).

There are about 140 species of orchids in CERRA. These include many species from the endemic terrestrial genera *Caladenia*, *Diuris*, *Prasophyllum*, *Pterostylis* and *Thelymitra*. There are also representatives of the small genera *Acianthus*, *Chiloglottis*, *Eriochilus* and *Plectorrhiza*, which are considered to be of Australian origin.

Beech Orchid (*Dendrobium falcorostrum*) is almost completely confined to *Nothofagus moorei*, and is therefore essentially restricted to CERRA

Rhizanthella slateri, a subterranean orchid, is known from 10 specimens at three sites. One site is in Lamington NP.

Neoastelia spectabilis is a monotypic genus restricted to the New England - Dorrigo area. It is closely related to *Astelia*, a Gondwanic genus with most species in New Zealand and some in South America.

Numerous species in the primitive angiosperm families Winteraceae, Trimeniaceae, Annonaceae, Monimiaceae and Lauraceae are restricted to the region of CERRA:

- three species of *Tasmannia* (Winteraceae) are confined to the region
- seven species of *Cryptocarya* (Lauraceae) are restricted to the region
- five species of *Endiandra* (Lauraceae) are restricted to the region; there are significant chemical differences between disjunct occurrences of *E. introrsa*.

Proteaceae is an important part of the Australian flora and appears to have its origins in East Gondwana. Thirteen species within CERRA, including six rainforest species, are rare or vulnerable to extinction. These include: *Alloxylon pinnatum*, *Macadamia tetraphylla*, *Macadamia integrifolia*, *Hicksbeachia pinnatifolia*, *Floydia praealta*, *Helicia ferruginea* and *Telopea aspera*.

Six rare or threatened species in the primitive angiosperm family Lauraceae occur in CERRA

At least 18 species of the Myrtaceae family in CERRA are rare or vulnerable to extinction. These include six rainforest species, two being undescribed species (Gen. nov. 'Border Ranges' (formerly *Austromyrtus* sp. aff. *lasioclada*) and Gen. nov. 'Blackall Range') in a new endemic genus for which CERRA is the major centre of diversity. About 13 species in Myrtaceae are essentially restricted to CERRA.

Several restricted members of Cunoniaceae, a basal family in the subclass Rosidae, are essentially restricted to CERRA:

- *Vesselowskyia rubifolia*, a monotypic endemic genus occurs from Barrington Tops to Dorrigo, Mount Hyland and Chaelundi Mountain.
- *Geissois benthamii* occurs from the Manning River to Tamborine Mountain, and is largely restricted to CERRA.

Austrobuxus swainii (Euphorbiaceae) is a rare member of an East Gondwanan genus, which occurs elsewhere in New Caledonia, with one other species in the Wet Tropics. Other threatened species in this family include *Fontainea australis* (vulnerable) which is essentially restricted to CERRA and *Baloghia marmorata* (endangered) which occurs within the CERRA region.

Petermannia cirrosa, sole member of endemic family Petermanniaceae, is essentially restricted to CERRA.

Akania bidwillii, sole member of the endemic family Akaniaceae, is essentially restricted to CERRA.

Leptopteris fraseri, the only Australian species in a genus of seven species in New Guinea, Australia, Polynesia and New Zealand, occurs from the Budawangs to Blue Mountains, Werrikimbe (a CERRA area), Mount Bartle Frere and Mount Bellenden Ker.

Lichens have been associated with the higher plant communities since Gondwanic times and have moved with these communities.

2. Vertebrate Fauna

A rich and diverse fauna, for some groups the most diverse in Australia. More than 20 vertebrate species have the major part of their distribution in CERRA.

CERRA contains the major portion of the habitats of two rare bird species of universally outstanding significance to science and conservation – Albert's Lyrebird (*Menura alberti*) and Rufous Scrub-bird (*Atrichornis rufescens*). The outstanding significance of the species stems from the fact that they form a relict group, with no near relatives anywhere in the world.

The Marbled Frogmouth (*Podargus ocellatus*) is a vulnerable species endemic to a few rainforest areas in south-east Queensland and north-east New South Wales, including a number of CERRA sites. Frogmouths are an old group that diverged from the nightjars and their relatives more than 70Ma.

The Black-breasted Button-quail (*Turnix melanogaster*) is a vulnerable species restricted to a few sites in south-east Queensland and north-east New South Wales. Button-quails are a distinct and isolated group with no near living relatives.

Coxen's Fig-Parrot (*Cyclopsitta coxeni*) and the Eastern Bristlebird (*Dasyornis brachypterus*) are two threatened species that have a major part of their range in the CERRA region. Coxen's Fig-Parrot is extremely rare and its state is considered critical. The Eastern Bristlebird is one of three species in an endemic genus, placed in its own subfamily; the group appears to have had a long history in Australia and diverged from the other subfamily between 20 and 30 Ma.

Among the frogs, several species that are largely confined to CERRA are of outstanding significance and considered potentially vulnerable. In light of the worldwide decline in frog populations, any frog species that are sparsely distributed in these rainforests and confined to specialised habitats could be considered potentially vulnerable.

Pouched Frog (*Assa darlingtoni*) is the sole member of the most primitive group of frogs in Australia. It is of universal significance because of its breeding behaviour: the tadpoles are raised in skin pouches on the flanks of the male.

Kyarranus/Philoria is a relict endemic genus with a long history in Australia. Most of the species are largely confined to CERRA.

Lechriodus fletcheri is a rare species in a relict genus. It is the most primitive member of a genus once widespread in Australia but now confined to CERRA and New Guinea.

Other rare species of frog largely confined to CERRA include *Mixophyes fleayi*, *Litoria subglandulosa*, *L. revelata* and *L. brevipalmata*.

There are several rare and possibly threatened species of mammal within CERRA. The Hastings River Mouse (*Pseudomys oralis*) is considered to be possibly endangered; it is now restricted to the area between the Main Range and the Barrington Tops area, but had a previous range from north of Brisbane to the New South Wales / Victoria border.

The New Holland Mouse (*Pseudomys novaehollandiae*) is a species which 'disappeared' for over 100 years. It is now known to have a patchy distribution in north-east New South Wales, Victoria and Tasmania. It is recorded from CERRA sites between Washpool and Barrington Tops.

The Parma Wallaby (*Macropus parma*) was thought to be extinct in Australia but is now known from montane areas of north-east NSW and is recorded from several CERRA sites.

The Yellow-bellied Glider (*Petaurus australis*) is considered vulnerable to extinction. It is apparently dependant on mature wet sclerophyll or other tall open forest at the rainforest-open forest ecotone.

The Fawn-footed Melomys (*Melomys cervinipes*) is considered vulnerable to extinction. It occurs in subtropical and tropical wet sclerophyll forests and rainforests from the Wet Tropics to south of Sydney.

The Golden-tipped Bat (*Kerivoula papuensis*) is a rainforest-dependant species which may be vulnerable to extinction. It occurs in a few widely disjunct locations along the eastern Australian coast including several CERRA sites.

The Greater Broad-nosed Bat (*Scoteanax rueppellii*) is a rare species belonging to a monotypic endemic genus. It occurs in two widely disjunct locations on the eastern coast, one in far north Queensland and the other on the central coast, including CERRA.

3. Invertebrate Fauna

Numerous rare species of invertebrates have highly restricted distributions within CERRA, among them many of outstanding biogeographical significance. Examples among the **molluscs** include:

- *Helicarion australis*, a snail with an almost vestigial shell found above 800 metres in the Border Ranges and Mt Warning
- an undescribed species from the Gondwanan family Charopidae found only on Mt Hobwee and Mt Merino in Lamington NP
- *Gyrocochlea paucilamellata*
- *Melocystis* sp. nov.
- *Posorites turneri*

Border Ranges is the centre of diversity for the **dung beetle** genus *Cephalodesmius*, which is notable for its striking parental care and its ability to synthesise balls of 'dung' from leaf litter. Three species occur in CERRA; only one species occurs outside.

Relict insect species of outstanding biogeographic significance include:

- the primitive wingless fungus bug *Kumarella scutellata*, known only from Lamington Plateau
- the primitive moss bug *Hackeriella veitchi*, associated with *Nothofagus* and known only from the McPherson Range and near Point Lookout in New England NP
- the primitive leafhopper *Myerslopella* sp., found only on Lamington Plateau

The small cockroach *Tyronicus montanus*, found only on the Lamington Plateau, is in a genus otherwise known only from the Wet Tropics and New Caledonia.

Species of **spiders** of biogeographic significance largely restricted to CERRA include:

- a member of the primitive relictual family Gradungulidae, found only in eastern Australia and New Zealand
- 'true' spiders largely restricted to CERRA include *Pararchaea binnaburra* in Lamington NP, and species of *Tasmanoonops* of which at least eight species occur in CERRA, several of which are confined to just one locality

7.3. COMMENTS AND UPDATE

1. Flora.

The figures given in the 1992 nomination document for families, genera and species of vascular plants recorded from CERRA are out of date, with the listing of additional areas on the Richmond and Koreelah Ranges and in the Macleay valley (see Section 10 below). Lists for the sites nominated in 1992 are included in Appendix 1. Lists for the additional sites are in Appendix 6.

The flora section of the list of rare or threatened species appended to this document (Appendix 11), which has been used to allocate significant species to individual sites, is based on Briggs and Leigh (1996) with some inclusions from species listed under the *Nature Conservation (Wildlife) Regulation 1994 (Queensland)* and the *Threatened Species Conservation Act 1995 (NSW)*.

1a. Orchidaceae. Ongoing survey and taxonomic revision of members of this family are identifying many new taxa. Many of these new taxa are rare or threatened and have very localised distributions. Some genera, such as *Pterostylis* and *Caladenia*, have recently had major revisions.

1b. Proteaceae. The former Wet Tropics populations of *Hicksbeachia pinnatifolia* are now recognised as a separate species – *H. pilosa*. Therefore, particularly as *H. pinnatifolia* occurs as two disjunct populations within CERRA (on the Mount Warning shield and in the Dorriggo area), the species is more threatened than previously thought.

Telopea sp. ‘Gibraltar Range’ is now described as *T. aspera* (Crisp & Weston 1995)

The recently discovered *Eidothea hardeneana* is considered endangered; the only known population occurs in Nightcap NP and Whian Whian SF, just outside the listed part of Nightcap NP.

1c. Eucryphia. The recent discovery of *Eucryphia jinksii* within CERRA represents a significant new occurrence of this Gondwanic genus. This new species occurs at a geographical midpoint between *E. moorei*, which is a dominant of cool temperate rainforest in southern New South Wales, and *E. wilksii*, which occurs as wind-shorn vine thicket on the upper slopes of Mount Bartle Frere in the Wet Tropics. *E. jinksii* is known from a small population in one small area in Springbrook NP; it is considered vulnerable (Forster & Hyland 1997).

1d. Leptopteris. The Wet Tropics populations of *L. fraseri* should probably be assigned to a separate taxon (P. Bostock, Qld Herbarium pers. comm)

1e. Lichens. DASET (1992) briefly mentions the association of lichens and rainforest since Gondwanic times. Rogers and Stevens (1981) provide more information:

The Australian lichen flora consists of about 2 000 species in some 170 genera; it appears to be remarkably low in endemics.

Placopsis, *Menegazzia* and *Pseudocyphellaria* are essentially subantarctic genera and presumably represent genera with their origins in the Gondwana land mass, which have since spread into the Northern Hemisphere in a minor way, but have generally failed to adapt to tropical conditions. India has no species of the first two genera and only eight species of the last; these genera seem to suggest closer ties for Australia with South America than the older Gondwana areas.

The distribution of a selection of temperate to subtropical and tropical genera shows strong links with Africa.

Although the lichen flora of North America is better known than that of Africa, India, Southeast Asia or South America, it is with the former Gondwana land masses that the Australian warm temperate to tropical lichen flora has the largest number of species in common. It appears that there is a detectable Gondwanan component not only in the cool temperate to antarctic taxa but in others as well.

2. Vertebrate Fauna.

The updated list of rare or threatened fauna found in CERRA, given in Appendix 11, is based on the current schedules of the New South Wales *Threatened Species Conservation Act 1995* and the Queensland *Nature Conservation (Wildlife) Regulations 1994*.

2a. Threatened frogs. DASET (1992) notes that ‘any frog species that are sparsely distributed in these rainforests and confined to specialised habitats could be considered potentially vulnerable’. Unfortunately, since this was written there has been a significant decline worldwide in populations of a number of frog species. This has included some species within the CERRA region.

Chytridiomycosis, a disease of amphibians caused by the chytrid fungus *Batrachochytrium dendrobatidis* has been implicated as the cause of rapid declines of amphibian populations in pristine and disturbed habitats (Morehouse *et al.* in press). Research has shown that there is increased mortality due to the disease

in colder months and at lower experimental temperatures (Berger *et al.* in press). This generally supports the theory that amphibian populations at higher altitudes have disappeared due to lower temperatures and hence greater susceptibility to disease (Laurance *et al.* 1996) but does not explain how this effect is consistent over various latitudes and at sites where only slight altitudinal differences in temperature occur (Berger *et al.* in press).

Factors other than chytridiomycosis that may also be involved in the decline of amphibians, or may make species more susceptible to the disease, include aerial-borne pollutants, global climatic change and increased levels of ultraviolet radiation (Nick Sheppard pers comm).

2b. *Pseudomys novaehollandiae* (New Holland mouse). This species has now been recorded in south-east Queensland including CERRA (Van Dyck & Lawrie 1997, Van Dyck 1998).

3. Invertebrate fauna

Until recently, little attention has been given to the conservation of invertebrates and the recognition of rare or threatened members of the group. Thirteen invertebrate species and one population of an invertebrate species are listed on the schedules of the NSW *Threatened Species Conservation Act 1995*. Only one of these, the flightless carabid beetle *Nurus brevis*, is recorded from the property from the former Mallanganee and Cambridge Plateau Flora Reserves. Two listed species occur just outside CERRA: *N. atlas*, which is restricted to the Alstonville area; and *Thersites mitchellae*, a land snail confined to lowland floodplain rainforest in the Tweed / Byron area.

Seven butterflies are listed as threatened in Queensland under the *Nature Conservation (Wildlife) Regulations 1994*. These include the Richmond Birdwing Butterfly (*Ornithoptera richmondia*), a species which occurs in the Tweed Shield Volcano Group of CERRA.

Williams (2002) highlights the importance of the property for invertebrate biodiversity. While he does not specifically address rare or threatened invertebrates, the generalisation made regarding the substantial level of endemism within the fauna notes that many species and genera are currently known from only single localities or from geographically restricted ranges. This suggests that there may be more species deserving recognition as rare or threatened.

4. Additional Ecosystem Values

4a. Stygofauna. A possible additional ecosystem value present at some CERRA sites (Pigna Barney and Willi Willi) is stygofauna (fauna inhabiting groundwater environments). Most of the eastern Australian stygofauna is largely concentrated in the upland karst systems of New South Wales and Tasmania. The Eastern Australian stygofauna represents a major element of continental subterranean biodiversity, and further investigation of the stygal fauna may contribute significantly to our understanding of the evolutionary history of the Australian Continent and individual karst areas (Thurgate *et al.* 2001). However, many prospective areas have yet to be studied, and most fauna collections are incidental to other surveys.

There are about 238 taxa present in Australia and about half of the fauna are stygobites (obligates and specialised forms) (82 spp.) and stygophiles (facultative species that seek out and utilise groundwater environments) (34 spp.). A significant proportion of the Australian fauna exhibit Gondwanan and Pangaea affinities (Thurgate *et al.* 2001). Relative to the composition of the world fauna, crustaceans dominate the Australian taxa.

Although the Australian continent is dry and generally lacks extensive karst and cave systems, nevertheless, Australia is a centre of regional stygofauna diversity. However, historically less research has been paid to the stygofauna of eastern Australia, yet the southern section of the CERRA World Heritage Area contains a significant concentration of stygofauna sites (Thurgate *et al.* 2001). Much of the fauna has yet to be determined but there are many highly localised and endemic taxa (e.g., Neoniphargidae-Amphipoda, Anaspidacea-Syncarida).

Karsts of eastern Australia are not uniformly distributed, being a series of scattered outcrops, and have “limited surface expression” (areal extent) (Thurgate *et al.* 2001). The “impounded karsts of New South Wales and Tasmania are complex systems, and many of them have experienced multiple phases of karstification interspersed with periods of marine transgression, burial, infilling and exhumation” (see discussion in Thurgate *et al.* 2001). Karsts of the New South Wales north coast are considered to be impounded formations - mostly relictual and dry - throughout the landscape. Few caves reach groundwater, but some have small stream systems. Representative sites on the New South Wales north coast are Stockyard Creek, Timor, Pigna Barney and Willi Willi (Thurgate *et al.* 2001).

The Eastern Australian fauna includes species with a range of adaptive dependencies on subterranean habitats:

- *Stygobites*. Obligate and specialised taxa.
- *Stygophiles*. Facultative taxa that seek out and utilise groundwater environments.
- *Stygoxenes*. Epigean taxa that occur accidentally and that exhibit no special adaptation or dependence upon groundwater (Thurgate *et al.* 2001).

Over one third of the Eastern Australian stygofauna are obligate groundwater animals (Thurgate *et al.* 2001).

The stygofauna of New South Wales and Tasmania are distinct at the generic and species level, but New South Wales contains fewer taxa (83 to 98) and the proportion of obligate and specialised stygobites, relative to included less specialised stigophiles and stygoxenes, is higher. The stygofauna of Queensland is poorly known.

In Eastern Australia, overall, crustaceans are dominant, and most stygobites are crustaceans. But gastropod snails (dominated by Hydrobiidae) are an additional important group within the faunal diversity. Insects are only a minor component in individual karst areas.

Amphipods and Hydrobiidae dominate the stygophiles and most insects and Decapoda are stygoxenes.

There is a high proportion of stygobites amongst some families, for example the Paramelitidae, Neoniphargidae and Psammaspididae (see Table 3), which in addition to the high level of local endemism “suggests strong selection pressures or long periods of isolation in subterranean waters for this fauna” (Thurgate *et al.* 2001).

Abundance of stygofauna may relate to available food resources and caves that contain root mats (a substantial and reliable food source) have recorded higher abundances of fauna.

The Eastern Australian fauna includes a Gondwanan and Pangaeian element (see Table 4), and ‘Higher’ crustaceans in particular possess these affinities. Crustacea include polyphyletic taxa and taxa with relictual distribution patterns, and these groups are valuable for biogeographic and evolutionary research (Thurgate *et al.* 2001). Some Eastern Australian karst systems have acted as refugia for stygofauna.

The distribution of the fauna in New South Wales is concentrated in highland areas, this corresponding with the greatest development of karst systems.

“Two congeneric species of an undescribed anaspid [Syncarida] family occur in caves and interstitial waters of the North Coast Region in New South Wales and they are considered to have close affinities with Koonungidae. ... Both species possess specialised raptorial grasping appendages and are probably active predators ... in contrast to most other syncarids that are omnivorous detritivores” (P. Serov & S. Eberhard, cited in Thurgate *et al.* 2001).

Table 3. Composition of major stygofauna groups in Eastern Australia

Taxa	Total No. Genera	Total No. Species	No. Stygobites	No. Stygophiles	Total No. Endemics**
<u>Amphipoda</u>					
Paramelitidae	10	35	21	9(5)*	18
Neoniphargidae	10	23	20	3	21
Other families	5	8	1	3	3
<u>Syncarida</u>					
Psammaspidae	2	13	13	-	11
Koonungidae	4	5	3	(2)	3
Aspididae	1	3	1	2	1
Other families	2	3	3	-	3
<u>Decapoda</u>					
Parastacidae	7	17	-	3	6
Other families	2	2	-	1	1
<u>Isopoda</u>					
Phreatoicidae	3	5	3	(2)	1
Janiridae	2	5	4	1	1
Amphisopidae	1	1	1	-	1
<u>Other Crustacea</u>	6	10	2(5)	(1)	-
<u>Gastropoda</u>					
Hydrobiidae	7	25	6(2)	9	12
Other families	8	9	-	-	6
<u>Coleoptera</u>					
Dysticidae	2	4	-	2(1)	-
Other families	2	5	-	-	-
<u>Trichoptera</u>					
Philopotamidae	1	2	-	1	-
Other families	2	2	-	-	-
<u>Other Insecta</u>	11	15	-	-	-
<u>Other Taxa</u>	16	38	4(1)	(2)	10
Totals	104	230	82-90	34-47	98

- after Thurgate *et al.* 2001

* Figures in brackets indicate undetermined taxa that are probably stygobites or stygophiles.

** Species that have only been collected from a single karst area or single cave are considered endemic (Thurgate *et al.* 2001).

Table 4. The origins and present global distribution of major stygal crustacean families collected from Eastern Australia

Order and Family	Affinities	Present Distribution
<u>Amphipoda</u> Paramelitidae Neoniphargidae Ceinidae	East Pangaea East Gondwana East Gondwana	Australia Australia, South Africa, South America Australia, New Zea, South Africa
<u>Syncarida</u> Psammaspididae Koonungidae Aspididae Stygocaridae Parabathynellidae	Gondwana Gondwana Gondwana Gondwana Gondwana	Australia Australia Australia Australia, New Zealand, South America Cosmopolitan
<u>Isopoda</u> Phreatoicidae Janiridae Amphisopidae	East Gondwana Gondwana East Gondwana	Australia, New Zealand, South Africa, India Australia, South America Australia, New Zealand, South Africa, India

- after Thurgate *et al.* 2001

7.4. INTEGRITY

The condition of integrity required for this criterion is:

The sites should contain habitats for maintaining the most diverse flora and fauna characteristic of the biographic province and ecosystems under consideration.

CERRA contains the largest and most significant remaining areas of subtropical rainforest, the largest remaining area of littoral rainforest in the region, the largest and most significant areas of warm temperate rainforest and nearly all areas of cool temperate rainforest north of the Hunter River. It is a stronghold for the flora and fauna associated with these rainforests and the adjoining *Eucalyptus*-dominated vegetation. It is of sufficient size to maintain viable populations of most of the significant species found within the property. While the result of on-going environmental sifting associated with climate change, the disjunct nature of the areas making up the property makes them susceptible to impact from factors such as fire and weed invasion. The property continues to meet the requirements of integrity for this criterion but would benefit from additions to minimise the edge effects.

7.5. DISTRIBUTION

All of the property contributes to this criterion.

7.6. THREATS

The threats are as outlined in Sections 5.6 and 6.6. A threat specific to this criterion is the fact that a number of rare or threatened species, particularly those of the warm subtropical rainforests and especially those on the Tweed Shield, have the majority of their populations outside the property.

8. ASSOCIATIVE NATURAL VALUES OF THE CENTRAL EASTERN RAINFOREST RESERVES OF AUSTRALIA

The natural values for which CERRA was listed as a World Heritage property have been outlined in earlier sections. Additional to those values, the property has other natural values that contribute to its global importance. These associative natural values have been recognised by one of two bodies – the IUCN (the World Conservation Union) or the Commonwealth of Australia World Heritage Expert Panel. Associative values identified by each are discussed below.

8.1. ASSOCIATIVE NATURAL VALUES IDENTIFIED BY IUCN

Criterion (iii) for natural heritage properties currently relates to properties which ‘contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.’ While CERRA was nominated under this criterion, IUCN did not support the listing of the property under criterion (iii) but stated (IUCN 1993) that ‘there are, however, many elements of criterion (iii) present and these should still be recognised in management.’ Therefore, the values present in CERRA that are relevant to criterion (iii) are not listed natural values but are associative natural values.

Adam (1987) summarises the attributes of CERRA relative to this criterion as follows:

“Rainforest in Australia provides a range of sensory experiences very different from that of sclerophyll communities – from the rampant luxuriance of subtropical rainforest with a diversity of plant forms, textures and colours, to the stately columnar trunks of warm temperate rainforest, to the ethereal mist and the cathedral calm of cool temperate *Nothofagus* forest. The distinctiveness of rainforest is heightened by the degree of difference between rainforest and its surrounding vegetation. In few places in the world can such different communities as rainforest and eucalypt woodland be found in close proximity.

“(CERRA) also provides many opportunities to view dramatic landscapes clothed with dense forest. All sites have their visual splendor but attention can be drawn to the Tweed (Mount Warning) volcano. The erosion caldera is one of the largest in the world and constitutes some of the most spectacular scenery on the continent. Mount Warning itself is a visible feature over a large area and is significant both in the history of the Aborigines and the white Australians, having been seen and named by Captain Cook.

“The Great Escarpment, which provides the western backdrop to the NSW coastal plain is a geomorphic feature which can be traced over several thousand kilometres. It is a major visual feature – a high abrupt wall densely clothed with tall forest. The sheer vastness of the forested landscapes along the Escarpment provides visual excitement of high order.”

The 1992 nomination (DASET 1992) argued that CERRA meets this criterion on two grounds – from the point of view of science (outstanding examples of ecosystems of outstanding significance) and from the point of view of being an area of exceptional natural beauty. The ecosystems of outstanding significance include examples of palaeovegetation and Gondwanan biota. The survival of relicts of palaeovegetation originating during the major climatic phases of the past 100 million years is of outstanding scientific significance. The survival of these relicts in refugia in the property has been possible because of factors unique to Australia’s tectonic, geological and geomorphological history, unmatched in any other part of the world. Furthermore, subtropical rainforests in the property have escaped the clearing and degradation that is the norm elsewhere in the subtropics.

Aspects of the exceptional natural beauty of the property which are emphasised include the variety of visual and other sensual experiences provided in rainforest, the outstanding volcanic landscapes, wild rivers and waterfalls, rocky tors, wildernesses, and the diversity of communities present in the property including heaths, swamps, open forests and woodlands.

Integrity:

The level of legislative protection, including the dedication of wilderness, ensures the continued integrity of the property in respect to this associative value.

Distribution:

The distribution of outstanding ecosystems is discussed in Section 5.4. The exceptional natural beauty and aesthetic attributes are distributed throughout the property and at all scales from the minute to the panoramic, with a concentration along the Great Escarpment and the associated shield volcanoes.

Threats:

Threats to the outstanding ecosystems have been discussed in Section 5.5. The main threat to the scenic and aesthetic values of the property is from the intrusion of inappropriate development into the landscape. Such impacts need not be necessarily within the the property boundaries to impair these values, particularly if they mar the beauty of the property when viewed from afar or visually intrude from lookouts within the property. The intrusion of factors such as low-flying aircraft may also negatively affect this value.

8.2. ASSOCIATIVE NATURAL VALUES IDENTIFIED BY THE WORLD HERITAGE EXPERT PANEL

The Commonwealth of Australia convened a World Heritage Expert Panel as part of the Regional Forest Agreement Process to undertake a comparative assessment of World Heritage themes and values of forests in three States – Queensland, New South Wales and Western Australia. The forests were assessed in relation to seven themes and fifteen sub-themes to identify forest areas in the three States that ‘warrant further investigation as possible best global expressions of each sub-theme’.

Five sub-themes were identified with respect to areas within the CERRA region:

- **Passive continental margins.** Marginal swells are characteristic of all passive continental margins. The Australian marginal swells are outstanding and exceptional in having volcanics to allow the process to be dated.
- **Refugia, Relicts.** Australia has outstanding examples of relict biota reflecting ancient Gondwanan biota.
- **Rainforest.** Australian rainforests are an outstanding example of ecosystems from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana.
- ***Eucalyptus*-dominated vegetation.** *Eucalyptus*-dominated vegetation is an outstanding example on a continental scale of forest and woodland vegetation dominated by a single genus. This vegetation has evolved under stress, including conditions of high climatic variability, nutrient deficiency, and high fire frequency.
- **Dreaming sites.** Australian provides an outstanding example of where the religious system of hunting-and-gathering societies is embodied in the landscape.

The second and third of these sub-themes are included in the values for which the property was listed. The Panel emphasised, in relation to the first of these two themes, the importance of the relict Rufous Scrub-bird (*Atrichornis rufescens*) and the diversity of Onychophorans in CERRA. In relation to the other sub-theme the Panel emphasised the importance of CERRA for terrestrial nemertines (ribbon worms). The importance of the Macleay Valley rainforests on limestone for land snails was also emphasised; the inclusion of The Castles FR within CERRA has sampled some of these rainforests, and recent additions of adjacent areas to NPWS estate may allow for better representation.

While the Panel felt that the values of the rainforest sub-theme were already represented in New South Wales, it identified the Bunya Mountains as containing the largest extant populations of an important Gondwanan species, Bunya Pine (*Araucaria bidwillii*), and recommended that the area be added to CERRA.

The remaining two natural sub-themes – passive continental margins and *Eucalyptus*-dominated vegetation – have previously not been formally recognised as values of CERRA. They are discussed in more detail below.

The fifth of these sub-themes relates to cultural rather than natural values and is not discussed further in this section. However, the lack of knowledge and understanding regarding the Aboriginal cultural values of CERRA is an important deficit that should be addressed (see Chapter 13).

8.2.1. Passive continental margins

Marginal swells are characteristic of all passive continental margins. The Australian marginal swells are outstanding and exceptional in having volcanics to allow the process to be dated.

Passive continental margins occur on all continents. Many include an asymmetrical marginal swell that runs parallel to the coastline and, sometimes, erosion of the outer part of the swell results in the formation of a spectacular escarpment separating the coastal plain and foothills from a high plateau region. The Great Escarpment and Great Divide in eastern Australia are part of a classic passive continental margin that runs parallel to the coast from Cape York to Victoria. This continental margin varies greatly in its form. Volcanicity from the Late Cretaceous to the Quaternary has resulted in numerous volcanoes and lava flows throughout the length of the continental margin. These volcanic sites are significant because they allow the dating of the geomorphic evolution of eastern Australia better than in any other passive margin in the world (World Heritage Expert Panel 1998).

One CERRA site, New England National Park in north-east New South Wales, includes outstanding and spectacular examples of the major features of the eastern passive continental margin. The erosional retreat of the Great Escarpment in this area has cut across a 19 million year old volcano, removing most of it. In the process, the retreat has exposed the feeder neck at The Crescent, and resulted in the formation of a huge cliff in the horizontal lavas at Point Lookout. In summary, a representative sample of the significant features of the area related to passive continental margins is within New England NP.

A geological feature shared by a group of CERRA sites, the Tweed Volcano, is an important individual feature that exemplifies the unique volcanicity associated with Australia's eastern passive continental margin.

Distribution:

Nearly all CERRA sites include features relevant to this value; Iluka NR is probably the only exception.

Threats:

The geological features related to this attribute are massive and generally insensitive to human impacts.

8.2.2. Eucalyptus-dominated vegetation

***Eucalyptus*-dominated vegetation in Australia is an outstanding example on a continental scale of forest and woodland vegetation dominated by a single genus. This vegetation has evolved under stress, including conditions of high climatic variability, nutrient deficiency, and high fire frequency.**

Eucalyptus is regarded as the most significant Australian plant genus (Barlow 1981). *Eucalypt*-dominated vegetation is recognised as an archetypal representative of Australia, its landscapes and biota. This is because of the dominance by the taxa of the majority of Australian forest and woodland ecosystems, the fact that nearly all the constituent species are endemic to the continent, and the ancient Australian origins of the eucalypts. (The term 'eucalypt' is used here to include not only the genus *Eucalyptus* (about 700 species) but also *Corymbia* (113 species, a genus recently described (Hill & Johnson 1995) to include some former members of *Eucalyptus*) and *Angophora* (15 species)).

The eucalypts belong in the family Myrtaceae, a family with origins associated with Gondwana. Ancestral forms of the eucalypts occurred in the moist rainforests that dominated Australia during the early Tertiary. Subsequent evolution of the genus is thought to have been strongly influenced by environmental stress, and the eucalypts are now an important part of the more-recently evolved component of the Australian flora.

