

Natural Heritage Criteria and the Attributes of Outstanding Universal Value (OUV) of the Wet Tropics of Queensland World Heritage Area

The notes that follow were derived by deconstructing the original 1988 nomination document to identify the specific themes and attributes which have been recognised as contributing to the *Outstanding Universal Value* of the Wet Tropics. The notes also provide brief statements of justification for the specific examples provided in the nomination documentation.

Steve Goosem, December 2012

Natural Heritage Criteria:

(1) Outstanding examples representing the major stages in the earth's evolutionary history

Values: refers to the surviving taxa that are representative of eight 'stages' in the evolutionary history of the earth. Relict species and lineages are the elements of this World Heritage value.

Attribute of OUV

(a) The Age of the Pteridophytes

Significance

One of the most significant evolutionary events on this planet was the adaptation in the Palaeozoic Era of plants to life on the land. The earliest known (plant) forms were from the Silurian Period more than 400 million years ago. These were spore-producing plants which reached their greatest development 100 million years later during the Carboniferous Period. This stage of the earth's evolutionary history, involving the proliferation of club mosses (lycopods) and ferns is commonly described as the Age of the Pteridophytes. The range of primitive relict genera representative of the major and most ancient evolutionary groups of pteridophytes occurring in the Wet Tropics is equalled only in the more extensive New Guinea rainforests that were once continuous with those of the listed area.

Example:

(i) Evolutionary history is represented by the earliest living ancestors of two main branches of land plants

Justification

The ancient Classes of Psilotopsida (*Psilotum*, *Tmesipteris*) and Lycoposida (Lycopodiaceae, Selaginellaceae and Isoetaceae) represent the earliest living ancestors of the two main branches of land plants. *Huperzia squarrosa* is the most primitive living lycopod.

Example:

(ii) Evolutionary history is represented by the diversity within ancient families of true ferns

Justification

The greatest evolutionary diversity for the seven ancient families of true ferns from the world's existing flora of about 36 families occurs in the Area (Lycopodiaceae, Selaginellaceae, Ophioglossaceae, Marattiaceae, Osmundaceae, Schizaeaceae and Gleicheniaceae). Eighteen out of the 27 genera from all seven families are represented in the Area by 41 species. These include the most primitive members of ancient orders of ferns (Class Pteropsida) such as the Marattiales (*Angiopteris*, *Marattia*), Ophioglossales (*Botrychium*, *Helminthostachys*, and *Ophioglossum*) and Osmundales (*Leptopteris*, *Todea*).

Example:

(iii) Evolutionary history is represented by the primitive fern families

Justification

The Schizaeaceae and Gleicheniaceae are the oldest and most primitive families of the largest group of pteridophytes, the Filicales. All four genera of the Gleicheniaceae and three of the four genera of the Schizaeaceae occur in the Area. *Actinostachys* is the most primitive genus in the Schizaeaceae and has a relict distribution.

Example:

(iv) *Evolutionary history is represented by the Area being a major centre of fern diversity*

Justification

The Area has the highest diversity of ferns in Australia and one of the highest levels of genetic diversity in the world. Thirty-one (86%) of the 36 known families and 111 of the 364 described genera (30%) of pteridophytes occur in the Area. The Area contains 64% of species and 88% of the genera of ferns occurring in Australia.

Example:

(v) *Evolutionary history is represented by the Area being a major centre of endemism for East Gondwanan fern taxa*

Justification

East Gondwanan fern genera include the monotypic endemic genera *Coveniella*, *Lastreopsis*, *Polystichum* (Aspleniaceae), *Pteridoblechnum* and *Steenisoblechnum* (Blechnaceae), *Oenotrichia* (Dennstaedtiaceae), *Leptopteris*, *Todea* (Osmundaceae), *Tmesipteris* (Tmesipteridaceae/Psilotaceae) and the Australian endemics *Lycopodiella* and *Huperzia* (Lycopodiaceae). The Area is the major centre of endemism for *Huperzia* with 9 of the 12 known species. Seven of these are either endangered or vulnerable to extinction, with the Wet Tropics being the only known location for *H. lockyeri* and *H. marsupiiiformis*.

Attribute of OUV

(b) The Age of the Conifers and Cycads

Significance

The origin of seed plants over 320 million years ago was one of the most significant events in the evolution of terrestrial vegetation, an adaptive breakthrough that allowed colonisation of habitats that were inhospitable to spore-producing plants and triggered a Lower Carboniferous diversification of vascular plants. This event also significantly facilitated the evolutionary radiation of other terrestrial organisms. The cone-bearing Cycads and Southern Conifers are the most ancient of living seed plants, little changed from ancestors that flourished in the Jurassic Period, termed the 'Age of the Conifers and Cycads' between 136 and 195 million years ago. The flora of this Period was a cosmopolitan flora of conifers, cycads, ferns, seed-ferns, ginkgos, herbaceous lycopods and horsetails. Jurassic fossils from the Talbragar Fish Beds near Gulgong in New South Wales reveal forests comprising *Agathis* and *Podocarpus* conifers with an understorey of the Cycadophyte, *Pentoxylon australica*. The closest modern counterpart of these forests occurs in the World Heritage area with a rare assemblage of *Agathis robusta*, *Podocarpus grayi* and *Lepidozamia hopei*.

Example:

(i) *Evolutionary history is represented by the diversity of cone bearing cycads and southern conifers which are the most ancient of living seed plants and were widespread in the Jurassic*

Justification

Cycads as a group are thought to have originated in the East Gondwanan sector of Pangaea prior to its break-up. The cycads contain more primitive features than any other living group of gymnosperms. The production of motile sperm cells is unique to cycads and one other gymnosperm, *Ginkgo biloba*. The discovery of this feature in 1896 provided the missing link between gymnosperms and the ferns and fern allies. One of the smallest cycads in the world, restricted to rainforest and wet sclerophyll forests in the Wet Tropics and to the McIlwraith Range on Cape York Peninsula, is the fern-like *Bowenia spectabilis*. Fossil species of both *Bowenia* and *Lepidozamia* have only been recorded from Eocene deposits at Anglesea, Victoria (*B. oecenica* resembling *B. spectabilis*), Bacchus Marsh, Victoria (*L. hopeites* resembling *L. hopei*) and at Nerriga in New South Wales (*B. papillosa*, *L. foveolata*). *Bowenia* is the only known cycad with bipinnate leaves which, from the fossil record, appear not to have changed over 45 million years.

