

AUSTRALIAN NATIONAL PERIODIC REPORT

SECTION II

Report on the State of Conservation of the Wet Tropics of Queensland

II.1. INTRODUCTION

a. State Party

Australia.

b. Name of World Heritage property

Wet Tropics of Queensland.

c. Geographical coordinates to the nearest second

Between latitudes 15 degrees 39 minutes south and 19 degrees 17 minutes south, and longitudes 144 degrees 58 minutes east and 146 degrees and 27 minutes east.

d. Date of inscription on the World Heritage List

9 December 1988.

e. Organization(s) or entity(ies) responsible for the preparation of the report

Wet Tropics Management Authority in conjunction with Environment Australia.

II.2. STATEMENT OF SIGNIFICANCE

a. Criteria

The Wet Tropics of Queensland met all four World Heritage criteria for a natural property. The criteria current at the time of listing (1988) and specified in the nomination [1] were:

1. Outstanding examples representing the major stages of the earth's evolutionary history
2. Outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment
3. Superlative natural phenomena, formations or features or areas of exceptional natural beauty
4. The most important and significant natural habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive.

b. Justification for listing

A summary 'statement of significance' was not included at the time of the Wet Tropics of Queensland nomination [1].

The Wet Tropics of Queensland contains one of the most complete and diverse living records of the major stages in the evolution of land plants, from the very first land plants to the pteridophytes, gymnosperms and angiosperms. The Wet Tropics of Queensland contains most of the relicts that exist on Earth of the flora of the forests which were part of the super continent Gondwana. The rainforests which constitute about 80% of the Property have more taxa with primitive characteristics than any other area on Earth. One of the outstanding features of the Wet Tropics of Queensland is that it contains a high diversity of ancient taxa representing long evolutionary lineages which preserve a greater degree of evolutionary heritage than places with a similar number of species but containing a succession of closely allied forms.

The Wet Tropics of Queensland provides an unparalleled living record of the ecological and evolutionary processes that shaped the flora and fauna of Australia over the past 415 million years when first it was part of the Pangaeian landmass, then the ancient continent Gondwana, and for the past 50 million years an island continent. During this 415 million years of evolution, the processes of speciation, extinction and adaptation have been determined by history, particularly continental drift and cycles of climatic change. The Wet Tropics of Queensland contains a unique record of a mixing of two continental floras and faunas. 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 of both flora and fauna, in some cases of common origin, that had been largely separated for at least 80 million years. As a centre of endemism, the Wet Tropics of Queensland provides fundamental insights into evolutionary patterns both in isolation from, and in interaction with, other rainforests.

The ancestry of all of Australia's unique marsupials and most of its other animals originated in rainforest ecosystems of which the Wet Tropics of Queensland still contains many of the closest surviving members. The Wet Tropics of Queensland contains one of the most important living records of the history of marsupials and songbirds. The Riversleigh fossil deposits (Australian Fossil Mammal Sites (Riversleigh/Naracoorte) World Heritage Area) are rich in marsupial fossil taxa closely related to those still living in the rainforests of the Wet Tropics of Queensland which represent the best surviving equivalent of the Oligo-Miocene rainforests of Riversleigh.

The Wet Tropics of Queensland is one of the most significant regional ecosystems in the world, with outstanding features of natural beauty and magnificent sweeping landscapes. Within the boundaries of the Property are some superlative scenic features highlighted by extensive sweeping forest vistas, wild rivers, waterfalls, rugged gorges and coastal scenery. The site also provides a terrestrial continuum with the Great Barrier Reef.

The Wet Tropics of Queensland holds an intact flora and fauna with hundreds locally endemic species restricted within its boundaries and provides the only habitat for numerous rare or threatened species of plants and animals.

Examples of the World Heritage values for which the Wet Tropics of Queensland was listed are included in the indicative values table following. These examples are illustrative of the World Heritage values of the property, and they do not necessarily constitute a comprehensive list of these values.

Natural criteria against which the Wet Tropics of Queensland was inscribed on the World Heritage List in 1988.	Examples of World Heritage values of the Wet Tropics of Queensland for which the property was inscribed on the World Heritage List in 1988.
<p>Criterion (i) outstanding examples representing the major stages of the earth's evolutionary history.</p>	<p>The Wet Tropics of Queensland contains one of the most complete and diverse living records of the major stages in the evolution of land plants, from the very first land plants to higher plants (Gymnosperms and Angiosperms), as well as one of the most important living records of the history of marsupials and songbirds. The property provides exceptional examples representing eight of the major stages in the earth's evolutionary history including:</p> <ul style="list-style-type: none"> - Age of the Pteridophytes; - Age of the Conifers and Cycads; - Age of the Angiosperms; - the final break-up of Gondwana; - biological evolution and radiation during 35 million years of isolation; - the origin and radiation of the songbirds; - the mixing of the continental biota of the Australian and Asian continental plates; and - the extreme effects of the Pleistocene glacial periods on tropical rainforest vegetation. <p>The World Heritage values include:</p> <ul style="list-style-type: none"> • ancient plant taxa representing two main branches of the earliest land plants, the Psilotopsida and the Lycopsidea; • 7 ancient families of true ferns, including Lycopodiaceae, Selaginellaceae, Ophioglossaceae, Marattiaceae, Osmundaceae, Schizaeaceae and Gleicheniaceae; • taxa in the oldest and most primitive families of the largest group of pteridophytes, the Schizaeaceae and Gleicheniaceae; • 31 of 36 families of pteridophytes (including 111 of 364 described genera); • fern genera of East Gondwanan origins, including <i>Coveniella</i>, <i>Lastreopsis</i>, <i>Polystichum</i>, <i>Pteridoblechnum</i>, <i>Steenisoblechnum</i>, <i>Oenotrichia</i>, <i>Leptopteris</i>, <i>Todea</i>, <i>Tmesipteris</i>, <i>Lycopodiella</i> and <i>Huperzia</i>; • the ancient, fern-like cycad <i>Bowenia spectabilis</i>; • the cycad families Cycadaceae, Zamiaceae (including the genera <i>Cycas</i>, <i>Lepidozamia</i> and <i>Bowenia</i>); • the rare assemblage of <i>Lepidozamia hopei</i>, <i>Podocarpus grayi</i> and <i>Agathis robusta</i> which includes the closest living counterparts of Jurassic-age fossils; • species of the only two surviving araucarian genera <i>Araucaria</i> and <i>Agathis</i>; • 3 endemic species of the podocarp genera <i>Prumnopitys</i> and <i>Podocarpus</i>; • 12 primitive angiosperm families in the orders Magnoliales and Laurales (Annonaceae, Austrobaileyaceae, Eupomatiaceae, Himantandraceae, Myristicaceae, Winteraceae, Hernandiaceae, Gyrocarpaceae, Idiospermaceae, Lauraceae, Monimiaceae and Atherospermataceae); • small, primitive, relict angiosperm families including Austrobaileyaceae, Idiospermaceae, Eupomatiaceae and Himantandraceae; • plant taxa considered to occupy major nodal positions in the evolution of the angiosperms (including taxa in the orders Hamamelidales, Rosales, Euphorbiales, Dilleniales, Violales, Theales, Celastrales and Gentianales); • relict taxa from Cretaceous angiosperm families (including Cunoniaceae, Proteaceae, Winteraceae, Myrtaceae, Monimiaceae, Rutaceae, Sapindaceae, Aquifoliaceae, Callitrichaceae, Chloranthaceae, Trimeniaceae, Epacridaceae, Olacaceae and Loranthaceae); • 153 genera in 43 families of angiosperms believed to represent the longest continuous history associated with the Gondwanan landmass; • frog species from the Gondwanan families Myobatrachidae and Hylidae (including primitive species from the genera <i>Mixophyes</i>, <i>Taudactylus</i>, <i>Litoria</i> and <i>Nyctimystes</i>); • reptiles of Gondwanan origin including geckoes of the subfamily Diplodactylinae and legless lizards of the endemic family Pygopodidae; • skinks of the <i>Sphenomorphus</i>, <i>Egernia</i> and <i>Eugongylus</i> groups, which are represented in the Oligo-Miocene fossil fauna of Riversleigh; • rainforest birds of Gondwanan origins including the Southern Cassowary, the orange-footed scrubfowl (<i>Megapodius reinwardi</i>) and the Australian brush-turkey (<i>Alectura lathami</i>); • primitive insect taxa that are relicts of the Gondwanan fauna;