Eucalyptus-dominated vegetation has no direct counterpart elsewhere, even amongst closely-related ecosystems (Busby 1992). Ecosystems similar to eucalypt ecosystems are included in the Sclerophyllous Forests, Scrubs or Woodlands Biome. These ecosystems are generally confined to the western or southern margins of continents. *Eucalyptus*-dominated ecosystems are the exception as they are widely distributed throughout the Australian continent, and dominate extensive parts of its northern, eastern and southern margins (World Heritage Expert Panel 1998).

The eucalypt ecosystems are also globally unusual in their distribution across an extremely wide range of habitats. The diversity of growth forms within the genus is also unusual, with a range from the tallest hardwoods in the world to stunted, open shrublands.

Blakers (1997) summarises aspects of eucalypt dominant vegetation relevant to its outstanding universal significance:

- the ancient origins of the eucalypts in Australia and other parts of Gondwana,
- the evolutionary history of the eucalypts, which reflects aspects of the recent geological history of the Australian continent,
- the extraordinary taxonomic diversity of the eucalypts, and their ongoing evolution,
- the unusual range of growth forms among the eucalypts,
- the outstanding success of the eucalypts in adapting to Australian environments and in dominating most of the woody vegetation of the continent,
- the wide diversity of the vegetation communities dominated by the eucalypts, and
- the unique ecology of eucalypt-dominated communities.

The World Heritage Expert Panel discussed the importance of the faunal component of the *Eucalyptus*-dominated ecosystems and the co-evolutionary aspects of the association. The vertebrate fauna of eucalypt ecosystems is relatively well known. The extensive invertebrate fauna is poorly known. However, it is known that they are diverse, important ecologically, and vary widely in distribution both geographically and in relation to host plants. An estimated 15-20% of the known Australian invertebrate fauna is dependant on eucalypts (World Heritage Expert Panel 1998).

The two major peaks of eucalypt species richness in the eucalypt forests of the continent occur in NSW – one in the north-east of New South Wales extending into south-east Queensland, and the other in the sandstone country centered on the Blue Mountains. The highest numbers (>70) are in the Dorrigo, Singleton, Sydney and Wollongong grids within the area from the Gympie grid southward to the Bairnsdale and Mallacoota grids, which is consistently the area of the highest numbers of taxa per grid in Australia (Chippendale 1981, Chippendale & Wolf 1981). Generally, areas of higher numbers of taxa per grid occur where there is a diversity of habitat and climates - mountains/ tablelands and adjoining slopes. Speciation in *Eucalyptus* has been, and is, most active in areas where there are varied habitats, reliable rainfall and few extremes of temperature (Chippendale 1981, Gill *et al.* 1985).

All major ecological types of eucalypt forest, except monsoon forest, are well represented in the north-eastern NSW/south-eastern Qld centre. As well, the genus *Angophora* and two of the eucalypt sub-genera, *Monocalyptus* and *Symphyomyrtus*, are most diverse within the forests of this and the Blue Mountains area.

Species groups d, l, m, n, u and v (Gill *et al.* 1985) attain their maximum richness within the forests of north-east NSW and south-east Queensland. Species groups e and f and assemblage group D also have their peak richness in south-east Queensland (Gill *et al.* 1985).

The World Heritage Expert Panel considered that, to some extent, the eucalypt-related values of north-east NSW and south-east Queensland are represented in CERRA. The Panel noted that this World Heritage area was designed for rainforest representation, and does not cover the variety of species and forest types in the region.

However, CERRA does include good representative examples of three of the six eucalypt-dominated vegetation types identified by the panel – the rainforest-eucalypt forest transition (mixed forest), eucalypt forests with dense, broad-leaved shrub understoreys (wet sclerophyll forest), and eucalypt forest and woodland with perennial grass understoreys (grassy forest) – and the interactions of these types with rainforest. Examples of two other eucalypt-dominated forest vegetation types – eucalypt forests with tall, small-leaved shrub understoreys (shrubby forest) and eucalypt forests with heath understoreys (heathy forests) – also occur. While the areas selected for nomination were restricted to those sampling the values associated with rainforests, the related values of the eucalypt-dominated forests were not ignored. The selection of boundaries for nominated areas, particularly in NSW, was based partially on the recognition that ecologically the eucalypt forests and the rainforests occur spatially along environmental continua and temporally with shifting transitions and patterns of dominance. The buffering role that eucalypt forest plays in protecting rainforest margins from climatic and environmental extremes was also a pragmatic consideration during the selection of boundaries. Understandably, the documentation of the values of the nominated areas concentrated on those related to rainforest. Nevertheless, values related to eucalypt forests including the origins of the sclerophyll flora, the unusual structural characteristics of the forests, and the characteristic Australian biota supported by these forests were identified (Adam 1987).

Adam (1987) also notes that the wet sclerophyll forests in northern NSW, which occur in contact with rainforest stands, have the highest mammal diversity of any habitat or region in Australia (Calaby 1966). With respect to rainforest vertebrate fauna, the importance of wet sclerophyll forest is highlighted by the fact

that there is no rainforest-inhabiting vertebrate in the central- eastern and southern Australian subtropical and temperate forests that does not also occur in wet sclerophyll forest, but frequently only when that wet sclerophyll forest has developed its rainforest subcanopy to provide critical resources for that species (Gilmore 1999). Because there is more wet sclerophyll forest than rainforest in south-east Australia, the viability of populations of many rainforest inhabiting vertebrates, including species which are recognised as attributes of CERRA (see above), may be dependent on these eucalypt forests.

The *Eucalyptus*-dominated vegetation has significant attributes additional to those identified above. While eucalypts are the dominant overstorey group, the understorey frequently includes genera such as *Grevillea*, *Hakea*, *Pultanea*, *Hovea*, *Daviesia*, *Persoonia*, *Themeda* and *Xanthorrhoea* which are regarded as ‘typically Australian’ and which represent a major stage in the development of Australian vegetation – the evolution of the autochthonous element.

The importance of wet sclerophyll forest for vertebrate fauna has been noted above. The dry sclerophyll forests are also important habitat for fauna. The species present are influenced by the fact that these more sclerophyll forests include fewer fleshy fruits and leaves and there is an increased emphasis on grasses and sedges, sap, nectar and dry fruits as food sources.

The invertebrates present in the sclerophyll forests are also distinctive. Williams (2002) identifies the importance of non-rainforest vegetation in CERRA for invertebrates as one of his four major generalisations:

- Significant invertebrate heritage values are not restricted to taxa inhabiting rainforest vegetation. The intervening matrix of sclerophyllous forests, and more rarely woodlands, shrub, heath and swamp complexes, and associated freshwater ecosystems, sustain distinctive non-rainforest invertebrate fauna values. Important higher taxa inhabiting these ecosystems are ruteline ‘christmas beetles in the tribe Anoplognathini, the family Elateridae, the speciose buprestid genus *Castiarina*, the tenebrionid tribe Heleini, the fly genera *Pelecorhynchus* and *Trichophthalma*, and athoracophorid, helcarionid and glacidorbid snails.

The World Heritage Panel concluded that fragmentation due to clearing in north-east NSW has resulted in a situation where representation of the outstanding catena of eucalypt forest diversity in the region can only be achieved in one extensive and largely-continuous area of natural forest. This area extends almost continuously from sub-alpine forest to the coast and contains populations of more than 80 eucalypt species and a wide range of ecological forest types. The Guy Fawkes Wilderness Area forms the most extensive component of this large natural area, which has been called ‘Moonee - Bindery’ (World Heritage Expert Panel 1998).

It was recommended by the panel that the Moonee - Bindery area be further investigated in relation to this sub-theme. It is also noted that, in order to capture the outstanding catena of eucalypt forest diversity in the region, consideration should be given to including other smaller reserves, areas of State Forest, and some private land extending from the Warra State Forest in the west to the coastal Moonee Beach Nature Reserve in the east. Subsequent allocation of State Forest and Crown lands to NPWS reserves has, in the short term at least, frustrated any plans to nominate this area as significant areas remain as production forest with a resultant lack of connectivity of reserve areas. However, it is noted that the recommended area lies as a band across and at right angles to the axis of CERRA (that is, as a transect across the Great Escarpment) and that a representative sample of the eucalypt-dominated communities in the area would probably require the nomination of some existing CERRA areas. It may be possible to design a future re-nomination of CERRA to include many of the eucalypt forest values of the area.

As an example, with relation to *Eucalyptus*-dominated vegetation and the Wet Tropics World Heritage Area, the panel recommended the possible addition of the catena of eucalypt communities on the inland slopes of the property and the assemblage of forest communities, dominated by *Eucalyptus* and *Melaleuca*, on the coastal plains adjacent to the property. The adoption of such an approach with relation to CERRA could result in all of the areas, and therefore values, sampled by the proposed Moonee-Bindery nomination area being included in CERRA. An approach with more of a rainforest orientation, but one which recognised the importance of *Eucalyptus*-dominated vegetation as an important sub-theme of CERRA, might include the nomination of areas which have small areas of rainforest within a predominately eucalypt-dominated matrix.

In south-east Queensland, the panel considered that CERRA would benefit, in relation to both the eucalypt-dominated vegetation sub-theme and the rainforest sub-theme, from some relatively minor additions, including the Bunya Mountains NP.

The validity of the eucalypt sub-theme was confirmed by the inscription of the Greater Blue Mountains Area in the World Heritage List in 2000. The relevant section of the justification for inscription read as follows:

“Australia’s eucalypt vegetation is worthy of recognition as an outstanding universal value, because of its adaptability and evolution in post-Gondwana isolation. The site contains a wide and balanced representation of eucalypt habitats from wet and dry sclerophyll, mallee heathlands, as well as localised swamps, wetlands, and grassland. 90 eucalypt taxa (13% of the global total) and representation of all four groups of eucalypts occur.”

Distribution:

Eucalyptus-dominated vegetation occurs on the margins of and sometimes intermingles with most areas of rainforest within CERRA. Some sites, including Washpool NP, Gibraltar Range NP, Dorriggo NP, New England NP, Werrikimbe NP and Barrington Tops NP, sample extensive areas of *Eucalyptus*-dominated vegetation.

Threats:

Existing threats to *Eucalyptus*-dominated vegetation and constituent plant and animal species include:

- Inappropriate fire regimes; frequency, intensity and seasonality of burning may adversely affect the communities and their constituent species.
- Exotic plant species; species which are significant because of the extent of their distribution within eucalypt-dominated vegetation or because of the severity of their impact include Broom (*Cytisus scoparius* var. *scoparius*), Lantana (*Lantana camara*) and Blackberry (*Rubus fruticosus* (agg.) spp.).
- Exotic animal species; species of concern include Feral Pigs (*Sus scrofa*), Goats (*Capra hircus*), Foxes (*Vulpes vulpes*) and Cats (*Felis catus*).
- Die-back of vegetation associated with Lerp, Bell Miner associated die-back, and Christmas Beetle attack.
- Localised damage due to increased visitation at some sites.

Potential threats include:

- clearing of vegetation
- introduction of more exotic plants and animals or spread of existing feral species
- introduction of plant or animal pathogens
- species loss and re-assemblages due to rapid climatic changes precipitated by human impacts on planetary processes; impacts associated with warming attributed to ‘Greenhouse Gases’ have been documented (Holmes 1999).

9. VALUES AND ATTRIBUTES OF SITE GROUPS WITHIN THE CENTRAL EASTERN RAINFOREST RESERVES OF AUSTRALIA

9.1. INTRODUCTION

Sites within the property generally fall into distinct groups, based either on geographic features or disjunctions. To avoid the needless repetition of treating each site separately, this section discusses the World Heritage values and attributes of groups of sites. Eight groups are recognised:

- The Main Range Group
- The Mount Barney Group
- The Tweed Shield Volcano Group
- The Coastal Group
- The Washpool/ Gibraltar Group
- The New England Group
- The Hastings Group
- The Barrington Group

The World Heritage values of CERRA can be summarised as follows:

1. CERRA WHA rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana.
2. CERRA WHA includes an outstanding range of ecosystems and taxa which demonstrate the origins and rise to dominance of cold adapted / dry adapted flora.
3. CERRA WHA includes outstanding geological features associated with the erosion of shield volcanoes.
4. CERRA WHA includes significant centres of endemism where ongoing evolution of flora and fauna species is taking place.
5. CERRA WHA includes the principal habitats of a large number of threatened species of plants and animals. These species are of outstanding universal value from the point of view of science and conservation, including relict and primitive taxa.

Each of these values has a number of attributes associated with it, as discussed above. Examples of key attributes related to the values are shown in Table 5. With the exception of the value that relates to specific geological features, it is obvious that all of the groups of sites contribute to all of the values. Attributes related to the exception are contained within the Tweed Shield Volcano Group and the New England Group.

The eight groups of sites are discussed in this section. The aim of the section is not to outline in detail all attributes that contribute to the World Heritage values for each group of sites. Rather, the primary intention is to present a summary of the habitats that are present, with some emphasis on the rainforest types, and to provide where possible more information on the relationships of the groups. Brief notes on fauna attributes are also provided and brief discussion of geological attributes, where appropriate. Tables 6 - 21 show the presence of rare or threatened species within individual sites in the groups. More detailed information on the presence of individual species within sites or groups of sites is contained in Appendices 1 – 5.

Many of the flora reserves added to CERRA are now within larger national parks. However, only the former flora reserve areas are listed as World Heritage. To avoid confusion and to emphasise that only the areas covered by the former flora reserves are listed, these areas are referred to by their previous (flora reserve) name.

Table 5. CERRA World Heritage Values and Attributes

Value 1. CERRA WHA rainforests are an outstanding example of ecosystems and taxa from which modern biota are derived. These rainforests are exceptionally rich in primitive and relict species, many of which are similar to fossils from Gondwana.

Key attributes reflecting Value 1:

- Habitats:
 - Subtropical rainforest
 - warm temperate rainforest
 - cool temperate rainforest
- Species:
 - all conifers and cycads, especially *Araucaria cunninghamii*
 - ancient ferns, including tree ferns
 - early angiosperm lineages in Austrobaileyales and Magnoliids (*Trimenia*, Atherospermataceae, Monimiaceae, Lauraceae, Annonaceae, Eupomatiaceae, Aristolochiaceae, Piperaceae, Peperomiaceae and Winteraceae)
 - other Gondwanic families (e.g. Proteaceae, Nothofagaceae, Casuarinaceae, Berberidopsidaceae, Myrtaceae, Eucryphiaceae, Cunoniaceae, Escalloniaceae, Pittosporaceae)
 - primitive group of Corvidae (including lyrebirds, bowerbirds, tree-creepers and the Rufous Scrub-bird)
 - other birds dating from Gondwana (e.g. Pale-yellow Robin, thornbills, scrubwrens and gerygones)
 - all frogs in families Myobatrachidae and Hylidae
 - chelid turtles, Leaf-tailed Gecko, Angle-headed Dragon
 - range of invertebrates with origins in Gondwana, including fresh-water crays, land snails, velvet worms, flightless carabid beetles, Richmond Birdwing Butterfly and glow-worms

Value 2. CERRA WHA includes an outstanding range of ecosystems and taxa which demonstrate the origins and rise to dominance of cold adapted / dry adapted flora.

Key attributes reflecting Value 2:

- Habitats:
 - cool temperate rainforest
 - dry rainforest
 - wet sclerophyll forest
- Species:
 - members of Myrtaceae, Proteaceae

Value 3. CERRA WHA includes outstanding geological features associated with the erosion of shield volcanoes.

Key attributes reflecting Value 3:

- Tweed Shield Volcano Caldera is possibly the best preserved erosion caldera in the world, notable for its size and age, and for the presence of a prominent central mountain mass and all three stages in the erosion of shield volcanoes – the planeze, residual and skeletal stages.
- The remnants of the Ebor Volcano represent the best example in eastern Australia of a radial drainage pattern related to a specific centre of eruption.

Table 5 (cont'd)

Value 4. CERRA WHA includes significant centres of endemism where ongoing evolution of flora and fauna species is taking place.

Key attributes reflecting Value 4:

- Habitats:
 - cool temperate rainforest
 - subtropical rainforest
 - warm temperate rainforest
 - dry rainforest
 - wet sclerophyll forest
 - montane heathlands
 - rocky outcrops
 - particularly in Border Ranges
- Species:
 - many Magnoliid genera
 - genera in other Gondwanic families
 - all fauna of low motility that occur in more than one isolated pocket of CERRA
 - frogs such as *Phyloria* and *Litoria pearsoniana* / *phyllochroa* complex
 - invertebrates such as snails, earthworms, fresh-water crays, velvet worms and carabid beetles

Value 5. CERRA WHA includes the principal habitats of a large number of threatened species of plants and animals. These species are of outstanding universal value from the point of view of science and conservation, including relict and primitive taxa.

Key attributes reflecting Value 5:

- Habitats:
 - subtropical rainforest
 - warm temperate rainforest
 - wet sclerophyll forest
 - montane heathlands
 - rocky outcrops
 - particularly in Border Ranges
- Species:
 - over 200 rare or threatened species of plants
 - over 140 orchids
 - 76 narrowly endemic rare or threatened plant species in the Border Ranges
 - rare or threatened plant species particularly in *Cryptocarya*, *Endiandra*, *Tasmannia*, Proteaceae, Myrtaceae, Euphorbiaceae
 - over 90 rare or threatened vertebrate fauna including Marbled Frogmouth, Eastern Bristlebird, *Phyloria* spp., Pouched Frog, barred frogs, Parma Wallaby, Yellow-bellied Glider, Hastings River Mouse, Golden-tipped Bat
 - invertebrates such as Richmond Birdwing Butterfly and the flightless carabid, *Nurus brevis*.

9.2. MAIN RANGE GROUP

The Main Range Group includes Main Range NP, State Forests of the Main Range (Gilbert, Goomburra, Spicers Gap, Emu Vale, Gambubal, Teviot and Killarney) and Wilsons Peak FR, plus Acacia Plateau FR which was added subsequent to the 1992 nomination (see Section 10) (Map 2). Main Range NP includes all the former Mount Mistake NP and Main Range NP. Wilsons Peak FR and Acacia Plateau FR are now part of Koreelah NP.

The major part of the Main Range Group extends from Mt Mistake and Kangaroo Mountain in the north to Wilsons Peak in the south, encompassing parts of three adjoining ranges – Mistake Mountains, Little Liverpool Range and Main Range. Acacia Plateau FR is a disjunct section of the Great Escarpment/Great Dividing Range to the south-south-west of Wilsons Peak which lies at the junction of the Main and McPherson Ranges.

The predominant rainforest type is cool subtropical rainforest. This type on the Main Range Group differs significantly from the equivalent type on the eastern McPherson Range and Tweed Range that is dominated by *Caldcluvia paniculosa* (Corkwood). This type in the Main Range Group is dominated by *Heritiera actinophylla* (Black Booyong) with associated *Dysoxylum fraserianum* (Rosewood) and *Sloanea woollsii* (Yellow Carabeen); the latter two species are often more common at higher altitudes. Scattered emergents of *Araucaria cunninghamii* (Hoop Pine), *Lophostemon confertus* (Brush Box) and *Ficus watkinsiana* (Moreton Bay Fig) are present. The Main Range Group stands of this rainforest type form part of the central section of the arc of the humid cool-subtropical element of the A1 floristic province that stretches discontinuously from the Tweed Shield to the Bunya Mountains.

Small stands of warm temperate rainforest with *Rhodamnia argentea* (Malletwood) and *Syzygium oleosum* (Blue Lilly Pilly) occur on sheltered southerly slopes below the cliffs in Wilsons Peak FR.

In exposed, elevated habitats on the Main Range there is a lower form of closed forest dominated by *Acmena smithii* (Lilly Pilly), with associated tall shrubland along clifftops. This association appears to replace similar *Nothofagus moorei* communities further east. A similar community is present on the Bunya Mountains (Oliver 1987). This forest type is perhaps similar to stands recognised by Adam (1992) as climatic warm temperate rainforest (simple notophyll-microphyll vine forest) stands, frequently dominated by *Acmena smithii*, such as occur on the higher parts of the Liverpool Range (Fisher 1985), the south coast of New South Wales and in Victoria (Patton 1930). The type is probably referable to the A2 floristic province.

Stands of dry rainforest dominated by *Araucaria cunninghamii* occur within the group. These form links between those on the Tweed Shield and the more extensive areas of rainforests of the C1 province in south-east Queensland. Species typical of the Queensland dry rainforests such as *Erythroxylum australe*, *Flindersia collina*, *Citribatus lancifolius*, *Toechima tenax*, *Denhamia pittosporoides*, *Cryptocarya bidwillii*, *Acronychia laevis* and *Melicope erythroxylon* are at or close to their southern limits in this area.

Tall open forest communities, commonly dominated by *Eucalyptus eugenoides*, *E. biturbinata*, *E. tereticornis*, *E. melliodora* and *E. saligna*, occur on basaltic soils at lower altitude, and *E. campanulata* is common on rhyolite-derived soils. The *E. campanulata* communities along the Main Range are probably the most extensive in Queensland (Oliver 1987).

The presence of 'temperate' species in the open forests at high altitudes along the summit and western slopes is a significant feature (Oliver 1987). These include *Eucalyptus obliqua*, *E. quadrangulata*, *E. nobilis*, *E. banksii* and *E. dunnii*; all are at their northern limit here. The disjunct populations of *E. deanii* on the Main Range are a northern outlier of a species otherwise known from the Hunter Valley and Northern Tablelands of the NSW-Queensland border (Oliver 1987).

A rocky heath community on The Prow (part of The Steamers) in Main Range NP contains a number of rare species, including *Helichrysum lindsayanum* and *Wahlenbergia glabra*. Areas of rock pavement communities with a range of noteworthy species including *Doryanthes palmeri* (Spear Lily) occur on the Main Range. *Leptospermum* - *Prostanthera* scrub occurs on the top of Wilsons Peak, with an unusual low forest (10 m) of *Rapanea variabilis* (Muttonwood) with a dense cover of epiphytic bryophytes. Good populations of the Large Spear Lily (*Doryanthes palmeri*), a species endemic to the northern section of CERRA, occur on rock pavements along the Main Range.

Oliver (1987) discusses the floristic relationships between the Scenic Rim and other areas. He notes that the moist, elevated habitats on basalt on the Main Range share many species with the Border Ranges and the Bunya Mountains. Many species of the drier habitats on basalt on the Main Range are shared with the elevated basalt-capped Consuelo and Buckland Tablelands 900 km away.

More than 540 species of plants in over 250 genera occur in Main Range NP (Novello & Klohs 1999). Nineteen, possibly twenty, rare or threatened plant species are recorded from the Main Range Group (see Table 6).

Fauna diversity in the Main Range Group reflects the wide diversity of habitats available. Excluding fish, 313 species of vertebrate fauna species (47 mammals, 197 birds, 53 reptiles and 16 amphibians) are recorded from Main Range NP. Twenty-nine of the fauna species recorded from the Main Range Group are considered rare or threatened or of management concern (see Table 7). These include one fish and one crayfish. The River Blackfish (*Gadopsis marmoratus*), a species with a very restricted distribution in Queensland, is known to occur in Dalrymple Creek in Goomburra SF. *Euastacus jagara* is a freshwater crayfish endemic to the Main Range Group, being known only from the Mt Mistake area and Goomburra SF.

Table 6. Rare or Threatened Flora of the Main Range Group

Species	Conservation Status*			Distribution in Main Range Group
	B & L	QLD	NSW	
<i>Bothriochloa bunyensis</i>	3VC	V	-	Main Range NP
<i>Callitris monticola</i>	3RC	R	-	Main Range NP
<i>Dendrobium schneiderae</i> var. <i>schneiderae</i>	3RC	R	-	Main Range NP
<i>Dipodium pulchellum</i>	3RC	R	-	Main Range NP
<i>Eucalyptus dunnii</i>	3RCa	R	-	Main Range NP
<i>Gossia gonoclada</i>	2E	E	-	Main Range NP
<i>Grevillea linsmithii</i>	3RCa	E	-	?Main Range NP (B&L)
<i>Lenwebbia prominens</i>	3RC	R	-	Main Range NP
<i>Macarthuria ephedroides</i>	3RC	-	-	Main Range NP
<i>Marsdenia coronata</i>	3VC	V	-	Main Range NP
<i>Muellerina myrtifolia</i>	3RC	R	E	Main Range NP, Wilsons Peak FR
<i>Papillilabium beckeri</i>	-	R	-	Main Range NP
<i>Pimelia umbratica</i>	2RC	R	-	Main Range NP
<i>Sarcochilus fitzgeraldii</i>	3VC	E	V	Main Range NP
<i>Sarcochilus hartmannii</i>	3VC	V	V	Main Range NP
<i>Sarcochilus weinthalii</i>	3VC	E	V	Main Range NP
<i>Solanum callium</i>	-	R	-	Main Range NP
<i>Sophora fraseri</i>	3VC	V	E	Main Range NP
<i>Wahlenbergia glabra</i>	2RC	R	-	Main Range NP
<i>Wahlenbergia scopulicola</i>	2RC	R	E	Main Range NP
<i>Westringia sericea</i>	3RC	R	-	?Main Range NP (B&L)

* Conservation Status for Australia is based on Briggs and Leigh (1996). Status in Queensland is based on the *Nature Conservation (Wildlife) Regulation 1994* and in NSW on the *Threatened Species Conservation Act 1995*.

Note: Briggs and Leigh (1996) incorrectly list Main Range populations of *Arundinella montana*, *Marsdenia longiloba* and *Plectranthus alloplectus*.

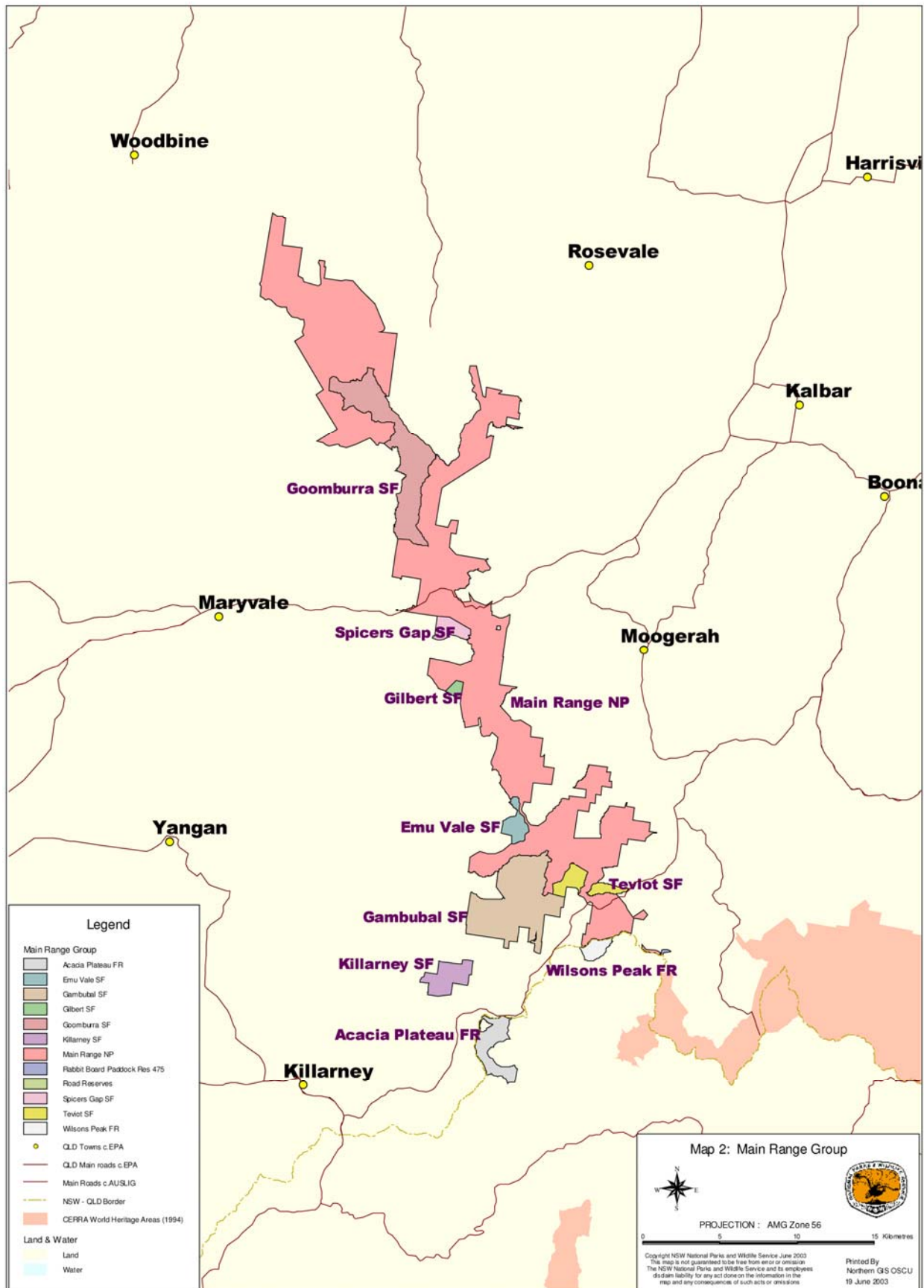


Table 7. Rare or Threatened Fauna of the Main Range Group

Species		Conservation Status*		Distribution**					
		QLD	NSW	MR	GO	EV	GB	WP	AP
<u>Invertebrates</u>									
<i>Euastacus jagara</i>	Main Range Spiny Crayfish	-	-	+	+				
<u>Fish</u>									
<i>Gadopsis marmoratus</i>	River Blackfish	-	-		+				
<u>Amphibians</u>									
<i>Lechriodus fletcheri</i>	Fletcher's Frog	R	-	+	+				+
<i>Litoria pearsoniana</i>	Cascade Frog	V	-	+	+				
<i>Mixophyes fleayi</i>	Fleay's Frog	E	E	+	+	+			
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	E	+					
<i>Philoria kundagungan</i>	Mountain Frog	R	V	+	+				+
<u>Reptiles</u>									
<i>Acanthophis antarcticus</i>	Common Death Adder	R	-	+					
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-toothed Skink	R	V	+	+				+
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V	+					
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	R	V	+					
<i>Saproscincus rosei</i>		R	-		+				
<u>Birds</u>									
<i>Accipiter novaehollandiae</i>	Grey Goshawk	R	-		+				
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	V	+	+	+			+
<i>Climacteris erythrops</i>	Red-browed Treecreeper	R	-	+	+				
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Fig-Parrot	E	E	+	+				+
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E	+					
<i>Menura alberti</i>	Albert's Lyrebird	R	V	+	+	+	+	+	+
<i>Ninox connivens</i>	Barking Owl		V	+					
<i>Ninox strenua</i>	Powerful Owl	V	V	+	+				
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove		V	+					+
<i>Turnix melanogaster</i>	Black-breasted Button-quail	V	E	+					
<i>Tyto novaehollandiae</i>	Masked Owl		V	+					
<i>Tyto tenebricosa</i>	Sooty Owl	R	V	+	+	+			+
<u>Mammals</u>									
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V	V	+				+	
<i>Miniopterus australis</i>	Little Bent-wing Bat		V	+					
<i>Petaurus australis</i>	Yellow-bellied Glider		V	+	+				
<i>Petaurus norfolcensis</i>	Squirrel Glider		V	+					
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	V	E	+		+			
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	-	V	+					+
<i>Phascolarctos cinereus</i>	Koala	M	V	+	+	+			
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	V	+			+		+
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse		V	+					
<i>Pseudomys oralis</i>	Hastings River Mouse	V	E	+		+	+		

* Conservation status is based on the *Nature Conservation (Wildlife) Regulation 1994* for Queensland and the *Threatened Species Conservation Act 1995* for New South Wales.