Example:

(ii) *Evolutionary history is represented by the Cycads' association with the most primitive pollination systems*

Justification

The pollination syndrome of cycads involving primitive groups of insect vectors is believed to represent the most primitive pollination system known, and the earliest examples of insect-plant symbiosis. The insect vectors involve

ancestral beetle families such as Curculionidae (weevils) and Tenebrionidae (tenebrionid beetles), Languriidae, Atherinidae (mortar and carpenter bees), Boganiidae and Nitidulidae. *Cycas media* is pollinated by native bees from the genus *Trigona*. This genus is the oldest known bee with fossil records from the Cretaceous Period preceding the origin of flowering plants. Beetles of the subfamily Paracucujinae (family Boganiidae) are restricted to the Cycadaceae, feeding on pollen as both larvae and adults.

Example:

(iii) Evolutionary history is represented by the Area having the highest diversity of cycad genera in Australia

Justification

Two of the three cycad families (Cycadaceae, Zamiaceae) and three genera (*Cycas*, *Lepidozamia*, *Bowenia*) occur in the Area representing the highest diversity of cycad genera in Australia and the greatest diversity of major cycad groups anywhere in the world. *Lepidozamia hopei*, restricted to the Wet Tropics, is the tallest of all living cycads growing to heights of 20 metres. A rare assemblage of *Lepidozamia hopei*, podocarp (*Podocarpus grayi*) and the araucarian, *Agathis robusta* in the Wet Tropics represents the closest living counterpart of a Jurassic forest - fossilised remains of which are found in the Talbragar Fish Beds of New South Wales.

Example:

(iv) Evolutionary history is represented by the diversity of southern conifers in the Area and the Australian sector of Gondwana being considered the site of origin of the austral conifers

Justification

The conifers include the tallest, biggest and oldest living things on this planet. Forests containing the gymnosperm group, the araucarians, are of immense interest to science for they are among the most ancient and primitive of the world's surviving conifers. The Australian sector of Gondwana is considered to have been the site of origin of these austral conifers. Both the Araucariaceae and Podocarpaceae dominate the Australian pre-Tertiary fossil record with a great diversity of species in the Jurassic and Cretaceous. They are regarded as the ancestral core of present-day per-humid rainforests which arose through progressive addition of angiosperms throughout the Cretaceous and Early Tertiary. Only two araucarian genera survive today. The greatest diversity of surviving evolutionary lineages of *Araucaria* and *Agathis* occur in the Wet Tropics. This area is also the most significant centre of survival for the major genetic lineages of *Prumnopitys* and *Podocarpus*, the most dominant and closely related relict genera of the Podocarpaceae. The three endemic species of *Prumnopitys* and *Podocarpus* in the Wet Tropics are considered rare with very small distributional ranges.

Attribute of OUV

(c) The Age of the Angiosperms

Significance

The emergence of the angiosperms some 200 million years after the first appearance of the gymnosperms marked the beginning of one of the most fundamental changes in biological diversity on Earth. By the late Cretaceous, gymnosperms had largely been replaced by angiosperms, although the beginnings of the modern flora did not emerge until the Tertiary. The current estimates of 235,000 species of flowering plants represent 88.7 per cent of all plant species on earth. East Gondwanan countries are known to contain the greatest concentration of archaic and relict taxa relating to the origins of flowering plants. The distribution of relict taxa in the individual continents reflects the timing of origin and spread of the different plant groups in relation to the rifting and drifting of continents once part of Gondwana.

The radiation of floras, as recorded in the fossil record, has occurred in discrete waves. The Wet Tropics region contains outstanding examples representing 5 major elements in the history of the angiosperms.

Australia was once part of the southern supercontinent Gondwana. Other parts of that landmass were made up of the continents now known as Africa and South America (West Gondwana) and Antarctica, the subcontinent of India and the now island fragments including New Zealand, New Caledonia, New Guinea and Madagascar. Australia, New Zealand and New Guinea were part of East Gondwana. A West Gondwanan origin has been proposed for the angiosperms.

Evidence suggests that diversification occurred quite rapidly and that a significant number of taxa had arisen before the break-up of Gondwana began about 120 million years ago. By this stage, angiosperms had appeared in the northern hemisphere and in South America and Southeast Gondwana (Antarctica and Australasia) and were apparently spreading in two essentially separate, diversifying streams. A significant part of the southern stream

became essentially isolated in Australia when, about 50 million years ago, it finally broke away from Antarctica and rafted towards the tropics.

Example:

(i) Evolutionary history is represented by the richest assemblage of families of primitive flowering plants

Justification

The first recognisable angiosperm pollen was *Clavatipollenites hughesii* described from the Early Cretaceous of southern England. It closely resembles that of *Austrobaileya* of the Austrobaileyaceae, a monotypic family found only in the Wet Tropics. The most primitive and ancient orders of living flowering plants are the Magnoliales and Laurales. Of the 19 angiosperm families described as the most primitive (*as per nomination date in 1988*), 12 occur in the Wet Tropics, giving it the highest concentration of such families on earth. These families are: Annonaceae, Austrobaileyaceae, Eupomatiaceae, Himantandraceae, Myristicaceae and Winteraceae of the order Magnoliales; Hernandiaceae (including Gyrocarpaceae), Idiospermaceae, Lauraceae and Monimiaceae (including Atherospermataceae) of the order Laurales.

Post nomination update based on modern phylogenetic interpretations:

The rainforests of the Wet Tropics have more plant taxa with primitive characteristics than any other area on earth. Modern phylogenetic taxonomy has substantially revised our understanding of which families are old and which families are much younger, but may retain primitive features. Based on a modern phylogeny, Metcalfe and Ford (2009) calculate that of the 28 near-basal angiosperm lineages, 16 are represented in the rainforests of the Wet Tropics. This is a similar level of representation found for the floras of New Caledonia and Costa Rica; however two primitive families, Austrobaileyaceae and Idiospermaceae are endemic to the Wet Tropics (Idiospermaceae is considered by some authorities as being synonymous with the family Calycanthaceae). The presence of this large number of angiosperm families with primitive characteristics and which phylogenetically can be described as originating from lineages that branched near the base of the angiosperm family tree represents a great repository of evolutionary history. In addition, the shared East-Gondwanan origins of the Wet Tropics and New Caledonia (and New Guinea) and the significance of plant taxa with primitive characteristics in their floras and their high levels of regional endemism suggests the persistence of rainforests in the region over millions of years and their long isolation from developing floras in other parts of the tropics.