Natural criteria against which the Wet Tropics of Queensland was inscribed on the World Heritage List in 1988.	Examples of World Heritage values of the Wet Tropics of Queensland for which the property was inscribed on the World Heritage List in 1988.
<p>Criterion (i) outstanding examples representing the major stages of the earth's evolutionary history.</p>	<ul style="list-style-type: none"> • primitive genera of the Proteaceae including <i>Placospermum</i>, <i>Sphalmium</i> and <i>Carnarvonia</i>; • 5 endemic species in the Myrtaceae group <i>Metrosideros</i>, which is the most primitive in the family and includes the genera, <i>Barongia</i>, <i>Ristantia</i>, <i>Sphaerantia</i> and the undescribed “Stockwellia”; • the East Gondwanan genus <i>Gymnostoma</i>, an ancestral form of the Casuarinaceae; • species in the genera <i>Euodia</i> and <i>Medicosma</i> in the family Rutaceae; • 9 species of dasyurids including one relict species, <i>Antechinus godmani</i>. • mammalian genera related to those of Oligo-Miocene age at Riversleigh, including <i>Hypsiprymnodon</i>, <i>Cercatetus</i>, <i>Pseudochirops</i> and <i>Trichosurus</i>; • the Musky Rat-kangaroo, <i>Hypsiprymnodon moschatus</i>, the most primitive of the kangaroos and the only living member of its group; • 5 species of ringtail possums, including 4 rainforest-dependent species; • passerine (Oscines) birds representing ancestral lineages of Australo-Papuan songbirds, (e.g. the bowerbirds and the scrubwrens, thornbills and gerygones); • Chowchilla, <i>Orthonyx spaldingii</i>, a relict endemic species also found in late Oligocene deposits (~25 million years BP) at Riversleigh; • areas where the extant rainforest flora and fossil pollen deposits provide a record of the mixing of long separated floras including old Gondwanan and Asian elements; • plant genera considered to have been of Gondwanan or Laurasian descent and to have entered Australia following collision of the Australian and Asian plates (including: <i>Alangium</i>, <i>Allophylus</i>, <i>Althoffia</i>, <i>Alyxia</i>, <i>Anthocephalus</i>, <i>Barringtonia</i>, <i>Berrya</i>, <i>Bombax</i>, <i>Bulbophyllum</i>, <i>Calophyllum</i>, <i>Canthium</i>, <i>Celtis</i>, <i>Cordia</i>, <i>Epipogium</i>, <i>Garcinia</i>, <i>Gardenia</i>, <i>Leea</i>, <i>Lethedon</i>, <i>Melia</i>, <i>Oreodendron</i>, <i>Phaleria</i>, <i>Securinega</i> and <i>Trema</i>); • taxa in the frog families Microhylidae and Ranidae which provide outstanding examples of the impact on the biota of the collision of the Australian and Asian plates; • Bats and rodents (including <i>Hydromys</i>, <i>Pogonomys</i>, <i>Uromys</i> and <i>Melomys</i>) which are considered to have entered Australia since connections with the Asian Plate were established; • fossil pollen records going back over 200,000 years from Butcher's Creek, Lynch's Crater and Lake Euramoo; and • Ancient taxa in the Araucariaceae (5 species), Podocarpaceae (7 species) and Casuarinaceae (1 species of <i>Gymnostoma</i>).
<p>Criterion (ii) outstanding examples representing significant ongoing geological processes, biological evolution and man's interaction with his natural environment.</p>	<p>The Wet Tropics of Queensland provides outstanding examples of significant ongoing ecological processes and biological evolution including exceptionally high levels of species diversity and endemism reflecting long-isolated ancient biota of the Australian wet tropics. The World Heritage values include:</p> <ul style="list-style-type: none"> • the high genetic diversity and endemism of the tropical rainforest ecosystems which constitute a major centre of evolution of rainforest flora; • endemic rainforest plant taxa (including 43 genera and at least 500 species); • plant and animal taxa exhibiting allopatric speciation (including the plant genera <i>Haplosticanthus</i>, <i>Pseuduvaria</i>, <i>Elaeocarpus</i>, <i>Ceratopetalum</i>, <i>Polyosma</i>, <i>Endiandra</i>, <i>Uromyrtus</i>, <i>Pilidiostigma</i>, <i>Buckinghamia</i>, <i>Orites</i>, <i>Stenocarpus</i>, <i>Sarcotoechia</i>, <i>Bubbia</i>, <i>Planchonella</i> and <i>Symplocos</i>); • plant and animal taxa which occur as disjunct populations, such as those associated with altitudinal and geographic barriers to gene flow; and • the diversity of flora and fauna, which includes: <ul style="list-style-type: none"> - 3,000 species of vascular plants (representing 1164 genera in 210 families), 11 mammal species, 370 bird species, 53 frog species, 170 reptile species, and 78 species of freshwater fish (in 48 genera and 35 families), more than 200 species of butterflies, 6 species of crayfish, and 217 species of land snails, and stream invertebrates).
	<p>The Wet Tropics of Queensland has outstanding features of natural beauty and magnificent sweeping landscapes. The World Heritage values include:</p>

Natural criteria against which the Wet Tropics of Queensland was inscribed on the World Heritage List in 1988.	Examples of World Heritage values of the Wet Tropics of Queensland for which the property was inscribed on the World Heritage List in 1988.
<p>Criterion (iii) contain unique, rare or superlative natural phenomena, formations or features of exceptional natural beauty.</p>	<ul style="list-style-type: none"> • the exceptional coastal scenery that combines tropical rainforest, white sandy beaches and fringing reefs just offshore; • rugged mountain peaks and gorges; • extensive vistas of undisturbed forest and valleys which descend rapidly in the lower reaches through spectacular waterfalls and cascades; and • superb gorge scenery with swiftly flowing rivers and spectacular waterfalls (e.g. Wallaman Falls which has the longest single drop (278 metres) of any waterfall in Australia).
<p>Criterion (iv) contain the most important and significant habitats where threatened species of plants and animals of outstanding universal value from the point of view of science and conservation still survive.</p>	<p>The Wet Tropics of Queensland provides important habitats for the <i>in situ</i> conservation of biological diversity, including the only habitat for numerous species of plants and animals of conservation significance which have outstanding universal value from the point of view of science and conservation. The World Heritage values include:</p> <ul style="list-style-type: none"> • plant communities and animal habitats, recognised as being floristically and structurally the most diverse in Australia (including 13 major structural types and 27 broad communities types of rainforest fringed and dissected by a range of sclerophyll forest and woodland types, mangroves and swamp communities); • plant taxa of conservation significance and their populations (which include more than 700 species of endemic plants representing 43 genera in 33 angiosperm, and 6 gymnosperm and fern families); and • animal taxa of conservation significance and their populations.

(i) Update of original nomination dossier

At the time of listing of the Wet Tropics of Queensland the wording and emphasis of the Criteria for nomination differed from the current natural value Criteria. Appendix 1 updates the information provided in the original nomination dossier [1] based on the present version of the Criteria and supported by more recent research findings. In this report the Wet Tropics of Queensland World Heritage area is referred to as the Property, while the broader biogeographic region of which the Property is part, is referred to as the Wet Tropics or the region.

(ii) Comparison with other areas

The rainforests of the Property are small in size when compared to the rainforests of other parts of the world. On a world scale the Wet Tropics rainforests have affinities from a topographical and climatic basis with upland tropical forest localities in the upper reaches of the Amazon and Congo basins and in the uplands of the east coast of Madagascar, Brazil and New Guinea [2]. The Property contains tropical forests at their latitudinal and climatic limits and are thus floristically and structurally less diverse and less species rich than those found in the large Indomalayan and Amazonian blocks. Unlike most other tropical evergreen equatorial forests, the Wet Tropics is subject to a short dry season which is another unique factor which influences its composition and structure.

The Wet Tropics is distinct from other tropical forests in that it has a strong Gondwanic element with a large number of plant and animal taxa with primitive characteristics (most notably amongst the angiosperms). In an evolutionary context, the Wet Tropics of Queensland is a living floral and faunal museum - a relict of the Gondwana era of 100 million years ago. Although some of these elements also occur in New Caledonia and to

a smaller extent in New Guinea, the Wet Tropics are of greater significance on this score and also display a co-evolution with related sclerophyll floras.

Much of the world's humid tropics is of recent origin, and although many areas possess exceptional species richness their level of endemism is generally quite low. The long-isolated ancient floras of New Caledonia, Madagascar and the Wet Tropics of Queensland, however, have exceptionally high levels of endemism. The Wet Tropics, as a centre of endemism, is unique being part of an ancient continental as opposed to island landscape. 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 endemic genera, 75 per cent are monotypic and none contain more than a few species. The Wet Tropics is the only habitat for about 350 species of plant and over 80 species of vertebrate animal that are regarded as rare, vulnerable or endangered.

The setting of the Wet Tropics adjacent to a fringing reef is another unique feature found only in a few Pacific Islands, in Indonesia and Belize [2]. In no other case would there be the prospect of protected tropical forest World Heritage site alongside a major marine/reef World Heritage site.

The size of the Property (8,943 km²) compares to other World Heritage tropical rainforest areas as follows:

Los Katios (Colombia)	720 km ²
Discovery Coast Atlantic Forest (Brazil)	1,120 km ²
Tai (Cote d'Ivoire)	3,300 km ²
Atlantic Forest Southeast (Brazil)	4,700 km ²
Rio Platano (Honduras)	5,000 km ²
Talamanca/Amistad (Costa Rica)	5,000 km ²
Dja (Cameroon)	5,260 km ²
Darien (Panama)	5,970 km ²
Thungyai-Huai Kha Khaeng (Thailand)	6,000 km ²
Wet Tropics of Queensland (Australia)	8,943 km ²
Manu (Peru)	15,328 km ²
Lorentz (Indonesia)	25,000 km ²
Salonga (Zaire)	36,000 km ²

Within the Australian context, the Wet Tropics region is a very distinctive bioclimatic/landform unit. Specifically, unlike much of continental Australia, the region has exceptionally steep environmental gradients and patterns and has the country's greatest variation in topographical relief. Compared to the sub-tropical and temperate forests found to the south in New South Wales, Tasmania and southern Queensland, the Wet Tropics contains a strong Indomalayan component and comprises a greater diversity of families, genera and species. The Wet Tropics region, although accounting for only 0.26 percent of the total area of the Australian continent, conserves a large proportion of Australia's biodiversity [3] (**Table 1**).

Table 1. Importance of the Wet Tropics to Australia's biodiversity

Taxonomic group	Percentage of Australia's total
Plants	
fern species	65
cycad species	21

conifer species	37
orchid species	30
vascular plant species	26
Animals	
mammal species including:	35
• marsupials	30
• bats	58
• rodents	25
bird species	40
frog species	29
reptile species	20
freshwater fish species	42
butterfly species	58

Within the Property there are over 2,800 known species of vascular plants, representing at least 1,037 genera and 221 families. Seventy-five genera are endemic to Australia and 43 are restricted to the Wet Tropics. Over 700 species are restricted to the Property [3]. The Wet Tropics possesses 41% of all Queensland's vascular plant species in slightly over 1% of the State's land area [3]

All these are indicators of the biological uniqueness of the area which sets it apart within the Australian and world context.

c. Additional information on significance since listing

(i) Natural Heritage

Additional or updated information on the natural values for which the Property was listed has been incorporated in the nomination update (Appendix 1).

(ii) Cultural Heritage

Although the Property was not listed for its cultural values the area between Cooktown and Cardwell contains the only recognised existing Australian Aboriginal rainforest culture. The oral pre-history of the surviving Aboriginal rainforest culture is the oldest known for any indigenous people without a written language [4].

Rainforest Aboriginal people have indicated they wish to have the Property recognised as a living cultural landscape. The Aboriginal view is that the natural values and cultural values cannot be separated. Cultural values include the living, continuous traditions of the Aboriginal peoples who are associated with the Wet Tropics. For this reason, Aboriginal people see their involvement in land management as essential to maintaining their culture.

Aboriginal occupation of the Wet Tropics of Queensland is thought to date back to at least 40,000 years ago [5]. The northern tribes (Barrineans) are considered to represent the first wave of the Aboriginal occupation of Australia, making theirs the oldest rainforest culture in the world [1]. Rainforest culture differed markedly from that of most other Australian Aboriginal tribes, with its heavy dependence on arboreal skills, everyday use of toxic plants and unique weapons [6]. Archaeological studies in Jiyer Cave in the Russell river valley have suggested occupation as far back as 5,000 years and the valley is believed to hold records dating back more than 10,000 years [7].