** Key to locations within Group:

MR = Main Range NP, Gilbert SF, Spicers Gap SF
GO = Goomburra SF
EV = Emu Vale SF

WP = Wilsons Peak FR
AP = Acacia Plateau FR
GB = Gambubal SF

9.3. MOUNT BARNEY GROUP

The Mount Barney Group includes Mount Barney NP, Burnett Creek SF, Mount Clunie FR and Mount Nothofagus FR, plus a number of crown reserves (Rabbit Board Paddock Reserve 475, Rabbit Board Paddock Reserve 470, Rabbit Board Paddock Reserve 603 and Rabbit Board Paddock Reserve 464 (Map 3). This area includes the rugged peaks, steep slopes and caldera valley of the central complex of the Focal Peak Shield Volcano.

Significant area of cool subtropical rainforest extends above 600m altitude from the western side of Mt Barney across the Mount Ballow peaks to the western side of the mountainous complex. While subtropical rainforest makes up the major proportion of the vegetation of the western part of Mt Barney NP, cool temperate rainforest dominated by *Nothofagus moorei* occurs above 900m altitude on Mt Ballow and Nothofagus Mountain, extending into Mount Nothofagus FR. This stand of *N. moorei* covers some 80ha and is the largest single stand in the Border Ranges region.

Floyd (1977) postulated that the cool temperate rainforests of the Tweed Shield and western McPherson Range have been separated from the more southern cool temperate rainforests of CERRA for a considerable length of time as both areas have endemic species (*Pittosporum o'reillyanum* on the shield, and *Vesselowskyia* species further south). Bale and Williams (1993) lent support to Floyd, recognising the McPherson Range as one of three extraneous refugia that are additional to a refugial core area (Upper Dorrigo to Hastings) and a near-core (Barrington). However, even though the Tweed Shield and the Mount Barney Group cool temperate rainforests may be similar, it would appear from the presence of *Cryptocarya nova-anglica* in the latter area and areas to the south, but not on the Shield, that the Shield stands were isolated prior to the separation of the Western McPherson stands from those further south. The presence of endemics such as *Pittosporum o'reillyanum* and *Parsonsia tenuis* in the Shield cool temperate rainforests supports this view.

The north-east half of Mt Barney NP is dominated by open forest. These range from moist tall open forest dominated by species such as *Lophostemon confertus* and *Eucalyptus campanulata* to drier tall open forest dominated by species such as *E. crebre*, *E. acmenioides* and *Corymbia maculata*. *E. oreades*, most common in the Blue Mountains west of Sydney, occurs as scattered stands to just north of the Queensland border, including on the upper slopes of Mt Barney. Plant communities dominated by this species are perhaps the most vulnerable to disturbance in the Scenic Rim region (Oliver 1987).

Several species of plant are endemic to the acid volcanic peaks of the Fassifern Valley. These relatively isolated montane 'islands' also support a number of species with disjunct distributions. *Cooperhooia scabridiuscula*, known only from Mt Barney and Mt Maroon in the Fassifern Valley and Mt Walsh 400km to the north, is a striking example (Oliver 1987). Table 8 shows the rare and threatened plant species recorded from the group.

Fauna of the area reflects the diversity of habitats. Included are rainforest species plus species of dry open forests and rocky outcrops. The rare or threatened species recorded from the group are shown in Table 9.

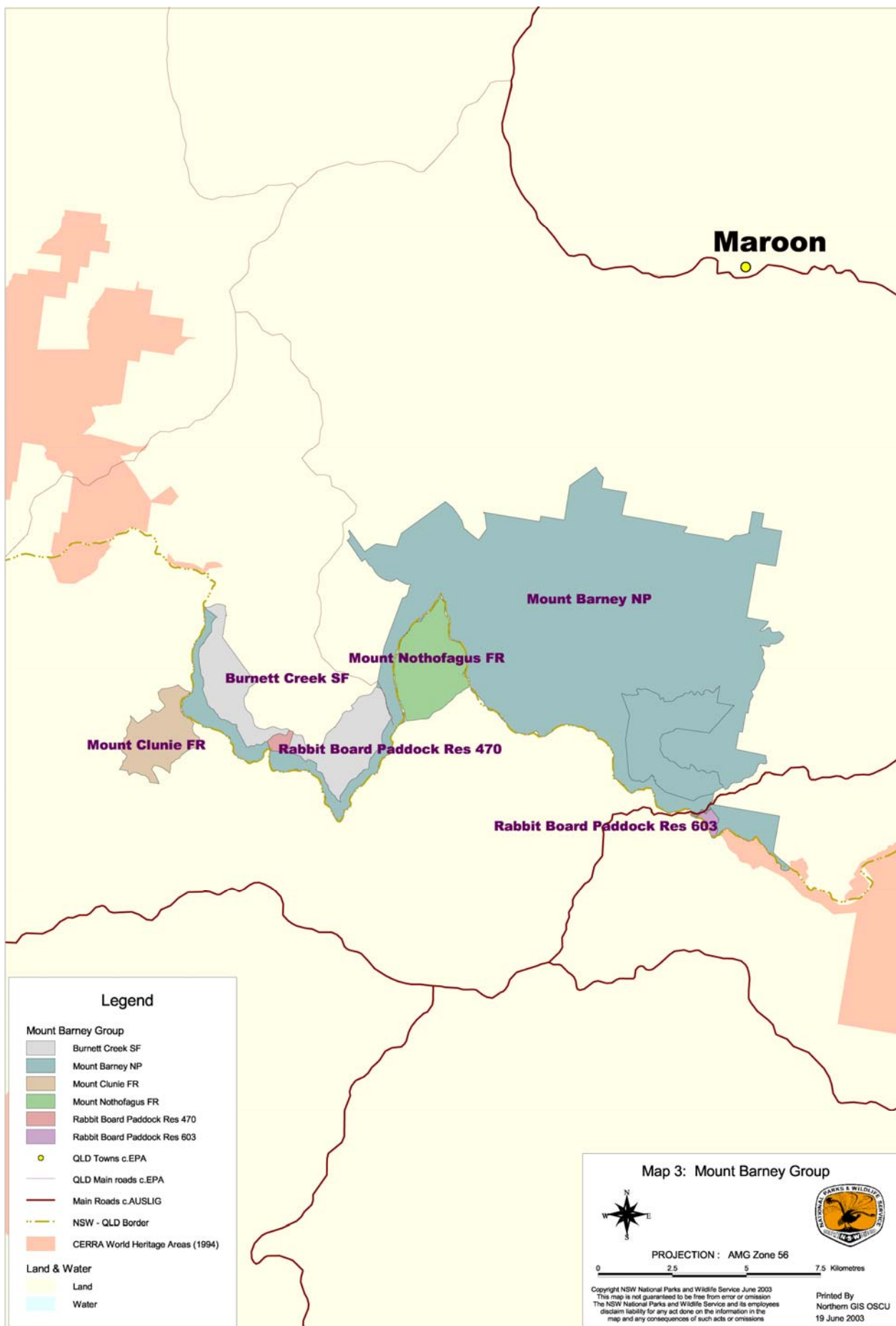


Table 8. Rare or Threatened Flora of the Mount Barney Group

Species	Conservation Status*			Distribution in the Mount Barney Group
	B & L	QLD	NSW	
<i>Acacia acronastes</i>	3RC	R	E	Mount Barney NP
<i>Acacia brunioides</i> ssp. <i>brunioides</i>	3RC	-	-	Mount Barney NP
<i>Acacia floydii</i>	2RC	-	-	Mount Barney NP
<i>Acacia saxicola</i>	2RC	R	-	Mount Barney NP
<i>Arundinella montana</i>	3RC	R	-	Mount Barney NP
<i>Banksia conferta</i> var. <i>conferta</i>	3RC	R	-	Mount Barney NP
<i>Bertya</i> sp. 'Mt Ernest'	2VC	V	-	Mount Barney NP
<i>Callitris monticola</i>	3RC	R	-	Mount Barney NP
<i>Clematis fawcettii</i>	3VC	V	V	Mount Barney NP
<i>Comesperma breviflorum</i>	2RC	R	-	Mount Barney NP
<i>Comesperma esulifolium</i>	-	R	-	Mount Barney NP
<i>Cooperhooia scabridiuscula</i>	3VC	V	-	Mount Barney NP
<i>Corybas montanus</i>	2VC	V	-	Mount Barney NP
<i>Cryptocarya nova-anglica</i>	3RCa	-	-	Mount Nothofagus FR
<i>Eucalyptus dunnii</i>	3RCa	R	-	Mount Clunie FR
<i>Eucalyptus michaeliana</i>	3RCa	R	-	Mount Barney NP
<i>Eucalyptus microcodon</i>	2RC	R	E	Mount Barney NP
<i>Euphrasia bella</i>	2VCit	V	V	Mount Barney NP
<i>Gahnia insignis</i>	3RCa	R	-	Mount Barney NP
<i>Grevillea linsmithii</i>	3RCa	R	-	Mount Barney NP
<i>Helichrysum lindsayanum</i>	2RCa	R	-	Mount Barney NP
<i>Hibbertia hexandra</i>	3RC	R	E	Mount Barney NP
<i>Hibbertia monticola</i>	2RC	R	-	Mount Barney NP
<i>Leionema elatius</i> ssp. <i>beckleri</i>	2EC	E	-	?Mount Barney NP(B&L)
<i>Leucopogon cicatricatus</i>	3RC	R	-	Mount Barney NP
<i>Marsdenia coronata</i>	3VC	V	-	Mount Barney NP
<i>Marsdenia longiloba</i>	3RC	R	E	Mount Barney NP
<i>Ozothamnus whitei</i>	3RC	R	-	Mount Barney NP
<i>Pandorea baileyana</i>	-	R	-	Mount Barney NP
<i>Persoonia volcanica</i>	2RC	R	-	Mount Barney NP
<i>Plectranthus alloplectus</i>	2RC	R	-	Mount Barney NP
<i>Pterostylis bicornis</i>	2VC	V	-	Mount Barney NP
<i>Pultenaea whiteana</i>	2RC-t	R	-	Mount Barney NP
<i>Ricinocarpus speciosus</i>	3RCi	-	-	Mount Barney NP
<i>Rulingia salviifolia</i>	2RC	R	-	Mount Barney NP
<i>Tetramolopium vagans</i>	2VC	R	-	Mount Barney NP
<i>Thelionema grande</i>	3RC	R	-	Mount Barney NP
<i>Westringia blakeana</i>	2RCa	R		Mount Barney NP
<i>Zieria montana</i>	3RC	-		Mount Barney NP

* Conservation status for Australia is based on Briggs and Leigh (1996). Status in Queensland is based on the *Nature Conservation (Wildlife) Regulation 1994* and in NSW on the *Threatened Species Conservation Act 1995*.

Notes:

Leucopogon cicatricatus. A ROTAP code of 3RCa is recommended for this taxon (Richards & Hunter 1997).

Table 9. Rare or Threatened Fauna of the Mount Barney Group

Species		Conservation Status*		Distribution in Group**			
		QLD	NSW	MB	BC	MC	MN
<u>Amphibians</u>							
<i>Litoria pearsoniana</i>	Cascade Frog	V			+		
<i>Litoria revelata</i>	Whirring Tree-frog	R		+			
<i>Philoria kundagungan</i>	Mountain Frog	R	V	+		+	
<u>Reptiles</u>							
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V	+			
<u>Birds</u>							
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V	V	+			
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	V	+			
<i>Chthonicola sagittata</i>	Speckled Warbler		V	+			
<i>Climacteris erythrops</i>	Red-browed Treecreeper	R	-	+			
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E	+			
<i>Menura alberti</i>	Albert's Lyrebird	R	V	+		+	+
<i>Ninox connivens</i>	Barking Owl		V	+			
<i>Podargus ocellatus plumiferus</i>	Marbled Frogmouth	V	V			+	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove		V	+	+	+	
<i>Ptilinopus superbus</i>	Superb Fruit-Dove		V	+			
<i>Tyto tenebricosa</i>	Sooty Owl		V	+			
<u>Mammals</u>							
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V	+			
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V	V	+			
<i>Kerivoula papuensis</i>	Golden-tipped Bat	R	V		+		
<i>Miniopterus australis</i>	Little Bent-wing Bat		V	+			
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	V	E	+			
<i>Phascolarctos cinereus</i>	Koala	M	V	+			

* Conservation status is based on the *Nature Conservation (Wildlife) Regulation 1994* for Queensland and the *Threatened Species Conservation Act 1995* for New South Wales

** Key to locations within Group:
 MB = Mount Barney NP
 BC = Burnett Creek SF
 MC = Mount Clunie FR
 MN = Mount Nothofagus FR

9.4. TWEED SHIELD VOLCANO GROUP

The Tweed Shield Group includes Mount Chinghee National Park, Rabbit Board Paddock Reserve 489, Prison Purposes Land 932, Prison Purposes Land 547, Border Ranges National Park, Lamington National Park, Limpinwood Nature Reserve, Springbrook National Park, Numinbah Nature Reserve, Mount Warning National Park, Amaroo Flora Reserve, Mebbin Lagoons Flora Reserve and Nightcap National Park (Map 4). This group lies wholly or, in the case of Border Ranges NP, largely on the landforms created by the erosion of the Tweed Shield Volcano.

The CERRA World Heritage property is essentially a subtropical and temperate rainforest property – rainforest types that fall into ecofloristic region A, and specifically into ecofloristic provinces A1 and A2 (Webb *et al.* 1984). This group represents a primary branch in the evolution of the Australian rainforests and has a Gondwanan ancestry, probably being the major rainforest type throughout the Tertiary (Adam 1992) and perhaps in the Cretaceous.

The remnant landforms of the Tweed Shield Volcano and the erosion caldera that has been carved out of the former massif are arguably the central feature of CERRA. The area is regarded as one of the two major rainforest refugia in continental Australia, the other being the Wet Tropics (Floyd pers. comm.). It is the locus of the core area of the A1 ecofloristic province (Webb *et al.* 1984) – the optimal humid mesotherm regime with eutrophic basaltic soils at low altitudes. These warm subtropical rainforests at lower altitudes on basalt-derived soils are the most structurally and floristically complex rainforests in central eastern Australia.

A humid cool-subtropical element ('cool' subtropical rainforest) extends on basalts generally above 800 metres altitude where rainfall is augmented by fog-drip. This type is also centred on the Tweed Shield, with significant areas of this type in Lamington and Border Ranges National Parks and Limpinwood Nature Reserve, with smaller areas in Springbrook, Nightcap and Mount Warning National Parks and Numinbah Nature Reserve. Beyond the shield volcano and within CERRA, this type is the major rainforest type along the Main Range from the Mistake Mountains to Wilsons Peak, and occurs in Acacia Plateau Flora Reserve, Dorrig National Park and New England National Park. Beyond CERRA, the type extends to the Bunya Mountains, parts of the upper Brisbane catchment and in the Sunshine Coast hinterland.

Another element within the A1 province is the humid mesotherm, simple notophyll vine forest (warm temperate rainforest) group which occurs on mesotrophic soils and is typically dominated by *Ceratopetalum apetalum* (Coachwood). The Tweed Shield is near the northern end of this element that extends south of CERRA and has outliers to the north as far as Kroombit Tops. Nevertheless, the shield volcano is one of the major refugia for this element and species such as *Eidothea hardeniana*, *Symplocos baeuerleni*, *Uromyrtus australis* and *Corokia whiteana* are endemic to this rainforest type on the shield.

The Tweed Shield is also part of the core area of ecofloristic province A2. The core area of this province is subtropical-lower montane and extends along the humid cloudy highlands from the Border Ranges south to the Illawarra. The rainfall is less seasonal than in A1 and is augmented by cloud-drip. Structurally, the rainforest is microphyll fern forest grading to simple microphyll vine-fern forest. These cool temperate rainforests are generally dominated by *Nothofagus moorei* (Antarctic Beech) in the north (the CERRA area), and *Eucryphia moorei* (Pinkwood) in the south. In the north there are gradations with cool subtropical rainforest, and *Ceratopetalum apetalum* may dominate on lower fertility soils.

In addition to being central to the subtropical rainforests and at the northern end of the arc of temperate rainforests, the Tweed Shield is also at the southern end of the C1 ecofloristic province. The core area is on the lowlands along the coast and in near-coastal areas north of Brisbane, and the optimal structural type is araucarian notophyll vine forest with tall *Araucaria cunninghamii* (Hoop Pine) or *A. bidwillii* (Bunya Pine) emergents. In more humid conditions above 1500mm rainfall the A1 rainforests replace this element. However, there is considerable overlap between the wetter fascies of C1 and the drier fascies of A1; examples occur on the western and northern sides of the shield.

The Tweed Shield is therefore a major refuge for Gondwanan rainforest, is the central core of the subtropical rainforests in Australia, and is at the northern and southern axes of temperate and dry rainforests respectively. As such it occupies a pivotal position both within CERRA and within the rainforests of Australia as a whole. The values encompassed by this area are not restricted to the rainforest communities but also extend to the plants and animals within them. There is a concentration of primitive, relict, endemic and threatened species

of flora and fauna within the Tweed Shield group and the area clearly demonstrates all of the values related to criteria (i) and (iv), and values related to the ongoing biological evolution in criterion (ii).

The Tweed Shield Volcano Group also clearly demonstrates values related to significant ongoing geological processes in criterion (ii). The Mount Warning erosion caldera that has been carved out of the shield is one of the major examples of this landform in the world, notable for its size and central mountain mass. The shield is also significant because all three stages of the erosion of the shield volcano – the planeze, residual and skeletal stages – are all present in the Tweed Shield complex.

This is an area of high biodiversity, the value of which is enhanced by the undisturbed nature of nearly all of Lamington NP, Springbrook NP, Limpinwood NR, Numinbah NR, Amaroo FR and Mebbin Lagoons FR, and large areas of Border Ranges NP and Mount Warning NP. Significant sections of the reserves are managed to maintain them free from human constructions such as walking tracks. A number of areas in NSW are formally gazetted as Wilderness Areas.

The Tweed Shield Volcano Group provides habitat for a highly diverse range of vertebrate species and is at or close to the centres of highest species diversity in Australia for birds, marsupials, frogs and snakes. One hundred and three species of rare or threatened plant species are recorded from the sites in the Tweed Shield Volcano Group (Table 10). Some 49 species of rare or threatened vertebrate species occur in the Tweed Shield Volcano Group (Table 11).

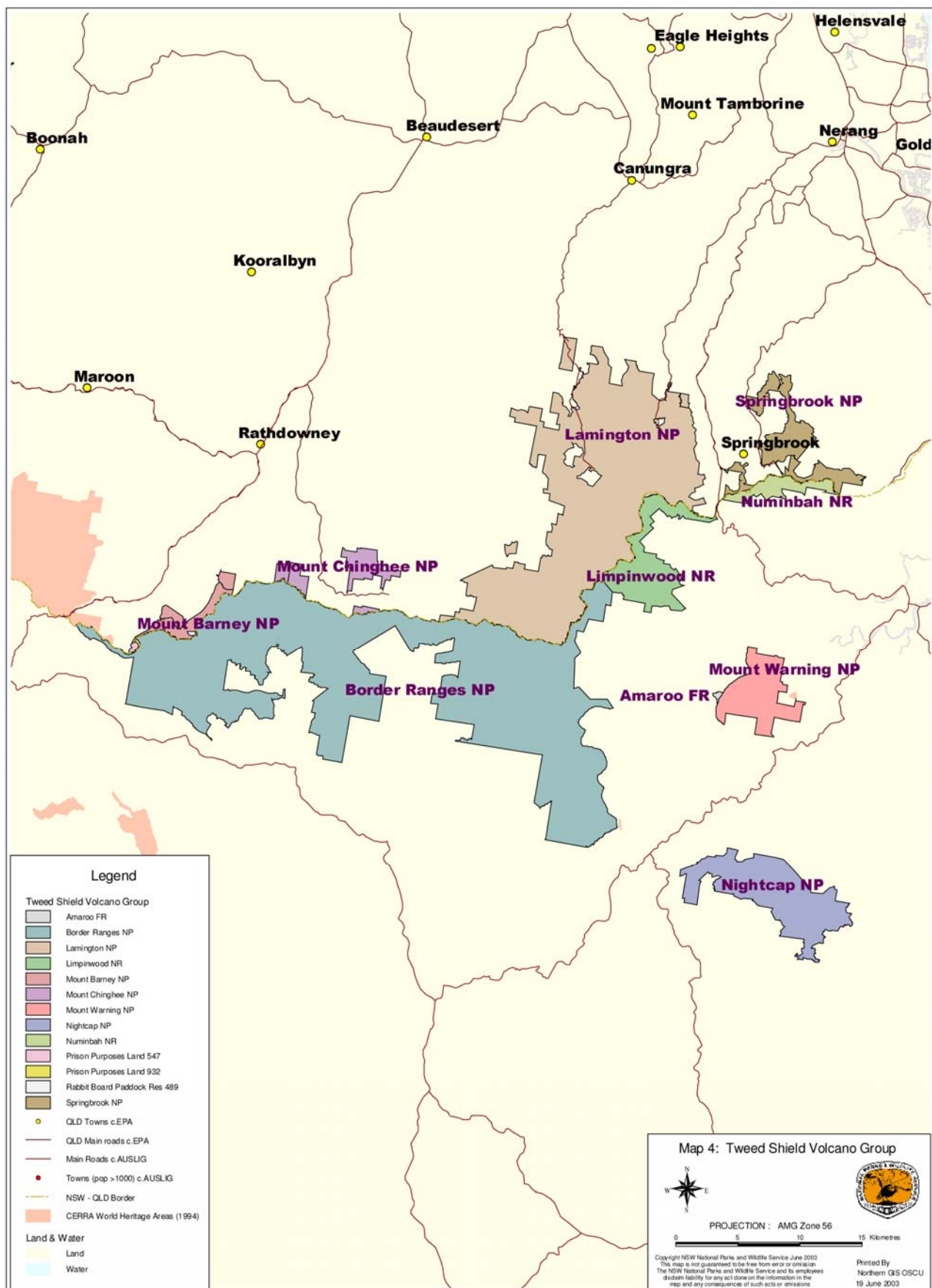


Table 10. Rare or Threatened Flora of the Tweed Shield Volcano Group

Species	Conservation Status*			Distribution in the Tweed Shield Volcano Group
	B & L	QLD	NSW	
<i>Acacia orites</i>	2RC	R	-	Springbrook NP, Lamington NP, Mt Warning NP, Nightcap NP, Numinbah NP
<i>Acianthus amplexicaulis</i>	3RC-	R	-	Border Ranges NP, Lamington NP
<i>Acomis acoma</i>	3RC	R	-	Border Ranges NP, Limpinwood NR
<i>Acronychia baeuerlenii</i>	3RC	R	-	Lamington NP, Springbrook NP, Limpinwood NR, Mt Warning NP, Nightcap NP, Amaroo FR
<i>Alloxylon pinnatum</i>	3RCa	R	-	Lamington NP, Springbrook NP, Border Ranges NP, Limpinwood NR, Numinbah NR
<i>Archidendron muellerianum</i>	3RCa	R	-	Springbrook NP, Border Ranges NP, Limpinwood NR, Mt Warning NP, Numinbah NR, Nightcap NP
<i>Ardisia bakeri</i>	2RC	R	-	Springbrook NP, Limpinwood NR, Numinbah NR
<i>Argophyllum nullumense</i>	3RCa	R	-	Lamington NP, Springbrook NP, Border Ranges NP, Limpinwood NR, Mt Warning NP, Nightcap NP, Numinbah NR, Amaroo FR
<i>Austrobuxus swainii</i>	3RCa	R	-	Springbrook NP, Border Ranges NP, Nightcap NP, Numinbah NR
<i>Banksia conferta</i> var. <i>conferta</i>	3RC	R	-	Lamington NP
<i>Brachyscome ascendens</i>	2RC	R	E	Lamington NP, Border Ranges NP
<i>Bulbophyllum argyropus</i>	3RCi+	R	-	Lamington NP
<i>Bulbophyllum globuliforme</i>	3VC	V	V	Lamington NP, Border Ranges NP
<i>Bulbophyllum weinthalii</i>	3RCi	R	-	Lamington NP
<i>Callerya australis</i>	3RC+	R	-	Lamington NP, Springbrook NP, Border Ranges NP, Mount Warning NP, Nightcap NP, Mt Chinghee NP
<i>Callitris monticola</i>	3RC	R	-	Lamington NP
<i>Cassia marksiana</i> (= <i>Cassia brewsteri</i> var. <i>marksiana</i>)	2RCi	R	E	Lamington NP
<i>Chiloglottis sphyrnoides</i>	3KC	-	-	Lamington NP
<i>Clematis fawcettii</i>	3VC	V	V	Lamington NP, Border Ranges NP, Limpinwood NR
<i>Comesperma esulifolium</i>	-	R	-	Springbrook NP, Lamington NP
<i>Cordyline congesta</i>	2RC	R	-	Lamington NP
<i>Corokia whiteana</i>	2VCi	-	V	Nightcap NP
<i>Corynocarpus rupestris</i> ssp. <i>arborescens</i>	3RC	R	-	Springbrook NP
<i>Cryptocarya foetida</i>	3VCi	V	V	Lamington NP
<i>Cupaniopsis newmanii</i>	2RC	R	-	Lamington NP, Border Ranges NP, Limpinwood NR
<i>Cyathea cunninghamii</i>	3RCa+	R	-	Lamington NP
<i>Cyperus rupicolus</i>	2RC	R	V	Lamington NP, Mount Warning NP, Nightcap NP, Border Ranges NP
<i>Dendrobium schneiderae</i> var. <i>schneiderae</i>	3RC	R	-	Lamington NP, Border Ranges NP
<i>Diospyros mabacea</i>	2ECi	-	E	Limpinwood NR
<i>Elaeocarpus williamsianus</i>	2ECi	-	E	Numinbah NR
<i>Endiandra floydii</i>	2VC	E	E	Numinbah NR
<i>Endiandra globosa</i>	2RC	R	-	Nightcap NP, Numinbah NR
<i>Endiandra hayesii</i>	3VC	V	V	Springbrook NP, Nightcap NP
<i>Endiandra introrsa</i>	3RCa	R	-	Springbrook NP, Nightcap NP
<i>Eucalyptus dunnii</i>	3RCa	R	-	Lamington NP, Border Ranges NP
<i>Eucalyptus fusiformis</i>	2RC	-	-	Lamington NP
<i>Eucalyptus microcodon</i>	2RC	R	E	Lamington NP, Springbrook NP, Border Ranges NP
<i>Eucryphia jinksii</i>	-	V	-	Springbrook NP

Species	Conservation Status*			Distribution in the Tweed Shield Volcano Group
	B & L	QLD	NSW	
<i>Euphrasia bella</i>	2VCit	V	V	Border Ranges NP, Limpinwood NR
<i>Floydia praealta</i>	3VC	V	V	Springbrook NP, Limpinwood NR, Mount Warning NP, Nightcap NP, Numinbah NR
<i>Fontainea australis</i>	3VCi	V	V	Springbrook NP, Limpinwood NR, Nightcap NP, Numinbah NR
<i>Gahnia insignis</i>	3RCa	R	-	Lamington NP, Springbrook NP, Nightcap NP, Numinbah NR
<i>Gaultheria viridicarpa</i> ssp. <i>merinoensis</i>	2VCit	-	V	Limpinwood NR
<i>Genoplesium sigmoideum</i>	2RC-t	R	-	Lamington NP
<i>Gonocarpus longifolius</i>	3RC	-	-	Border Ranges NP
<i>Helichrysum</i> sp. 'Mt Merino'	2RC	-	-	Lamington NP, Border Ranges NP, Limpinwood NR
<i>Helicia ferruginea</i>	-	R	-	Springbrook NP, Lamington NP, Limpinwood NR, Numinbah NR, Mt Warning NP, Nightcap NP
<i>Hibbertia hexandra</i>	3RC	R	E	Lamington NP, Nightcap NP, Springbrook NP
<i>Hicksbeachia pinnatifolia</i>	3RC	V	V	Springbrook NP, Nightcap NP, Amaro FR, Limpinwood NR
<i>Huperzia varia</i>	-	R	-	Lamington NP
<i>Isoglossa eranthemoides</i>	2EC	-	E	Mt Warning NP
<i>Kunzea bracteolata</i>	3RC	R	-	Limpinwood NR
<i>Lastreopsis silvestris</i>	2RCa	R	-	Lamington NP, Border Ranges NP, Springbrook NP, Limpinwood NR, Mt Warning NP
<i>Leionema elatius</i> ssp. <i>beckleri</i>	2EC	E	-	Lamington NP
<i>Lenwebbia lasioclada</i>	3RC-	R	-	Lamington NP
<i>Lenwebbia prominens</i>	-	R	-	Lamington NP, Limpinwood NR, Border Ranges NP, Nightcap NP, Springbrook NP, Mt Chinghee NP
<i>Lepiderema pulchella</i>	2RC	R	V	Lamington NP, Springbrook NP, Border Ranges NP, Limpinwood NR, Numinbah NR
<i>Macadamia tetraphylla</i>	2VC	V	V	Lamington NP, Springbrook NP, Limpinwood NR, Mt Warning NP, Nightcap NP, Numinbah NR
<i>Marsdenia longiloba</i>	3RC	R	E	Lamington NP
<i>Neimeyera whitei</i>	3RCa	V	V	Nightcap NP, Numinbah NR, Springbrook NP, Limpinwood NR, Amaro FR
<i>Ochrosia moorei</i>	2ECi	E	E	Springbrook NP, Numinbah NR, Amaro FR
<i>Olearia heterocarpa</i>	2RCa	R	-	Lamington NP, Springbrook NP, Nightcap NP
<i>Helmholtzia glaberrima</i> (syn. <i>Orthothylax glaberrimus</i>)	2RCa	R	-	Springbrook NP, Lamington NP, Border Ranges NP, Limpinwood NR, Nightcap NP, Mt Warning NP, Numinbah NR
<i>Owenia cepiodora</i>	2VCi	V	V	Lamington NP, Border Ranges NP, Mt Warning NP
<i>Ozothamnus vagans</i>	2RCa	V	-	Lamington NP, Border Ranges NP, Nightcap NP, Numinbah NR, Mount Warning NP, Limpinwood NR
<i>Ozothamnus whitei</i>	3RC	R	-	Lamington NP, Border Ranges NP
<i>Pandorea baileyana</i>	-	R	-	Lamington NP, Springbrook NP, Mount Warning NP, Border Ranges NP, Limpinwood NR
<i>Papillilabium beckleri</i>	-	R	-	Lamington NP
<i>Pararistolochia laheyana</i>	2RC+	R	-	Lamington NP, Border Ranges NP, Limpinwood NR, Numinbah NR, Mt Warning NP, Nightcap NP
<i>Parsonsia tenuis</i>	2RC-t	R	-	Lamington NP, Border Ranges NP, Limpinwood NR
<i>Persoonia volcanica</i>	2RC	R	-	Border Ranges NP
<i>Pimelia umbratica</i>	2RC	R	-	Lamington NP, Border Ranges NP
<i>Pittosporum oreillyanum</i>	2RCat	R	-	Lamington NP, Border Ranges NP, Limpinwood NR
<i>Plectranthus nitidus</i>	2KCi	E	E	Nightcap NP, ?Lamington NP (B&L)
<i>Pneumatopteris pennigera</i>	3VCa+	R	-	Lamington NP
<i>Podolepis monticola</i>	2RCa	R	-	Lamington NP, Border Ranges NP, Limpinwood NR

Species	Conservation Status*			Distribution in the Tweed Shield Volcano Group
	B & L	QLD	NSW	
<i>Podolobium aestivum</i>	3RC	-	-	Mount Warning NP
<i>Pomaderris notata</i>	2RC-t	R	-	Lamington NP, Mount Warning NP, Limpinwood NR
<i>Pultenaea pycnocephala</i>	3RCa	R	-	Lamington NP
<i>Quassia</i> sp. 'Mt Nardi'	3RC	-	-	Nightcap NP, Numinbah NR, Springbrook NP, Limpinwood NR
<i>Rhizanthella slateri</i>	3KC	-	V	Lamington NP
<i>Rhodamnia maideniana</i>	2RC	R	-	Springbrook NP, Numinbah NR
<i>Rulingia salviifolia</i>	2RC	R	-	Lamington NP, Border Ranges NP, Mount Warning NP
<i>Sarcochilus dilatatus</i>	3RC	R	-	Lamington NP
<i>Sarcochilus fitzgeraldii</i>	3VC	-	V	Lamington NP, Limpinwood NR, Mount Warning NP, Numinbah NR, Springbrook NP, Border Ranges NP
<i>Sarcochilus hartmannii</i>	3VC	V	V	Lamington NP, Mount Warning NP, Nightcap NP, Springbrook NP
<i>Sarcochilus weinthalii</i>	3VC	E	V	Lamington NP
<i>Schistotylus purpuratus</i>	3RCi	-	-	Border Ranges NP
<i>Solanum callium</i>	-	R	-	Mount Chinghee NP, Border Ranges NP
<i>Sophora fraseri</i>	3VC	V	V	Lamington NP
<i>Symplocos baeuerlenii</i>	2VC	V	V	Springbrook NP, Mount Warning NP, Nightcap NP, Numinbah NR, Limpinwood NR
<i>Syzygium hodgkinsoniae</i>	3VC	V	V	Springbrook NP, Limpinwood NR, Mount Warning NP, Nightcap NP, Numinbah NR
<i>Syzygium moorei</i>	2VCi	-	V	Springbrook NP
<i>Tinospora tinosporoides</i>	3RC	V	V	Mount Warning NP, Amaroo FR
<i>Trichosanthes subvelutina</i>	3RC	-	-	Lamington NP, Border Ranges NP, Springbrook NP, Numinbah NR, Mt Warning NP
<i>Uromyrtus australis</i>	2ECi	-	E	Nightcap NP
<i>Uromyrtus lamingtonensis</i>	2RC	R	-	Lamington NP, Limpinwood NR
<i>Wahlenbergia glabra</i>	2RC	-	-	Lamington NP
<i>Wahlenbergia scopulicola</i>	2RC	R	E	Lamington NP, Border Ranges NP
<i>Westringia blakeana</i>	2RCa	R	-	Lamington NP, Nightcap NP, Springbrook NP
<i>Westringia rupicola</i>	2VC	V	-	Springbrook NP, Lamington NP
<i>Zieria adenodonta</i>	2RC-t	R	-	Lamington NP, Mount Warning NP
<i>Zieria</i> sp 'Thornton Peak'	2RC	R	-	Lamington NP

* Conservation status for Australia is based on Briggs and Leigh (1996). Status in Queensland is based on the *Nature Conservation (Wildlife) Regulation 1994* and in NSW on the *Threatened Species Conservation Act 1995*.