The 16 families and 46 genera of primitive dicots in the Wet Tropics. Numbers in parentheses refer to the number of Wet Tropics species represented per family or genera (after Metcalfe & Ford 2009)

Family	Genera	Family	Genera
1. Annonaceae (30)	1. Cananga (1) 2. Desmos (2) 3. Fitzalania (1) 4. Goniothalamus (1) 5. Haplostichanthus (5) 6. Meiogyne (3) 7. Melodorum (4) 8. Miliusa (2) 9. Polyalthia (4) 10. Pseuduvaria (5) 11. Uvaria (1) 12. Xylophia (1)	10. Idiospermaceae (1)	1. Idiospermum (1)
2. Aristolochiaceae (6)	1. Aristolochia (2) 2. Pararistolochia (4)	11. Lauraceae (82)	1. Beilschmiedia (9) 2. Cassytha (1) 3. Cinnamomum (4) 4. Cryptocarya (28) 5. Endiandra (29) 6. Linderia (1) 7. Litsea (8) 8. Neolitsea (2)
3. Atherospermataceae (3)	1. Daphnandra (1) 2. Doryphora (1) 3. Dryadodaphne (1)	12. Monimiaceae (23)	1. Austromatthaea (1) 2. Endressia (1) 3. Hemmantia (1) 4. Hedycarya (1) 5. Levieria (1) 6. Palmeria (2) 7. Steganthera (6) 8. Wilkiea (10)
4. Austrobaileyaceae (1)	1. Austrobaileya (1)	13. Myristicaceae (2)	1. Myristica (2)
5. Cabombaceae (1)	1. Brasenia (1)	14. Nymphaeaceae (2)	1. Nymphaea (2)
6. Ceratophyllaceae (1)	1. Ceratophyllum (1)	15. Piperaceae (14)	1. Peperomia (5) 2. Piper (9)
7. Eupomatiaceae (2)	1. Eupomatia (2)	16. Winteraceae (7)	1. Bubbia (4) 2. Tasmannia (3)
8. Hernandiaceae (2)	1. Hernandia (2)		
9. Himantandraceae (1)	1. Galbulimima (1)		

Example:

(ii) Evolutionary history is represented by species belonging to small, relict primitive angiosperm families

Justification

The Australian Wet Tropics has the highest concentration of small, relict and virtually extinct, primitive angiosperm families in the world. These are Austrobaileyaceae, Eupomatiaceae, Idiospermaceae and Himantandraceae. Two of these, the monospecific Austrobaileyaceae and Idiospermaceae, are restricted to the region. The ditypic Eupomatiaceae and Himantandraceae extend outside of Australia, only to New Guinea and East Malesia respectively. They are the last few remnants of an ancient assemblage that have survived the attrition of rainforest during dry cycles of the last ice ages in the Pleistocene. *Eupomatia* fossils derive from the Cretaceous and have been discovered in America indicating a much larger former range.

Example:

(iii) Evolutionary history is represented by Orders occupying nodal positions in the evolution of the angiosperms

Justification

Higher dicotyledonous angiosperms form five major groups accounting for 70 per cent of all living flowering plants. The initial major radiation of these groups occurred in the Cretaceous with ancient members of the sub-classes Hamamelidae and Rosidae being especially important. The orders Hamamelidales, Rosales, Euphorbiales, Dilleniales, Violales, Theales, Celastrales and Gentianales, are considered to occupy major nodal positions in the evolution of the angiosperms. Within these orders, key families with a relict distribution are of considerable importance. Those represented in the Wet Tropics are: Hamamelidales (Hamamelidaceae); Rosales (Alseuosmiaceae, Cunoniaceae, Davidsoniaceae, Escalloniaceae, Eucryphiaceae, Pittosporaceae); Celastrales (Aquifoliaceae, Icacinaceae, Celastraceae); Euphorbiales (Euphorbiaceae); Dilleniales (Dilleniaceae); Violales (Flacourtiaceae); Theales (Ochnaceae); Gentianales (Apocynaceae).

Example:

(iv) Evolutionary history is represented by Gondwanan Angiosperm families of Cretaceous origin

Justification

One of the most sudden and significant transformations of terrestrial plant life occurred in the Mid-Cretaceous leading to a vast and rapid spread of flowering plants throughout the world. Catastrophic events around the Cretaceous–Tertiary boundary led to major extinctions of angiosperm taxa. An estimated 75 per cent of all living species were lost, particularly in the northern hemisphere. However, East Gondwana in the southern hemisphere was relatively unaffected, and consequently the highest concentrations of Cretaceous angiosperm families survived in that region, many of which were still present on the Australian landmass when it finally broke away from Antarctica. Today, the highest concentration of relict taxa from Cretaceous angiosperm families survives in the Wet Tropics. Cretaceous families include the Cunoniaceae, Proteaceae, Winteraceae, Myrtaceae, Monimiaceae, Rutaceae, Sapindaceae, Aquifoliaceae, Callitrichaceae, Chloanthaceae, Trimeniaceae, Epacridaceae, Olacaceae and Loranthaceae.

Pollen similar to that of *Syzygium* and *Eugenia* (Myrtaceae) occurs in Campanian and Maastrichtian sediments on the Antarctic Peninsula and the Palaeocene of Australia. *Eugenia* is now represented in Australia by a single species. It is the largest genus in the Myrtaceae (~1000 species), concentrated today in tropical America, and the only genus shared between the Old World and New World. *Syzygium*, the second largest genus (~500 species), on the other hand occurs exclusively in the Old World with 55 species still remaining in Australia. The Wet Tropics is the most significant centre of survival in Australia with 31 species, 16 being Wet Tropics endemics.

Example:

(v) Evolutionary history is represented by East Gondwanan Families or Genera

Justification

East Gondwana (Australia, New Guinea, New Zealand and New Caledonia) was a key area for the early radiations of flowering plants. Significant numbers of taxa believed to have originated in East Gondwana still survive in rainforests within these areas. The Wet Tropics have a special position as the area with the longest continuous history as part of the parent landmass. Angiosperm taxa recorded from the Wet Tropics and believed to have originated in East Gondwana includes 153 genera in 43 families.

Attribute of OUV

(d) The final break-up of Gondwana

Significance

The final stage in the break-up of Gondwana had a profound effect on global climates and consequently on the evolution of all subsequent life forms. When Australia was still attached to Antarctica, warm equatorial currents reaching pole-wards ensured a generally more equably wet and warm climate. The detachment and northward drift of the Australian continent allowed the development of circumpolar currents. Temperature gradients between the equator and the poles increased dramatically and the Antarctic ice cap began to form. Forest types once mixed or closely juxtaposed now mostly became geographically separated and extensive regional extinctions of species occurred. However, the effects of global cooling and accompanying aridity were maximally compensated for in Australia's Wet Tropics region by the northward drift of Australia towards the tropics. As a consequence of this and a wide range of available altitudinal gradients, the Wet Tropics is the only large part of the entire Australasian region where rainforests have persisted continuously since Gondwanan times, preserving in the living flora the closest modern-day counterpart of the Gondwanan forests.