The Rainforest CRC is presently collating information and undertaking research into whether there is a substantive case for a renomination of the Property, in whole or part, on cultural grounds.

II.3. STATEMENT OF AUTHENTICITY/INTEGRITY

a. Integrity

At the time of inscription, the condition of the Property ranged from pristine to various stages of regeneration resulting from a range of human activities. Human impact in the wider Wet Tropics region is relatively low compared to other tropical forest regions, with a large proportion of the region's forest cover originally present at the time of first European settlement remaining. The majority of the region's lowland and basalt tableland forest cover, however, has been cleared for agricultural purposes and large parts of the Property have been affected by selective logging [2].

Early timber cutters commenced the exploitation of red cedar (*Toona ciliata*) and kauri pine (*Agathis* spp) in the region from 1874 and some of the more accessible parts of the Property would have been affected. Following the establishment of the Department of Forestry in the 1930s a structured timber industry was established based on the selective removal of commercial timber species. At one time or another about 160 of the region's rainforest species have been milled. Long-term average yields from the Property prior to listing were 63,000 cubic metres of timber per annum from a productive area of 158,000 hectares. Up until listing, therefore, parts of the Property had been available to a 70 year history of selective logging of varying intensity [8]. Nevertheless, much of the Property is in a virgin condition having been inaccessible to logging [2].

At the time of inscription, clearings within the Property totalled 7,538 ha most of which were associated with the provision of community infrastructure [3] (**Table 2**). Linear service corridor clearings accounted for over half this total (4,475 ha) of which 2,406 ha are still maintained for the provision of community and management access and electricity distribution. Patch clearings accounted for a further 2,733 ha, the largest contributor (2,129 ha) being three artificial dams and impoundments (Paluma Dam, Koombaloo Dam and Copperlode Falls Dam) which were present prior to listing. Boundary anomalies include narrow slivers of agricultural land which were included in the nomination for a range of reasons, but primarily to produce a sensible management boundary. These clearings and disturbances affect natural integrity through internal fragmentation and edge effect impacts. Other disturbances to integrity include incursions by exotic plants, animals and diseases.

Table 2. Extent of habitat loss within the Property at the time of listing.

Clearing Type	Total Area (ha)
Linear service corridor clearings	
Powerlines	772
roads	3679
Railways	22

Cableways	2
<i>total linear clearings</i>	4,475
Patch clearings	
Quarries	43
inundation (dams)	2129
recreation areas	45
Settlements	120
communication facilities	3
fire degraded hill slopes	105
Other	288
<i>total patch clearings</i>	2733
Boundary anomalies	
Paddocks	197
Sugarcane	65
pine plantations	36
orchards & plantations	32
<i>total boundary anomalies</i>	330

For further details of contemporary pressures on the integrity of the Property refer Section II.5 (Factors Affecting the Property)

b. Maintenance and enhancement of values

Logging has been a prohibited activity in the Property since 1987 and infrastructure associated with this industry has been phased-out, including the closing of over 6,500 km of unformed logging roads and snigging tracks which had a combined cleared area footprint of approximately 2,070 ha.

There have been no clearings associated with new powerline or road construction within the Property since listing (refer to Sections II.5c (iii), (iv) for more details).

There has been a progressive conversion of land tenures within the Property to national park (eg from 14% at time of listing [2] to 32% in 2002) and a progressive reduction in the area of various lease tenures (refer to Section II.4e for more details)

A statutory management plan for the Property has been in place since 1998. The Plan has identified 461,620 ha as being remote from human disturbances and zoned to ensure its protection. A further 414,372 ha has been identified as in a mostly natural state and has been zoned to promote its restoration wherever practical or opportunities arise. A further 18,259 ha has been identified which accommodates existing infrastructure needed for community services. Such areas have been zoned and regulated to ensure that the impact of activities associated with community services is managed to minimise the effect on the integrity of the Property (refer to Section II.4a (i) for more details).

In the Daintree section of the Property a strategic freehold land acquisition program has been implemented. The program objective was to secure protection of World Heritage values adjacent the Property and protect habitat connectivity. Approximately 2,500 hectares of land has been procured through voluntary surrender agreements or direct purchase. Other significant parcels of land have been identified in the Daintree Futures Study [9] and will continue to be targeted for purchase or conservation covenanting through other government funding initiatives.

Conservation covenants with land-holders are designed to ensure that activities on private land are sympathetic with maintaining important habitat and afford protection for wildlife (refer to Section II.4b,e for more details.). Other significant conservation measures have included recovery programs for the endangered southern cassowary, stream dwelling frogs, mahogany glider, northern bettong and spotted-tailed quoll (refer to Sections II.5c (xii), (xiii) for more details) and pest control programs (refer to Section II.5c (vii), (viii) for more details).

There is an active program of rainforest rehabilitation occurring within the region supported or encouraged by the Authority (refer to Section II.5c (i), (ii) for more details).

c. Boundaries review

No formal revision of the boundary has occurred since the Property was listed.

d. Buffer zone/mechanisms

There are more than 2500 individual blocks of land adjoining the Property's 3000 kilometre boundary. Both Queensland's *Wet Tropics World Heritage Protection and Management Act 1993* [10] (Wet Tropics Act) and the statutory *Wet Tropics Management Plan 1998* [11] (Wet Tropics Plan) apply only to lands within the boundaries of the World Heritage Area and not to neighbouring properties. However, a co-operative approach to management is being actively pursued with neighbours in an attempt to maximise the benefits and minimise any negative impacts (both for neighbours and the Property). This includes co-operative approaches to management issues such as control of feral pigs, weeds and fire management.

The Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) [12] also has provisions to control activities that occur outside the boundaries of the World Heritage properties which have the potential to significantly impact upon World Heritage values (refer to Section II.4a(i) for more details).

Co-operative management agreements are also actively canvassed with land holders, Aboriginal peoples and other parties both within and outside the Property as a means of achieving sympathetic management of lands adjoining the Property (refer to Section II.4a(i), II.4c(iv) for more details).

The Wet Tropics Management Authority provides advice to local government planning processes in accordance with the *Integrated Planning Act 1997* [14] as well as regional planning exercises (refer to Sections II.4a(ii), II.4b(ii) for more details).

In response to the findings of a comprehensive survey of landholders within or neighbouring the Property in 1999 (refer to Section II.6b for more details) the Authority has instigated a good neighbour program including the formation of a Landholder and Neighbour Liaison Group chaired by an Authority Board member to promote communication and cooperation.

All of the above mechanisms can be viewed as providing a level of 'buffering' and protection for the Property's World Heritage values which may be impacted from activities adjacent the Property.

II.4. MANAGEMENT

a. Statutory protective measures

(i) World Heritage legislation

Commonwealth legislation

The Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) [12] establishes management principles intended to promote national standards of management, planning, environmental impact assessment, community involvement, and monitoring for all of Australia's World Heritage properties. The EPBC Act regulates actions that will, or are likely to have, a significant impact on the world heritage values of a declared world heritage property. This includes actions that occur outside the boundaries of a world heritage property. Actions which are taken in contravention of the EPBC Act may attract a civil penalty of up to \$5.5 million, or a criminal penalty of up to \$46,200 or, in extreme cases, up to 7 years imprisonment. An 'action' includes a project, development, undertaking or any activity or series of activities.

State legislation

The *Wet Tropics World Heritage Protection and Management Act 1993* [10] together with its subordinate statute, the *Wet Tropics Management Plan 1998* [11] provide the legal framework and statutory mechanisms for management of the Property. In general, the legislation regulates activities within the Property that have the potential to impact on World Heritage values including destruction or disturbance to native vegetation, watercourses or earth [16].

Wet Tropics Management Plan

The regulatory aspect of the Plan is based on five broad approaches:

- zoning the area according to the relative integrity of localities;
- prohibiting a range of activities which could potentially impact on the Property, in particular activities which destroy vegetation, result in land degradation or affect streams;
- the Plan provides a limited relaxation of this general prohibition by conditionally allowing some specified activities;
- it regulates other activities through a permit system;
- the Plan also provides for negotiated agreements which may enable activities which might otherwise be prohibited to be undertaken provided the agreement ensures that there is some contribution to the achievement of the Primary Goal of management of the Property.

Four key components of the statutory Plan include:

- a zoning scheme (Table 3),

- a permit system,
- assessment guidelines and codes of practice
- co-operative management agreements.

The Plan divides the Property into four management zones, based on a “distance from disturbance” model.

Table 3. Zoning scheme summary

	Zone A	Zone B	Zone C	Zone D
Physical condition	Remote from disturbance and in a mostly natural state.	Not remote from disturbance but still in a mostly natural state.	Land on which or adjacent to which there is existing infrastructure needed for community services.	Land on which there are, or are proposed to be, significant developed facilities to enable visitors to appreciate and enjoy the Property.
Physical and social setting	A natural area remote from disturbances associated with modern technological society. Visitors may expect opportunities for solitude and self reliance without an obvious management presence.	A natural area, which may be undergoing recovery or rehabilitation towards its natural state. An area where a visitor may expect opportunities for solitude and self reliance with a limited management presence.	An area with some disturbance by activities associated with modern technological society. A visitor may expect low key opportunities for nature appreciation and social interaction in a natural setting. Management presence may be obvious.	A mostly natural area with visitor facilities integrated into the surrounding landscape. Visitors may expect many opportunities to appreciate and enjoy the Property in a natural setting. A management presence may be obvious.
Management intent	To protect land in its natural state. If land is disturbed, to remove disturbance and restore land to its natural state.	To restore land to its natural state wherever practical, by relocating disturbances to land where they will have less impact, or to rehabilitate the land over time where opportunities arise.	To accommodate community services. To ensure that the impact of activities associated with community services is managed to minimise the effect on the integrity of the Property.	To accommodate developed visitor facilities to enable visitors to appreciate and enjoy the Property. To ensure that the impact of visitor infrastructure is managed to minimise the effect on the integrity of the Property.
Total Area	461,620 ha	414,372 ha	18,259 ha	168 ha

Assessment guidelines and codes of practice can be prepared which are relevant to decision making under the Plan. Once a guideline is approved by the Board decision makers must have regard to the information in them, when issuing a permit or other activity.

Co-operative management agreements are voluntary agreements negotiated with landholders who are willing to manage their land in a way that will help the World Heritage Area. In return, they receive assistance from the Authority. The result is a cooperative partnership with mutually satisfying outcomes.

The Plan is administered by the Wet Tropics Management Authority but it also establishes other agencies such as QPWS as permit issuing bodies.