Notes:

- *Chiloglottis sphyrnoides*. A ROTAP code of 3RCa is recommended for this taxon (Copeland & Hunter 1999).
- Briggs and Leigh (1996) incorrectly list *Euphrasia bella* and *Gaultheria viridicarpa* ssp. *merinoensis* as occurring in Lamington NP.

Table 11. Rare or Threatened Fauna of the Tweed Shield Volcano Group

Species		Status*		Distribution in Tweed Group**								
		Qld	NSW	BR	LA	SP	LI	NU	MW	NI	AM	ML
<u>Amphibians</u>												
<i>Assa darlingtoni</i>	Pouched Frog	R	V	+	+	+	+		+	+		+
<i>Lechriodus fletcheri</i>	Fletcher's Frog	R		+	+	+			+	+		+
<i>Litoria brevipalmata</i>	Green-thighed Frog	R	V	+								
<i>Litoria pearsoniana</i>	Cascade Frog	V		+	+	+			+	+		
<i>Litoria revelata</i>	Whirring Tree-frog	R		+	+	+						+
<i>Mixophyes fleayi</i>	Fleay's Frog	E	E	+	+	+				+		
<i>Mixophyes iteratus</i>	Giant Barred Frog	R	E		+	+				+		
<i>Philoria loveridgei</i>	Loveridge's Frog	R	V	+	+	+	+		+	+		
<u>Reptiles</u>												
<i>Acanthophis antarcticus</i>	Common Death Adder	R		+	+	+			+			
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-toothed Skink	R	V	+	+					+		
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake		V		+							
<i>Hoplocephalus stephensi</i>	Stephen's Banded Snake	R	V	+	+				+	+		+
<i>Ophioscincus truncatus</i>	a burrowing skink	R				+						
<u>Birds</u>												
<i>Amauornis olivaceus</i>	Bush-hen		V		+	+		+		+		
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V	V	+	+	+	+	+				
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V	V	+	+	+		+				
<i>Climacteris erythrops</i>	Red-browed Treecreeper	R		+	+				+	+		
<i>Climacteris picumnus</i>	Brown Treecreeper		V	+	+							
<i>Coracina lineata</i>	Barred Cuckoo-shrike		V	+	+				+	+		
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Fig-Parrot	E	E	+	+	+					+	
<i>Dasyornis brachypterus</i>	Eastern Bristlebird	E	E	+	+					+		
<i>Dupetor flavicollis</i>	Black Bittern		V	+						+		
<i>Erythrorhynchus radiatus</i>	Red Goshawk	E	E		+							
<i>Lophoictinia isura</i>	Square-tailed Kite	R	V								+	
<i>Menura alberti</i>	Albert's Lyrebird	R	V	+	+	+	+	+	+	+	+	+
<i>Monarcha leucotis</i>	White-eared Monarch		V	+	+				+	+	+	+
<i>Ninox connivens</i>	Barking Owl		V	+	+			+				
<i>Ninox strenua</i>	Powerful Owl	V	V	+	+	+		+	+			
<i>Pachycephala olivacea</i>	Olive Whistler	R	V	+	+		+	+		+		
<i>Podargus ocellatus plumiferus</i>	Marbled Frogmouth	V	V	+	+	+			+	+	+	+
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove		V	+	+	+	+	+	+	+	+	+
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove		V	+	+	+		+	+	+	+	+
<i>Ptilinopus superbus</i>	Superb Fruit-Dove		V	+	+				+			
<i>Rallus pectoralis</i>	Lewin's Rail	R			+							
<i>Turnix melanogaster</i>	Black-breasted Button-quail	V	E		+	+						
<i>Tyto novaehollandiae</i>	Masked Owl		V	+						+		
<i>Tyto tenebricosa</i>	Sooty Owl	R	V	+	+	+			+	+		
<u>Mammals</u>												
<i>Aepyprymnus rufescens</i>	Rufous Bettong		V	+	+							
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V	+	+	+						
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V	V	+	+	+	+		+	+	+	+

Species		Status*		Distribution in Tweed Group**								
		Qld	NSW	BR	LA	SP	LI	NU	MW	NI	AM	ML
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle		V	+	+					+		
<i>Kerivoula papuensis</i>	Golden-tipped Bat	R	V	+	+							
<i>Macropus parma</i>	Parma Wallaby		V	+								
<i>Miniopterus australis</i>	Little Bent-wing Bat		V	+	+				+	+		
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat		V	+	+	+			+	+		
<i>Mormopterus norfolkensis</i>	Eastern Little Mastiff-bat		V	+	+							
<i>Myotis adversus</i>	Large-footed Mouse-eared Bat		V	+	+					+		
<i>Nyctimene robinsoni</i>	Queensland Tube-nosed Bat		V	+	+				+	+		+
<i>Nyctophilus bifax</i>	Queensland Long-eared Bat		V						+	+	+	
<i>Petaurus australis</i>	Yellow-bellied Glider		V	+	+							+
<i>Petaurus norfolkensis</i>	Squirrel Glider		V	+	+				+			
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	V	E		+							
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale		V	+	+				+			
<i>Phascolarctos cinereus</i>	Koala	M	V	+	+	+			+	+	+	+
<i>Planigale maculata</i>	Common Planigale		V	+	+							
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	V	+	+	+				+		
<i>Pseudomys gracilicaudatus</i>	Eastern Chestnut Mouse		V	+	+							
<i>Pseudomys oralis</i>	Hastings River Mouse	V	E	+	+							
<i>Pteropus alecto</i>	Black Flying-fox		V							+		
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox		V	+	+					+		
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat		V		+						+	
<i>Scoteanax ruepellii</i>	Greater Broad-nosed Bat		V	+	+							
<i>Syconycteris australis</i>	Queensland Blossom Bat		V						+			
<i>Thylogale stigmatica</i>	Red-legged Pademelon		V	+	+		+			+		

* Conservation status is based on the *Nature Conservation (Wildlife) Regulation 1994* (Qld) for Queensland and the *Threatened Species Conservation Act 1995* (NSW) for New South Wales

** Key to locations in the Tweed Shield Volcano Group:

BR = Border Ranges NP
LA = Lamington NP
SP = Springbrook NP
LI = Limpinwood NR
NU = Numinbah NR
MW = Mount Warning NP
NI = Nightcap NP
AM = Amaroo FR
ML = Mebbin Lagoons FR

9.5. COASTAL GROUP

Iluka NR is the only reserve in this group (Map 5). The reserve is only 136ha in extent and is therefore significantly smaller than other CERRA sites. However, it is the only CERRA site that samples littoral rainforest, a subform of rainforest that is naturally restricted in distribution and one that has suffered considerably from human activities including clearing, urbanisation and sand mining.

In NSW, littoral rainforest now consists of only 1200 ha scattered as many small fragments behind coastal dunes and on headlands.

The sites where littoral rainforest occurs provide some very strong constraints to the development of rainforest. Strong, persistent salt-laden winds result in salt scalding of non salt-tolerant species to produce horizontal wind shearing and dense rigid canopy tops. Rainfall is generally lower than in mountains further inland, but this factor is partially compensated by the high atmospheric moisture content associated with the predominant sea breezes.

Sites on marine sands, such as is the case for Iluka NR, have the additional constraint that the sand substrate is very nutrient poor and often sharply drained. Paradoxically, the salt-laden winds that carry the toxic common table salt also import mineral nutrients such as calcium, magnesium, potassium and phosphorus from salt spray. Fragments in the sand, including shells, also provide calcium and phosphorus.

The suprising thing is that rainforest exists at all in the littoral zone. Its existence in such a harsh area provides the opportunity to study the relationship between environmental selection pressures and the characteristic structure and species composition.

The environmental sifting that littoral rainforest conditions have imposed over millions of years has selected for a sub-set of the Gondwanic species that make up subtropical rainforest. The most salt-tolerant group of species, and therefore the group making up much of the canopy exposed to salt-laden winds, includes some very ancient lineages such as the gymnosperm *Podocarpus elatus* and the magnoliid *Eupomatia laurina*. While less salt-tolerant, another gymnosperm *Araucaria cunninghamii* is fairly common in stands of littoral rainforest to the north of Iluka NR.

On the inland side of the rainforest the interface with the adjoining woodland appears to be dynamic and is controlled in many places by fire, although there seem to be some sections where topographic features impose a stable boundary. Transects to monitor this interface have been established for nearly twenty years.

Lowland rainforest areas, including littoral rainforest areas such as Iluka NR, are importance for providing seasonal food resources for species such as fruit doves. Two of the threatened fauna species that use the Iluka littoral rainforest habitat are fruit doves. Most of the other threatened bird species are water birds and seashore birds, but two other land birds, the White-eared Monarch and the Barred Cuckoo-shrike are of note.

Iluka NR is an ideal site for recreation, education and scientific investigation because of its ease of access. Tourism provides a significant input of money to the local economy and it is acknowledged by the local Chamber of Commerce that the World Heritage status of Iluka NR was paramount in easing the town through a depressed period in the early 1990s. Scientific investigations have a long history in Iluka NR and one of the largest running bird banding projects in NSW has been conducted at the site. The Koala population on the site and the adjacent area has been intensively studied over the past two decades. The reserve is also part of the habitat of the endangered population of coastal Emus.

Tables 12 and 13 show the rare and threatened species of flora and fauna known from the Coastal Group.

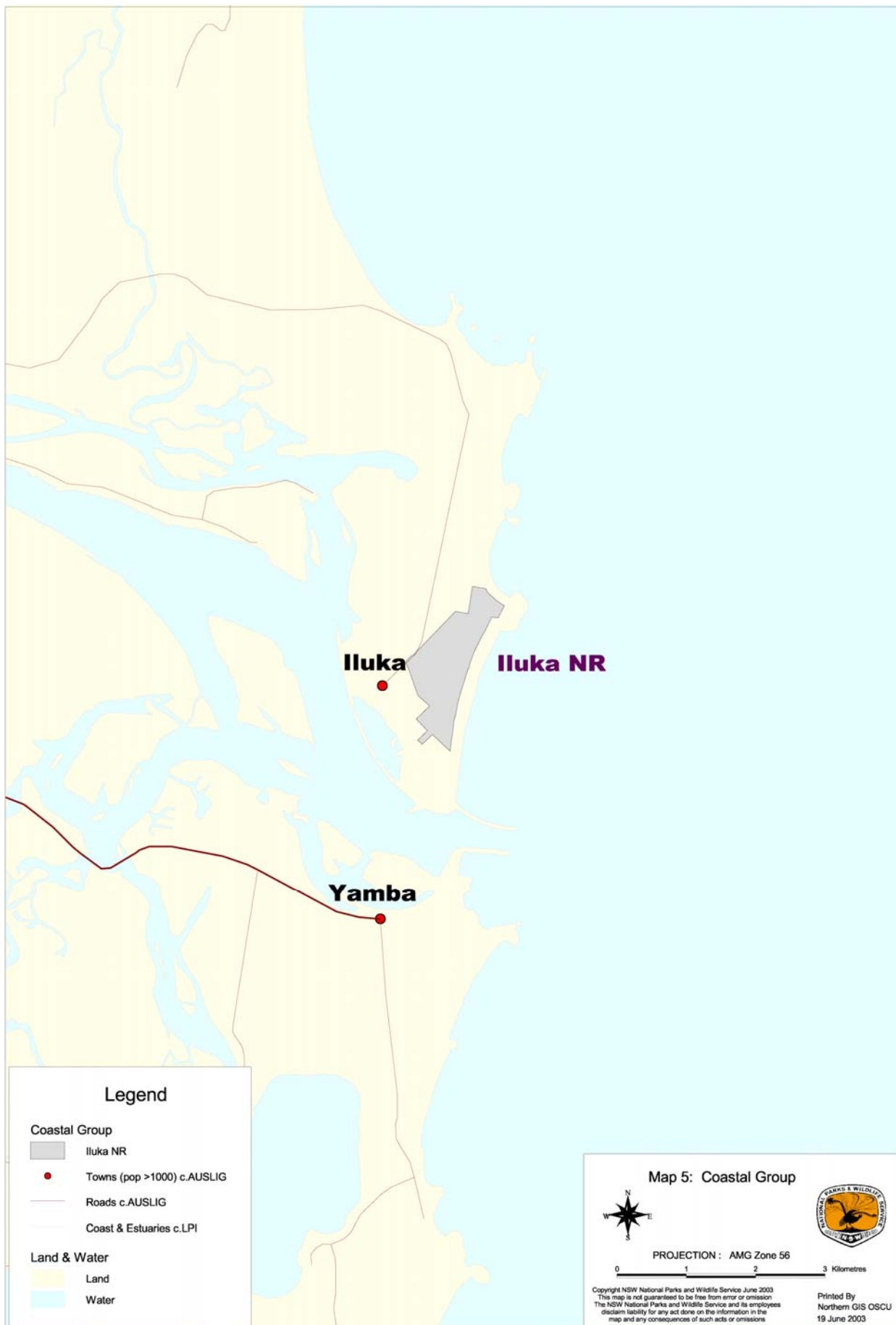


Table 12. Rare or Threatened Flora of the Coastal Group

Species	Conservation Status *	
	B and L	NSW
<i>Cryptocarya foetida</i>	3VCi	V
<i>Tinospora tinosporeoides</i>	3RC	V

* Conservation status for Australia is based on Briggs and Leigh (1996). Status in NSW based on the *Threatened Species Conservation Act 1995*.

Note: Briggs and Leigh (1996) incorrectly lists *Acronychia bauerlenii* as occurring in Iluka NR

Table 13. Rare or Threatened Fauna of the Coastal Group

Species		Conservation status*
<u>Birds</u>		
<i>Coracina lineata</i>	Barred Cuckoo-shrike	V
<i>Charadrius leschenaultii</i>	Greater Sand Plover	V
<i>Charadrius mongolus</i>	Lesser Sand Plover	V
<i>Dromaius novaehollandiae</i>	Emu	Endangered Population
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	E
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	V
<i>Haematopus longirostris</i>	Pied Oystercatcher	V
<i>Monarcha leucotis</i>	White-eared Monarch	V
<i>Pandion haliaetus</i>	Osprey	V
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V
<i>Sterna albifrons</i>	Little Tern	E
<i>Xenus cinereus</i>	Terek Sandpiper	V
<u>Mammals</u>		
<i>Dasyurus maculatus maculatus</i>	Spotted-tailed Quoll	V
<i>Miniopterus australis</i>	Little Bent-wing Bat	V
<i>Nyctophilus bifax</i>	Queensland Long-eared Bat	V
<i>Petaurus australis</i>	Yellow-bellied Glider	V
<i>Petaurus norfolcensis</i>	Squirrel Glider	V
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V
<i>Phascogale cinereus</i>	Koala	V
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V
<i>Syconycteris australis</i>	Queensland Blossom Bat	V

Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW).

9.6. WASHPOOL/ GIBRALTAR GROUP

The Washpool/ Gibraltar Group includes Washpool NP and Gibraltar Range NP (Map 6). It is a block of rugged mountain country bounded by the Great Escarpment to the east and the Demon Fault to the west. Gibraltar Range NP is a high plateau rising to 1200m and extending to the north into Washpool NP as a series of high ridges and plateaux dissected by steeply inclined valleys.

The Washpool/ Gibraltar Group is characterised not by concentrations of rare or threatened rainforest taxa or rainforest taxa at the limits of their range but by the diversity of plant communities and the mosaic distribution of wet sclerophyll forests and rainforest.

Warm temperate rainforest is the most extensive rainforest type within the area. The Willowie Scrub in Washpool NP covers 3000ha. It is the largest remaining stand of *Ceratopetalum apetalum* dominated warm temperate rainforest in the world. An unlogged area, Willowie Scrub also demonstrates a number of the seral stages of warm temperate rainforest.

Subtropical and dry rainforests are very limited in extent in the Washpool/ Gibraltar Group. Cool temperate rainforest is absent, even though there are high altitude sites with high rainfall. However, the area may have acted as a link in the past between cool temperate areas in the McPherson Range to the north and the New England Group to the south.

Wet sclerophyll forests with some exceptional areas of old growth forest and numerous examples of the intergrades between this forest type and rainforest are a feature of the Washpool/ Gibraltar Group. Some of these forests have canopies up to 70m above the ground.

Dry sclerophyll forests are also well represented, with a large number of eucalypt species present. On shallow soils in steep and rocky areas, forests often give way to wet or dry forms of scrub. Some of these scrubs are examples of rainforest reduced to closed shrub status referable to Suballiance 46 (*Leptospermum* spp.-*Notelaea venosa*-*Prostanthera* spp.) (Floyd 1990).

Heathlands are common on the shallow soils over granite in Gibraltar Range NP. These heathlands are extremely species-rich and spectacularly colourful during the flowering season. Sedge swamps and frost hollow grasslands are also present.

The Washpool/ Gibraltar Group is a valuable habitat complex supporting a high diversity of species. About a quarter of the 141 recorded species of bird reach their geographic limits in the area. This is a consequence of the rapid transition from the uplands to the coastal plain to the east, with 33 coastal species at their western limit, eight species at their eastern limit and one species at its southern limit.

A population of Rufous Scrub-bird in warm temperate rainforest in Gibraltar Range NP is very significant. This species is normally associated with cool temperate rainforest, further evidence that *Nothofagus* may have previously occurred in the area.

The presence of species such as figs at high altitudes results in a number of fruit-eating birds being recorded at unusually high altitudes. These include the Wompoo Fruit-Dove and the Rose-crowned Fruit-Dove, both vulnerable species.

A number of mammals that have disappeared from much of their former habitat elsewhere still retain populations within the Washpool/ Gibraltar Group. These include macropods such as the Long-nosed Potoroo, the Rufous Bettong and the Parma Wallaby. The carnivorous Spotted-tailed Quoll has dense populations in the area. The abundance of this carnivore and the density of ground-dwelling mammals may be due to the absence of the Fox. A notable feature of the fauna of the area is the rarity of introduced species.

Rare and threatened species of flora and fauna recorded from the Washpool/ Gibraltar Group are shown in Tables 14 and 15 respectively.

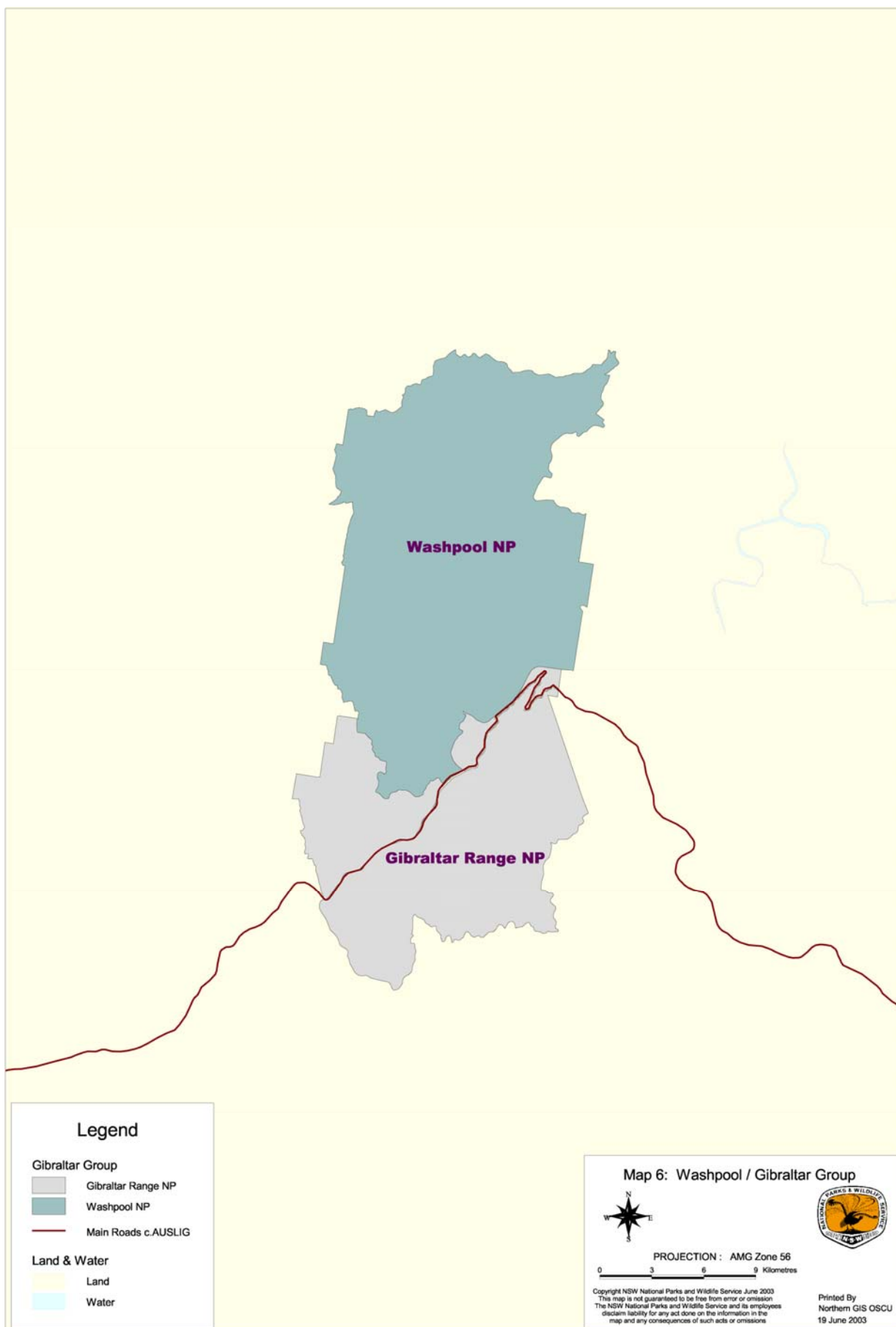


Table 14. Rare or Threatened Flora of the Washpool/ Gibraltar Range Group

Species	Conservation Status*		Distribution in the Washpool/ Gibraltar Range Group
	B & L	NSW	
<i>Acacia brunioides</i> ssp. <i>brunioides</i>	3RC	-	Gibraltar Range NP
<i>Acacia cangaensis</i>	2RC		Gibraltar Range NP
<i>Acacia tessellata</i>	2RC-		Washpool NP
<i>Callitris monticola</i>	3RC		Gibraltar Range NP
<i>Chiloglottis sphyrnoides</i>	3KC		Gibraltar Range NP
<i>Conospermum burgessiorum</i>	3RCa		Gibraltar Range NP
<i>Cryptandra lanosiflora</i>	3RCa		Gibraltar Range NP
<i>Dillwynia</i> sp. 'Gibraltar Range'	2RC-t		Gibraltar Range NP
<i>Dodonaea serratifolia</i>	2RC		Gibraltar Range NP
<i>Eucalyptus codonocarpa</i>	3RC		Gibraltar Range NP
<i>Eucalyptus olida</i>	2RCa		Gibraltar Range NP
<i>Grevillea acanthifolia</i> ssp. <i>stenomera</i>	3RC		Gibraltar Range NP
<i>Grevillea acerata</i>	2RC-t		Gibraltar Range NP
<i>Grevillea mollis</i>	2VCit		Gibraltar Range NP
<i>Grevillea rhizomatosa</i>	2VC-t	V	Gibraltar Range NP
<i>Hibbertia</i> sp. 'New England'	3RC		Gibraltar Range NP
<i>Hibbertia villosa</i>	3KC		Gibraltar Range NP
<i>Keraudrenia corollata</i> var. <i>denticulata</i>	3RC		Gibraltar Range NP
<i>Kunzea bracteolata</i>	3RC		Gibraltar Range NP
<i>Marsdenia longiloba</i>	3RC-	E	Gibraltar Range NP
<i>Melaleuca tortifolia</i>	2RC-t		Gibraltar Range NP, Washpool NP
<i>Persoonia rufa</i>	2RCa		Gibraltar Range NP
<i>Plectranthus suaveolens</i>	3KC		Gibraltar Range NP
<i>Podolobium aestivum</i>	3RC		Gibraltar Range NP
<i>Pultenaea pycnocephala</i>	3RCa		Gibraltar Range NP
<i>Pultenaea</i> sp. 'Gibraltar Range'	2RC-t		Gibraltar Range NP
<i>Ricinocarpus speciosus</i>	3RCi		Gibraltar Range NP
<i>Telopea aspera</i>	2RCa		Gibraltar Range NP
<i>Thelionema grande</i>	3RC		Gibraltar Range NP
<i>Tylophora woolsii</i>	2E	E	Gibraltar Range NP

* Conservation status for Australia is based on Briggs and Leigh (1996). Status in New South Wales is based on the *Threatened Species Conservation Act 1995*.

Notes:

- *Acacia tessellata*. A ROTAP code of 3RCa is recommended by Copeland and Hunter (1999).
- *Chiloglottis sphyrnoides*. A ROTAP code of 3RCa is recommended for this taxon (Copeland & Hunter 1999).

Table 15. Rare or Threatened Fauna of the Washpool/ Gibraltar Range Group

Species		Conservation Status*	Distribution in Group	
			WP	GR
<u>Amphibians</u>				
<i>Assa darlingtoni</i>	Pouched Frog	V	+	+
<i>Litoria subglandulosa</i>	New England Tree-frog	V	+	+
<i>Mixophyes balbus</i>	Stuttering Frog	E	+	+
<i>Mixophyes iteratus</i>	Giant Barred Frog	E	+	+
<i>Philoria pughi</i>	a sphagnum frog	V	+	+
<u>Reptiles</u>				
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V		+
<u>Birds</u>				
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V	+	+
<i>Botaurus poiciloptilus</i>	Australasian Bittern	V		+
<i>Burhinus grallarius</i>	Bush Stone-curlew	E	+	
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	+	+
<i>Climacteris picumnus</i>	Brown Treecreeper	V		+
<i>Erythrotriorchis radiatus</i>	Red Goshawk	E	+	
<i>Lophoictinia isura</i>	Square-tailed Kite	V		+
<i>Neophema pulchella</i>	Turquoise Parrot	V	+	
<i>Ninox strenua</i>	Powerful Owl	V	+	+
<i>Pachycephala olivacea</i>	Olive Whistler	V	+	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	+	+
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	+	+
<i>Stagonopleura guttata</i>	Diamond Firetail	V		+
<i>Tyto tenebricosa</i>	Sooty Owl	V	+	+
<u>Mammals</u>				
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	+	+
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V	+	
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	+	+
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle	V	+	
<i>Macropus dorsalis</i>	Black-striped Wallaby	E		+
<i>Macropus parma</i>	Parma Wallaby	V	+	+
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V	+	
<i>Petaurus australis</i>	Yellow-bellied Glider	V	+	+
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	+	
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	E		+
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	+	
<i>Phascolarctos cinereus</i>	Koala	V	+	+
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	+	+
<i>Pseudomys oralis</i>	Hastings River Mouse	E	+	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	+	
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	+	+
<i>Thylogale stigmatica</i>	Red-legged Pademelon	V	+	+

* Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW).

Key to locations in the Group:

WP = Washpool NP

GR = Gibraltar Range NP

9.7. NEW ENGLAND GROUP

The New England Group includes Mount Hyland NR, Dorriggo NP, New England NP and Cunawarra FR (Map 7). Dorriggo NP, New England NP and Cunawarra NR lie on the edge of the Great Escarpment, while Mt Hyland NR rises from the north-western side of the Dorriggo Plateau. One of the main centres of rainforest in NSW at the time of European settlement, the wide altitudinal range and rugged topography of the area results in the presence of rainforest types from warm subtropical to cool temperate.

The area is at the southern limit of rainforest Suballiance 1: *Heritiera trifoliata*, the most luxuriant subtropical rainforest (Floyd 1990), and few examples of the *Heritiera trifoliolata* Alliance occur further south. The lowland subtropical rainforests are a refugial area for the core of the A1 ecofloristic province (Webb *et al.* 1984) and include the southern limit of lowland subtropical rainforest species such as *Hicksbeachia pinnatifolia*, *Castanospora alphandii* and *Toechima dasyrrache*.

Dry rainforest is generally absent. *Araucaria cunninghamii* is at its southern limit very close to this area and, while it does occur in the small stands of dry rainforest, it is most common as a component of warm temperate rainforest and sometimes occurs in cool temperate rainforest.