Example:

(i) *Evolutionary history is represented by relicts of early descendants of Gondwanic frog fauna*

Justification

Several groups regarded as likely relicts or early descendants of the Gondwanan fauna at the time of the final break-up are represented in the Wet Tropics. Of Australia's four families of frogs, the Myobatrachidae and Hylidae are believed to have had Gondwanan origins. Close relatives are found in South America. Contrary to earlier beliefs, molecular studies suggest that the major generic-level splits in the Australian frog fauna are very old. Among the oldest lineages are *Mixophyes* and *Taudactylus*. Of the six species in the genus *Taudactylus*, one of the most primitive groups of frogs in Australia, two are restricted to the Wet Tropics. *T. rheophilus* has been recorded only from Bellenden Ker Range, Lamb Range, Carbine Tableland and Thornton Peak, all recognised refugial areas. *Mixophyes* is represented in the Wet Tropics by *M. schevilli*, the Northern Barred Frog.

Example:

(ii) *Evolutionary history is represented by relicts of early descendants of Gondwanic reptile fauna*

Justification

Among the Australian reptile fauna, the geckoes of the subfamily Diplodactylinae and the endemic family of legless lizards (Pygopodidae) are generally accepted as having Gondwanan origins. Within the Wet Tropics, the diplodactyline geckoes are represented by *Carphodactylus*, *Diplodactylus*, *Nephrurus*, *Oedura*, *Phyllurus* and *Saltuarius*. *Carphodactylus laevis*, the Chameleon Gecko, is the only member of the genus and is restricted to the Wet Tropics. Australian skinks fall into three groups, the *Sphenomorphus* group, *Egernia* group and *Eugongylus* group. All three groups are represented in the Oligo-Miocene fossil fauna of Riversleigh, and some taxa are practically indistinguishable from living forms. The Riversleigh fossils indicate that the Australian skink fauna has arisen from evolution within Australia.

Example:

(iii) *Evolutionary history is represented by relicts of early descendants of Gondwanic bird fauna*

Justification

Of the birds occurring in the rainforests of the Wet Tropics, those with accepted Gondwanan origins include the Southern Cassowary and the megapodes. Of the three megapodes in Australia, two are found in the rainforests of the Wet Tropics: the orange-footed scrubfowl (*Megapodius reinwardt*) and the Australian brush-turkey (*Alectura lathami*).

Example:

(iv) *Evolutionary history is represented by relicts of early descendants of Gondwanic insect fauna*

Justification

Many primitive insects have been conserved in the Wet Tropics as relicts of the Gondwanan fauna, mainly in the upland areas. The present-day distribution of most of these insects suggests their origins pre-date the separation of Australia and New Caledonia and New Zealand about 80 million years ago. The presence of these ancient, relict insect taxa demonstrates the great antiquity of uninterrupted rainforest habitat in the Wet Tropics.

Attribute of OUV

e) The origins of the Australian sclerophyll flora and marsupial fauna

Significance

Australia was an isolated landmass during several million critical years when the extant flora was being shaped. Climate change and infertile soils were major influencing factors. After separation of the Australian landmass from Antarctica and during its isolated drift towards the equator, there was a general increase in aridity. At this time, major evolutionary radiations took place within the flora, particularly in the plant families Proteaceae, Myrtaceae, Casuarinaceae, Epacridaceae and Rutaceae, and within the marsupials. The Wet Tropics contains the highest concentration of the surviving remnants of the ancestral stock from which evolved the sclerophyll flora and marsupial fauna that now dominate the Australian landscape. The rainforests of the region also contain a number of bird species that may represent the ancestral forms from which certain dry-adapted taxa have evolved.

Example:

(i) *Evolutionary history is represented by ancestral stock from which the sclerophyll Proteaceae and Myrtaceae component of Australia's flora evolved*

Justification

Primitive genera of the Proteaceae are found in the Wet Tropics. In this family that now comprises a very important component of Australia's sclerophyll flora; seven of the genera are restricted to the Wet Tropics. At least three of these, *Placospermum*, *Sphalmium* and *Carnarvonia* are considered primitive. *Placospermum coriaceum* has the greatest array of primitive features of any living Proteaceous genus.

Example:

(ii) *Evolutionary history is represented by ancestral stock from which the sclerophyll Casuarinaceae component of Australia's flora evolved*

Justification

Fossil evidence indicates that the ancestral form of the Casuarinaceae family was the East Gondwanan rainforest genus *Gymnostoma*, which was widespread in Australia during the early Tertiary. *Gymnostoma* now has a relict distribution in Australia with just one species that is restricted to the Wet Tropics.

Example:

(iii) *Evolutionary history is represented by ancestral stock from which the sclerophyll Rutaceae component of Australia's flora evolved*

Justification

The family Rutaceae is considered to have originated in Gondwana before the Tertiary. The Tribe Zanthoxyleae of the Rutaceae family is considered to have given rise to the Tribe Boronieae, a long isolated group of 20 genera occurring in Australia and New Caledonia. There are 245 Australian species in the Boronieae which now so characterise this continent's sclerophyllous heathlands. Five species of the small genus *Euodia/Melicope* together with the endemic genus *Medicosma* (5 species) occurring in the Wet Tropics from within the Zanthoxyleae Tribe have close affinities to the ancestors of *Boronia*

Example:

(iv) *Evolutionary history is represented by ancestral stock from which the marsupial component of Australia's fauna evolved*

Justification

The most primitive of the Australian marsupials are the dasyuroids a group that probably are preceded in the evolutionary history of the marsupials only by the didelphoids of South America. Immunological studies of albumins suggest that this group diverged from the diprotodont marsupials about 40 million years ago. Nine species of dasyuroids are found in the Wet Tropics including one restricted species, the Atherton Antechinus (*Antechinus godmani*), which is considered a relict species.

The earliest marsupials evolved in 'rainforests' on the basis that extant rainforest-dependent species are among the most primitive of their respective groups. The Oligo-Miocene rainforests have been described as the "Green Cradle" for Australia's dry-adapted marsupials. The Riversleigh deposits are rich in marsupial fossils including taxa closely related to those living in the rainforests of the Wet Tropics. Indeed, the rainforests of the Wet Tropics represent the best surviving equivalent of the Oligo-Miocene rainforests of Riversleigh. They share several mammalian genera with

the Oligo-Miocene Upper Site of Riversleigh, including *Hypsiprymnodon*, *Cercartetus*, *Pseudochirops* and *Trichosurus*.