(ii) Other relevant State legislation

Under the *Nature Conservation Act 1992* [17] the Queensland Parks and Wildlife Service (QPWS), has primary responsibility for nature conservation in Queensland including:

- dedication and declaration of protected areas;
- protection of native wildlife and habitats;

- regulation of the use of protected wildlife;
- managing protected areas;
- managing commercial tour operations (including permit issue);
- maintaining infrastructure and public contact in areas under its management;
- and
- protection of cultural heritage including identification, recording, and protection of particular cultural sites.

The *Vegetation Management Act 1999* [19] together with the *Vegetation Management Regulation 2000* [20], makes vegetation clearing on freehold land assessable under the *Integrated Planning Act 1997* [21] while the *Land Act 1994* [22] and its associated regulation [23] governs vegetation management on leasehold and other state land. The Queensland Government has begun implementing vegetation clearing controls [18] on lands outside the boundaries of the Property. Although there is no blanket ban on clearing in the region, landholders now require approval in most cases to clear native vegetation on freehold land and leasehold land. This will aid in the buffering and protection of the Property's natural values.

The *Integrated Planning Act 1997* (IPA) [14] establishes an 'integrated development assessment system' (IDAS). IDAS is a framework that establishes a common statutory system for making, assessing and deciding development applications. The Authority is referred to for advice regarding any reconfiguration of a lot, or a material change of use on land adjacent the Property where the local government considers the development is not of a minor nature.

(ii) Other relevant State legislation

Under the *Nature Conservation Act 1992* [17] the Queensland Parks and Wildlife Service (QPWS), has primary responsibility for nature conservation in Queensland including:

- dedication and declaration of protected areas;
- protection of native wildlife and habitats;
- regulation of the use of protected wildlife;
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b. Planning policies and strategies

(i) Specific World Heritage strategies

Protection through partnerships

The Authority operates under a policy document, *Protection Through Partnerships* [24], which outlines policies, guidelines and actions for achieving desired management outcomes. **Table 4** lists the key policy areas covered in this document. In addition, as the need arises, the Wet Tropics Board produces policy statements to guide and clarify decision making.

Table 4. Key components of *Protection Through Partnerships*

Management Processes	Conservation Practice and Land Protection	Presentation, Visitor Management and Enjoyment	Managing Resource Use
<ul style="list-style-type: none"> • management partnerships • codes of practice • Aboriginal interests • co-ordinated planning • land tenure • boundary management 	<ul style="list-style-type: none"> • flora and fauna conservation • feral animals • weeds and diseases • rehabilitation • fire • scenic management • cultural heritage 	<ul style="list-style-type: none"> • presentation, information and interpretation • visitor research • walking opportunities 	<ul style="list-style-type: none"> • collecting plants and animals • private land use • defence use • communication facilities • grazing • beekeeping • farming • water storage, diversion and extraction • electricity infrastructure • roads and access

Nature Based Tourism Strategy

In August 2000 the Authority released a Nature Based Tourism Strategy to provide the basis for tourism management in the Property. The Strategy divides the Property into 12 tourism precincts according to their distinctive features and tourism focus. The Strategy encourages cooperative partnerships between the tourism industry, managing agencies, indigenous people, conservation groups and the community.

Wet Tropics Walking Strategy

In November 2001 the Authority released the Wet Tropics Walking Strategy. The strategy identifies over 170 different walks in the region and aims to provide a coordinated approach to their management.

Conservation Strategy

In 2001 the Authority commenced development of a Wet Tropics Conservation Strategy for the Property. The Strategy will identify priority conservation measures required as a focus for directing management resources to address key conservation issues. The Strategy is scheduled for completion in 2003.

(ii) Other relevant strategies and plans

Local government planning

The Property falls within 14 local government jurisdictions. Local government is responsible for preparing and implementing local government planning schemes under IPA [21] and making decisions on development applications under associated Integrated Development Assessment Schemes. Local government also prepares local laws under the *Local Government Act 1993* [26].

Where there is inconsistency between a management plan prepared under the *Wet Tropics World Heritage Protection and Management Act 1993* and a local government planning scheme, the Wet Tropics Plan prevails over the planning scheme to the extent of the inconsistency.

All local government jurisdictions within the region have developed Pest Management Plans which identify and target the major environmental and agricultural weeds and pest animals found within different sections of the region.

FNQ 2010 Regional Plan

The non-statutory FNQ 2010 Regional Planning Process [25] was a co-operative, whole-of-government exercise involving Commonwealth, State and Local Governments, as well as business, tourism, environment, development, primary production, human services and Aboriginal and Torres Strait Islander groups. The resulting *FNQ Regional Plan* [25] provides a strategic framework to guide growth and development in the Wet Tropics region with due consideration given to environmental, social and economic opportunities and constraints. The *FNQ Regional Plan* and process has a pivotal role in guiding regional planning decisions under the *Integrated Planning Act 1997*, and provided a significant opportunity for World Heritage management interests to be properly considered within a regional context. Key initiatives of the *FNQ Regional Plan* include:

- a regional growth management strategy
- identification of priority biodiversity and rehabilitation areas within the region
- regional level studies with respect to water infrastructure demands and road access.

The Authority is represented on the FNQ 2010 Implementation Coordination Group.

Wet Tropics Natural Resource Management Plan (NRMP)

Preparation of the NRMP commenced in 2002. The plan will build on existing studies such as those produced as part of the FNQ 2010 Regional Planning Process (above). The NRMP will identify key natural resource management priorities within the region which in turn will form the basis for allocation of Commonwealth funding under the Natural Heritage Trust. The Authority is represented in the NRMP process to ensure World Heritage issues and conservation priorities as espoused in the Conservation Strategy are properly recognised.

c. Aboriginal Interests

Aboriginal communities comprising over 20 Aboriginal language groups have associations with the Property. Aboriginal traditional owners have custodial responsibilities for managing their cultural heritage, which includes the natural environment. The preamble of the *Wet Tropics World Heritage Protection and Management Act 1993* states: “It is also the intention of the Parliament to acknowledge

the significant contribution that Aboriginal people can make to the future management of cultural and natural heritage within the Property, particularly through joint management agreements’. The Act further requires the Authority to perform its functions, as far as practicable, in consultation and co-operation with Aboriginal peoples.

Mechanisms for achieving recognition of Native Title rights and greater Aboriginal involvement in management are provided under legislation such as the *Aboriginal Land Act (Queensland) 1991* [28], the *Native Title Act (Commonwealth) 1993*, the *Native Title (Qld) Act 1993* [29] and the *Wet Tropics Management Plan 1998*.

The Authority’s Aboriginal Resource Management Program (ARM) is responsible for facilitating agreements and partnerships with Rainforest Aboriginal peoples in relation to their involvement in the management of the Property. The program liaises closely with Aboriginal representative organisations such as ATSIC (Aboriginal and Torres Strait Islander Commission), relevant Native Title representative bodies and key tribal organisations such as Giringun Elders and Reference Group, Djabugay Tribal Aboriginal Corporation and the Burungu Aboriginal Corporation. The Authority has secured the services of three Aboriginal community liaison officers (CLOs) to work with the ARM program to facilitate the liaison between Rainforest Aboriginal people and the Authority.

(i) Review

A review of Aboriginal involvement in the management of the Property entitled ‘*Which Way Our Cultural Survival*’ [30] was completed in 1998. The process was directed by an all-Aboriginal steering committee.

The Review presents a commentary on current approaches to Aboriginal involvement in the Wet Tropics World Heritage Area and provides a series of recommendations regarding ways of more effectively meeting land management needs and the aspirations of Rainforest Aboriginal people.

(ii) Interim Negotiating Forum

A key recommendation of the Review was to establish an Interim Negotiating Forum (INF) between Rainforest Aboriginal people, the Authority, QPWS and the Department of Natural Resources and Mines (DNRM) to negotiate solutions to complex management issues and recommendations identified in the Review.

The INF is seen as the starting point to a regional agreement between management agencies and Rainforest Aboriginal people. The key issues being discussed within the INF are:

- recognition of the cultural values of the World Heritage Area;
- native title and World Heritage management;
- Aboriginal involvement in policy, planning, and management;
- the development of meaningful management agreements; and
- traditional resource use, and the use of ecological knowledge.

(iii) Native Title

Approximately 80% of the Property is considered potentially claimable under the *Native Title Act 1993* [29]. Currently, 16 native title claims have been lodged with the National Native Title Tribunal over land in the World Heritage Area, though none have

yet reached the final determination stage. Presently 282,966 ha or 32% of the Property is under claim. The Authority views negotiated management agreements with native title interests as the preferred method of resolving competing land and resource use issues. The Authority is part of a Queensland Government's negotiation team involved in Indigenous Land Use Agreement negotiations with relevant Native Title Representative Bodies representing claimant interests.

(iv) Management Agreements

The *Wet Tropics Management Plan* is designed to support negotiated management agreements with Aboriginal interests under Part 3 Division 5 'Negotiations and variation of controls under agreements'. The first management agreement, under Division 5, occurred in 2001 with the Djabugay Tribal Aboriginal Corporation regarding the Mona Mona Aboriginal Reserve.

(v) Protocols

The Authority has developed protocols for engaging Rainforest Aboriginal people. The protocols relate to consultation and negotiation with Aboriginal people during the planning and carrying out of projects within the Property. These include strategic planning initiatives such as walking track strategies, infrastructure projects, management planning and prescribed burning, feral animal and weed control programs and Authority-supported scientific research projects. The protocols are also designed to ensure that Aboriginal people are properly consulted about activities which require a permit under the Plan [31].

d. Administrative and contractual arrangements

The Commonwealth *Wet Tropics of Queensland World Heritage Area Conservation Act 1994* [15] gives effect to the 1990 State-Commonwealth World Heritage Area Management Scheme. The scheme outlines broad structural and funding arrangements for the management of the Property.

The Wet Tropics Management Authority is a body corporate with statutory powers defined under the *Wet Tropics World Heritage Protection and Management Act 1993*. A board of 6 directors with specified functions and powers is also set up under this Act. The executive director of the Authority is a non-voting director of the Board. The Authority falls within the portfolio of the Queensland Minister for Environment, and as part of the Queensland public sector, the Authority is subject to established public sector legislation, regulations, standards and guidelines governing its administrative functions and arrangements [32].