Warm temperate rainforests are extensive on the less fertile soils derived from metamorphosed sedimentary rocks on much of the Dorriggo Plateau. Dominated by *Ceratopetalum apetalum*, the warm temperate rainforests include endemic species such as *Cryptocarya dorriggoensis* plus a suite of species such as *Austrobuxus swainii*, *Endiandra introrsa*, *Alloxylon pinnata*, *Calamus muelleri* and *Triunia youngiana* that are shared with the Tweed Shield Volcano Group. These disjunct populations of these species have probably been separated for a considerable length of time and in some cases there are probably significant genetic differences. For example, *Endiandra introrsa* is known to have significant chemical differences between the two areas of distribution, even though the populations appear identical macroscopically (Bandaranayake 1982). However, *Triunia youngiana* from the Eastern Dorriggo is genetically close to that in the Big Scrub area on southern side of the Tweed Shield and both are genetically distinct from Border Ranges populations (Shapcott 2002).

Cool temperate rainforests dominated by *Nothofagus moorei* have their lowest and highest altitude occurrences in the New England Group (nearly 1600m at Point Lookout in New England NP and under 500m on the Bo Bo River near to Dorriggo NP). Floyd (1990) notes that the number of trees and shrubs that are mainly restricted to cool temperate rainforest is at a maximum along the Bellinger Escarpment (48 species), closely followed by the Hastings (44 species). Floyd postulated that the Bellinger Escarpment – Upper Hastings is the refugial core area for *Nothofagus moorei* cool temperate rainforest. Floristic analyses undertaken by Bale and Williams (1993) supported this conclusion, recognising the Upper Dorriggo to Hastings as the refugial core; the Eastern Dorriggo, the area supporting the lowest altitude stands of *N. moorei* was considered to be one of three extraneous refugia.

The cool temperate rainforest type occurs not only as pure stands but also within warm temperate rainforest, cool subtropical rainforest and eucalypt open forest. The area provides good opportunities for studying the factors governing the distribution and inter-relationships of these forest types.

The rainforests of Mt Hyland include a rainforest type that is marginal to cool temperate rainforest. *Nothofagus* is not present but many of its common associates are, indicating that *Nothofagus* may have been present in the past. Mt Hyland also shows the effects of increased altitude and decreased nutrients on subtropical rainforest, with less species and less luxuriant rainforest present.

Scrub on summits often equates to low closed forest of Floyd's Suballiance 46: *Leptospermum* spp. – *Notelaea venosa* – *Prostanthera* spp. (Floyd 1990). These are examples of rainforest under extreme conditions including exposure to cold and strong winds and subsistence on skeletal soils.

The New England Group includes very diverse eucalypt communities, ranging from lowland to sub-alpine, including near-coastal, sub-alpine and dry tableland communities. This results in an extremely diverse collection of eucalypt species and the area is recognised as supporting one of the greatest diversities of eucalypts on the continent (Chippendale & Wolf 1981). Several commercially important species, including *Eucalyptus nitens* at its northern limit and *E. dunnii*, reach their geographic limits in the area.

The subalpine heath and swamp communities on the plateau edge in New England NP further increase the diversity of the area. A feature of Dorrig NP is the grassland on the Killungoondie Plains interspersed with *Nothofagus* forest. The origins of this grassland are the subject of debate, but severe frosts are probably responsible for their maintenance.

In addition to *Cryptocarya dorrigensis* in the warm temperate rainforest, endemic plant species of the rainforests include *Neoastelia spectabilis*, a large herb of cool temperate rainforest, and *Denhamia moorei*, a small tree of cool temperate rainforests. The large Ringwood tree (*Anetholea anisata*) is endemic to lowland sites within the group and nearby. Table 16 lists the rare or threatened flora known from the sites in the New England Group.

The fauna of the Group reflects the diversity of the vegetation. Species characteristic of subtropical rainforests such as fruit-doves occur in low altitude areas while species such as the Rufous Scrub-bird are found in the high altitude cool temperate rainforests and adjoining open forest. Twenty-seven threatened fauna species are known to occur in the sites in the New England Group. These species are listed in Table 17.

The New England Group also includes features that contribute to recognised World Heritage values related to ongoing geological processes. The sites include significant portions of the remnant Ebor Volcano. These remnants provide an outstanding example of the erosion of a shield volcano. The Ebor Volcano represents the best example in eastern Australia of a radial drainage pattern related to a specific centre of eruption.

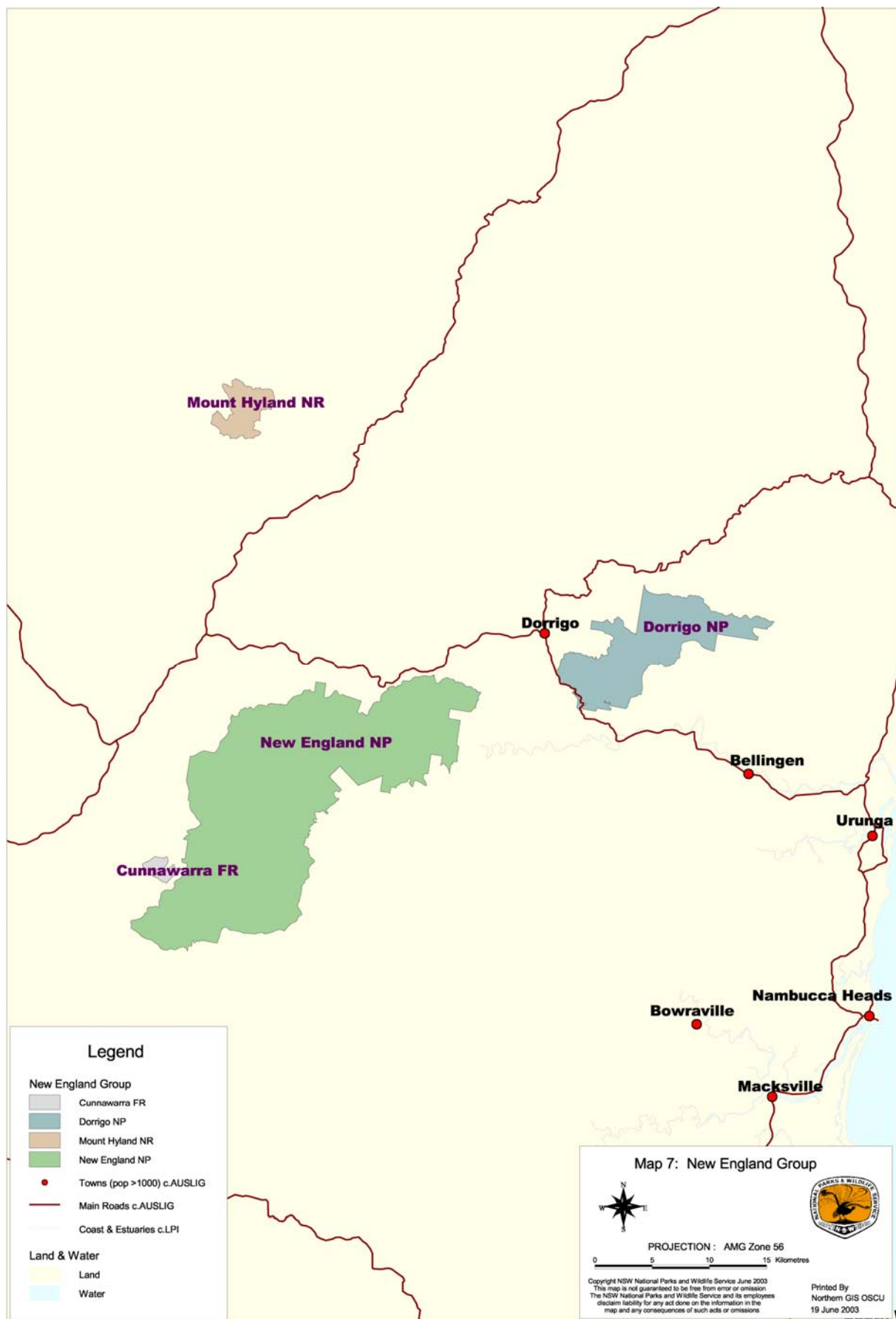


Table 16. Rare or Threatened Flora of the New England Group

Species	Conservation Status*		Distribution in Group
	B & L	NSW	
<i>Acacia tessellata</i>	2RC-		New England NP
<i>Acianthus amplexicaulis</i>	3RC-		New England NP, Dorrigo NP
<i>Acianthus apprimus</i>	2R		New England NP
<i>Alloxylon pinnatum</i>	3RCa		New England NP, Dorrigo NP
<i>Anetholea anisata</i>	2RCa		Dorrigo NP
<i>Austrobuxus swainii</i>	3RCa		New England NP, Dorrigo NP
<i>Bosistoa floydii</i>	2RCi		Dorrigo NP
<i>Bulbophyllum argyropus</i>	3RCi+		Dorrigo NP
<i>Carex capillacea</i>	3RC+		New England NP
<i>Chiloglottis palachila</i>	3RC		New England NP
<i>Cryptandra lanosiflora</i>	3RCa		New England NP
<i>Cryptocarya dorrigoensis</i>	2RCa		New England NP, Dorrigo NP
<i>Cryptocarya nova-anglica</i>	3RCa		Mount Hyland NR, New England NP, Cunnawarra NP
<i>Cynanchum elegans</i>	3ECi	E	New England NP
<i>Denhamia moorei</i>	2RC		Mount Hyland NR, New England NP, Dorrigo NP, Cunnawarra FR
<i>Diuris venosa</i>	2VC	V	New England NP
<i>Endiandra introrsa</i>	3RCa		Dorrigo NP
<i>Eucalyptus approximans</i>	2RC-	E	New England NP
<i>Eucalyptus dorrigoensis</i>	3KC		Dorrigo NP
<i>Euphrasia orthocheila</i> ssp. <i>orthocheila</i>	3RC-		New England NP
<i>Euphrasia ramulosa</i>	3RC		New England NP
<i>Gaultheria viridicarpa</i> ssp. <i>viridicarpa</i>	2VCit	V	New England NP
<i>Gingidia montana</i>	2VCit+	E	New England NP
<i>Goodenia fordiana</i>	2RC-		New England NP, Dorrigo NP, Cunnawarra FR
<i>Haloragis exalata</i> ssp. <i>velutina</i>	3VC-	V	New England NP
<i>Helichrysum</i> species 2	2RC-		New England NP, Cunnawarra NP
<i>Marsdenia liisae</i>	3RC-		Dorrigo NP, New England NP
<i>Marsdenia longiloba</i>	3RC-	E	New England NP
<i>Melaleuca tortifolia</i>	2RC-t		New England NP
<i>Neostelia spectabilis</i>	2VCit	V	New England NP
<i>Niemeyera whitei</i>	3RCa	V	New England NP, Dorrigo NP
<i>Olearia flocktoniae</i>	2ECi	E	Dorrigo NP, Mount Hyland NR
<i>Parsonsia dorrigoensis</i>	2VCi	V	Dorrigo NP, New England NP
<i>Quassia</i> sp. 'Mt Nardi'	3RC		Dorrigo NP
<i>Sarcochilus aequalis</i>	3RC-		Dorrigo NP
<i>Sarcochilus fitzgeraldii</i>	3VC	V	New England NP, Dorrigo NP
<i>Schistotylus purpuratus</i>	3RCi		New England NP, Dorrigo NP
<i>Styphelia perileuca</i>	2VC	V	New England NP
<i>Tasmannia glaucifolia</i>	3VCi	V	New England NP
<i>Tylophora woollsii</i>	2E	E	New England NP
<i>Typhonium eliosurum</i>	3RC		Dorrigo NP
<i>Wahlenbergia glabra</i> ssp. 'Point Lookout'	2RC-t		New England NP, Cunnawarra NP

Conservation status for Australia is based on Briggs and Leigh (1996). Status in New South Wales is based on the *Threatened Species Conservation Act 1995*.

Notes:

- *Acacia tessellata*. A ROTAP code of 3RCa is recommended by Copeland and Hunter (1999).
- *Acianthus* sp. aff. *forficatus*. A ROTAP code of 2RCa is recommended for this taxon (Clarke *et al.* 2000).
- *Callistemon* sp. aff. *pungens*. A ROTAP code of 2VCit is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Chiloglottis sphyrnoides*. A ROTAP code of 3RCa is recommended for this taxon (Copeland & Hunter 1999). It occurs in New England NP.
- *Chiloglottis* sp. aff. *pluricallata*. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Chiloglottis* sp. aff. *sphyrnoides*. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Corybas* sp. A. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Diuris* sp. aff. *ochroma* (New England). A ROTAP code of 2VCi is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Eryngium* sp. (Ebor Falls, J.B. Williams s.n., NE28062). A ROTAP code of 2VCi is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Leucopogon cicatricatus*. A ROTAP code of 3RCa is recommended for this taxon (Richards & Hunter 1997). It occurs in New England NP.
- *Ozothamnus* sp. (Ebor Falls). A ROTAP code of 3RC- is recommended for this taxon (Clarke *et al.* 2000).
- *Ozothamnus whitei*, a ROTAP species, has been incorrectly recorded for New England NP. It was confused with *Telfordia* sp. aff. *obovata* (Clarke *et al.* 2000).
- *Persoonia procumbens*, a ROTAP species, has been incorrectly recorded for New England NP. It was confused with *P. oleoides*.
- *Prostanthera* sp. nov. A ROTAP code of 2VCi is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Pterostylis* sp. aff. *parviflora*. A ROTAP code of 2RCa is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP and Cunnawarra NP.
- *Telfordia* sp. aff. *obovata*. A ROTAP code of 2RCa is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP and Cunnawarra NP.
- *Veronica* sp. B. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in New England NP.
- *Zieria* sp. Confused with *Z. lasiocaulis*, this species is either undescribed or a southern extension of *Z. montanus* from Queensland. It is a significant species (Clarke *et al.* 2000).

Table 17. Rare or Threatened Fauna of the New England Group

Species			Conservation Status*	Distribution in Group			
				MH	DO	NE	CU
<u>Amphibians</u>							
<i>Adelotus brevis</i>	Tusked Frog	Endangered population				+	
<i>Assa darlingtoni</i>	Pouched Frog	V	+	+			
<i>Litoria booroolongensis</i>	Booroolong Frog	E		+	+		
<i>Litoria subglandulosa</i>	New England Tree-frog	V		+	+		+
<i>Mixophyes balbus</i>	Stuttering Frog	E	+	+	+		+
<i>Mixophyes iteratus</i>	Giant Barred Frog	E			+		
<i>Phyllorhina sphagnicola</i>	Sphagnum Frog	V	+	+	+		
<u>Reptiles</u>							
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V			+		
<u>Birds</u>							
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V			+	+	
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V			+		
<i>Ninox connivens</i>	Barking Owl	V				+	
<i>Ninox strenua</i>	Powerful Owl	V	+	+			
<i>Pachycephala olivacea</i>	Olive Whistler	V				+	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V			+	+	
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	+	+	+		
<i>Tyto novaehollandiae</i>	Masked Owl	V			+		+
<i>Tyto tenebricosa</i>	Sooty Owl	V	+	+	+		
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E				+	
<u>Mammals</u>							
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V			+	+	
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	+	+	+		
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle	V				+	
<i>Macropus parma</i>	Parma Wallaby	V				+	
<i>Miniopterus australis</i>	Little Bent-wing Bat	V				+	
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V			+	+	
<i>Petaurus australis</i>	Yellow-bellied Glider	V			+		
<i>Petaurus norfolcensis</i>	Squirrel Glider	V				+	
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V			+	+	
<i>Phascogale cinerea</i>	Koala	V			+	+	
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V			+	+	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V			+		
<i>Thylogale stigmatica</i>	Red-legged Pademelon	V					+

Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW).

Key to locations within Group:

MH = Mount Hyland NR
DO = Dorrigo NP
NE = New England NP
CU = Cunnawarra FR

9.8. HASTINGS GROUP

The Hastings Group includes Werrikimbe NP, Fenwicks Scrub FR, Banda Banda FR and Mount Seaview NR (see Map 8). The sites lie on the Great Escarpment and are centered on the upper catchments of the Hastings and Forbes Rivers to the south and Kunderang Brook to the north. Mt Banda Banda (1258m) is the highest point on this section of the New England Tableland. The Kunderang Brook section of Werrikimbe National Park has since been transferred to Oxley Wild Rivers National Park.

The upper Hastings was one of the six major areas of rainforest in NSW at the time of European settlement. The sites include the largest remaining stands of rainforest within this area. These stands includes areas of subtropical, dry, warm temperate and cool temperate rainforests.

The Hastings Group is part of the core refugial area for *Nothofagus moorei* dominated cool temperate rainforest (Bale & Williams 1993). It also includes the best development of *Nothofagus moorei* in terms of height and canopy structure. The cool temperate rainforest often occurs with warm temperate rainforest elements and occasionally with subtropical rainforest elements (*Sloanea woolsii*). The relationship between cool temperate rainforest and eucalypt forest on plateau is complex and may be related to fire.

Warm temperate rainforest on the sites includes the *Ceratopetalum-Doryphora* and *Ceratopetalum-Sloanea woolsii* types and substantial areas still remain. An interesting component of this rainforest type near Werrikimbe Trig is Filmy King Fern (*Leptopteris fraseri*). This species is elsewhere known only from moist microhabitats from the Budawangs to the Blue Mountains.

Subtropical rainforest is less common. Much of the lowland subtropical rainforest has been cleared and is now rare in area. A small stand remains in Mt Seaview NR. Cool subtropical is present in valley heads at higher altitudes to the east of Forbes River. *Sloanea woolsii* is a prominent species in these stands.

Lowland areas of dry rainforest have also been mainly cleared, but a good example of the Shatterwood (*Backhousia sciadophora*) type occurs in Mt Seaview NP. Macleay dry rainforest also occurs in Kunderang Brook section of Werrikimbe NP.

Some fine stands of wet sclerophyll forest occur in the sites. Forests dominated by Tallowwood (*Eucalyptus microcorys*), Sydney Blue Gum (*E. saligna*) and Brush Box (*Lophostemon confertus*) frequently grade into rainforest. Of note is a good example of unlogged Blackbutt (*E. pilularis*) forest in Mt Seaview NR. On the plateau, species such as Messmate (*E. obliqua*) and *E. cameronii* which are more typical of the New England Tableland are present. Snow Gum (*E. pauciflora*), Black Sally (*E. stellata*) and *E. acaciiformis* occur in a few colder areas. Blue Mountains Ash (*E. oreades*), most common in the Blue Mountains, is present in a few stands.

Swamp, grassland, heath and scrub communities are also present within sections of the Hastings Group. The diversity of vegetation within the sites is reflected in the diversity of plant species present and, while the area is not noted for endemism within its flora, there are a number of rare or threatened species present. These are listed in Table 18.

In common with most of the other CERRA sites, the rugged escarpment topography and resultant diversity of vegetation types results in a wide diversity of fauna. A few of the noteworthy species present include those essentially confined to *Nothofagus* cool temperate rainforest such as the Olive Whistler and Rufous Scrub-bird, species confined to moist refugia such as the Sphagnum Frog, species of sedgeland and grasslands such as the Hastings River Mouse and species of the eucalypt forests such as the Koala. A more complete list is included in Table 19.

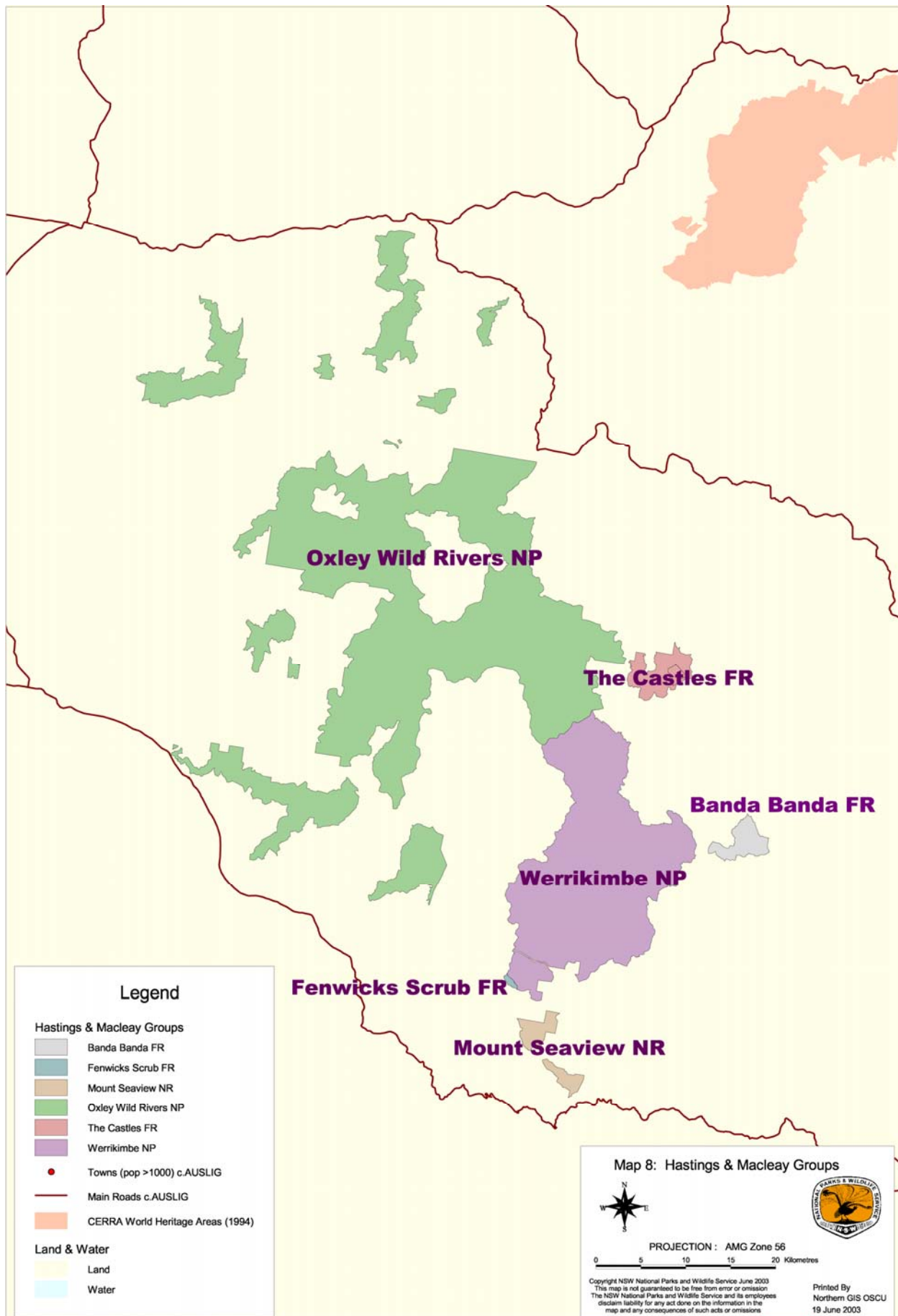


Table 18. Rare or Threatened Flora of the Hastings Group

Species	Conservation Status*		Distribution in Group
	B & L	NSW	
<i>Acacia tessellata</i>	2RC		Banda Banda FR, Werrikimbe NP
<i>Callitris oblonga</i>	3VCa	V	Werrikimbe NP
<i>Chiloglottis anaticeps</i>	2KC		Werrikimbe NP
<i>Cryptandra lanosiflora</i>	3RCa		Werrikimbe NP
<i>Cryptocarya nova-anglica</i>	3RCa		Werrikimbe NP
<i>Dodonaea serratifolia</i>	2RC		Banda Banda FR
<i>Goodenia fordiana</i>	2RC		Werrikimbe NP
<i>Grevillea acanthifolia</i> ssp. <i>stenomera</i>	3RC		Werrikimbe NP
<i>Grevillea linsmithii</i>	3RCa		Werrikimbe NP
<i>Marsdenia liisae</i>	3RC		Banda Banda FR
<i>Marsdenia longiloba</i>	3RC	E	Werrikimbe NP
<i>Sarcophilus aequalis</i>	3RC		Werrikimbe NP
<i>Sarcophilus fitzgeraldii</i>	3VC		Werrikimbe NP
<i>Schistotylus purpuratus</i>	3RCi		Werrikimbe NP
<i>Thismia rodwayi</i>	3RC+		Werrikimbe NP

* Conservation status for Australia is based on Briggs and Leigh (1996). Status in New South Wales is based on the *Threatened Species Conservation Act 1995*.

Notes:

- *Acacia tessellata*. A ROTAP code of 3RCa is recommended by Copeland and Hunter (1999).
- *Chiloglottis sphyrnoides*. A ROTAP code of 3RCa is recommended for this taxon (Copeland & Hunter 1999). It occurs in Werrikimbe NP.
- *Leucopogon cicatricatus*. A ROTAP code of 3RCa is recommended for this taxon (Richards & Hunter 1997). It occurs in Werrikimbe NP.

Table 19. Rare or Threatened Fauna of the Hastings Group

Species		Conservation Status*	Distribution in Group			
			WK	FS	BB	MS
<u>Amphibians</u>						
<i>Litoria booroolongensis</i>	Booroolong Frog	E	+			
<i>Litoria subglandulosa</i>	New England Tree-frog	V	+			
<i>Mixophyes balbus</i>	Stuttering Frog	E	+			
<i>Philoria sphagnicola</i>	Sphagnum Frog	V	+		+	+
<u>Birds</u>						
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V	+		+	
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	+			+
<i>Chthonicola sagittata</i>	Speckled Warbler	V	+			
<i>Climacteris picumnus</i>	Brown Treecreeper	V	+			+
<i>Melanodryas cucullata</i>	Hooded Robin	V	+			
<i>Ninox strenua</i>	Powerful Owl	V	+			
<i>Pachycephala olivacea</i>	Olive Whistler	V	+		+	+
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	+			+
<i>Tyto novaehollandiae</i>	Masked Owl	V	+			+
<i>Tyto tenebricosa</i>	Sooty Owl	V	+		+	
<u>Mammals</u>						
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	+	+		+
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle	V	+		+	
<i>Kerivoula papuensis</i>	Golden-tipped Bat	V				+
<i>Macropus parma</i>	Parma Wallaby	V	+			
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	+			
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V	+			
<i>Petaurus australis</i>	Yellow-bellied Glider	V	+			
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	+			
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	+			
<i>Phascolarctos cinereus</i>	Koala	V	+			
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	+			
<i>Pseudomys oralis</i>	Hastings River Mouse	E	+			
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	+			

* Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW).

Key to locations within Group:

WK = Werrikimbe NP

FS = Fenwicks Scrub FR

BB = Banda Banda FR

MS = Mount Seaview NR

9.9. BARRINGTON GROUP

The Barrington Group includes Barrington Tops NP, Keeripit Beech FR and Jerusalem Creek FR (Map 9). The Flora Reserves have since been added to Barrington Tops NP, and approximately 200 ha of the park has been incorporated into the new Mount Royal NP. The sites incorporate a high elevation plateau with steep and dissected ridge and valley systems falling from it, with an altitudinal range from less than 200 metres to just under 1600 metres. The plateau lies at the end of the Mount Royal Range, an offshoot from the Great Escarpment which divides the catchments of the Manning and Hunter Rivers.

The rainforests of the Barrington Group have been relatively little affected by clearing. The major types present are subtropical and cool temperate, with small areas of warm temperate rainforest. The sites contain an unsurpassed series of gradations between sclerophyll forests and rainforests in response to factors such as altitude, aspect, soil, rainfall and fire history.

Lowland subtropical rainforest occurs in the lower altitude valleys, with perceptible differences in stands in eastern and western valleys, probably due to differences in rainfall. Cool subtropical rainforest stands occur up to about 1000m altitude. These stands include a significant portion of warm temperate rainforest species and might be regarded as a transition between the two types.

Few warm temperate rainforest stands occur and Coachwood (*Ceratopetalum apetalum*) is absent from nearly all stands. The exception is the stand containing Coachwood and *Acradenia euodiiformis* in Jerusalem Creek FR.

Nothofagus moorei reaches its southern limit in the Barrington Group but cool temperate rainforest dominated by the species is extensive on the upper slopes and on protected sites on the plateau. Bale and Williams (1993) recognised Barrington Plateau as a near-core refugia area for this forest type, and with over 1000ha of cool temperate rainforest stands, the area includes the second largest occurrence of *Nothofagus moorei*. A feature of the forest type is the variety of associations formed with other species and the variety intergrades and boundaries with other forest types.

Eucalypt forests are also diverse within the Barrington Group, ranging from wet to dry and from lowland to subalpine. In contrast to other CERRA groups, this group of sites is characterised by extensive subalpine woodlands dominated by Snow Gum (*Eucalyptus pauciflora*) with locally common Black Sally (*E. stellata*). Such subalpine habitats have a limited and disjunct distribution in Australia and a number of restricted species of herbs and shrubs are associated with these habitats.

Open swamps are also common on the plateau in association with the woodlands, making this the most extensive, relatively untouched habitat of its kind north of Kosciuszko NP, which lies 500km to the south. Grassland balds are also present on the summits of some peaks.

The Barrington Group occurs in a region of major phytogeographic interest. The area is the southern limit for a number of cool and warm temperate rainforest species including *Nothofagus moorei*, *Vesselowskyia venusta*, *Tasmannia stipitata*, *Trochocarpa* sp. nov., *Cryptocarya foveolata*, *Orites excelsa* and *Acradenia euodiiformis*, subtropical rainforest species including *Sloanea woollsii*, *Cryptocarya erythroxylon* and *C. meisnerana* and the sclerophyll / rainforest emergent *Lophostemon confertus*. The presence of the dry Hunter River corridor to the south of the Barrington Group is probably a partial explanation of these southern limits.

A number of southern species such as *Blechnum penna-marina* and *B. fluviatile* reach their northern limit within the area, highlighting the links between the area and the Kosciuszko area in southern NSW.

A list of rare or threatened plant species recorded from the Barrington Group is included in Table 20.

A number of animal species also reach their distributional limits in the area. These include the Rufous Scrub-bird, the Paradise Riflebird and the Pale-yellow Robin. Other noteworthy animals include the Olive Whistler, the Wompoo Fruit-Dove, the Hastings River Mouse and the Broad-toothed Rat. A more complete list is included in Table 21.