The Musky Rat-kangaroo, *Hypsiprymnodon moschatus*, which is restricted to the Wet Tropics, is probably the most primitive of the kangaroos and the only living member of the group that has retained the mobile first toe on the hind foot, a characteristic of possums. It is unique in representing an early stage of evolution of macropods from an arboreal possum-like stock.

The Wet Tropics area is particularly significant for ringtail possums. Of the six species in Australia, five occur in the Wet Tropics and the four rainforest-dependent species Wet Tropics' endemics. The Lemuroid Ringtail, *Hemibelideus lemuroides*, the only member of the genus, forms a single lineage with the Greater Glider, *Petauroides volans*, sharing a common ancestor with the remainder of the ringtails, *Pseudocheirus* and *Pseudochirops* species.

Attribute of OUV

f) The origin and radiation of the songbirds

Significance

It is thought that the passerines may have originated in Gondwana where the order diverged in two major radiations, the suboscines in west Gondwana (South America) and the oscines in east Gondwana (Australasia). Researchers have proposed a new classification that divides the oscine passerines into two major groups (parvorders), Corvida and Passerida. Studies suggest that the two groups diverged about 60 million years ago, when Australia was still part of Gondwana, and that the Corvida probably originated in that part of Gondwana that is now Australia when the vegetation of Australasian Gondwana was then dominated by rainforest.

Example:

i) *Evolutionary history is represented by the ancestral lineages of the Passerines (Oscines)*

Justification

The Corvida includes 40 per cent of the world's songbird families. Most of the living members are confined to Australia and New Guinea. The Wet Tropics is the most important area for several lineages of Australo-Papuan songbirds, eg the bowerbirds and the scrubwrens, thornbills and gerygones. Bowerbirds, which are confined to Australia and New Guinea, are the only birds known to decorate their courting grounds. Two species, the Golden Bowerbird (*Amblyornis newtonianus*) and Tooth-billed Catbird (*Scenopoeetes dentirostris*), are endemic to higher altitude areas in the Wet Tropics. *Ailuroedus* may be the most ancient genus.

A likely relict species endemic to the Wet Tropics is the Chowchilla, *Orthonyx spaldingii*. Fossils of *Orthonyx* have been found in late Oligocene deposits (~25 million years) at Riversleigh in north-west Queensland.

Example:

(ii) *Evolutionary history is represented by the close links with the diverse bird fauna of PNG*

Justification

The Wet Tropics is also of major importance in understanding the origins of the diverse bird fauna of PNG. Many genera are shared between the two areas. In at least some cases, this would appear to be the result of relatively ancient connections. One example is *Orthonyx* as discussed above. Another is the robin genus, *Heteromyias*. *H. cinereifrons* is endemic to the uplands of the Wet Tropics, whereas the only other species in the genus, *H. albispecularis*, is restricted to the highlands of New Guinea.

Attribute of OUV

(g) The mixing of the continental biota of the Australian and Asian continental plates

Significance

The Wet Tropics contains a unique record of a mixing of two continental floras and faunas that has no known parallel. This mixing occurred following the collision of the Australian and Asian continental plates about 15 million years ago. This collision was a unique event in that it mixed two evolutionary streams (both flora and fauna), in some cases of common origin, that had been largely separated for at least 80 million years. Whereas other continental collisions that led to a mixing of the biota have occurred, e.g., that of North and South America, none of those continents had such a long period of separation prior to collision.

Example:

- (i) **Evolutionary history is represented by the unique record of the mixing of two continental floras that has no parallel. Plants from the Asian plate constituted both old Gondwanan and Asian elements**

Justification

Parts of the Wet Tropics represent a stable fragment of Gondwana in which rainforest has existed continuously and whose extant flora, together with fossil pollen deposits provide a unique record of the mixing of long separated floras. Genera considered to have been of Gondwanan or Laurasian descent but to have entered Australia following the collision of the Australian and Asian continental plates and occurring in the Wet Tropics include *Alangium*, *Allophylus*, *Althoffia*, *Alyxia*, *Anthocephalus*, *Barringtonia*, *Berrya*, *Bombax*, *Bulbophyllum*, *Calophyllum*, *Canthium*, *Celtis*, *Cordia*, *Epipogium*, *Garcinia*, *Gardenia*, *Leea*, *Lethedon*, *Melia*, *Oreodendron*, *Phaleria*, *Securinega*, *Trema*.

Example:

- (ii) **Evolutionary history is represented by the unique record of the mixing of two continental faunas.**

Justification

Among the fauna, two families of frogs provide outstanding examples of the impact on the biota of the collision of the Australian and Asian plates. These are the Microhylidae and Ranidae. The microhylids occur in South America, Madagascar, southern Asia and New Guinea with just two genera occurring in Australia. Australian microhylids are from two genera, *Cophixalus* and *Austrochaperina*. Fifteen of the sixteen species are confined to north-eastern Australia. Twelve species are endemic to the Wet Tropics region. All but one are rainforest species, the exception being *Cophixalus saxatilis* which lives among the boulder piles of the Black Trevelyan Range.

Of the Australian mammals, the rodents and bats are considered to have entered since connections with the Asian plate were established. Sixty per cent of Australia's bat species are found in the Wet Tropics. Several of the Australian rodent genera, including *Hydromys*, *Pogonomys*, *Uromys* and *Melomys*, have their centres of diversity in New Guinea and have entered Australia relatively recently. They represent a second wave of the "Old Endemics" among the rodents.

Attribute of OUV

- (h) The extreme effects of the Pleistocene glacial periods on tropical rainforest vegetation.**

Significance

Even though marked changes in global climates had occurred during the Tertiary, it was not until about 2.5 million years ago, that a series of dramatic changes of climate, the Pleistocene ice ages, began, which changed the face of the earth, causing extinctions, speciation and profound changes to the distributions of plants and animals. The peak of glaciation occurred at 18 000 BP, sea levels were at their lowest for the past 150 000 years.

Example:

- Evolutionary history is represented by relict taxa that survived the Pleistocene ice ages**

Justification

Fossil pollen records going back over 200,000 years, of unparalleled continuity and resolution for this period, from three sites within the Wet Tropics, Butcher's Creek, Lynch's Crater and Lake Euramoo, indicate that rainforests underwent severe contractions during the Pleistocene ice ages. There is evidence of many extinctions and near extinctions within the Wet Tropics (*Nothofagus* c.f. *brassii*, *Phyllocladus* spp., and *Dacrydium* spp. - all large, long-lived trees). Outstanding examples of ancient taxa that survived and persist as relicts within the Wet Tropics today include the Araucariaceae (5 species) and Podocarpaceae (7 species) and Casuarinaceae (1 species, *Gymnostoma*).