The Authority's functions are defined under s.10 of the Act and include regulatory, planning, coordinating, funding and monitoring functions and in ensuring that management activities are complementary and contribute to achieving the Primary Goal (to ensure the protection, conservation, presentation, rehabilitation, and transmission to future generations, of the natural heritage of the Wet Tropics of Queensland World Heritage property). The Authority does not have day-to-day field management responsibilities. Field-based management of the Property is primarily the responsibility of land managers such as the Queensland Parks and Wildlife Service (QPWS).

In addition to its two statutory advisory committees - the Community Consultative Committee and the Scientific Advisory Committee, the Authority has also established

three key stakeholder liaison groups - Landholders and Neighbours, Tourism Industry and the Conservation Sector Liaison Groups.

e. Changes in Land Ownership and/or Legal Status

The Property comprises a variety of land tenures including freehold, leasehold, unallocated state land, state forest, timber reserve, forest reserve and national park. A corresponding range of government agencies and private land holders have responsibilities for managing these tenures under a range of legislation. World Heritage listing of this Property does not affect land ownership.

Under the *Wet Tropics Management Plan 1998*, landholders may have certain special rights (subject to certain conditions). These rights apply to:

- freehold title holders
- native title holders
- government landholders

Freehold and native title rights include:

- building a residence
- building an access
- establishing a garden or orchard
- extracting water for domestic use.

Special rights for government landholders include operation of community infrastructure.

Transfer of ownership of leasehold or privately-owned land is not restricted. However, the Authority's general policy is to support the conversion of land tenure within the Property to achieve a higher order of protection where opportunities arise. The outcome of this policy has seen the area of national park increase by 35,878 ha between 1992 and 2000, state forests also increased by 26,510 ha over this period while the total area of leases and freehold land has been reduced by 53,055 ha (**Tables 5 & 6**). During 2001/02 a program of conversion of State Forests within the Property to the protected area estate was undertaken. Approximately 288,400 ha of State Forest within the Property has been transferred under the *Nature Conservation Act 1992* to Forest Reserve, of which 259,382 ha is unencumbered by leases. This tenure conversion which occurred in 2001 involved 32% of the World Heritage Area, with further staged transfers scheduled over the next few years.

Table 5. Trends in areas of different land tenures in the Wet Tropics World Heritage Area [3].

Tenure	Area (ha)							
	1992	1995	1996	1997	1998	1999	2000	2002
National parks	249,866	250,318	266,588	266,707	269,827	269,827	285,744	286,214
Forest reserve	-	-	-	-	-	-	-	259,382
State forests	320,790	331,215	339,937	339,931	348,049	348,049	347,300	89,442
Timber reserves	84,280	73,822	73,951	73,949	73,949	73,949	74,163	62,610
Various reserves & dams	10,707	10,566	10,202	10,207	10,207	10,207	10,207	10,207
Unallocated State Land	58,162	65,980	56,224	70,330	70,501	70,501	60,515	60,515
Leasehold	143,140	135,749	120,708	106,872	95,363	95,243	90,146	90,146
Freehold & similar	17,402	17,560	17,614	17,401	17,499	17,629	17,341	17,341
Roads, Esplanades	5,903	5,903	5,889	5,716	5,718	5,718	5,696	5,696
Rivers	3,307	3,307	3,307	3,307	3,307	3,307	3,308	3,308
Total	894,420	894,420	894,420	894,420	894,420	894,420	894,420	894,420

Table 6. Proportional trends in land tenure in the Wet Tropics World Heritage Area [3].

Tenure	Percentage of WHA						
	1992	1995	1997	1998	1999	2000	2002
National parks	28	28	30	30	30	32	32
Forest reserve	-	-	-	-	-	-	29
State forests	36	38	38	38	38	39	10
Timber reserves	9	8	8	8	8	8	7
Various reserves & dams	1	1	1	1	1	1	1
Unallocated State Land	7	7	8	8	8	7	7
Leasehold	16	15	12	12	12	10	11
Freehold & similar	2	2	2	2	2	2	2
Rivers, roads, esplanades	1	1	1	1	1	1	1
Total	100	100	100	100	100	100	100

f. Contact details of manager

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 Cairns Corporate Tower
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 Australia.
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 Fax: +61 7 40311364
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Heritage Management Branch
 Environment Australia
 GPO Box 787
 Canberra ACT 2601
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 Fax: +61 2 6274 2095
<http://www.ea.gov.au>

g. Staffing, financial and training resources

The Wet Tropics Management Authority has 30 permanent staff positions with total funding of \$7.428 million for 2000/2001 which included \$0.534 million for the completion of the Daintree Rescue Program (**Tables 7 & 8**). Funding is provided to the Authority by the Commonwealth and Queensland governments. A significant proportion of the Authority's budget supports field-based government land management agencies such as the Queensland Parks and Wildlife Service. The Authority supplies funding to these land management agencies to enhance the standard of management and for special World Heritage projects, over and above normal or routine operational expenses. Therefore, routine operational expenses and other resources of QPWS are additional to the figures presented in these tables.

Table 7. Summary of Authority expenditure by program

Program	2000/2001 ¹	1999/2000	1998/1999	1997/1998	1996/1997
Corporate Services	1,286,132	1,462,404	1,175,500	1,087,009	1,152,196

Aboriginal Resource Management	599,000	508,294	355,000	351,000	276,570
Area Conservation	2,326,474	2,878,653	2,819,181	2,853,800	2,369,009
Planning & Research	988,662	1,027,524	1,209,996	848,947	601,847
Community Relations	1,058,222	1,345,419	1,086,841	1,007,705	1,206,572
Daintree Rescue	534,000	1,012,000	4,501,000	7,580,544	8,832,709
Total	6,792,491	8,234,293	11,147,518	13,729,005	14,438,903

[†] An additional \$635,057 goes directly to the Environmental Protection Agency (EPA) bringing the total for 2000/01 financial year to \$7,427,548 (see also Table 9 below)

Table 8. Summary of Authority expenditure by agency

Agency	2000/2001	1999/2000	1998/1999	1997/1998	1996/1997
Wet Tropics Management Authority	4,685,612	4,305,339	3,551,228	3,875,524	3,091,757
Queensland Parks & Wildlife Service	1,275,879	1,625,554	1,885,191	1,632,312	1,755,612
Environmental Protection Agency	635,057	336,000	105,500	-	-
Department of Natural Resources	831,000	955,400	1,096,250	945,000	953,500
Daintree Planning Co-ordination		1,012,000	4,312,179	6,444,169	7,747,634
Other Organisations			197,170	832,000	890,400
Total	7,427,548	8,234,293	11,147,518	13,729,005	14,438,903

The Authority's expenditure for staff training and development increased from \$44,000 in 1999/2000 to \$50,000 in 2000/2001. In addition, in-house training was provided to authority staff in a range of areas including workforce diversity, cross cultural awareness and technical skills such as GIS. **Table 9** provides data available since the 1993-1994 financial year.

Table 9. Expenditure on Wet Tropics Management Authority staff training and development

	Financial Year							
	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01
Expenditure (\$)	53,000	52,030	75,300	12,750	22,600	28,050	44,000	50,000
Number of permanent staff	19	19	18	23	30	30	30	30

h. Scientific and technical studies

The *Wet Tropics Research and Information Needs Report* [33] (RAIN Report) was produced by the Authority in association with its land management partners. The report identifies priority research areas and key information knowledge gaps needed to assist informed decision making about key forces affecting change on the Property.

In 1993 the Commonwealth Government, Wet Tropics Management Authority, James Cook University, Griffith University, the University of Queensland and the CSIRO formed the Rainforest CRC (Cooperative Research Centre for Tropical Rainforest Ecology and Management) [34] as a national centre for understanding rainforest ecology and management. The Centre, located in Cairns, brings together the capabilities and facilities of the nation's leading rainforest research organisations.

In 1999 the Rainforest CRC received funding commitments for a further seven years, with a Commonwealth contribution of \$16 million together with \$3 million in cash and \$40 million in-kind from the CRC's partners. It now features a wider partnership base with the inclusion of the tourism industry, Aboriginal interests, and other government land management agencies.

The seven research programs of the current term of the Rainforest CRC (1999 to 2006) include:

1. Environmental planning and management in tropical rainforests

2. Functional ecology: evaluating ecosystem goods and services in a dynamic landscape
3. Rainforest visitation and business
4. Rainforest access: managing and monitoring impacts
5. Rehabilitation and restoration
6. Conservation principles and management
7. Aboriginal and collaborative management

The outcomes of the Rainforest CRC's research programs are being progressively utilised and incorporated into planning and management. The *RAIN Report* is being used as a key component in promoting World Heritage research priorities within the Rainforest CRC and with other research organisations. Examples of research outputs from the Rainforest CRC are available through their web site [76].

The arrangement with the Rainforest CRC is resulting in a very large scientific research effort being directed specifically at assisting and improving the management capability of the Property and the broader region. The Authority is represented on both the Governing Board and the Executive of the Rainforest CRC. The Authority is represented on all Program Support Groups and commits a minimum of \$150,000 annually to support the research of the centre.

The Authority has commissioned a major vegetation and geology mapping project which began in late 1997 and is due for completion by 2004. This updated and detailed mapping covers the whole Wet Tropics region and will provide a consistent base for management, planning, scientific research and statutory protection.

The statutory Scientific Advisory Committee (SAC) advises the Board on scientific matters. Members of the scientific community nominate for the committee and are appointed by the Board every three years. The role of the SAC includes the identification and evaluation of research needs in all areas of science including the social, biological and physical sciences. The committee also evaluates the effectiveness of the Authority's management and is called upon to examine and advise on development proposals and perceived threats to the Property.

i. Visitation

The Wet Tropics region has experienced substantial increases in both domestic (**Figure 1**) and international (**Figure 2**) visitors over the past two decades. The major tourist destination at present is the Great Barrier Reef, but substantial numbers also visit the Property. Between 1985 and 1995 the annual number of visitors to the region increased from 840,000 to around 2 million [35]. Visitor trends and projections (**Table 10**) forecast in the *FNQ Regional Plan* [25] predict a linear rate of increase resulting in an almost doubling of total visitors to the region by 2016 with an increasing trend in the numbers of international visitors being a major contributing factor.