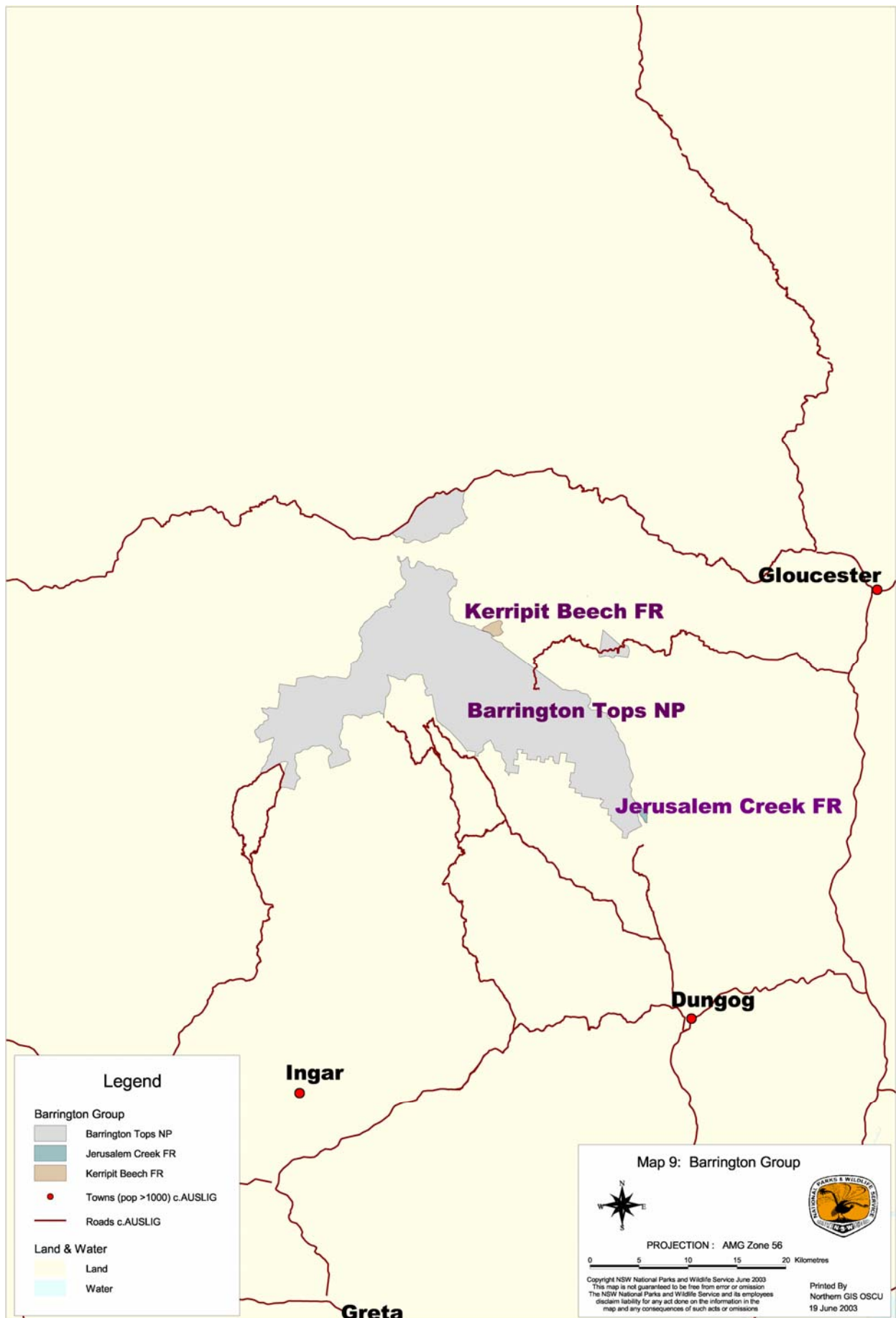


Table 20. Rare or Threatened Flora of the Barrington Group

Species	Conservation Status*		Distribution in Group
	B & L	NSW	
<i>Acacia barringtonensis</i>	3RCa		Barrington Tops NP
<i>Asperula asthenes</i>	3VC	V	Barrington Tops NP
<i>Chiloglottis palachila</i>	3RC		Barrington Tops NP
<i>Chiloglottis platyptera</i>	2KC		Barrington Tops NP
<i>Chionogentias barringtonensis</i>	2RC		Barrington Tops NP
<i>Diuris venosa</i>	2VC	V	Barrington Tops NP
<i>Eucalyptus largeana</i>	3RC		Barrington Tops NP
<i>Euphrasia ciliolata</i>	2KC		Barrington Tops NP
<i>Grevillea granulifera</i>	3KCa		Barrington Tops NP
<i>Leptospermum argenteum</i>	2RC		Barrington Tops NP
<i>Marsdenia liisae</i>	3RC		Barrington Tops NP
<i>Marsdenia longiloba</i>	3RC	E	Barrington Tops NP
<i>Ozothamnus</i> sp. 'Barrington Tops'	2KC-t		Barrington Tops NP
<i>Plantago cladarophylla</i>	2RC		Barrington Tops NP
<i>Plantago palustris</i>	2RC		Barrington Tops NP
<i>Pomaderris costata</i>	3RC-		Barrington Tops NP
<i>Pterostylis cucullata</i>	3VCa	V	Barrington Tops NP
<i>Pterostylis elegans</i>	3KC		Barrington Tops NP
<i>Pterostylis</i> species D	3VCa	V	Barrington Tops NP
<i>Senecio macranthus</i>	3RC		Barrington Tops NP
<i>Senna acclinis</i>	3RC	E	Barrington Tops NP
<i>Tasmannia glaucifolia</i>	3VCi	V	Barrington Tops NP
<i>Tasmannia purpurascens</i>	2VC-t	V	Barrington Tops NP
<i>Tylophora woollsii</i>	2E	E	Barrington Tops NP

* Conservation status for Australia is based on Briggs and Leigh (1996). Status for New South Wales based on the *Threatened Species Conservation Act 1995*.

Notes:

- *Chiloglottis* sp. aff. *sphymoides*. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in Barrington Tops NP.
- *Corybas* sp. A. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in Barrington Tops NP.
- *Ozothamnus* sp. 'Ebor Falls'. A ROTAP code of 3RC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in Barrington Tops NP.
- *Veronica* sp. B. A ROTAP code of 3KC- is recommended for this taxon (Clarke *et al.* 2000). It occurs in Barrington Tops NP.

Table 21. Rare or Threatened Fauna of the Barrington Group

Note: Records only from Barrington Tops National Park

Species		Conservation status*
<u>Amphibians</u>		
<i>Litoria booroolongensis</i>	Booroolong Frog	E
<i>Litoria subglandulosa</i>	New England Tree-frog	V
<i>Mixophyes balbus</i>	Stuttering Frog	E
<i>Mixophyes iteratus</i>	Giant Barred Frog	E
<u>Reptiles</u>		
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V
<u>Birds</u>		
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V
<i>Burhinus grallarius</i>	Bush Stone-curlew	E
<i>Calyptorhynchus lathami</i>	Glossy Black-Cockatoo	V
<i>Chthonicola sagittata</i>	Speckled Warbler	V
<i>Falco hypoleucos</i>	Grey Falcon	V
<i>Ninox strenua</i>	Powerful Owl	V
<i>Pachycephala olivacea</i>	Olive Whistler	V
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V
<i>Tyto novaehollandiae</i>	Masked Owl	V
<i>Tyto tenebricosa</i>	Sooty Owl	V
<u>Mammals</u>		
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V
<i>Macropus parma</i>	Parma Wallaby	V
<i>Mastacomys fuscus</i>	Broad-toothed Rat	Endangered population
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V
<i>Mormopterus norfolkensis</i>	Eastern Little Mastiff-bat	V
<i>Petaurus australis</i>	Yellow-bellied Glider	V
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	E
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V
<i>Phascolarctos cinereus</i>	Koala	V
<i>Planigale maculata</i>	Common Planigale	V
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V
<i>Pseudomys oralis</i>	Hastings River Mouse	E
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V
<i>Thylogale stigmatica</i>	Red-legged Pademelon	V

* Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW).

10. RESERVES INCLUDED IN THE 1994 LISTING WHICH WERE NOT INCLUDED IN THE 1992 NOMINATION

In response to the 1992 nomination, IUCN indicated that further consideration be given to the addition of certain areas to the property. In north-east New South Wales, these included the Richmond Range / Focal Peak region, rainforests of the Macleay Valley, and extensions to Barrington Tops NP, Mt Seaview NR and Mount Hyland NR. Following discussions with State Forests of NSW, it was agreed that a number of flora reserves would be added to the nomination. These included areas in the Richmond Range / Focal Peak region and the Macleay Valley, plus four other flora reserves (Acacia Plateau FR, Mebbin Lagoons, Cunnawarra and Jerusalem Creek) which were nearly contiguous with the nominated sites. Additionally, analysis of the rainforest values of the Macleay Valley region resulted in the addition of the Oxley Wild Rivers National Park to the nomination.

IUCN accepted the addition of these flora reserves and the national park on the basis of a brief report that included a discussion of the rainforests of the areas. Relevant information contained in that report, plus additional information, is included below for each of these areas. More detailed information on the presence of individual species within sites or groups of sites is contained in Appendices 6 – 10.

10.1. MEBBIN LAGOONS FLORA RESERVE

This is a small (11 ha) reserve within the former Mebbin SF; most of this State Forest, including this reserve, has now been included in Mebbin NP. The reserve is nestled at the base of the Tweed Range at 420 metres altitude. Behind it the cliffs of the inner wall of the Mt Warning caldera rise to the crest of the caldera rim about 1000 metre altitude; the crest of the Tweed Range forms the boundary of Border Ranges NP. The reserve encompasses a basalt bench at the base of the cliffs. This bench slopes slightly to the west into the east facing cliffs, resulting in the formation of semi-permanent freshwater lagoons. These lagoons vary in size and number depending on season and rainfall.

Large Flooded Gum (*Eucalyptus grandis*) and Brush Box (*Lophostemon confertus*) surround the lagoons with well-developed subtropical rainforest of Black Booyong (*Heritiera actinophylla*), Red Bean (*Dysoxylum molissimum*) and Giant Water Gum (*Syzygium francisii*), with stands of Bangalow Palm (*Archontophoenix cunninghamiana*) and large Moreton Bay Figs (*Ficus macrophylla*). The area is important for rainforest pigeons as it contains many fleshy-fruited plants.

This area forms part of the Tweed Shield Volcano Group and contributes to the World Heritage values of that group (see Section 9.4).

10.2. ACACIA PLATEAU FLORA RESERVE

Acacia Plateau FR forms part of the Main Range Group (see Section 9.2). The 585 ha reserve is situated about 12 km east of Killarney on the eastern fall of the Great Dividing Range in the former Koreelah SF; the area is now within Koreelah NP. Drainage of the area is by Trough Creek and an unnamed creek. These are tributaries of Koreelah Creek, which feeds the Clarence River. Altitude ranges from 520m on the eastern boundary to 1067m on the plateau on the western boundary.

The northern and western boundaries of the reserve follow the crest of the Great Dividing Range, which here forms the State border. The topography of the northern and western parts of the reserve is a flat to undulating plateau; this plateau (part of Acacia Plateau) varies in width from a few metres to almost a kilometre, and extends beyond the reserve into Queensland, where it is almost completely cleared. The eastern edge of the plateau within the reserve ends in a series of clifflines and steep slopes, giving way to undulating to steep land at lower elevations.

The geology is Tertiary volcanics that overlie and intrude Jurassic sediments. The volcanic rocks comprise massive basalt, rhyolite and trachyte lava flows from the Focal Peak volcano and associated fissures and vents. In the reserve, a relatively thin basalt cap remains on the higher areas to the west and north, over a layer of trachyte which has resisted weathering to form the cliffs below the plateau. Most of the lower (eastern) section of the reserve is underlain by a large trachyte dome which was pushed up through the

Jurassic sediments. The Jurassic Walloon Coal measures outcrop on the south-eastern boundary of the reserve; these measures comprise sandstones, siltstones, mudstones and coal seams, intermixed with areas of basalt.

The climate is warm temperate with common winter frosts and occasional snowfalls. The annual rainfall is about 1300 mm, with a marked summer/autumn maximum. Much of the following data is based on Floyd (1979a).

Rainforest covers about 80% of the reserve. Black Booyong (*Heritiera actinophylla*) subtropical rainforest occurs at lower elevations, generally below 800m, where it is protected from cold winter westerly winds and hot dry north-westerly summer winds. Associated species include Rosewood (*Dysoxylum fraserianum*), Giant Stinging Tree (*Dendrocnide excelsa*), Socketwood (*Daphnandra* sp.) and Brush Bloodwood (*Baloghia inophylla*).

Yellow Carabeen (*Sloanea woolsii*) subtropical rainforest occurs at higher altitudes and on the plateau. Associated species include Rosewood, Crabapple (*Schizomeria ovata*), Giant Stinging Tree, Black Booyong, Socketwood and Sour Cherry (*Syzygium corynanthum*).

Hoop Pine (*Araucaria cunninghamii*) dry rainforest occurs on the drier sites, often in association with the subtropical rainforest types. Common associates of the Hoop Pine are Giant Stinging Tree, Gap Axe (*Arytera divaricata*) and Brush Bloodwood.

Viney scrub rainforest occurs on the poorest, rocky, exposed sites. Common species are Brush Bloodwood, Whalebone Tree (*Streblus brunonianus*), Scrub Wilga (*Geijera latifolia*) and Native Holly (*Coelobogyne ilicifolia*). Formerly logged areas of the Yellow Carabeen type, which have been classified as viney scrub, are gradually progressing back to subtropical rainforest.

Sclerophyll forest types occur at lower altitudes and include Sydney Blue Gum (*Eucalyptus saligna*), Tallowwood (*E. microcorys*) - Sydney Blue Gum, Brush Box (*Lophostemon confertus*) and New England Blackbutt (*E. campanulata*) types.

There is a limited amount of information on the fauna of the reserve. It is known that two amphibian, eight reptile, six bird and nine mammal species occur; these include two threatened amphibians, one threatened reptile, five threatened birds and two threatened mammals (see Table 7).

10.3. NSW FOCAL PEAK GROUP

The Focal Peak region is the western extension of the Border Ranges region of north-eastern NSW. Rainforest in the region is predominantly associated with basaltic remnants of the Focal Peak Shield Volcano. This shield volcano, centered just to the north of the Queensland/ NSW border in the Mount Barney area, now remains in NSW as part of the western McPherson Range, Great Dividing (Main) Range/ Great Escarpment, Richmond Range, Koreelah Range and Capeen (Tooloom) Range. In Queensland, the shield remnants form parts of the western McPherson Range, the Mount Barney area, and the southern end of the Main Range. Basalt plateaux remain along these ranges and subsidiary vents occur as plugs throughout the region.

The largest remaining areas of rainforest in the Queensland section of the Focal Peak region and a number of areas in the New South Wales section (western section of Border Ranges NP, Mount Nothofagus FR, Mount Clunie FR and Wilsons Peak FR) were included in the 1992 nomination. Omissions from the nomination included the significant areas of rainforest which occur on the Richmond, Koreelah and Capeen Ranges. A selection of flora reserves in these areas (see below) was put forward for listing in response to the IUCN assessment of the 1992 nomination. At the time of listing all these reserves were within state forests; all are now within national parks or nature reserves.

The rainforests occur predominantly on the crests of the ranges on basalt soils and in moist, sheltered sites at lower altitudes. Rainfall in the Focal Peak / Richmond Range region is generally lower than on the Mt Warning Shield and is marginal for the development of wet subtropical rainforest. Drier forms of subtropical rainforest and dry rainforest consequently make up a significant portion of the rainforest present in the region. Wet sclerophyll forests with understoreys ranging from grass to well-developed rainforest form a

mosaic with rainforest stands at higher altitudes. At lower altitudes, basaltic soils are scarcer and rainfall is less, and dry sclerophyll forests and woodlands are common.

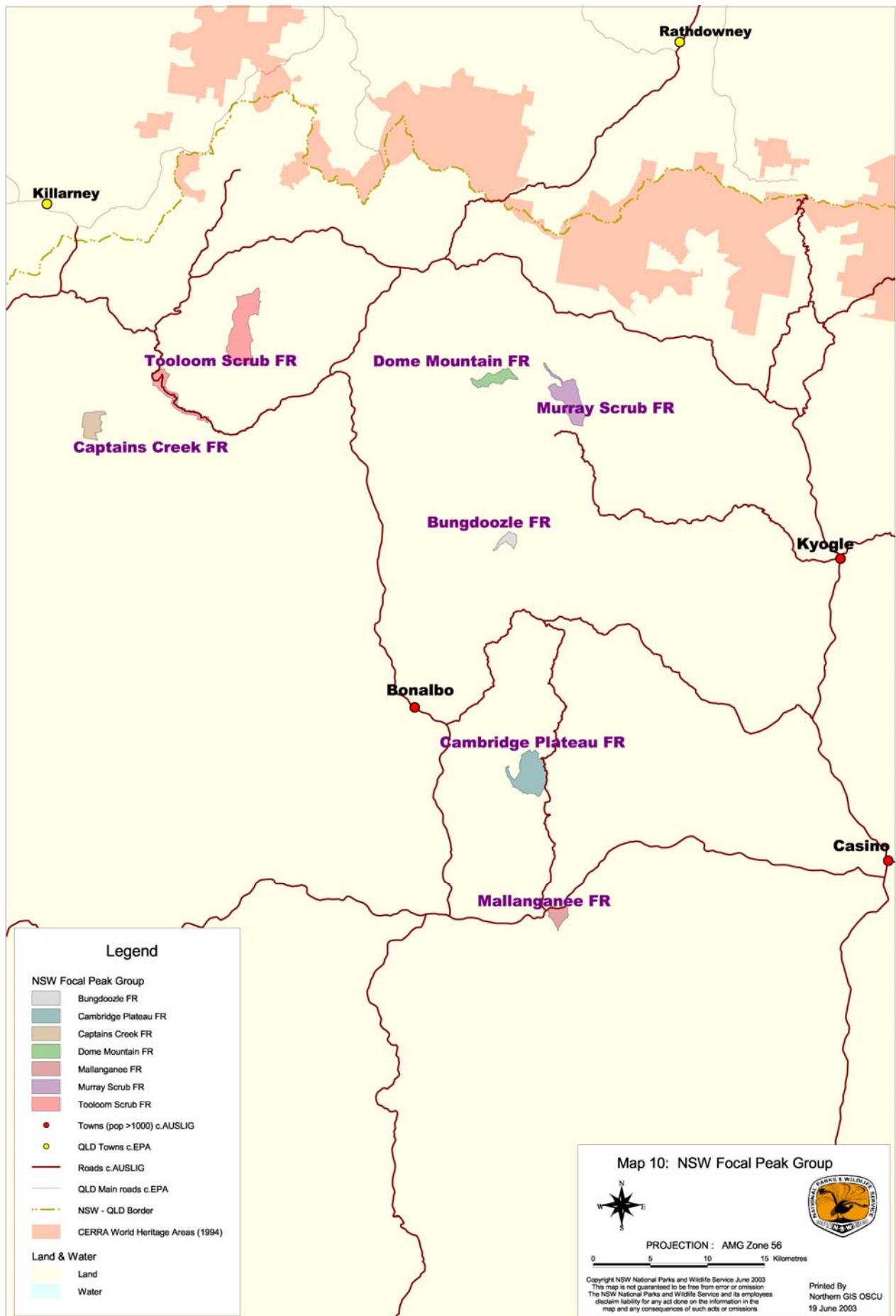
Two major rainforest types, subtropical and dry, occur in the subject areas. Three relatively large (3-4000 ha) stands of subtropical rainforest occur on or around the main plateaux of the Koreelah, Tooloom and Richmond Ranges, and smaller stands occur elsewhere on protected sites with southerly or easterly aspects. The dry rainforest type is found on areas of lower rainfall, principally on basalt-derived or basaltically enriched soils. It is widespread in the region in the Acacia Plateau area, on the southern sections of the Koreelah and Richmond Ranges, on the Razorback Range to the east of the Richmond Range, and at lower altitudes on the Richmond Range near the Richmond River. Rainforest that is intermediate between the subtropical and dry types is well-developed in the region and, in common with many of the dry rainforest stands, often has emergent Hoop Pine (*Araucaria cunninghamii*). The region includes a very large percentage of the remaining rainforest with araucarian emergents in NSW.

Wet sclerophyll forests with an upper stratum of Brush Box (*Lophostemon confertus*) and various species of *Eucalyptus* adjoin most rainforest stands, particularly in the moister north-eastern part of the region. Given the absence of further disturbance, these areas could be expected to develop into mature rainforest.

Floristically, the region is of significance because it is at the western limit of many of the common species of the moister rainforests to the east and the eastern extension of species more common in the dry western 'scrubs'. Other suites of species reach their northern or southern limits in the region. Rainforests of the region include a large percentage of the araucarian dry and subtropical types in NSW and the populations of associated species such as *Planchonella pohlmaniana*, *Cryptocarya bidwillii*, *Siphonodon australe*, *Rhodamnia whiteana*, *Flindersia collina*, *Citriobatus lancifolius*, *Croton stigmatosus*, *Denhamia pittosporoides*, *Excoecaria dallachyana*, *Melicope erythrococca*, *Casearia multinervosa* and *Erythroxylon australe*. Five species regarded as rare or threatened (Briggs & Leigh 1996) – *Acianthus amplexicaulis*, *Bosistoia floydii*, *Clematis fawcettii*, *Eucalyptus dunnii* and *Owenia cepiodora* – are known to occur in the reserves (see Table 22). Several other threatened species that generally occur in the ecotones of rainforest and sclerophyll forest have populations outside the listed areas but within the national parks enclosing the listed areas; these include *Corchorus cunninghamii*, *Rapanea* species 'Richmond River', *Senna acclinis* and *Sophora fraseri*. The threatened orchid *Pterostylis nigricans*, also occurs nearby. Two other threatened species, *Sarcophilus weinthalii* and *Syzygium hodgkinsoniae*, have unconfirmed records from the area (NPA undated). A form of *Corymbia variegata* which occurs on the Richmond Range in tall forests as a tree up to 50 metres is commonly known as Richmond Range Spotted Gum and was incorrectly called *Eucalyptus maculata* 'var. grayi'. This form probably represents one of several physiological ecotypes that show little, if any, morphological distinction (Hill & Johnson 1995).

The region supports more species of mammals than any other region of comparable size in Australia (Calaby 1966). It is a refuge for many vertebrate species that are now extinct or greatly reduced in numbers elsewhere. It was estimated in 1993 that 25% of the rare and vulnerable species and 29% of the endangered species of vertebrates in NSW occur in the region.

Seven flora reserves within the NSW section of the Richmond Range / Focal Peak region were added to the areas included in the 1992 nomination (see Map 10). These seven areas were subsequently listed in 1994. More information on each follows; much of this data is drawn from Floyd (1979b, 1980a, 1980b, 1981, 1982), Forestry Commission of NSW (1989) and Working Plans for individual areas.



10.3.1. Captains Creek Flora Reserve

This reserve encompasses 380 ha. Formerly part of the south-western section of Beaury SF, it now forms part of Captains Creek NR. Two main rock types occur in the reserve – Jurassic sediments and overlying Tertiary basalt. Topographically, the area is composed of moderate slopes, with steeper slopes at the heads of creeks and at the ends of small ridges. The soils include fertile krasnozems derived from the basalt, and less fertile podsolics from the sedimentaries. The area has a subtropical climate with winter frosts. There is an annual rainfall of about 900mm; this rainfall has a pronounced summer/autumn maximum.

Vegetation includes rainforest and eucalypt forest. The rainforest runs through the centre of the reserve from north to south, with eucalypt types to the east and west. The rainforest is a very good example of the dry inland Broad-leaved Leopard Tree (*Flindersia collina*) – Ivorywood (*Siphonodon australe*) association of the dry rainforest subform. The area was formerly dominated by Hoop Pine (*Araucaria cunninghamii*), but the larger stems were removed by past logging operations. In many respects, the area is comparable to Mallanganee FR, but is considerably drier. Captains Creek is an important link between the more extensive dry rainforest stands to the east and the dry scrubs to the west of the Great Dividing Range in northern NSW and southern Queensland. This link includes the presence of species such as Northern White Lilly Pilly (*Acronychia laevis*) and the western smooth-leaved form of Quinine Bush (*Alstonia constricta*) which is here up to 13m in height (Floyd 1982). Floyd also commented on the good specimens of *F. collina* and *S. australe*, and noted that this was the best sample he had seen in NSW of *Casuarina multinervosa*.

Eucalypt types include Grey Box (*Eucalyptus mollucana*)-Grey Ironbark (*E. siderophloia*), Grey Box, Grey Gum (*E. propinqua*)-Grey Ironbark-White Mahogany (*E. acmenioides*), and small areas of Dunn's White Gum (*E. dunnii*), Brush Box (*Lophostemon confertus*) and Forest Red Gum (*E. tereticornis*)-Grey Gum.

10.3.2. Tooloom Scrub Flora Reserve

The reserve, with an area of 1665 ha, was formerly part of Beaury SF and is now part of Tooloom NP. It lies at an altitude of 400m – 900 m on the eastern fall of Koreelah Range. Topography is steep to moderate with areas of plateau. It includes a waterfall (Rockhill Creek Falls) which is 100 m high. The geology is Jurassic sediments, overtopped by Tertiary basalt that forms most of the land surface. The climate is subtropical with a rainfall of about 1000 mm in valleys and higher on ranges; there is a distinct summer rainfall maximum. Heavy winter frosts occur.

The reserve is in two parts - Roadside section (460 ha) and Rockhill section (1200ha). The Roadside section on each side of the Legume-Urbenville Road is a transect from low altitude sedimentary soils to high altitude basalt. This samples a vegetation sequence from Forest Red Gum (*Eucalyptus tereticornis*) woodland in the valley, through various eucalypt types including Grey Box-Northern Grey Gum, Tallowwood (*E. microcorys*)-Sydney Blue Gum (*E. saligna*) and Dunn's White Gum (*E. dunnii*), to extensive stands of Booyong (*Heritiera actinophylla*)-dominated rainforest on the plateau.

The Rockhill section is mostly Booyong type with small areas of eucalypt forest and rock. Some of the rainforest was heavily logged before being added to the reserve.

Recreational and scenic features of the reserve include Tooloom Lookout, which gives fine views of the Koreelah Creek valley, and the spectacular Rockhill Creek Falls.

10.3.3. Dome Mountain Flora Reserve

This reserve covers 340 ha. Formerly part of Richmond Range SF, the area is now part of Toonumbar NP. Lying on the southern fall of Dome Mountain, the topography is generally steep to very steep, but with occasional benches. Geologically, the area is underlain by Jurassic sediments. A narrow tongue of basalt caps the upper parts of the reserve at about 600 – 900 metres altitude; subtropical rainforest is essentially confined to this basaltic area. This subtropical rainforest is of the White Booyong (*Heritiera trifoliata*) type, with scattered Flooded Gum (*Eucalyptus grandis*) and Brush Box (*Lophostemon confertus*) emergents at lower altitudes. Black Booyong (*Heritiera actinophylla*), Giant Water Gum (*Syzygium francisii*), Pigeonberry (*Cryptocarya erythroxylon*) and Bangalow Palm (*Archontophoenix cunninghamiana*) are common associated rainforest canopy species and there is a dense understorey of Bangalow Palms

(*Archontophoenix cunninghamiana*) and Cabbage Palms (*Livistona australis*), with common small trees including Brush Bloodwood (*Baloghia inophylla*) and Beetroot (*Ellatostachys nervosa*).

10.3.4. Murray Scrub Flora Reserve

This reserve covers 740 ha and is now included in Toonumbar NP. It consists of a broad basin lying between 300 and 800 metres in altitude. It slopes up to cliffs on its eastern side, and is drained by Ironpot Creek. Geology is Tertiary basalt overlying Jurassic sediments. It has a subtropical climate with an annual rainfall of about 1400mm.

The vegetation is predominantly subtropical rainforest of the White Booyong (*Heritiera trifoliata*) type, with Bangalow Palm (*Archontophoenix cunninghamiana*) on moister sites. Outstanding specimens of Coogera (*Arytera divaricata*), Beetroot (*Ellatostachys nervosa*), Socketwood (*Daphnandra* sp), Smooth-barked Bolly Gum (*Neolitsea australiensis*), Whalebone Tree (*Streblus brunonianus*), Sandpaper Fig (*Ficus fraseri*), White Bean (*Ailanthus triphysa*) and Native Elm (*Aphananthe philippinensis*) have been recorded from the rainforest.

Wet sclerophyll forest of Tallowwood (*Eucalyptus microcorys*)-Sydney Blue Gum (*E. saligna*), Flooded Gum (*E. grandis*) and Brush Box (*Lophostemon confertus*) occupy the less fertile and more fire-prone sites.

10.3.5. Bungdoozle Flora Reserve

This is a reserve of 145 ha, formerly part of Richmond Range SF and now included in Richmond Range NP. It lies in the head of a creek system at altitudes from 510 to 600 metres with mostly gentle slopes, becoming steep in the west. Geology is Tertiary basalt overlying Jurassic sediments. The climate is subtropical with an annual rainfall of about 1400mm.

Vegetation is subtropical rainforest of the White Booyong (*Heritiera trifoliata*) type, with some Black Booyong (*Heritiera actinophylla*) present. Small areas of sclerophyll forest of the Flooded Gum (*E. grandis*), Brush Box (*Lophostemon confertus*) and Grey Gum (*E. propinqua*)-Grey Ironbark (*E. siderophloia*)-White Mahogany (*E. acmenioides*) types are also present.

10.3.6. Cambridge Plateau Flora Reserve

This is an area of 870 ha, formerly in Richmond Range SF but now within Richmond Range NP. It is generally a gentle plateau but with cliffs to the east and steep slopes to the south-west. It mainly occupies the headwaters of Trynney Creek, which has a sheltered moist southern aspect, but also includes the drier slopes into Tunglebung Creek that have west to north-west aspects. The area lies between 270 and 590 metres in altitude. Geologically, it is Tertiary basalt overlying Jurassic sediments. The climate is subtropical with a rainfall of about 1200 to 1500mm.

The vegetation is a magnificent example of subtropical rainforest of the Black Booyong (*Heritiera actinophylla*) type. Purple Cherry (*Syzygium crebrinerve*) and Yellow Carabeen (*Sloanea woolsii*) are very common associated tree species, and White Booyong (*Heritiera trifoliata*), Giant Stinging Tree (*Dendrocnide excelsa*) and Yellowwood (*Flindersia xanthoxyla*) are common; Black Muskheart (*Alangium villosum*) is a common small tree.

10.3.7. Mallanganee Flora Reserve

This reserve has an area of 222 ha. Formerly within Cherry Tree North SF, it is now part of Mallanganee NP. It lies on the eastern fall of the Richmond Range between altitudes of 170 and 380 metres, with moderate to steep topography. The geology is Tertiary basalt overlying Jurassic sediments. The climate is subtropical, and the annual rainfall is about 1200mm.

Dry rainforest dominates this area. Originally this was of the Hoop Pine (*Araucaria cunninghamii*) type throughout, but Hoop Pine is now generally absent in the northern part of the reserve and Yellowwood (*Flindersia xanthoxyla*), Lacebark (*Brachychiton discolor*) and White Cedar (*Melia azederach*) are now common in the overstorey. A number of species of restricted distribution in NSW such as Onion Cedar (*Owenia cepiodora*), Tingle-tongue (*Melicope erythrococca*), Bat's Wing Coral Tree (*Erythrina vespertillio*),

Ivorywood (*Siphonodon australe*), Casearia (*Casearia multinervosa*), Strychnine Tree (*Strychnos arborea*), Quinine Bush (*Alstonia constricta*), Sticky Orange Thorn (*Citriobatus lancifolius*), *Acalypha capillipes*, *Tinospora smilacina* and Fire Vine (*Tragia novae-hollandiae*) occur within this area, and it is structurally and floristically very similar to dry rainforest areas in the headwaters of the Brisbane River. The best known population of the endangered Ripple-leaf Muttonwood (*Rapanea* species 'Richmond River') occurs just outside the flora reserve, but within the nature reserve.

Small areas of Grey Ironbark (*Eucalyptus siderophloia*) and Richmond Range Spotted Gum (*Corymbia variegata*) also occur.

10.3.8. World Heritage Values and Associative Natural Values of the Richmond Range / Focal Peak Group

The sites in this group include important examples of the rainforests of the A1 and C1 floristic provinces, including warm subtropical rainforests and dry rainforests, plus superb examples of the intergrades of the two. Araucarian emergents are common within the rainforests of the group, and Hoop Pine (*Araucaria cunninghamii*) can be found in the full range from warm subtropical rainforest (such as Cambridge Plateau) to dry rainforest types (such as Mallanganee and Captains Creek) that are more typical of south-eastern Queensland. The position of this group at the edge of the core C1 area is reflected in the significant number of dry rainforest species reaching their distributional limit here.

Additionally, the area includes good examples of the boundaries between rainforest and *Eucalyptus*-dominated open forests, including both sharp boundaries between rainforest and open forest and diffuse ecotones between the two. The juxtaposition of the two forest types and the variety within each contribute to the outstanding fauna values of the group.

The group is rich in biodiversity. Rare or threatened plants occurring within the group include five, maybe seven, species (Table 22).

Threatened fauna includes one species of carabid beetle, four species of frogs, three species of reptiles, 14 species of birds and 14 species of mammals. These species are listed in Table 23.