Natural Heritage Criteria:

- (2) Outstanding examples representing significant ongoing ecological and biological processes**

Values: refers to the importance and value of dynamic ecological processes. In the context of the Wet Tropics these include:

- *Biogeographic processes leading to areas of high endemism.*

- *Refugial processes including biogeographic interactions allowing shifts of refugial locations along altitudinal gradients.*
- *Processes leading to speciation.*
- *Processes leading to the evolution and maintenance of biological diversity in a range of habitats along gradients of substrate, elevation and climate.*
- *Significant ongoing successional landscape processes occurring in the wet tropical coastal zone.*
- *Interactions between open forests and rainforests in terms of their significance as part of an evolutionary continuum from rainforests to sclerophyll forests.*
- *Ongoing processes of landscape, forest composition and species distribution changes associated with rainforest recolonisation following the most recent glaciation and climatic perturbations in the Holocene and Recent periods.*
- *Processes of colonisation and sifting on recent volcanics and sedimentary sites.*
- *Natural recovery processes following natural events such as cyclones.*

Attribute of OUV

(a) Processes leading to areas of high endemism and speciation

Significance

Geological history involving the separation and drifting of continents, volcanism, mountain building and erosion has profoundly influenced the evolutionary history of life on earth. Tropical rainforests, in particular, are one of the most significant biomes harbouring the majority of the earth's genetic diversity. Processes resulting in areas of exceptional species richness or of high endemism are of outstanding scientific interest. Most of the world's humid tropics are of recent origin and endemism in these areas of high species richness is generally quite low. The long-isolated ancient floras of New Caledonia, Madagascar and the Wet Tropics, however have exceptionally high levels of endemism.

These centres of endemism are not only historically important, but are significant as diverse pools of unique genetic material retaining elements over the widest evolutionary time span and of potential significance in new radiations in a world of changing global climates.

The Wet Tropics centre of endemism is unique as part of an ancient continental as opposed to island landscape, uplifted more than 100 million years ago and tectonically stable for the greater part of the period of angiosperm evolution.

Example:

Biogeographic processes leading to areas of high endemism

Justification

The Wet Tropics is second only to New Caledonia in the number of endemic rainforest plant genera conserved per unit area (43 genera and 500 species). Of the surviving endemic genera 75 per cent are monotypic and none contain more than a few species.

Many of the endemic species and genera are narrowly restricted within the Wet Tropics and several local centres of endemism have been identified all of which encompass altitudinal gradients within the most equably wet climatic zones allowing for mobility of refugia and survival of relict taxa during climatic fluctuations on geological time scales.

Example:

Speciation processes

(i) disjunct populations within Wet Tropics

Justification

Allopatry (occupying different areas) is an important mechanism of speciation. Among the plants, genera best exhibiting allopatric speciation include *Haplostichanthus*, *Pseuduvaria*, *Elaeocarpus*, *Ceratopetalum*, *Polyosma*, *Endiandra*, *Uromyrtus*, *Pilidiostigma*, *Buckinghamia*, *Orites*, *Stenocarpus*, *Sarcotoechia*, *Bubbia*, *Planchonella* and

Symplocos. Many outstanding examples of disjunctions that may eventually lead to new species are described in detail in the Nomination document.

Several species of fauna restricted to the Wet Tropics also occur as two or more disjunct populations and examples of these are also described in detail in the Nomination document.

Example:

Speciation processes

(ii) Disjunct populations: extra-Wet Tropics region

Justification

Species with disjunct populations outside the Wet Tropics similarly have potential for allopatric speciation. There are numerous examples among the plants that have been described in detail in the Nomination document, including:

Maytenus bilocularis, *Cassia marksiana*, *Pseudoweinmannia lachnocarpa*, *Pollia crispata*, *Dysoxylum fraserianum*, *Premna lignum-vitae*, *Ixora beckleri*, *Euodia micrococca*, *Ripogonum discolor* and *Phaleria chermsideana*.

Similarly, among the animals the following species occur in the Wet Tropics as populations isolated by ecological barriers and many of which are recognised as subspecies: Brown Antechinus (*Antechinus stuartii adustus*), Yellow-footed Antechinus (*Antechinus flavipes rubeculus*), Common Dunnart (*Sminthopsis murina tatei*), Red-cheeked Dunnart (*Sminthopsis virginiae virginiae*), White-footed Dunnart (*Sminthopsis leucopus*), Spotted-tailed Quoll (*Dasyurus maculatus gracilis*), Yellow-bellied Glider (*Petaurus australis reginae*), Long-tailed Pygmy-possum (*Cercartetus caudatus macrurus*), Red-legged Pademelon (*Thylogale stigmata*), Little Cave Bat (*Vespadelus pumilus*), Golden-tipped Bat (*Kerivoula papuensis*), Bush Rat (*Rattus fuscipes coracinus*), Cape York Rat (*Rattus leucopus cooktownensis*), Swamp Rat (*Rattus lutreolus lacus*), Australian King Parrot (*Alisterus scapularis minor*), Double-eyed Fig-Parrot (*Cyclopsitta diophthalma macleayana*), Pale-yellow Robin (*Tregellasia capito nana*), Yellow-breasted Boatbill (*Machaerirhynchus flaviventer secundus*), Brown Gerygone (*Gerygone mouki mouki*), Grey Fantail (*Rhipidura fuliginosa frerei*), Eastern Whipbird (*Psophodes olivaceus lateralis*), Spotted Catbird (*Ailuroedus melanotis maculosus*), Satin Bowerbird (*Ptilonorhynchus violaceus minor*),

Example:

Processes of genetic differentiation

Justification

Geological processes occurring in the Wet Tropics region have left many species restricted to upland areas and divided by altitudinal barriers into two or more disjunct allopatric populations. As allopatry is an important mechanism of speciation, these species must be regarded as potential examples of ongoing evolution.

Studies have revealed a surprising level of genetic diversity within the rainforest skinks, frogs, snails and some other faunal groups. The studies were directed at determining the level of variation within mitochondrial DNA and a range of enzymes from specimens collected at different sites throughout the species' distributional range. The results show major genetic breaks, clearly separating populations. The magnitude of the genetic difference between the different populations is of such an order that geographic separation probably occurred more than 5 million years ago. Major genetic barriers so far identified include the Macalister Range north of Cairns and the Tully and Herbert Gorges.