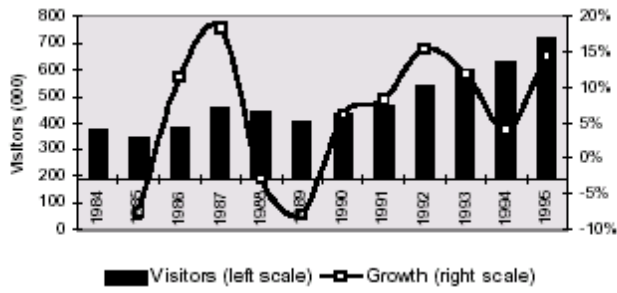


Figure 1. Domestic visitors to the Wet Tropics region [35]

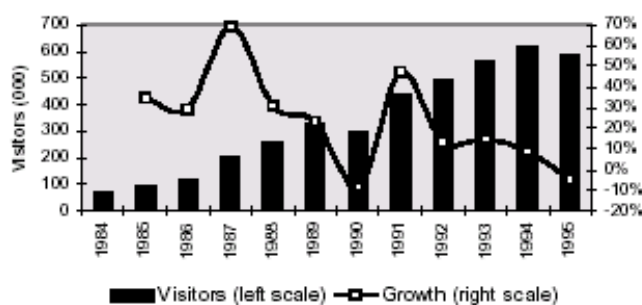


Figure 2. International visitors to the Wet Tropics region [35].

Table 10. Wet Tropics visitor trends and projections between 1993 –2016 [35]

Visitor Details	Trends			Projections			
	1993	1996	1999	2001	2006	2011	2016
<i>Domestic</i>							
Increase	123	184	317	127	280	270	250
Number ('000)	1,456	1,640	1,773	1,900	2,180	2,450	2,700
Average per day	19,147	20,219	21,859	23,425	26,877	30,205	33,288
<i>International</i>							
Increase	-	101	296	103	310	300	300
Number ('000)	541	642	837	940	1,250	1,550	1,850
Average per day	10,375	11,611	1,405	16,740	22,260	27,630	32,945
<i>Total visitors ('000)</i>							
Increase	1,997	2,292	2,610	2,840	3,430	4,000	4,550
Average per day	29,523	31,830	36,764	40,164	49,137	57,808	66,233

A survey of visitors to the region revealed nearly half the respondents (45.6%) nominated rainforest experiences as one of their three main reasons for visiting the region. In 1998, over 48% of Queensland's nature based tourism operators were based in the region and 210 companies had permits to visit the Property. The only detailed source of information on visitor numbers to the Property was a 1993 survey which estimated 4.77 million visits (3.4 million visitor days) were made to 180 sites in the World Heritage Area [36]. A similar survey was conducted in 2002 but the results are not yet available.

j. Fostering a role of the Property in the life of the community

(i) Involvement of the community in management

The following committees, groups and processes have been established by the Authority to promote community engagement and liaison in matters associated with the Property.

Community Consultative Committee

The Community Consultative Committee is a statutory committee under the Act which is appointed by the Board. Its function is to provide advice on the views of the regional community on specific management issues of concern or interest to the community.

Members of the Committee are selected from a broad range of stakeholders including conservation, education, tourism, rural, scientific, recreation and local government interests.

Landholders and Neighbours Liaison Group

This group acts as a conduit for a two-way flow of information between the Authority and landholders and neighbours of the Property. The Property has more than 300 freehold and leasehold properties within its boundaries and more than 2,500 immediate neighbours.

Tourism Industry Liaison Group

This group provides a regular forum for the tourism industry, the Authority and land management agencies to discuss and liaise about tourism issues related to the Property. Members are nominated by key tourism industry groups.

Conservation Sector Liaison Group

The Conservation Sector Liaison Group provides a regular forum for conservation groups and the Authority to identify and discuss conservation issues relating to the Property. Members are nominated by relevant conservation groups.

Management Plan consultation process

An extensive community consultation program was implemented during the development of the Wet Tropics Management Plan [24], including:

- three community attitudes surveys undertaken in 1992, 1994 and 1996;
- a questionnaire distributed throughout the region in 1992 seeking identification and rating, by the public, of the issues perceived to be most important in managing the Property;
- 48 regional and special interest workshops were undertaken;
- a public comment program throughout the initial *Wet Tropics Strategic Directions* phase of planning, involving public workshops, a free telephone service, invitations to provide comments and suggestions and a free postal comment form;
- release for public comment of the Draft Wet Tropics Plan in 1995 with public meetings and workshops, a free telephone service, invitations to provide comments and suggestions and a free postal comment form. The Draft Plan remained on public exhibition for over six months; and
- following the close of public exhibition in April 1996 a detailed submissions report was prepared. Further intensive rounds of consultation and negotiation took place with representative bodies of major community sectors as well as government land management agencies, continuing up to the time of finalisation of the Plan in 1998.

Nature Based Tourism and Walking Strategy consultation process

The Authority established a steering committee involving a broad range of stakeholder interests to provide direction for developing the strategies. Many public workshops were conducted as well as a public release of the drafts inviting submissions.

Volunteers

A network of Wet Tropics volunteers has been set up throughout the region with coordination provided by local QPWS officers. Volunteer activities are diverse and include bird counts, revegetation, cleanups, walking track maintenance, interpretative activities and displays, children's activities, production of newsletters and leaflets,

helping customers at information counters and public education. QPWS provides the volunteers with year-round training in guiding walks, wildlife handling and care, front counter skills and First Aid.

Other community groups assist in the management and maintenance of the Property through initiatives such as community reforestation projects and cassowary conservation initiatives.

Wet Tropics Rainforest Foundation

The Australian Wet Tropics Rainforest Foundation [37] is a charitable organisation created to facilitate and promote involvement of Australian corporations in the conservation and management of the Property. The Foundation is a not-for-profit organisation overseen by an independent Board of Directors recruited from the business community.

(ii) Education, interpretation and awareness raising

The Authority produces a range of educational and interpretive materials to inform locals and visitors about the Property. They range from statutory documents like the Annual Report and State of the Wet Tropics Report, to leaflets which explain issues such as the management arrangements and research results.

Website

The Wet Tropics website [38] was launched in late 1999 and attracts more than 4,000 sessions per month.

Newspaper

Two editions of the Wet Tropics Newspaper are published each year. This paper is inserted into regional newspapers and is available from over 30 visitor centres and QPWS offices throughout the Wet Tropics.

Wet Tropics Update

This newsletter focuses on the latest in policy decisions, management initiatives and on-the-ground activities undertaken by the Authority.

Living with Cassowaries

Local Councils and the Cassowary Advisory Group have produced a range of brochures for residents in known cassowary habitat areas. The brochures offer advice on dog control, driving in cassowary areas, planting cassowary food trees and cassowary-friendly fencing. Other awareness raising products include vehicle stickers encouraging traffic to slow down in cassowary areas and the design of attention grabbing road signage and traffic calming devices.

Neighbours Newsletter

To improve communication with its 3000 immediate neighbours, the Authority produces a regular newsletter to inform neighbouring landowners of issues of particular relevance to them.

Public Contact Rangers

The Authority funds a number of QPWS public contact ranger positions in Townsville, Cardwell, Lake Eacham, Innisfail and Cairns.

Wet Tropics Visitor Centres

There are many visitor centres throughout the region which provide information on the Property. **Table 11** includes centres which have received funding and/or support from the Authority.

Table 11. Visitor Centres that have received funding and/or support from the Authority [39].

Centre	Type	Year Established	Staff	2001 Visitor numbers
C4	Interpretive	1993	Volunteers	18,570
Frosty Mango	Information	1994	Staff	N/A
Hinchinbrook	Information	1994	Council & volunteers	25,991
TEL-Stuart	Information	1994	Volunteers	29,921
Daintree Environment Centre	Interpretive	1995	Staff	33,000
Habitat	Information	1995	Staff	130,000
Lake Morris	Information	1995	Staff	N/A
Malanda	Interpretive	1995	Council & volunteers	11,000
Mareeba	Information	1995	Council & volunteers	29,782
Mission Beach	Information	1995	Volunteers	26,276
Cardwell	Interpretive	1996	QPWS & volunteers	18,000
Ravenshoe	Interpretive	1997	Volunteers	13,000
Lake Barrine	Information	1998	Staff	>120,000
Cooktown	Interpretive	2000	Staff & volunteers	N/A

Annual Cassowary Awards

To mark the 10th anniversary of the Property's World Heritage listing, the Board initiated the 'Cassowary Awards' to recognise those community members making outstanding contributions to the Property in terms of its management, protection, presentation and research. Presentation of these awards is now an annual event.

k. Cultural and social effects

The World Heritage listing of the Property undoubtedly precipitated wide-ranging social impacts within the region. In 1987 it was anticipated that listing of the Property would result in the almost complete collapse of the region's timber industry. It was also expected that such a dramatic contraction of a core regional industry would result in marked negative social impacts in those communities most heavily dependent upon the timber industry. Two social impact assessments (SIA) were conducted one in 1987 prior to listing with the other conducted four years later to assess the effectiveness of strategies implemented to address anticipated listing-related social impacts [40].

The initial SIA was used as the basis of a compensation package designed to ensure forcibly retrenched timber workers would not be unfairly disadvantaged and that the costs associated with preserving the Property could be borne by the wider Australian community. In early 1988 the Commonwealth Government began implementing a Structural Adjustment Package (SAP) in order to address the potential negative social problems identified from the 1987 studies. The three components of the SAP were job creation, business compensation and financial assistance for forcibly displaced timber workers. A sum of \$75.3 million was allocated for the SAP, comprising \$50.9 million for employment-related programs and \$24.4 million for business compensation. The job creation component comprised public works projects, tree planting projects, private sector initiatives and local community initiatives. Assistance for displaced workers

included a dislocation allowance, an early retirement package, a retraining subsidy and a relocation allowance.

All logging within the Property had ceased by 1988 and by 1991 there were only two licensed timber mills still operating in the Atherton and Ingham forestry districts, whereas prior to listing there were 12 mills in operation employing 486 timber workers. By 1991, 413 of these timber mill workers had been made redundant. In the same period, the number of independent timber logging contractors declined from 48 to 13, and the number of special purpose sawmillers declined from 16 to 10.

The town of Ravenshoe, in particular, was identified as being especially susceptible to negative social impacts due to the combined factors of heavy dependency on the timber industry, a high proportion of single parent families, high unemployment and the highest proportion of young people employed in the timber industry. In 1987, the general expectation in Ravenshoe was that listing would signal the 'death' of the community. However, in 1990 Ravenshoe was found to be experiencing a population increase and new businesses had opened [40]. This unexpected finding was found to be largely uninfluenced by the SAP but greatly influenced by the perception that Ravenshoe was in such dire straits that land values fell dramatically, resulting in large tracts of land being subdivided and sold as cheap 'house and land packages'. These packages attracted an influx of new residents and businesses and stimulated associated economic growth in the district [40].