Table 22. Rare or Threatened Flora of the NSW Focal Peak Group

Species	Conservation Status*		Distribution in Group
	B & L	NSW	
<i>Acianthus amplexicaulis</i>	3RC-		Dome Mountain FR
<i>Bosistoa floydii</i>	2RCi		Cambridge Plateau FR
<i>Clematis fawcettii</i>	3VC	V	Murray Scrub FR, Cambridge Plateau FR
<i>Eucalyptus dunnii</i>	3RCa		Tooloom Scrub FR
<i>Owenia cepiodora</i>	2VCi	V	Mallanganee FR
? <i>Sarcophilus weinthalii</i>	3VC	V	Unsubstantiated records
? <i>Syzygium hodgkinsoniae</i>	3VC	V	Unsubstantiated records

Conservation status: Briggs and Leigh 1996 (B and L) for Australia, *Threatened Species Conservation Act 1995* (NSW) for NSW

Table 23. Rare or Threatened Fauna of the NSW Focal Peak Group

Species		Conservation Status*	Distribution in Group**						
			TS	DM	MS	CC	BD	CP	MA
<u>Invertebrates</u>									
<i>Nurus brevis</i>	a flightless carabid beetle	E						+	+
<u>Amphibians</u>									
<i>Litoria brevipalmata</i>	Green-thighed Frog	V	+						
<i>Mixophyes fleayi</i>	Fleay's Frog	E	+						
<i>Philoria kundagungan</i>	Mountain Frog	V	+						
<i>Philoria richmondensis</i>	a sphagnum fog	V	+	+					
<u>Reptiles</u>									
<i>Coeranoscincus reticulatus</i>	Three-toed Snake-tooth Skink	V	+	+					
<i>Hoplocephalus bitorquatus</i>	Pale-headed Snake	V	+						
<i>Hoplocephalus stephensii</i>	Stephen's Banded Snake	V	+						
<u>Birds</u>									
<i>Atrichornis rufescens</i>	Rufous Scrub-bird	V	+						
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V						+	
<i>Climacteris picumnus</i>	Brown Treecreeper	V	+						
<i>Coracina lineata</i>	Barred Cuckoo-shrike	V			+				+
<i>Cyclopsitta diophthalma coxeni</i>	Coxen's Fig-Parrot	E	+			+		+	
<i>Erythrorhynchus radiatus</i>	Red Goshawk	E	+						
<i>Menura alberti</i>	Albert's Lyrebird	V		+	+				
<i>Ninox connivens</i>	Barking Owl	V	+				+	+	
<i>Ninox strenua</i>	Powerful Owl	V	+						+
<i>Pomatostomus temporalis</i>	Grey-crowned Babbler	V	+						
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	+	+				+	+
<i>Ptilinopus regina</i>	Rose-crowned Fruit-Dove	V	+					+	
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V	+		+			+	
<i>Turnix melanogaster</i>	Black-breasted Button-quail	E	+						
<i>Tyto tenebricosa</i>	Sooty Owl	V	+					+	+
<u>Mammals</u>									
<i>Aepyprymnus rufescens</i>	Rufous Bettong	V	+						
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	+				+		
<i>Kerivoula papuensis</i>	Golden-tipped Bat	V	+					+	
<i>Macropus dorsalis</i>	Black-striped Wallaby	E	+			+			+
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	+						
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V	+						
<i>Petaurus australis</i>	Yellow-bellied Glider	V	+				+		
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	+						
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V	+				+		+
<i>Phascolarctos cinereus</i>	Koala	V	+					+	+
<i>Planigale maculata</i>	Common Planigale	V	+						
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	+				+		
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V							+
<i>Thylogale stigmatica</i>	Red-legged Pademelon	V	+						

* Conservation status is based on the *Threatened Species Conservation Act 1995* (NSW)

** Key to locations in Group:

TS = Tooloom Scrub FR
MS = Murray Scrub FR
BD = Bungdoozle FR

DM = Dome Mountain FR
CC = Captains Creek FR
CP = Cambridge Plateau FR

The group has associative natural values related to outstanding ecosystems Criterion (iii). The range of rainforest types from warm subtropical to araucarian dry represents ecosystems that reflect the rise of dry-adapted flora; the presence of intermediate communities allows insights into the processes driving the evolution of the species and communities. The property also has associative values related to areas of exceptional beauty. The disjunct volcanic remnants of the Focal Peak Shield Volcano remain as plateaux, escarpments and free-standing massifs which give the region its distinctive landscape.

The *Eucalyptus*-dominated vegetation values are well developed within the group and its surrounds. The variety of interactions between rainforest and eucalypt open forest has been noted above. Many of the eucalypt areas are of additional value because they are old growth forests.

10.4. CUNNAWARRA FLORA RESERVE

The reserve has an area of about 400 ha. Formerly part of Styx River SF, it is now included in New England NP and Cunnawarra NP. The area lies about 65 km east of Armidale and 14 km south of Ebor. It ranges in altitude from about 1000 metres to 1400 metres above sea level.

The reserve includes part of the upper catchment of Georges Creek and the slope into Cunnawarra Creek; both streams feed the Macleay River. The two valley systems are deeply dissected and clifflines or very steep slopes have formed at the edge of an overlying Tertiary basalt flow.

More easily weathered rocks below the basalt cap have been eroded to form V-shaped valleys with moderate slopes from 15 to 30 degrees. These rocks are Permian sedimentary shales and claystones which have been indurated to form hard greywacke close to the junction with the basalt.

A belt of massive rocks and boulders occur beneath the basalt cliffline; these have rolled or fallen from the steeper slopes above. Decomposition of the basalt has given rise to high fertility kraznozom soils and to enrichment of the poorer sedimentary soils downslope.

Rainfall in the area is in excess of 1500 mm, with a summer/autumn maximum and mists are common, particularly in winter. Snow falls on the higher ridges several times a year, and gale force winds during winter and spring may affect exposed sites.

Vegetation of the reserve includes rainforest and wet sclerophyll forest on the sheltered south-eastern slopes and dry sclerophyll forest on the north-western slopes and ridge tops.

Two rainforest types are present - warm temperate rainforest and cool temperate rainforest. The former covers 34 ha and occurs in the Cunnawarra Creek catchment on the lower slopes towards the creek where temperatures are higher and soils are derived from less-fertile sedimentary rock. It is clearly dominated by Coachwood (*Ceratopetalum apetalum*) and Sassafras (*Doryphora sassafras*), with associated Prickly Ash (*Orites excelsa*) and Hard Corkwood (*Endiandra sieberi*). Antarctic Beech (*Nothofagus moorei*) and Brown Barrel (*Eucalyptus fastigata*) are occasional emergents.

Cool temperate rainforest dominated by Antarctic Beech covers 184 ha of the reserve. It occurs on the upper slopes on fertile soils below the cliffline, where it is cool and moist and sheltered from dry westerly winds. Epiphytic ferns are common, and orchids, including Beech Orchid (*Dendrobium falcorostrum*) are present. Dominance by Antarctic Beech is almost total on the fertile upper slopes but on the poorer lower slopes the proportion and number of associated tree species increases, particularly Coachwood.

Tall wet sclerophyll forest dominated by Brown Barrel (*Eucalyptus fastigata*) with a continuous understorey of Antarctic Beech cover an area of 16 ha below the cliffline in the top end of the Georges Creek basin. The rainforest is apparently several hundred years old, and no regeneration of the eucalypts is evident.

Massive Manna Gum (*Eucalyptus nobilis*) trees, with heights of over 70 metres and diameters of up to 2.5-3 metres, are an outstanding feature of the reserve. These are among the largest trees in NSW. They dominate an area of 22 ha of tall wet sclerophyll forest on the moist, fertile soils of the sheltered mid slopes of the Georges Creek basin. Like the previous wet sclerophyll forest type, this type also has a continuous

understorey of Antarctic Beech rainforest and is a later stage of the transition from sclerophyll forest to rainforest.

Tall open forest dominated by Messmate (*Eucalyptus obliqua*) and Manna Gum covers 53 ha on fertile, but stony, basaltic soils on the ridge tops. Brown Barrel is an associated species and the understorey is grassy, with Tussocky Grass (*Poa* spp.) and Mountain Pepper Bush (*Tasmannia stipitata*).

Dry sclerophyll forest occurs on western facing slopes of the Cunawarra Range. It covers 84 ha and is dominated by New England Blackbutt (*Eucalyptus campanulata*), Messmate, Diehard Stringybark (*E. cameronii*) and occasional Manna Gum.

This area forms part of the New England Group (see Section 9.7) and contributes to the World Heritage Values of that group.

10.5. MACLEAY GROUP

The Macleay Group is contiguous with the Hastings Group (see Section 9.8 and Map 8). It comprises Oxley Wild Rivers NP and The Castles FR. The Macleay valley system lies to the north of Werrikimbe NP and south of New England NP. While they are contiguous, the rainforests of the Macleay Valley can be discussed by reference to three major sections. These are, from east to west, the Carrai Plateau / Willi Willi area, Kunderang Brook, and the Macleay Gorges. These are discussed in turn; the information is drawn largely from Floyd (1980b, 1983a, 1983b, 1990). This discussion is followed by a discussion of the two sites added to the World Heritage list.

Carrai Plateau / Willi Willi section

Rainfall in the Macleay Valley is lower than that in the surrounding mountains and rainforest is consequently restricted to sites of higher soil fertility. Of particular importance in this respect is the Yessabah Limestone belt which outcrops between Yessabah Caves area in the south-east and the southern end of the Carrai Plateau in the west. This limestone is a distinctive landscape feature as in places it forms massive cliffs. Caves are also a feature of the limestone. The soil derived from the limestone is often shallow, but where it is deeper, as at the base of cliffs, it is a fertile brown loam that is naturally rich in calcium. Sheltered sites, particularly on the moister southern and eastern aspects, favour the development of rainforest. As rainfall in the area is generally marginal for rainforest, except around the higher peaks and along the eastern edge of the Carrai plateau, dry rainforest is by far the most common subform. Only small areas of subtropical rainforest occur on the more favourable sites and warm temperate rainforest on the plateau edge. The Willi Willi Laurel (*Cryptocarya williwilliana*) is essentially confined to dry rainforest on limestone in this region.

Three types of dry rainforest have been recognised:

- Low altitude eastern dry rainforest occurs on limestone outcrops between Willi Willi Caves and Yessabah Caves. This type includes the southern limits of a number of species including *Harpullia hillii*, *Deeringia arborescens*, *Helichrysum bidwillii*, *Hoya australis*, *Caesalpinia subtropica*, *Tragia novae-hollandiae* and *Rauwenhoffia leichhardtii*. This type is inadequately conserved in Willi Willi Caves NR.
- High altitude dry rainforest lacks many of the species found at warmer locations. The best examples are on Crown Land on the southern slopes of Double Head, Flat Top, Jacobs Ladder and Jacobs Mount immediately downslope of warm temperate/subtropical rainforest. Willi Willi NP conserves some of this type.
- Low altitude western dry rainforest forms the bulk of the dry rainforest in the Willi Willi - Carrai region. Five subtypes are discernable. The cool moist limestone and cool plateau edge limestone subtypes are well represented in The Castles FR. The warm dry and cool plateau edge subtypes not on limestone are not conserved within the region but do occur further south in Mt Seaview NR and Woko NP. The fifth subtype, the lowland warm dry limestone subtype, contains the greatest diversity of species of any of the rainforests in the region; it is not conserved.

Kunderang Brook section

Kunderang Brook lies immediately to the west of the Carrai plateau and drains into the Macleay River, their confluence being about ten kilometres downstream of the junction of the Apsley and Macleay Rivers. Part of the upper catchment of Kunderang Brook lay within the World Heritage listed Werrikimbe NP but now has been transferred to Oxley Wild Rivers NP. The lower catchment, which is almost wholly within Oxley Wild Rivers NP, is discussed further here.

While areas of subtropical, warm temperate and cool temperate rainforests occur in the upper catchment, dry rainforest is the major subform within the Kunderang Brook catchment. It is the only rainforest subform that has any significant representation in the lower section of Kunderang Brook, which is largely in the rainshadow of the Carrai plateau. Dry rainforest in the area is generally confined to steep upper slopes and gullies of tributaries of Kunderang Brook, sites sheltered from fires burning down off the spurs above, which carry *Eucalyptus*-dominated forests.

Four types of dry rainforest are recognised from the area:

- Shatterwood (*Backhousia sciadophora*) - Giant Stinging Tree (*Dendrocnide excelsa*) association occurs over a wide altitudinal range within the area and Kunderang may be the centre of optimal development for Shatterwood, a normally restricted species. The rare Gorge Laurel (*Cryptocarya floydii*) is known from this type.
- Shatterwood - Yellow Tulip (*Drypetes australasica*) association has limited occurrence in the area. It is particularly notable for the profusion of epiphytes present. This rainforest type is broadly similar to, but drier than, the low altitude western type of the Carrai Plateau - Willi Willi area.
- Wollomombi Wattle (*Acacia diphylla*) association is almost exclusively dominated by Wollomombi Wattle. The association often occurs on the upper margin of the Shatterwood associations and may be a fire disclimax.
- Grey Myrtle (*Backhousia myrtifolia*) - Brush Box (*Lophostemon confertus*) association has a very limited distribution in the area.

The first three of these dry rainforest associations are also well represented on the western side of the Macleay River downstream of the junction of Kunderang Brook and the Macleay River (the former East Kunderang Station area, for example).

The dry rainforests of this area show strong affinities with, but are generally moister and structurally better developed than, those of the Macleay Gorges (see below) and the Guy Fawkes Gorges. Typical gorge species occurring in Kunderang Brook stands closest to these areas to the west and north-west include *Croton stigmatosus*, *Dendrocnide photinophylla*, *Melia azederach* and *Codonocarpus attenuatus*. Other typical gorge species such as *Cryptocarya floydii*, *Ficus rubiginosa*, *F. superba* var. *henneana*, *Acacia diphylla*, *Croton insularis*, *Brachychiton discolor*, *B. populneus*, *Notelaea microcarpa* var. *velutina*, *Spartothamnella juncea* and *Myoporum montanum* continue further up Kunderang Brook.

Macleay Gorges section.

Upstream of its junction with Kunderang Brook, the Macleay River and its tributaries have carved a deep gorge system into the eastern edge of the New England Tableland. The walls of these gorges are vertical or near vertical due to the erosion of the underlying slates along their vertical cleavage planes. Sheets of slate frequently break off and slip to the bottom of the gorges or form loose scree slopes.

Tall woodlands dominated by eucalypts occur on the tablelands adjoining the gorges, and eucalypt-dominated open forests and woodlands clothe many of the gentler slopes within the gorges. Much of the steeper gorge sides are bare rock or scree, but, where there is some build-up of soil between the rocks, heath and scrub may develop.

On sites which are sheltered, where the soil is somewhat deeper, and particularly where the topography collects any sub-surface drainage, rainforest may develop. This occurs as three types along a gradient from moist and protected at one extreme to dry and exposed at the other:

- Shatterwood - Giant Stinging Tree - Socketwood (*Daphnandra* sp.) association occurs as the best-developed rainforest in the gorges and has some subtropical rainforest affinities. It occurs in moist sheltered gullies particularly where the soils are enriched by basalt. This type has strong affinities with the Kunderang Brook dry rainforests and has in common with them a very well developed epiphyte component.
- Native Olive (*Olea paniculata*) - Narrow-leaved Scrub Wilga (*Geijera salicifolia*) – Yellow Persimmon (*Diospyros australis*) dry rainforest association occurs on steeper and drier slopes than the above type. Gorge Laurel is present in some stands.
- Ravine Bird's Eye (*Alectryon forsythii*) – Gorge Mock Olive (*Notelaea microcarpa* var. *velutina*) association is limited to small pockets of accumulated soil with minimal moisture for rainforest development and adequate protection. This is low rainforest only 2.5 to 4 metres in height and might be classified as a closed scrub or thicket.

The Castles FR and Oxley Wild Rivers NP were added to the areas included in the 1992 nomination and were subsequently listed in 1994. Each is discussed further below.

10.5.1. The Castles Flora Reserve

This reserve has an area of about 2360 hectares. Formerly part of Carrai SF, the reserve is now within The Castles NR. It is situated in the headwaters of Stockyard Creek and Warbro Brook, which drain into the Macleay River. Therefore, it samples some of the Carrai Plateau, part of the Carrai Plateau/Willi Willi section of the Macleay rainforests.

Topography is generally steep to very steep with frequent cliffs. A small area of flat to undulating country occurs to the west of Hogsback Mountain at an altitude of over 900m. In the east, the reserve falls to 500m altitude. The higher elevations of the reserve have a cool temperate climate with a rainfall of about 2000mm falling mainly in summer and autumn. At lower elevations, the climate is warm temperate and temperatures are higher and rainfall is lower.

The reserve is located over a sequence of Middle Carboniferous to Middle Permian marine sedimentary deposits. Mostly ranging from mudstone to conglomerate, the sediments include the massive Lower Permian Yessabah Limestone, which extends in a band through the south of the reserve. The Yessabah limestone has produced a series of caves and some 37 caves in or close to the reserve have been recognised.

Because of the range of altitudes, varied topography and different soil parent materials, there is considerable variation in the vegetation of the reserve. Nearly half of the reserve is covered in rainforest, about one third in low dry eucalypt communities, with the remainder being occupied by taller sclerophyll communities and rock.

Three broad rainforest types occur - subtropical, warm temperate/subtropical and dry. The subtropical rainforest covers about 80 ha and is limited to sheltered creeks and gullies, on soils derived from limestone in the eastern half of the reserve. The dominant canopy species are Black Booyong (*Heritiera actinophylla*) and Giant Stinging Tree (*Dendrocnide excelsa*) with Rosewood (*Dysoxylum fraserianum*) and Flame Tree (*Brachychiton acerifolius*) as common associates. Native Plum (*Guilfoylia monostylis*), Turnipwood (*Akania bidwillii*) and Brown Beech (*Pennantia cunninghamii*) are common small sub-canopy trees.

Warm temperate/subtropical rainforest is restricted to about 30ha at altitudes above 900m in the far west of the reserve. The intrusion of temperate elements into what would probably otherwise be subtropical rainforest is due to the low average temperatures associated with high altitude. Common canopy species in this type are Black Booyong, Yellow Carrabeen (*Sloanea woollsii*), Rosewood, Prickly Ash (*Orites excelsa*), Sassafras (*Doryphora sassafras*), Crabapple (*Schizomeria ovata*) and Corkwood (*Calcdcluvia paniculosa*).

Dry rainforest is quite extensive within the reserve (about 981ha) and occurs on a range of sites, but most commonly on steep slopes with a generally southerly or easterly aspect. There is considerable floristic and structural diversity and three broad types are recognised on the limestone - high altitude Shatterwood (*Backhousia sciadophora*)-Giant Stinging Tree-Black Booyong association and low altitude Shatterwood-Yellow Tulip (*Drypetes deplanchei*) association eastern and western. Most dry rainforest in the reserve is of the low altitude western type and the reserve is important in conserving this type. Shatterwood is probably the most common and extensive tree species in the dry rainforest in the reserve and is sometimes almost the only canopy species present. Other generally common tree species include Native Holly (*Alchornea ilicifolia*), Cleistanthus (*Cleistanthus cunninghamii*), Python Tree (*Austromyrtus bidwillii*), Yellow Tulip and Yellow Persimmon (*Diospyros australis*).

The tall sclerophyll forest types present include Sydney Blue Gum (*Eucalyptus saligna*) (9 ha), Tallowwood (*Eucalyptus microcorys*)-Sydney Blue Gum (42 ha), New England Blackbutt (*Eucalyptus campanulata*) (80 ha), Grey Gum (*Eucalyptus punctata*)-White Mahogany (*Eucalyptus acmenioides*) (70ha) and Brush Box (*Lophostemon confertus*) (86 ha). Low dry eucalypt forest types include Grey Gum-White Mahogany (359 ha) and New England Blackbutt.

Various herb and shrub communities with scattered, stunted trees occur on localised patches of very steep slopes with skeletal soil and outcropping rock. The ground cover is typically dense graminoids, such as

Kangaroo Grass (*Themeda australis*) and Mat Rushes (*Lomandra* spp), with scattered to fairly dense herbs and low shrubs such as *Plectranthus graveolens* and Mountain Boobialla (*Myoporum montanum*). Scattered low trees include Forest Red Gum (*Eucalyptus tereticornis*) and/or (*Eucalyptus melliodora*).

Plant species of significance include:

- Willi Willi Laurel (*Cryptocarya williwilliana*), which is confined to the Yessabah Limestones,
- *Macrozamia communis*, which is close to its northern limit,
- *Helichrysum bidwillii*, which is at or about its southern limit,
- *Caesalpinia subtropica*, which is close to its southern limit, and
- *Muehlenbeckia rhyticarya*, which is rare in northern NSW.

The caves within the limestone belt provide important habitat for bat fauna. Carrai Bat Cave is a roost for up to 10 000 bats, but is not a breeding cave. Three species of bats – Little Bent-wing Bat (*Miniopterus australis*), Eastern Bent-wing Bat (*M. schreibersii*) and Eastern Horseshoe Bat (*Rhinolophus megaphyllus*) – are known to be present in the caves.

10.5.2. Oxley Wild Rivers National Park

Oxley Wild Rivers NP samples a significant part of the Kunderang Brook and Macleay Gorges sections of the Macleay rainforests. The reserve encompassed 93 220 hectares when it was listed as a World Heritage area in 1994. There have been significant additions to the reserve since then, including a transfer of 9 600 ha from the World Heritage listed Werrikimbe National Park. It is estimated that the final reserve system is potentially 285 000 hectares in extent. The estimated total area of rainforest in the Macleay Gorges / Kunderang Brook is about 15 000 hectares.

Rainforest is obviously not the dominant vegetation type in this reserve. However, the area is a biophysical unity and contains superlative examples of the gorges dry rainforests and an unparalleled sample of the transition of dry rainforest along gradients of moisture, exposure and soil depth. Thus, while not a predominantly rainforest area, Oxley Wild Rivers NP represents an extreme of rainforest distribution and complements other World Heritage listed rainforest areas.

The dry and steep Macleay Gorges are regarded as a ‘hotspot’ for rare and endangered species of plants (L. Copeland, pers. comm.). They are the centre of distribution of restricted species such as the Ravine Bird’s Eye, the Gorge Wattle (*Acacia ingramii*) and the Gorge Hakea (*Hakea fraseri*). They are of special importance to plant geographers as they encompass part of a vital corridor whereby species such as the Wollomombi Wattle, Gorge Laurel, Narrow-leaved Scrub Wilga and the Gorge Mock Olive have interconnections with populations in the Bunya Mountains area with those in the Macleay Valley via the Clarence Valley and its most southern tributary, the Guy Fawkes River. The presence in these gorges of species such as Black Cypress Pine (*Callitris endlicheri*), Kurrajong (*Brachychiton populneus*), Cough Bush (*Cassinia laevis*), Mealy Saltbush (*Rhagodia parabolica*), Western Silkpod (*Parsonsia lanceolata*) and Caustic Vine (*Sarcostemma australe*) - species that are more typical of the western slopes of NSW - suggests that the area has acted as a refugium in past arid cycles.

10.5.3. World Heritage Values and Associative Natural Values of the Macleay Group

The Macleay Group has World Heritage values related to all of the three criteria for which the property was listed. The reserves include excellent examples of the seemingly oxymoronic vegetation type, dry rainforest. The development of dry adapted flora from ever-wet Gondwanan rainforest was an important stage in the earth’s evolutionary history. The sifting of rainforest taxa to develop rainforest communities that could tolerate periods of restricted water availability paralleled the emergence of taxa such as eucalypts that are adapted to fire. The spread of these floras was stimulated by the marked decrease in precipitation in the mid-late Miocene that was accompanied by development of a distinct dry season and an increase in burning. The Macleay Group, particularly Oxley Wild Rivers NP, contains excellent examples of the development and interaction of these two dry adapted floras, the dry rainforests and the eucalypt forests. The role of fire in determining the boundaries between the two is particularly evident, with the rainforest being generally confined to areas of no or low intensity or infrequent fire (Mantle 1997).

Dry rainforest on the most marginal sites is structurally reduced to microphyll vine thicket. While floristically related to araucarian notophyll or microphyll vine forests further north, it is distinct enough to be recognised as a specific suballiance, the *Alectryon forsythii*-*A. subdentatus*-*Notelaea microcarpa* suballiance (Floyd 1990). This suballiance has its major occurrences in the Guy Fawkes River, Wollombi-Chandler Rivers and Aspley-Tia Gorges; the latter two areas are both within Oxley Wild Rivers NP.

The presence of a number of endemic or near-endemic plants within the Macleay Group has been noted above. While there are no vertebrates known to be endemic to these reserves, the limestone habitats are important sites of invertebrate endemism. Limestone outcrops, particularly those of the Macleay Valley, are important focal points of terrestrial snail endemism (Stanisic 1997, Williams 2002). Cave systems, often associated with limestone, are important for conservation of associated, often endemic or localised, arachnid and insect faunas.

Lists of rare and threatened plant and animal species are shown in Tables 24 and 25.

Table 24. Rare or Threatened Flora of the Macleay Group

Species	Conservation Status*		Distribution in Group
	B & L	NSW	
<i>Acacia barringtonensis</i>	3RCa		Oxley Wild Rivers NP
<i>Acacia ingramii</i>	2RCa		Oxley Wild Rivers NP
<i>Acacia tessellata</i>	2RC	V	The Castles
<i>Bertya ingramii</i>	2VCit	E	Oxley Wild Rivers NP
<i>Bothriochloa biloba</i>	3V	V	Oxley Wild Rivers NP
<i>Callistemon pungens</i>	3R		Oxley Wild Rivers NP
<i>Chiloglottis platyptera</i>	2KC		Oxley Wild Rivers NP
<i>Cryptocarya floydii</i>	3RCi		Oxley Wild Rivers NP
<i>Cryptocarya williwilliana</i>	2RCi		The Castles FR
<i>Cynanchum elegans</i>	3ECi	E	Oxley Wild Rivers NP
<i>Discaria pubescens</i>	3RCa		Oxley Wild Rivers NP
<i>Dodonaea rhombifolia</i>	3RCa		Oxley Wild Rivers NP
<i>Dodonaea serratifolia</i>	2RC		Oxley Wild Rivers NP
<i>Eucalyptus elliptica</i>	3KC		Oxley Wild Rivers NP
<i>Eucalyptus magnificata</i>	3K		Oxley Wild Rivers NP
<i>Eucalyptus malacoxylon</i>	3R		Oxley Wild Rivers NP
<i>Eucalyptus michaeliana</i>	3RCa		Oxley Wild Rivers NP
<i>Eucalyptus nicholii</i>	3VC		Oxley Wild Rivers NP
<i>Eucalyptus youmanii</i>	2RC		Oxley Wild Rivers NP
<i>Gonocarpus longifolius</i>	3RC		Oxley Wild Rivers NP
<i>Grevillea beadleana</i>	3ECi	E	Oxley Wild Rivers NP
<i>Grevillea beadleana</i>	3ECi	E	Oxley Wild Rivers NP
<i>Grevillea granulifera</i>	3KCa		Oxley Wild Rivers NP
<i>Grevillea guthrieana</i>	3V	E	Oxley Wild Rivers NP
<i>Hakea fraseri</i>	2VC-	V	Oxley Wild Rivers NP
<i>Haloragis exalata</i> subsp. <i>velutina</i>	3VC-		Oxley Wild Rivers NP, The Castles FR
<i>Hibbertia hermanniifolia</i>	3RCa		Oxley Wild Rivers NP
<i>Olearia</i> sp.2 (Wollomombi; J.B. Williams s.n. 1974)	2KC-		Oxley Wild Rivers NP
<i>Ozothamnus adnatus</i>	3KC-		Oxley Wild Rivers NP
<i>Phebalium squamulosum</i> subsp. <i>verrucosum</i>	2RC-		Oxley Wild Rivers NP
<i>Picris evae</i>	3V	V	Oxley Wild Rivers NP
<i>Plectranthus suaveolens</i>	3KC		Oxley Wild Rivers NP
<i>Prostanthera cineolifera</i>	2K	V	Oxley Wild Rivers NP
<i>Pultenaea campbellii</i>	3K	V	Oxley Wild Rivers NP
<i>Ricinocarpus speciosus</i>	3RCi		Oxley Wild Rivers NP
<i>Sarcophilus aequalis</i>	3RC-		Oxley Wild Rivers NP
<i>Sarcophilus fitzgeraldii</i>	3VC-	V	Oxley Wild Rivers NP
<i>Sarcophilus hartmannii</i>	3VC	V	The Castles
<i>Senecio macranthus</i>	3RC-		Oxley Wild Rivers NP
<i>Senna acclinis</i>	3RC-	E	Oxley Wild Rivers NP
<i>Thesium australe</i>	3VCi+	V	Oxley Wild Rivers NP
<i>Westringia glabra</i>	2RC-		Oxley Wild Rivers NP

Conservation status: Briggs and Leigh 1996 (B and L) for Australia, *Threatened Species Conservation Act 1995* (NSW) for NSW

Table 25. Rare or Threatened Fauna of the Macleay Group

Species		Conservation Status*	Distribution in Group	
			OWR	TC
<u>Amphibians</u>				
<i>Adelotus brevis</i>	Tusked Frog	Endangered population	+	
<i>Litoria booroolongensis</i>	Booroolong Frog	E	+	
<u>Birds</u>				
<i>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo	V	+	
<i>Chthonicola sagittata</i>	Specked Warbler	V	+	
<i>Climacteris picumnus</i>	Brown Treecreeper	V	+	
<i>Melanodryas cucullata</i>	Hooded Robin	V	+	
<i>Neophema pulchella</i>	Turquoise Parrot	V	+	
<i>Ninox strenua</i>	Powerful Owl	V	+	+
<i>Pachycephala olivacea</i>	Olive Whistler	V		+
<i>Pandion haliaetus</i>	Osprey	V	+	
<i>Ptilinopus magnificus</i>	Wompoo Fruit-Dove	V	+	+
<i>Ptilinopus superbus</i>	Superb Fruit-Dove	V		+
<i>Stagonopleura guttata</i>	Diamond Firetail	V	+	
<i>Tyto novaehollandiae</i>	Masked Owl	V	+	+
<i>Tyto tenebricosa</i>	Sooty Owl	V	+	+
<i>Xanthomyza phrygia</i>	Regent Honeyeater	E	+	
<u>Mammals</u>				
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	+	
<i>Falsistrellus tasmaniensis</i>	Great Pipistrelle	V	+	
<i>Miniopterus australis</i>	Little Bent-wing Bat	V	+	+
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	V	+	+
<i>Petaurus australis</i>	Yellow-bellied Glider	V	+	
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	+	
<i>Petrogale penicillata</i>	Brush-tailed Rock Wallaby	E	+	
<i>Phascogale cinereus</i>	Koala	V	+	
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	+	
<i>Pseudomys oralis</i>	Hastings River Mouse	E	+	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	+	

* Conservation status is based on the *Threatened Species Conservation Act 1995*

Key to locations in Group:

OWR = Oxley Wild Rivers NP

TC = The Castles FR

10.6. JERUSALEM CREEK FLORA RESERVE

This 60 ha reserve is the most southerly site in CERRA. It was, at the time of its World Heritage listing in 1994, within Chichester SF; it has recently been added to Barrington Tops NP. The reserve lies about 20 km north of Dungog.

The reserve is underlain by the Carboniferous sediments of the Wootten Beds. Soils are red/orange in colour and are shallow and probably highly leached. The topography is mostly gentle, with some moderate to steep sections adjacent to Jerusalem Creek and associated drainage lines. The reserve lies between 500 m and 800 m above sea level.