Example:

Ecological continua:

Spectrum of biological diversity present within a range of elevation, climate and substrates

Justification

The Tall Open Forests on the drier western margins of the rainforest are significant as part of an evolutionary continuum of rainforest and sclerophyll forests. Eucalypts that now dominate the Australian landscape are considered to have evolved from rainforest stock and radiated into drier environments from the margins of closed forests. The first appearance of these wet sclerophyll forests in the fossil record was by the late Miocene. Within the Wet Tropics, especially in the Cowley–Kurrimine Beach area and the mouth of the Murray River, active geological processes including coastline progradation have produced dynamic mosaics of rainforests, melaleuca and mangrove forests, and sandridge and swale communities. These complexes contain some of the oldest extant roots of an evolutionary continuum that originated from ancestral rainforests.

Natural Heritage Criteria:

(3) Superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

Values:

- High levels of biodiversity.
- High degree of endemism.
- Relict taxa and lineages representative of evolutionary stages.

- Exceptional scenery including rugged mountain peaks, gorges and canyons, extensive vistas of undisturbed forests, exceptional coastal scenery, outstanding natural features, spectacular waterfalls, rich visual mosaics, juxtaposition of life-forms.
- Wild rivers.

Attribute of OUV

Example:

Natural phenomena

Significance

The Wet Tropics is one of the most significant regional ecosystems in the world. Despite its relatively small size, the exceptionally high genetic diversity and endemism make it a superlative example of tropical rainforest. It has been described as a key to the origins and ancient habitats of primitive flowering plants; as a key to the processes of past climatic sifting of taxa and community types; and as a biological link with temperate and other tropical zones. Northern Australia has been postulated as a major centre of evolution of rainforest flora. The living history of this evolution is best conserved in the World Heritage Area.

Attribute of OUV

Example:

Beauty and Aesthetics

Significance

Apart from the diverse tropical rainforests that present a complex array of life forms, there are outstanding features of natural beauty and magnificent sweeping landscapes. Between the Daintree River and Cedar Bay there is exceptional coastal scenery that combines tropical rainforest, white sandy beaches and fringing reefs just offshore. Rugged mountain peaks and gorges are among the dominating superlative features of the landscape. The stark peak of Mt Pieter Botte with its massive granite outcrops provides extensive vistas of undisturbed forest and the valley of Roaring Meg Creek which in its lower reaches descends rapidly through a series of spectacular waterfalls and cascades. The region between the Bellenden Ker Range and the Atherton Uplands including the Walter Hill Range contains superb gorge scenery with swiftly flowing rivers. The Russell, Mulgrave and Johnstone Rivers are wild rivers. In this area of high rainfall and rugged topography, spectacular waterfalls abound. Wallaman Falls on Stony Creek, dropping 278 metres into a deep canyon, has the longest single drop of any waterfall in Australia.

Natural Heritage Criteria:

(4) The most important habitats for the in situ conservation of biological diversity, including those containing threatened species of plants and animals of outstanding universal value from the point of view of science and conservation.

Values: there are two important features of this criterion:

- a. The emphasis is on 'habitats' in conserving populations where the habitats of individual populations are defined in terms of their total resource requirements;
- b. the importance of biodiversity in determining habitats for individual populations and the resultant emphasis on interrelationships.

Attributes of OUV

- Habitats for conserving biodiversity.
- Habitats of threatened taxa.
- Threatened and rare communities.

Significance

The Wet Tropics conserves an extraordinary degree of biological diversity as well as providing the major habitat for numerous threatened species of outstanding universal significance. Although the Wet Tropics represents less than one-tenth of one per cent of the land surface of the continent it contains: 65% of Australia's fern species, 21% of Australia's cycad species, 37% of Australia's conifer species, 30% of Australia's orchid species, 36% of Australia's mammal species (including 30% of the marsupial species, 58% of the bat species and 25% of the rodent species), 50% of Australia's bird species, 25% of Australia's frog species, 23% of Australia's reptile species, 37% of Australia's freshwater fish species, and about 60% of Australia's butterfly species.

About 3,000 plant species found in the area represent 17 per cent of Australia's vascular plants from 210 families and 1,164 genera. The diversity of ferns is the highest in Australia. More than 700 species, or 23 per cent of the total, are endemic to the Wet Tropics. Regional endemism is particularly high in 33 angiosperm and six gymnosperm and fern families, most of which are old, primitive or relict and with a high proportion of species that are either rare or threatened. Of the total of more than 500 rare or threatened plant species (*as at time of Nomination*), 330 are endemic. More than 80 are endangered or vulnerable to extinction. Of the 49 monotypic genera in the area (represented by a single surviving species), 19 are rare or vulnerable to extinction.

The Wet Tropics has the highest diversity in Australia for many groups, including rainforest mammals and frogs, bats, freshwater fish, insects and land snails. It also has the highest level of endemism for several groups, particularly rainforest frogs and reptiles.

The majority of plants in the rainforests of the Wet Tropics have a restricted distribution either as isolated or disjunct populations. High concentrations of monotypic genera reflecting the refugial nature of the rainforests are found at several locations.

The Wet Tropics is the only habitat for about 400 species of plants and over 70 species of animals that are regarded as rare, vulnerable or endangered. Included in the list are many rare and very restricted species belonging to the primitive angiosperm families. These include *Idiospermum australiense* (Idiospermaceae), eight undescribed species of *Haplostichanthus* (Annonaceae), *Wilkiea wardellii* and *Tetrasyandra* sp. (Monimiaceae), *Endiandra anthropophagorum* and *E. microneura* (Lauraceae). There are also rare species within two undescribed genera in the Myrtaceae family, both with very restricted distributions. The genera, *Barongia*, *Ristantia* and *Sphaerantia* may have considerable significance in relation to the evolution of sclerophyllous Myrtaceae taxa.

The list of rare and threatened species includes 16 monotypic genera restricted to the Wet Tropics. They are *Austromuelleria trinervia* (R), *Baileyoxylon lanceolatum* (R), *Barongia lophandra* (R) *Crispiloba disperma* (R), *Hexaspora pubescens* (V), *Kuntheria pedunculata* (R), *Lenbrassia australiana* (R), *Mitrantia bilocularis* (V), *Stockwellia quadrifida* (V), *Neostrearia fleckeri* (R), *Noahdendron nicholasii* (R), *Normanbya normanbyi* (V), *Oreodendron biflorum* (V), *Ostrearia australiana* (R), *Sphalmium racemosum* (R) and *Whyanbeelia terraereginae* (R). Rare species in endemic ditypic genera include *Buckinghamia ferruginiflora*, *Darlingia ferruginea*, *Hypsophila halleyana*, *Peripentadenia mearsii*, *P. phelpsii*, *Sphaerantia chartacea* and *S. discolor*.