The 1991 study concluded that the SAP was flawed in that it was short-term in its effects. The early retirement assistance was not well accepted with many recipients believing the maximum payout of \$30,000 did not represent fair compensation for the premature termination of a working life. The Public Sector projects, which essentially entailed local councils employing displaced timber workers was more successful [40].

While listing certainly caused significant social impacts at the individual level, at the community level any impacts appear to have been overshadowed by changes in other areas of the regional economic base (see also Economic Effects section below).

I. Economic effects

A number of socio economic analyses were commissioned by the Queensland Government, the timber industry and the Commonwealth Government to assess the possible social and economic dislocation that might result from the World Heritage listing of the Wet Tropics.

The timber industry had been a major contributor to the Wet Tropics regional economy since settlement, and the effects of this industry permeated many aspects of regional activity including production, income, employment, land and house prices, taxation levels, income redistribution, retail and wholesale trade amongst others.

At the time of listing, the gross value of sales of timber from the region was around \$26 million. Driml [36] converted this value to the 1994 dollar equivalents of \$34 million in order to make post-listing comparisons between tourism and logging to the regional economy. This figure of \$34 million is directly comparable with the gross expenditure on tourism of \$443 million (**Table 12**). These figures indicate that the gross expenditure

on tourism is around ten times the gross value of logging and timber production in the year logging ceased in the Property.

The tourism industry contributes significantly to the economy at both a local and regional scale. Direct tourism use of the Property was estimated to generate over \$179 million in 1993, based on expenditure associated with commercial tours, hire cars and running costs for private vehicles (**Table 12**). Total gross expenditure for the region (which includes flow-on effects to the local economy) is estimated to be \$753 million [36].

Table 12. Gross expenditure in Wet Tropics region by visitors to the Property [36]

Expenditure	\$ million
Gross expenditure on visits to the Property	179
Gross expenditure on accommodation etc	264
Total gross expenditure (output)	443
Direct and indirect output contribution with 1.7 multiplier	753

At the regional level, the growth in tourism since listing has more than offset the negative economic impacts resulting from the cessation of logging [41]. It must be acknowledged, however, that tourism did not provide an alternative for many individuals and some communities previously dependent on the timber industry.

II.5. FACTORS AFFECTING THE PROPERTY

a. Global environmental pressures on the Property

(i) Global warming

Climatic conditions in the Wet Tropics are subject to a degree of natural variability with cyclic phenomena like El Nino exerting an important influence. Nevertheless, the build up of greenhouse gases from human activities is contributing to the present accelerated rate of climate change observed over the last 100 years with greenhouse gases currently at levels unprecedented in at least the last 400,000 years [47].

The anticipated changes in global climate are expected to occur at a rate too fast for evolutionary processes, such as natural selection, to keep pace. In addition, landscape fragmentation related to human activities will markedly limit the opportunity for some species to migrate. Predicted warming for coastal north east Queensland is 1.4 to 5.8°C by 2100, relative to 1990 with +4% to -10% changes in rainfall per degree of warming [48]. More El Nino-like conditions and greater tropical cyclone frequency and intensity are anticipated [49]. Computer simulations suggest that the relative humidity surface will shift upwards on tropical mountains by hundreds of metres during the winter dry season [50]. This suggests that the Property's upland nodes of endemism are likely to be particularly susceptible to climate change effects in the near future [51].

Due to this predicted rapid climate change and the increasing frequency of severe climatic events such as cyclones, floods and droughts, the biodiversity and locally endemic and spatially restricted species that are keystone elements of the Property's World Heritage values are predicted to be under severe pressure over the next few decades. Research suggest that the rainforests of the Wet Tropics are extremely sensitive to climate change [52] with preliminary modelling results suggesting that up

to 66% of all the Wet Tropics endemic vertebrate faunal species may be lost over the next 50 to 100 years as a consequence (D. Hilbert & S. Williams *pers com*).

(ii) Examples of recent actions addressing the issue of global warming

At present we do not know the full extent of what might be threatened by rapid climate change, where the threats might be greatest, the long term effects of these threats, how climate change might interact with other threats such as regional clearing and fragmentation patterns, fire, weeds and feral animals, and whether or where some areas may provide continued habitat or new areas of habitat in the future. The Rainforest CRC has commenced a program of research to help answer some of these questions and assist in determining feasible regional-scale management options to anticipate predicted change.

b. Regional development pressure

(i) Regional population growth

The Wet Tropics region is the most populated of northern tropical Australia with most inhabitants living within 50km of the Property’s boundaries in the major cities of Cairns and Townsville, smaller coastal towns and the closely settled farming areas of the Atherton Tableland. As an indicator of trends in population growth, data for the subregion covering the seven local government areas (LGAs) of Cairns, Atherton, Cardwell, Douglas, Eacham, Johnstone and Mareeba is provided. This subregion covers most of the major population centres surrounding the Property.

As at 30 June 1999, there were 197,066 persons usually resident in the subregion of which 120,895 were resident in Cairns City (**Table 13**). Between June 1994 and June 1999, the annual average growth rate was 2.4 per cent reducing to 1.5 per cent in 1998-99 [42].

Table 13. Recent population trends in the major subregion of the Wet Tropics [42]

Local government area	Area km ²	Estimated resident population			Average annual change per cent	
		1994	1998	1999	1994-99	1998-99
Atherton	621	9,659	10,386	10,469	1.6	0.8
Cairns	1,846	104,458	118,735	120,895	3.0	1.8
Cardwell	3,056	8,594	9,491	9,661	2.4	1.8
Douglas	2,447	8,842	10,318	10,499	3.5	1.8
Eacham	1,123	6,166	6,414	6,451	0.9	0.6
Johnstone	1,635	19,081	20,185	20,302	1.2	0.6
Mareeba	53,457	17,805	18,627	18,789	1.1	0.9
Total	64,185	174,605	194,156	197,066	2.4	1.5

Census data show that the population of the subregion has increased from 60,620 persons in 1947 to 208,637 persons in 1996. Most growth has occurred since the early 1970s (**Figure 3**). Between 1947 and 1971 the population increased by 32,980 persons, while between 1971 and 1996 the population more than doubled.

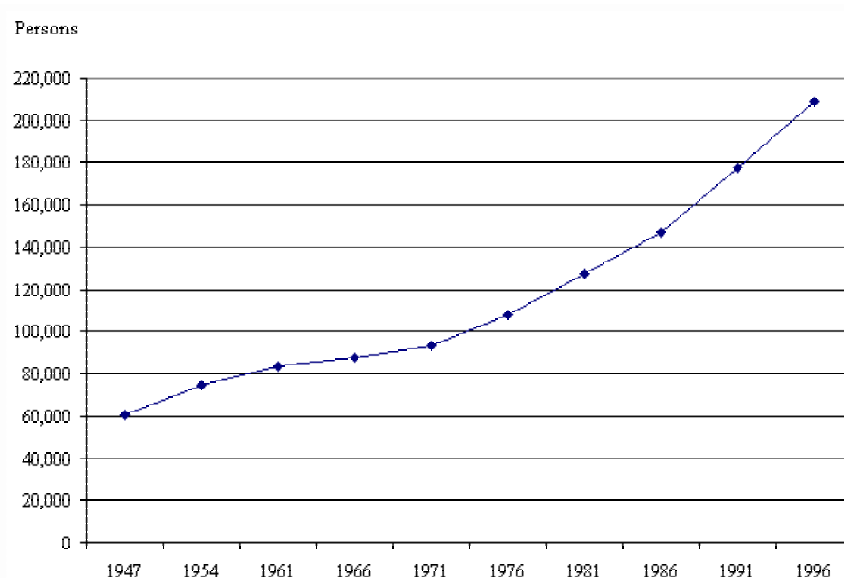


Figure 3. Cairns subregion location census population counts from 1947 to 1996 [42].

By the year 2016, it is projected that the population will increase to 263,890 persons (Table 14). Cairns City is projected to remain the most populous local government area with a projected population of 171,440 persons by 2016. Cairns' share of the population is expected to increase from 60.8 per cent in 1996 to 65.0 per cent in 2016.

Table 14. Population projections by local government area (LGA), 1996 to 2016 [42]

LGA	1996	2001	2006	2011	2016	Average annual change 1996-2016 (%)
Atherton	10,130	10,900	11,540	12,140	12,720	1.1
Cairns	113,510	126,510	141,580	156,550	171,440	2.1
Cardwell	9,110	10,380	11,320	12,190	13,020	1.8
Douglas	9,700	11,180	12,540	13,940	15,370	2.3
Eacham	6,290	6,580	6,810	7,000	7,170	0.7
Johnstone	19,780	20,840	21,670	22,370	22,970	0.8
Mareeba	18,220	19,160	19,880	20,570	21,200	0.8
Subregion	186,740	205,550	225,340	244,760	263,890	1.7

Development associated with a rapidly increasing regional population is leading to greater pressures being placed on the Property. These pressures include demands for energy supplies and distribution corridors, telecommunication facilities, the upgrading and duplication of transport corridors and increased demands for water supplies for domestic, agricultural and industrial uses.

(ii) Tenure within World Heritage Area

The Property includes within its 3,125 km boundaries almost 730 separate parcels of land, including freehold land, national parks, forest reserves, state forests, and a range of leases and reserves (Table 15). Use rights and responsibilities associated with different tenures have significant implications for management of the Property especially with respect to freehold and leasehold tenures and with respect to native title rights.

Table 15. Land tenure in the Wet Tropics World Heritage Area.

Tenure	Area (ha)	Percentage of WHA
National parks	286,214	32
Forest reserve	259,382	29
State forests	89,442	10
Timber reserves	62,610	7
Various reserves & dams	10,207	1
Unallocated State Land	60,515	7
Leasehold	90,146	11
Freehold & similar	17,341	2
Roads, Esplanades, Railways	5,696	0.6
Rivers	3 308	0.4
Total	894,420	100

Eighty percent of the Property is potentially subject to native title rights under native title legislation. The expression of native title rights could potentially have both positive and negative impacts on protection and conservation of the Property. The Authority is involved in Indigenous Land Use Agreement negotiations to ensure Property interests are properly considered.

Table 16 provides a measure of land subject to formal tenure associated with Aboriginal interests or subject to agreements under various statutes.