Climate of the area is warm temperate with a late summer/early autumn rainfall maximum. The average annual rainfall is about 1300 mm. Frost occurs in winter, and there are occasional light snow falls.

The vegetation of the reserve includes rainforest and wet sclerophyll forest and ecotones between the two. Most of the area was logged in the past, and is now regenerating.

Warm temperate rainforest dominated by Coachwood (*Ceratopetalum apetalum*) covers about 34 ha of the reserve. It occurs on shallow and apparently infertile soils derived from coarse-grained sedimentaries such as sandstone. A common associate is Bonewood (*Acradenia euodiiformis*), and one part of the reserve, on the upper slopes, carries a virtually pure stand of this species. Bonewood is near its southern limit in this area. Other associated species include Prickly Ash (*Orites excelsa*), Sassafras (*Doryphora sassafras*), Crabapple (*Schizomeria ovata*), Callicoma (*Callicoma serratifolia*) and Water Gum (*Tristaniopsis laurina*).

The occurrence of Coachwood warm temperate rainforest in this reserve is significant because Coachwood is absent from most of the Barrington Tops and adjacent foothill areas. The reserve represents probably the best occurrence in this area of an otherwise fairly widespread and characteristic form of rainforest. The association of Coachwood and Bonewood occurs in many rainforest areas north to the Border Ranges.

Sydney Blue Gum (*Eucalyptus saligna*) tall wet sclerophyll forest covers about 16 ha of the reserve. It is generally present as an open and scattered overstorey of the eucalypt with an understorey of well-developed Coachwood.

Silvertop Stringybark (*Eucalyptus laevopinea*) tall wet sclerophyll forest covers about 10 ha of the reserve. This has been heavily logged in the past and regrowth Silvertop Stringy is dominant, with associated Sydney Blue Gum, White Mahogany (*Eucalyptus acmenioides*), Brush Box (*Lophostemon confertus*) and Turpentine (*Syncarpia glomulifera*).

This area is part of the Barrington Group and contributes to the World Heritage Values of that group (see Section 9.9).

11. NATIONAL AND INTERNATIONAL CONTEXT

11.1. LINKS WITH OTHER AUSTRALIAN WORLD HERITAGE SITES.

There are three distinct areas of World Heritage rainforest in Australia – the Tasmanian Wilderness, the Wet Tropics of Queensland and CERRA. A fourth Australian World Heritage Area (WHA), the Lord Howe Island Group, is also a predominantly rainforest property and there are biogeographic links between its flora and that of CERRA. Fraser Island WHA also contains areas of rainforest and these have floristic links with CERRA rainforests, particularly with the rainforests of Iluka NR. There are also links with the limited areas of rainforest in Kakadu WHA including some common widespread species and a shared Gondwanic ancestry.

CERRA falls at an intermediate position in the transect of eastcoast Australian rainforest. While having an intermediate geographic position, the subtropical and temperate rainforests of the property are distinct from the tropical rainforests represented in the Wet Tropics WHA and the Tasmanian temperate rainforests of the Tasmanian Wilderness WHA.

Floristically, the rainforests of the property occupy a separate floristic region from the tropical rainforests, representing a separate line of evolution from the common Gondwanan stock. The tropical rainforests also contain a stronger Indomalayan component; they also lack the strong Gondwanan influence and the interspersed rainforest / sclerophyll structure and composition that are found in CERRA.

The rainforests of Tasmania occupy a floristic province distinct from those of the property, and a significant portion of the Tasmanian rainforest flora may be of relatively recent derivation from species present in CERRA.

The Blue Mountains WHA also falls within the intermediate geographic position between the rainforests of tropical Queensland and the temperate rainforests of Tasmania. While predominantly a *Eucalyptus*-dominated property, the Blue Mountains WHA does include some areas of rainforest and, with a few exceptions, the species contained in these rainforests are shared with CERRA. Links to the north and south are shown by species such as the filmy fern *Craspedophyllum marginatum*, which is known only from the McPherson Range, the Blue Mountains and Tasmania. The Blue Mountains endemic conifer the Wollemi Pine (*Wollemia nobilis*) has links to CERRA, being a monotypic member of a genus that is a sister of *Araucaria*, while all other species in the genus of another Blue Mountains endemic conifer, *Microstrobos fitzgeraldii*, are found only in the Tasmanian highlands.

The property also has links to the Australian Fossil Mammal Sites (Riversleigh / Naracoorte) WHA. A very much reduced legacy of the Tertiary rainforest fauna which is documented from the Fossil Mammal Sites persists in CERRA. Furthermore, both properties are examples of thematic serial nominations as both required the listing of multiple discrete sites to capture the essential attributes of the subject theme.

11.2. LINKS WITH WORLD HERITAGE SITES OUTSIDE AUSTRALIA

The strongest links with World Heritage sites outside of Australia are with areas within the former supercontinent of Gondwana. The strongest links are with sites in New Zealand and South America.

Te Wahipounamu (South-west New Zealand) WHA in New Zealand has a very strong Gondwanic heritage. Links with CERRA include shared Gondwanic plant families such as Podocarpaceae, Nothofagaceae and Cunoniaceae and genera such as *Nothofagus*.

Gondwanic links with sites in South America are also strong. Los Glaciares WHA in Argentina is of particular note with genera such as *Nothofagus* being well represented.

12. BOUNDARIES

The 1993 IUCN evaluation of the CERRA nomination notes:

“There has been a tendency in Australia to take an incremental or phased approach to delimiting boundaries of World Heritage properties. This has resulted in some substantial conservation achievements but it does entail regular re-visiting of the nominations. In the case of this nomination all of the main elements are now present but there is a need for Queensland and New South Wales to keep small additions under review both from a value-added viewpoint and to strengthen manageability.”

IUCN identified six areas as possible additions – Bunya Mountains, Richmond Range, Carrai / Macleay, areas adjacent to Mount Seaview, western slopes of Mount Hyland and Barrington Tops. The addition of a scatter of areas in New South Wales to the nomination partially addressed these omissions (see Section 10), but it was understood that many of these areas were only ‘seed’ areas for future larger rainforest reserves. Many of these reserves are now in place.

While the current boundaries of CERRA contain all of the values for which the property was listed, there are a number of areas the inclusion of which would improve the integrity of the property. The acceptance of *Eucalyptus*-dominated vegetation as a theme worthy of World Heritage recognition loosens the previous constraints which limited potential areas to predominantly rainforest areas and which did not easily cater for the ‘stepping stones’ of rainforest emeshed in ‘moist hardwood forests’ between the major stands of rainforest. The opportunity now exists to secure a property which more wholly represents all of the facets of rainforest from successional communities to mature closed forest plus representative areas of the eucalypt-dominated vegetation that adjoins and is mixed and inter-digitated with rainforest.

There have been significant additions, including rainforest areas, to the national park estate in New South Wales since the 1992 nomination. These occurred as part of the Regional Forest Agreement process, and it is anticipated that significant additions may occur in south-east Queensland once the process is completed in that State. A re-appraisal of reserve areas in north-east New South Wales and particularly the recent additions has been undertaken and indicates that some large areas are suitable for nomination as additions to the property (Hunter, in prep.). A similar appraisal should be undertaken in south-east Queensland prior to any future re-nomination of the property.

Areas meriting consideration for addition to CERRA fall into one or more of the following categories:

- **complementary areas:** areas with outstanding examples of the attributes and values for which the property was listed
- **sibling areas:** areas which protect the values within the listed area, but which may otherwise be too small for listing
- **sclerophyll areas:** areas which strengthen the representation of the eucalypt sub-theme within CERRA

Additional factors that contribute to consideration for inclusion include the role an area plays in connecting existing or potential World Heritage areas and in minimising edge effects.

12.1. COMPLEMENTARY AREAS

These are areas that contain outstanding examples of the attributes and values for which CERRA was listed.

One obvious area in this regard is the Bunya Mountains. The desirability of including this area was noted in the 1993 IUCN evaluation. Furthermore, the World Heritage Expert Panel recommended that the Bunya Mountains NP area be subject to further investigation as a possible addition to CERRA. The panel commented that the Bunya Mountains NP contains the largest extant populations of the relict Bunya Pine (*Araucaria bidwillii*). The biogeographic significance of this important Gondwanan species was stressed, and the cultural significance of the species to Aboriginal people was noted. The presence of the related Hoop Pine (*Araucaria cunninghamii*) in the park was also noted. The panel also stated that CERRA would benefit in relation to the eucalypt-dominated sub-theme from the addition of some relatively minor areas in Queensland, including the Bunya Mountains NP.

The Bunya Mountains area was included in the draft of the 1992 nomination and only minor work would be required to finalise the nomination of the area.

Other areas that are obvious additions to CERRA include the large areas of rainforest and moist eucalypt forest which have been added to national park estate in the Richmond Range / Focal Peak area of NSW. These areas are centered on former flora reserve 'seed' areas – Acacia Plateau, Captains Creek, Tooloom Scrub, Dome Mountain, Murray Scrub, Bungdoozle, Cambridge Plateau, and Mallanganee Flora Reserves – that were added to the 1992 nomination, and include Koreelah, Tooloom, Toonumbar, Richmond Range and Mallanganee National Parks and Captains Creek NR.

Other rainforest areas in NSW that are obvious candidates for addition to the property include:

- Mt Jerusalem NP, Mebbin NP and additions to Nightcap NP within the region of the Tweed Shield Volcano Group,
- Additions to the parks of the Washpool / Gibraltar Group,
- Nymboi-Binderay NP, Bindari NP, Cascade NP, Junuy Juluum NP, Bellinger River NP, Cunnawarra NP and additions to Dorriggo NP, New England NP and Mount Hyland NR within the region of the New England Group,
- Willi Willi NP, The Castles NR, Carrai NP and additions to Oxley Wild Rivers NP in the Macleay Group,
- Cottan-bimbang NP and additions to Werrikimbe NP in the region of the Hastings Group, and
- Additions to Barrington Tops NP in the region of the Barrington Group.

These rainforest areas share or complement the attributes outlined in previous sections for the listed sites.

The question of additions to the northern part of the property in Queensland remains unresolved. The property within NSW is bounded to the south by a major dry corridor – the Hunter River Valley – that over geological time has separated the rainforest areas to the north of it from those to the south. There is no such obvious barrier at the northern end.

An analysis of the position of CERRA within the eight rainforest ecofloristic provinces recognised by Len Webb and his co-workers (Webb & Tracey 1981, Webb *et al.* 1984) may help guide further additions to the property. CERRA currently includes portions of four of the eight provinces – the A1, A2, C1 and C2 provinces. Representation within CERRA of each of these four provinces is variable, and it would be true to say that this is predominantly an A1/A2 property (that is, predominantly made up of temperate and subtropical rainforest types). However, as discussed in Section 9.4, the Tweed Shield Volcano Group can lay claim to being the central focus of the values of property – it is the core of the A1 province, lies close to the cores of the C1 and C2 provinces and is at the northern limit of the A2 province – and significant areas of araucarian dry rainforest of the C1 province lie on its western and northern flanks and extend into Queensland.

The A1 province has as its core area the optimal humid mesothermal regime on mainland Australia as identified by Nix (1982). It is centered on subtropical coastal south Queensland and northern NSW with fertile basaltic soils at low altitudes generally not exceeding 200–300 metres altitude – the 'Big Scrub' area. Further north there are outliers on patches of basaltic red earths on wet uplands to the west of Gladstone and Mackay, while to the south outliers occur on basalts in the Bellinger and lower Dorriggo plateau. Obviously, the lower altitude basalt areas of the Tweed Shield were central to this ecofloristic province. Most of this type at lower altitudes and on tablelands has been cleared. Small areas occur in CERRA at lower altitudes in sites such as Springbrook, Lamington, Mt Warning, Nightcap, Border Ranges and Dorriggo National Parks. Remaining sites beyond those listed are small but probably vital to the continued functioning of CERRA processes and ecosystems (see 12.2 below). Possible additions in south-east Queensland should be investigated.

A humid cool-subtropical element of this province extends on basalts to about 900 metres altitude in southern Queensland and northern NSW, where rainfall is augmented by fog-drip. This element is very well represented in CERRA and includes major areas within Main Range, Mt Barney, Springbrook, Lamington, Border Ranges, Mt Warning, Nightcap and Dorriggo National Parks.

A humid / subhumid cool subtropical element ascends in places to above 800 metres in northern NSW and southern Queensland. This is araucarian notophyll vine forest, such as occurs on the Bunya Mountains. It is currently represented in CERRA by some areas in Lamington and Border Ranges National Parks and in flora reserves in the Richmond Range area. Beyond the property, this element is present in areas such as the Conondale Range.

Another element of the A1 province occurs on mesotrophic soils (soils of intermediate fertility). These are soils derived from acid volcanics or sedimentaries which are generally basaltically enriched. They support simple microphyll and simple notophyll vine forest, and are often dominated by Coachwood (*Ceratopetalum apetalum*). They occur from about 100-900 metres altitude in northern NSW and the fringes of the Border Ranges in Queensland. Beyond the property there are possibly opportunities to include further sites in areas such as the Conondales, D'Aigular Range and Kroombit Tops.

The C1 floristic province has its core to the north of the Tweed Shield in the Brisbane Valley, with the major extant area being the Bunya Mountains. While most areas of rainforest within this floristic group have been cleared or heavily modified, opportunities for increasing their representation in the property should be considered.

The C2 floristic province has a minor representation within the property and opportunities to increase its representation in the property within NSW are very limited, consisting of a small number of very small disjunct areas on the Northern Slopes. More extensive areas remain in Queensland but their disjunct occurrences and context may render them unsuitable for addition. Nevertheless, consideration should be given to adding representative samples of this group if feasible.

There remain the rainforests of southern NSW and the Gippsland area in Victoria. These are not appropriate additions to CERRA, although it is noted that one area in this group, Mt Dromedary FR, was included in the 1985 nomination of the central eastern rainforests and the areas share many values and attributes with CERRA. However these areas, the rainforest values they contain and the linkages they provide between rainforests to the north and south should not be neglected as a possible future nomination.

12.2. SIBLING AREAS

These are areas which protect the values within the listed area, but which may otherwise be too small for listing. Of particular interest here are the remaining remnants of the lowland warm subtropical rainforests; these are the rainforests which occur at the core of the A1 province. They include the remnants of the rainforests on the most fertile soils and gentle terrain that were the most structurally and floristically complex rainforests in central eastern Australia at the time of European settlement. The rainforests on the coastal floodplains and lower altitude basalt plateaux were, because of their relatively fertile soils and ease of access, the first and most heavily impacted areas following European settlement. They include areas such as the former Big Scrub on the southern flanks of the Tweed Shield Volcano; this former area of 75 000 ha of lowland subtropical rainforest is now more than 99.9% cleared. Also included in this lowland group are littoral rainforests; naturally rare, this rainforest type has suffered from mineral sand mining and urbanisation.

These lowland rainforests are poorly represented in the property but are arguably the evolutionary engines of the subtropical rainforest. They are characterised by endemic species, some of which are apparently recently evolved species. These areas are also characterised by concentrations of rare and threatened species, particularly on the Tweed Shield. While clearing may have contributed to the rare or threatened status for some species, for others it is a reflection of the natural rarity of some species in these complex rainforests. Some of these endemic, rare or threatened species are not present in the property. Some which are present have the majority of their populations beyond the property. There are obvious implications for the continued existence of the latter group if the populations beyond the property are not sympathetically managed.

The diversity, endemism and threatened status are not confined to flora. Animal taxa confined to these lowland rainforests are often threatened; an example is the land snail *Thersites mitchellae* mentioned earlier. Of more direct importance to the property and its World Heritage attributes are those species that are seasonal altitudinal migrants from the higher altitude rainforests, which are well represented in the property, to lowland forests. Included in this group are rare and threatened species such as the Wompoo Fruit-Dove (*Ptilinopus magnificus*), Rose-crowned Fruit-Dove (*P. regina*) and the White-eared Monarch (*Monarchus leucotis*) and typical species such as the bowerbirds, the Paradise Riflebird (*Ptiloris paradiseus*) and Noisy Pitta (*Pitta versicolor*). The 'bottom line' for these species, particularly the threatened species, is that their continued existence is dependant on the continued availability of winter food resources in the lowland. Date *et al.* (1996) summarise the position with respect to the rainforest pigeons as follows:

"Nesting and foraging habitats for rainforest pigeons are extensive in the conservation reserve system of northeastern NSW, but these habitats, which are largely at high elevations, lack winter food resources.

Instead, pigeons congregate in remnant rainforest and exotic berry-bearing trees and shrubs in agricultural areas at lower elevations and near the coast. They rely on these habitats for food during winter and it is the restricted extent of this habitat that probably limits their abundance, not the area or quality of habitat at higher elevations. The conservation and management of rainforest pigeons requires the protection of low elevation and coastal rainforest remnants.”

Significant World Heritage attributes are therefore dependant on resources beyond the property. These resources are generally within the lowland remnants, a number of which are conservation reserves. Many of these lowland areas, such as the Big Scrub remnants in the Alstonville area, are probably too small and disjunct from the property to merit inclusion. However, recognition should be given to the role they play in supporting the World Heritage attributes of the property and therefore allowing natural processes within the property to continue.

Other lowland areas are either larger in size or less disjunct or both and might be considered for addition. These include areas such as Nicholls Scrub, Burleigh Head and Mount Tamborine on the Queensland section of the Tweed Shield and areas such as Stotts Island and Broken Head in New South Wales.

12.3. SCLEROPHYLL AREAS

How far the net is cast in including *Eucalyptus*-dominated vegetation in the property is partly dependent on decisions regarding future nomination(s) of the theme within Australia. Particularly relevant is whether areas will continue to be nominated separately (such as was the case for the Blue Mountains) or whether they will be nominated as a serial nomination. This was touched on briefly in the discussion of this theme above (Section 8.2.2).

Expansion of the property to include the range of attributes related to the *Eucalyptus*-dominated vegetation theme within south-east Queensland and north-east New South Wales is a possible approach. It is not the role of this report to explore all of the ramifications of such an approach. Suffice it to say that such an approach could provide connectivity and consolidation of the property. This is not to deny that it might also create further disjunctions in areas such as the tablelands west of the Great Escarpment and on coastal lowlands.

However, it is clear, given that the theme is now recognised, that eucalypt vegetation that borders and intergrades with rainforest areas could be considered for addition to the CERRA property. This is particularly the case for sclerophyll forests associated with the listed sites and especially areas with rainforest understoreys. Such eucalypt forests provide the opportunity to buffer and protect the edges of rainforest areas and to link rainforest areas. Specific areas which might be considered include the eucalypt-dominated forests adjoining the rainforests on the western side of the Main Range and the northern section of Mount Barney NP.

13. KNOWLEDGE GAPS

Aila Keto, the senior author of the 1992 CERRA nomination (DASET 1992), summarised major deficiencies in our current knowledge of the property when, in the letter finalising her work, she wrote:

“Inventory data on flora and fauna and basic ecological data are inadequate for management purposes and further data collection and research should be a priority for the future.”

This statement may seem surprising, particularly with respect to inventory data, given that the areas referred to include some of the oldest national parks in the world, that they occur in some of the earliest settled parts of the continent, and that most lie in close proximity to capital cities – Brisbane or Sydney – or other cities with universities – Lismore, Armidale or Newcastle. Nonetheless, the statement is valid, as any attempt to access data on the areas soon shows.

In the case of the New South Wales sites, the most up-to-date data on the floristic composition of many areas is contained in the reports prepared by A.G. Floyd during the 1970s and early 1980s. While these reports are of the highest quality, it must be acknowledged that only limited parts of each site were surveyed, and that a limited amount of time was spent in each. In Queensland, some sites have a comparable level of flora survey. Lamington NP may have a little more but others, especially in the Main Range area, have much less. Few, if any, CERRA areas in either New South Wales or Queensland have a sufficient level of information available on either vegetation or floristics to allow confident management decisions to be made. Information on most fauna species and assemblages within CERRA is similarly limited.

Recent survey work in north-east New South Wales as part of the North East Forests Biodiversity Survey (NEFBS 1994a, 1994b, 1994c, 1994d), the Upper North East New South Wales assessment (NPWS 1995, Sheringham & Westaway 1995), the Interim Assessment Process of the region's forests, and the Comprehensive Regional Assessment of the forests was not planned for and, not surprisingly, has contributed little to the filling of gaps in our knowledge of CERRA sites. Indeed, because rainforest was excluded from logging and therefore considered to be safe, it was specifically excluded from detailed survey work. Paradoxically, our knowledge of the distribution of rainforest has been increased because rainforest areas were specifically 'mapped out' to exclude them from further assessment in projects such as the Broad Old Growth Mapping project and the CRAFTI mapping project.

Recent surveys have also highlighted the fallacy of the assumption that the flora and fauna of central eastern Australia are well known. For example, some 10 plant taxa that are probably new species were first collected during surveys in northern NSW over the past two years, and Gilmore (1999) believes that there are several new species of *Antechinus* to be described and at least one uncollected species of frog in north-east New South Wales. This should probably not be surprising – there were more undescribed rainforest tree species collected in the subtropics in the 1970s than at any other time since settlement. New species of tree continue to be found in the rainforests of the region and the number of reptiles and amphibians recognised for the area has increased significantly over the past few decades (M.Murphy pers.comm.).

While still not adequate, our knowledge of the rainforest plant and animal species, their assemblages and the distribution of each are at least reasonably developed. The same cannot be claimed for our understanding of the evolutionary and ecological determinants of rainforest biodiversity. In particular there is limited understanding of the effects of fragmentation on the structure, composition and persistence of rainforest ecosystems.

Comparative genetic distribution studies for a number of birds, reptiles, frogs and snails in the Wet Tropics have revealed deep genetic divergences in several species across the Black Mountain Barrier, a section of the Great Escarpment that currently carries a band of rainforest linking two large rainforest massifs but that did not support rainforest during glacial periods – a comparable area in CERRA might occur between Levers Plateau and the Tweed Range / Lamington Plateau. They have also shown historical disjunctions in some species within the major massifs.

The results of work in the Wet Tropics has many implications for CERRA, particularly as many of the rainforest areas in the CERRA region are, in contrast to the main Wet Tropics area, disjunct even under climatic regimes, such as are now present, which are favourable for rainforest. It can be assumed there are probably many 'evolutionary significant units' (historically isolated and independently evolving groups of populations) (Moritz 1994) for many species within CERRA. In some cases, the long periods of isolation may have resulted in changes which merit recognition at the varietal or species level. Limited work has been

done in this field in CERRA but has indicated that similar patterns occur here. The genetic variations in the frog *Litoria pearsoniana* have been investigated by Mahony and Knowles (1994) and Donnellan *et al.* (in press) who conclude that it is part of a species complex with at least four Evolutionary Significant Units. McGuigan *et al.* (1998) investigated the species in the northern part of its range in south-east Queensland and north-east New South Wales and showed little contemporary gene flow among the rainforest isolates.

An improved understanding of the evolutionary history of the property's disjunct rainforest blocks would provide the means of understanding their present occurrence as discrete blocks, as well as their current dynamics. Such an understanding would allow for informed prediction of future changes in the distribution of the rainforests and their constituent species and their viability.

There is a rudimentary understanding of the underlying processes and ecological changes associated with disturbance and the subsequent recovery or succession of the rainforest in CERRA. In particular the interactions between plants, animals and physical environmental factors that influence succession are poorly understood. Many sites in CERRA have been subject to past disturbance and are threatened by exotic species invasion, and a firm understanding of the succession and dynamics of rainforest is necessary to guide management. This knowledge is particularly important for identification of those areas where intervention is required, and to direct that intervention.

Studies of succession and its dynamics generally focus on the documentation of different stages of succession on different soil types and under different climatic conditions. Within CERRA in NSW, there are a number of growth plots and research plots put in place by State Forests which, while specifically established to provide data on the growth rates of tree species following logging, would provide very useful information on the recovery of rainforest following disturbance. Plots in place with good data sets on file include the Airdrop Road plots in Border Ranges NP (this study includes eight plots with different intensities of logging and three control plots), The Cornpatch in Nightcap NP (this plot records the re-establishment of rainforest on a cleared site), and a scatter of sites in temperate rainforests in the property. Similar research plots may be present in some Queensland sites. Of course, there is, adjacent to Lamington NP, a site of great importance to the understanding of rainforest succession – the area of regenerating rainforest on the O'Reilly property which was the subject of Dr Mike Hopkins's landmark studies of succession in subtropical rainforests (Hopkins 1978).

One research plot of immense interest to an understanding of succession is the Gradys Creek slip plot in Border Ranges NP. This is a site in a relatively isolated, unlogged, rainforest catchment where twelve hectares of forest-clad hillside slid downslope into the creek. The resulting bared slope has undergone secondary succession in the midst of a large rainforest area and in the absence of human interference (Floyd 1978). This plot has been partially re-disturbed by a second slip and is overdue for follow-up measurement.

A better understanding of the interactions between fire and rainforest is necessary to develop fire management strategies aimed at conserving the CERRA rainforest heritage. In particular, fire management must be designed to suit not only the rainforest areas but also to suit the surrounding habitats.

It is unclear if plant pathogens are causing or contributing to rainforest death in some parts of the property. Death of plant species of all strata and all lifeforms in disjunct small areas of rainforest in Nightcap, Border Ranges and Dorriggo National Parks has been observed over the past decade (Hunter, pers. obs.). The cause remains unknown and requires investigation.

The decline of frogs in recent years has received some attention. The species affected include some that are attributes of the World Heritage Values of the property. Research is underway and should be encouraged. It should also be recognised that the property includes all or most of the habitat for some of these species and management should adopt the precautionary principle and aim to minimise or exclude human impacts from those habitats.

Greenhouse warming is a threat that is largely beyond the control of managers but is one which has the potential to seriously affect the World Heritage Values of CERRA. The effects of this process have already become evident in Central America (Holmes 1999). It is not clear if this is also the case in CERRA and, given a paucity of baseline data for high-altitude sites, it may only become obvious in hindsight. It is highly desirable that monitoring is put in place to gather the baseline data and to track changes that occur. The placement of basic weather-recording stations in selected locations in the short term is advisable. Longer-

term monitoring should include the monitoring of vegetation transects and populations of potentially susceptible high-altitude species.

The Aboriginal cultural values of the property remain poorly documented. It is important that a better understanding of this aspect of the property be gained soon. The landscapes of CERRA are the very basis of the spiritual lives of the Aboriginal people and are central to their Dreaming. The Aboriginal people have maintained involvement with many sites in the property and have a right to have their spiritual and custodial connections with such sites recognised. There are currently several land claims lodged over portions of the property. It is advisable that we become educated and involved in the forthcoming negotiations by choice rather than as a legal reaction.

14. MANAGEMENT

It is desirable that the manager of a site within a World Heritage property is aware of the World Heritage values relevant to the site and, in particular, how the attributes of the site contribute to those values. It is hoped that this report will contribute to that understanding.

The manager is required to remain vigilant that activities in or near the property do not significantly affect the World Heritage Values. That is, the manager must manage and monitor the attributes to avoid impact on the values. However, there remains the question of just what attributes are most important and what attributes should be monitored, plus the related larger question of when does an impact on an attribute or attributes become a significant impact on a World Heritage value or values?

There is probably no simple answer to those questions. However, a few guidelines might include:

- Concentrate first on attributes which contribute to more than one of the values (criteria). For example, the Rufous Scrub-bird is both a relict Gondwanan species and vulnerable to extinction; the bowerbirds are Gondwanan species but not threatened. Obviously, management and monitoring should concentrate on the Scrub-bird and a 'watching brief' kept on the bowerbirds to identify any significant decline in the species. For similar reasons a plant species such as *Eucryphia jinksii* should have priority over a common species such as Coachwood (*Ceratopetalum apetalum*).
- Use a precautionary approach. The values for which the property is listed are biological values that emphasise the persistence of biological features from Gondwanan times and the ongoing evolution of these and other features. Therefore, management of the property to maintain this natural process is central to the continued integrity and maintenance of the values of the property. The most effective and efficient way to ensure the continued unhindered operation of natural processes is to maintain healthy ecosystems free of human interference. This is attained by identifying such areas and planning for activities such as recreation outside of them. 'If it ain't broke, don't fix it.' However, a caveat is that small disjunct areas are not unimportant, particularly as part of the ongoing sifting and development of rainforest and as sources of genetic novelty. Therefore, a balance between maintaining large natural areas free of impact and not impacting on smaller disjunct areas needs to be found.
- Management of a World Heritage property is an extension of management of State conservation reserves. Most of the attributes have significance at both levels, but some species that are common at the State level are of significance at the global level. The time frame for management of World Heritage areas is explicitly at the evolutionary scale; this is implied in managing at the State level. The public, in respect to World Heritage areas, is the planetary population and not just the State population. Management of World Heritage properties therefore requires a broader outlook with the attendant vision and attitude. The cliché 'Think Globally, Act Locally' is completely relevant to this task.

15. RECOMMENDATIONS

This report has taken a sweeping view of the property and its values and attributes. Several matters requiring further work have been identified. These include gaps in our knowledge of the property, and management requirements. The following recommendations are made:

- Undertake further survey of the sites to increase knowledge of the biodiversity within the property.
- Undertake investigations to gain a better understanding of the effects of fragmentation on rainforest ecosystems.
- Undertake genetic mitochondrial DNA techniques on selected vertebrate and invertebrate species to map the history of isolation of the major blocks of rainforest within the property.
- Undertake studies of succession to gain a better understanding of the underlying processes and ecological changes associated with rainforest recovery and maintenance. Data gathered from plots established in former state forest areas might assist such studies.
- Undertake research to gain a better understanding of the relationship between rainforests and fire to guide the long-term conservation of rainforest and adjacent habitats.
- Investigate causes of rainforest die-back.
- Gather baseline climatic data, particularly in high-altitude sites, to monitor changes postulated to occur as a result of global warming due to greenhouse gases.
- Establish long-term vegetation monitoring transects and monitoring of populations of selected high-altitude fauna taxa to quantify effects of global warming.
- Support research aimed at identifying and halting the cause of widespread deaths in frog species.
- Document, and incorporate into management, information on the Aboriginal cultural values of the property.
- Prioritise work on critically threatened species.
- Encourage the implementation of biological control of weed species such as *Ageratina* spp.
- Formally protect areas identified as high conservation areas and control activities that might affect the unimpeded operation of natural processes.
- Investigate and implement ways of affording small, disjunct rainforest areas, especially lowland remnants, the status of World Heritage areas.

16. CONCLUSION

The key attributes contributing to the World Heritage values of the property are outlined in Sections 5, 6 and 7. The associative natural values of the property are outlined in Section 8.

16.1. LISTED NATURAL VALUES

The Central Eastern Rainforest Reserves (Australia) property retains all of the values for which it was nominated and listed as a World Heritage area in 1994 under criteria (i), (ii) and (iv). The property continues to meet the requirements for integrity.

New information relating to the values relevant to the criteria are outlined in Sections 5, 6 and 7. Despite the new information, there are still considerable gaps in knowledge regarding the flora and fauna of the property and the ecological processes of the area. Knowledge of the evolutionary history of the rainforest blocks is also lacking, as is knowledge of the possible impacts of global warming. These knowledge gaps and others are discussed in Section 13.

16.2. ASSOCIATIVE NATURAL VALUES

There are very high natural values present for a range of natural values in addition to those for which the property was listed. These associative natural values include:

- Attributes associated with Criterion (iii). These relate to outstanding ecosystems (relict palaeovegetation) and areas of outstanding beauty and aesthetic importance.
- Attributes associated with passive continental margins. This includes most of the landforms underlying the property.
- Attributes associated with the *Eucalyptus*-dominated vegetation theme. The property straddles one of the most eucalypt species rich regions and includes many of the attributes related to the theme.

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