Within the Proteaceae there are several rare and very restricted species including *Alloxyylon flammeum*, *Helicia blakei*, *H. recurva*, *Orites*, *Megahertzia* and *Catalepidia*.

There are in the vicinity of 70 species recorded only from the type locality and another 80 or so restricted endemic species for which current records indicate a north-south distribution of less than 25 kilometres.

There are many rare and/or threatened species among the fauna endemic to the Wet Tropics. Of particular concern is the decline in population numbers of seven species of frogs endemic to the Wet Tropics. On current indications, one third of the frog species endemic to the Wet Tropics are endangered. Populations of the Southern Cassowary, *Casuarius casuarius*, have declined as a result of clearing and habitat fragmentation and the species is considered endangered. The Southern Cassowary is recognised as a 'keystone' species, playing a critical role in the dispersal of the seeds of large-fruited rainforest plants. Among the mammals, several species are considered threatened and two, the Mahogany Glider and the Tropical Bettong, are endangered.

Attribute of OUV

Habitats for conserving biodiversity and rare & threatened species of flora and fauna

Example: **Vegetation Diversity**

Justification

The forests of the Area occur across a diverse range of rainfall, geology, drainage, altitude and evolutionary history. As a result there is a spectrum of plant communities and habitats recognised as being floristically and structurally the most diverse in Australia. The rainforests of the Area have been classified into 13 major structural types and 27 broad communities types correlated with climatic zones and soil parent material (*Tracey & Webb mapping as at time of Nomination*). These rainforest types are fringed and dissected by a range of sclerophyll forest and woodland types, mangroves and swamp communities.

Example: **Plant Diversity**

Justification

Within the Wet Tropics there are over 3,000 species of vascular plants, representing 1164 genera and 210 families. Seventy-five genera are endemic to Australia and 43 are restricted to the Wet Tropics with over 700 species restricted to the Area. The outstanding significance of the Area is that it contains many taxa representing long, distinct lineages and therefore preserves a greater degree of evolutionary heritage than places with a similar number of species but containing a succession of closely allied forms.

The Area contains the habitats of 17 per cent of Australia's vascular plant species comprising 65 per cent of Australia's fern species, 21 per cent of Australia's cycad species, 37 per cent of Australia's conifer species and 30 per cent of Australia's orchid species.

Example: **Rare & Threatened Plants**

Justification

The Wet Tropics region has the highest density of rare and threatened plant species in Queensland. Of the 433 species officially listed for the bioregion, 383 are conserved within the World Heritage Area. The presumed extinct species, in general, have not been recorded for over 50 years. Of the endangered species, there are 10 orchid species and four tassel fern species listed; similarly there are eight vulnerable orchid species and a further 4 tassel fern species listed, reflecting not only the loss of lowland habitat in the region but also the impact of illegal collection.

Example: **Animal Diversity**

Justification

Recent studies have shown a surprising level of genetic diversity within several animal groups. The results show major genetic breaks that represent very distinct evolutionary lineages. Findings from these genetic studies indicate that individual disjunct populations are the evolutionary significant unit of conservation rather than the species *per se*.

Mammals

Of the eleven mammal species endemic to the region, all except the Mahogany Glider and Tropical Bettong are rainforest dependent. Most of the rainforest dependent endemics are restricted to the uplands and, as a consequence, occur as a number of isolated populations. In addition to the endemic species, there are at least eight subspecies of mammals restricted to the area.

The Area contains the habitats of 36 per cent of Australia's mammal species, including 30 per cent of Australia's marsupial species, 58 per cent of Australia's bat species and 25 per cent of Australia's rodent species.

Birds

More than 370 species have been recorded. There are more than 130 species that principally inhabit the closed forests. The majority of the thirteen Wet Tropics endemic species are confined to the upland rainforests. Many other species have most of their range within the area and at least another ten birds have subspecies restricted to the Wet Tropics. The Area contains the habitats of 50 per cent of Australia's bird species.

Frogs

The region has Australia's highest diversity of frogs. There are 53 species of frog in the region, 43 of which are regional endemics. Twenty-one of the 26 rainforest dependent frogs are only found in the Wet Tropics. Seven species of endemic, stream dwelling, rainforest dependent frog have suffered sudden, precipitous declines over their entire ranges in the last few years. The Area contains the habitats of 25 per cent of Australia's frog species,

Reptiles

There are about 170 species of reptiles within the Wet Tropics area. Twenty-two species are endemic to the region including 20 of the 30 rainforest dependent species, giving a level of endemism of 66 per cent within this group. The skinks are a particularly diverse group within the Wet Tropics with sixteen species endemic to the area. The Area contains the habitats of 23 per cent of Australia's reptile species.

Freshwater Fish

The Wet Tropics region has a greater diversity of freshwater fish than any other in Australia. Of around 190 species in Australia, 78 occur in streams of the Wet Tropics. Eight freshwater fish species are endemic to the region. The region contains two-thirds (48 genera) of the continent's fish genera and 25 (71%) of Australia's 35 freshwater fish families. This extraordinary diversity reflects the diversity of stream habitats and the highly variable but predictable seasonal flow rates. The Area contains the habitats of 41 per cent of Australia's freshwater fish species.

Invertebrates

The Wet Tropics has the richest insect fauna in Australia. There are more than 200 species of butterflies recorded from the region, including many restricted species. There are at least six species of crayfish restricted to cool, permanent streams above 800 m altitude. Land snails form an extraordinarily diverse group with 217 recognised species, of which 185 (85 per cent) are Wet Tropic endemics. Two Wet Tropics streams, Yuccabine Creek and Birthday Creek, have recorded the highest diversity of stream invertebrates anywhere on earth.

Example:

Rare & Threatened Fauna

Justification

There are many rare and/or threatened species among the fauna endemic to the Wet Tropics. Of particular concern is the dramatic decline in population numbers of seven species of frogs endemic to the Wet Tropics. In addition to four missing upland stream dwelling frogs in the Wet Tropics, (*Litoria nyakalensis*, *Taudactylus rheophilus*, *Litoria lorica* and *Taudactylus acutirostris*) there are also three declining species which although still found at lower altitudes, have generally disappeared from sites above 450 metres altitude (*Litoria nannotis*, *Litoria rheocola* and *Nyctimystes dayi*). The causes of the declines have not yet been identified.

Populations of the Southern Cassowary, *Casuarius casuarius*, have declined as a result of clearing and habitat fragmentation and the species is considered endangered. The Southern Cassowary is recognised as a 'keystone' species, playing a critical role in the dispersal of the seeds of large-fruited rainforest plants.