Table 16. Land (ha) formally under Indigenous management

Form of management	October 1992	June 2000	June 2001
Deed of Grant in Trust	8,055	8,055	8,055
Leasehold/Trusteeship*	5,011	16,791	16,791
Determined Native Title	0	7	7
Cooperative Management Agreements	0	0	1,600
TOTAL	13,066	24,853	26,453

* Note the trusteeship incorporates Reserves under Aboriginal Trustee

(iii) Regional Clearing Patterns

Most of the coastal lowlands below the 80 metre contour in the region, is freehold agricultural land which was extensively cleared in the past for crops such as sugar cane. Similarly, the fertile soils and gentle terrain of the basalt tablelands, led to widespread selective clearing of this landform from the time of European settlement of the region.

The Statewide Landcover and Trees Study (SLATS) monitors vegetation clearing over Queensland using satellite imagery [43]. For the period 1991 to 1995 the clearing rate for the entire Wet Tropics region averaged 3,583 ha per year (**Table 17**) reducing very substantially for the period 1997 to 1999 (**Table 17**) where the average clearing rate was almost a third of the 1991-95 rate.

Table 17. Average annual rates of clearing in Wet Tropics between 1991 and 1999 [43], [44].

1991 - 1995		1997 - 1999	
Clearing rate (ha/yr)	% region area/year	Clearing rate (ha/yr)	% region area/year
3,583	0.2	1,275	<0.1

An overall summary of the pattern and intensity of clearing within the Wet Tropics region for the period 1997-99 is provided in **Table 18** [43].

Table 18. Summary of regional forest conversion for the 1997-1999 period (km² per year)

Pasture	Crops	Infrastructure	Settlement	Total
4.48	7.23	0.78	0.27	12.75

All of the above clearing data relate to areas external to the Property, however regional patterns and trends in clearing, land uses and the array of associated impacts originating from the region surrounding the Property are underlying threats to the overall long-term integrity of the Property. Some of the associated impacts include fragmentation of habitat, severing of wildlife corridors, reduction in habitat refuges, increased demand for water, reduced water quality, changing water tables and introductions and spread of pest plants, animals and diseases.

(iv) Regional landuse

Landuses of the area surrounding the Property are predominantly agricultural (**Table 19**). In coastal areas the main crops have been, and remain, sugarcane and bananas. Agricultural landuses on the Atherton Tableland are rapidly changing especially the expansion of irrigated crops such as sugarcane [45]. Some crops, like tobacco and navy beans, are currently declining in importance but many other high value crops, including mango, avocado macadamias, longans, lychees, custard apple, cut flowers and rare fruits, are increasing in suitable parts of the region [45]. Most clearing within the region is associated with agricultural expansion, and most demand for new or expanded water impoundments or increased subterranean water pumping is due to changing agricultural landuses and practices.

Table 19. Value of agricultural production in the Wet Tropics [46]

Agricultural commodity	Value to Wet Tropics region
	\$m
Sugar cane	232.8
Bananas	149.9
Milk	41.3
Tobacco	24.4
Cattle and calves slaughtered	21.8
Mangoes	20.4
Nurseries	12.0
Poultry slaughtered	10.1
Avocados	8.8
Potatoes	7.8
Total	567.8

The total gross value of agricultural production in the region for the year ended March 1998 was \$567.8 million, representing 9.8 per cent of the Queensland total. Sugar cane production (\$232.8 million) accounted for 41.0 per cent of the value of agricultural production in the region, and 19.6 per cent of Queensland's production of this commodity while 94.2 per cent of Queensland's banana production comes from the region [46].

The increasing regional population is also manifested in an expansion and intensification of urban development and urban clearing with increased demand for associated infrastructure. A number of the areas identified in the FNQ 2010 regional planning process as priority biodiversity areas such as the Daintree-Cape Tribulation coastal strip and the Mission Beach and Kuranda areas are all parts of the region undergoing rapid urban growth.

c. Direct environmental pressures on the Property

There are several categories of contemporary human activities occurring within the Property which have been identified as having the potential to impact negatively on the condition of World Heritage values, including:

- clearing and fragmentation;
- altered drainage patterns and flow regimes;
- environmental pests; and
- undesirable habitat alteration/degradation [33], [75].

(i) Clearing and fragmentation

Prior to the commencement of the *Wet Tropics Management Plan* approximately 15ha of forested freehold land within the Property was cleared and converted to sugar cane. A further 69ha of freehold native forest was converted to pasture. Two small clearings totalling 1 ha have also been recorded in the Daintree lowlands section of the Property. The expansion of the Herberton water supply resulted in the inundation of 5ha of open eucalypt forest and a further 1ha was cleared in upgrading the South Mission Beach water supply pipeline.

Most pre-listing clearings within the Property were associated with networks of community infrastructure such as powerline easements, roads, water pipelines, water impoundments and weirs, all of which cause internal habitat fragmentation to forest blocks and watercourses. The length and cleared area associated with linear community infrastructure is presented elsewhere in this report (refer Section II.3a for more details).

Although there have been no clearings associated with new roads in the Property since listing, there have been several road upgrades and emergency repairs which have resulted in the removal of some trees and an increased road footprint, contributing to increased fragmentation of habitat (the fragmentation impact is probably of greater ecological concern than the loss of trees *per se*). Additional passing lanes have been constructed on the Cook, Kennedy and Gillies Highways. Corners and sharp curves have been straightened to allow passage of B-Double road transports on the Rex and Kennedy Highways. A major upgrade of the Tully-Mission Beach Road has been completed. Cyclone, flood, landslip and slumping damage has resulted in small sections of major repair works being undertaken on the Palmerston, Kennedy and Gillies Highways, the Alexander Range Road, 'Southedge' management road and many more minor access roads within the Property. It is estimated that the combined post-listing clearing resulting from road upgrades and major repairs amount to less than 10ha.

(ii) Examples of recent actions addressing the issue of clearing and fragmentation

Natural recovery and regrowth is the main approach being relied upon by the Authority to restore integrity to previously logged parts of the Property and to progressively enhance connectivity and ecological processes to other areas of disturbance within the Property. The Authority also actively supports and promotes strategic tree planting and other environmental restoration approaches within degraded parts of the Property and adjoining lands [53]. There are a range of rehabilitation initiatives and many thousands of trees that have been planted since listing both within and adjacent to the Property.

The Authority's priorities for rehabilitation are focussed on the re-establishment of ecologically functional wildlife corridors, the decommissioning of obsolete infrastructure especially roads, tracks, powerline clearings and old mine sites and the stabilisation of other disturbed sites. The Authority is also concerned with tree planting hygiene issues to avoid the possibility of introducing weeds and diseases into the Property and has assisted the QPWS' Centre for Tropical Restoration attain nursery accreditation and to develop strict field work protocols.

There is a large-scale research effort by the Rainforest CRC aimed at improving the ecological outcomes of tree planting activities in the region. Researchers have completed a detailed audit and assessment of a very large number of tree plantings, undertaken for a wide variety of purposes, using a wide variety of techniques. This audit in conjunction with specific research studies will also:

- increase our understanding of the basic biology of ecosystems to design more effective restoration strategies;
- by comparing results across a range of sites, determine which restoration strategies are most generally useful; and
- determine where best to allocate efforts in large-scale restoration projects.

A successful prosecution and imprisonment for illegal removal of 15 logs from the Property occurred in 2001 (refer Section II.5e for more details).

(iii) Community Services Infrastructure

Essential services supplied by community infrastructure are important for regional development but the construction and maintenance of infrastructure also detracts from the overall integrity of the Property. One of the most significant impacts associated with infrastructure corridors, particularly through rainforests, is their array of habitat fragmentation effects.

Within the Property are an assortment of electricity supply facilities including three hydro-electric schemes with power stations and associated dams, tunnels and other works, 222 km of power transmission lines, 98 km of power distribution lines, 1 substation, and various ancillary facilities such as roads, buildings, houses and workshops.

The habitat fragmentation impacts of road infrastructure can be amplified by road use resulting in noise, vibration, movement, dust, emissions, and lights which can interfere with wildlife activities and behaviour. Road use can also be a significant source of mortality for wildlife.

A summary of the length and purpose of roads and access tracks within the Property which remain available for use under the *Wet Tropics Management Plan 1998* is provided in **Table 20**.

Table 20. Extent, types and purpose of maintained roads in the Property

Road class and purpose	Length (km)
State controlled roads (roads which form part of the State's road network)	101
Community access roads (local community transport roads)	150
Presentation unrestricted (roads which provide vehicle-based presentation opportunities)	230
Presentation restricted (roads where public access may be restricted and a permit is required)	234
Landholder access (provide legal access to properties in or adjacent to the Property)	153
Management (provide access for management activities including the service of public utilities)	345
Total	1213

(iv) Examples of recent actions addressing the issue of community infrastructure

Codes of Practice

Under the *Wet Tropics Management Plan 1998* [11] infrastructure agencies require a permit to undertake maintenance activities which have the potential to impact on the Property [16]. One tool employed by the Authority and infrastructure agencies to mitigate impacts is the use of environmental Codes of Practice. These codes are also applied as a condition of Wet Tropics permits. Codes of Practice have been produced for road [54], electricity [55] and water [56] infrastructure.

Environmental Management Plans

As well as these general Code of Practice provisions, the Authority also requires Environmental Management Plans (EMP) be developed as an additional condition of some permits to allow more explicit compliance monitoring. For example, EMPs are now a requirement for permits associated with the maintenance of all major powerline easements and roads within the Property. The intention of these EMPs is to provide detailed prevention, minimisation and mitigation strategies for controlling environmental impacts of powerline easement and road maintenance activities at specific sites. Their purpose is to identify and map both environmental values and potential maintenance activity impacts to those values; to specify mitigation strategies together with appropriate monitoring; and if an undesirable or unforeseen level of impact occurs, specify the appropriate corrective action.

Powerlines

Several initiatives have been introduced to reduce ecological impacts associated with powerlines including:

- Production of the Queensland Electricity Supply Industry Environmental Code of Practice [55].
- The Rex Range alignment of the upgraded Turkinje-Port Douglas line was designed to straddle a narrow section of the Property thereby avoiding any need for clearing within the Property.
- The route for the upgraded 275 KV Chalumbin-Woree line although utilising an existing powerline corridor clearing through the Property, has been designed using

very high towers. These very high towers negate the requirement for any clearing under the line being maintained, so that rainforest canopy connectivity will be allowed to re-establish. The towers have also been designed so that they can be maintained by helicopter, thereby eventually eliminating the need for associated maintenance roads through the Property. Cleared areas associated with the construction of the tall towers on ridge lines have been rehabilitated through a program of tree planting, and significant connectivity has been allowed to re-establish naturally in the intervening gully areas.

- The testing of a range of rehabilitation techniques along powerline easements in the South Johnstone/Palmerston area by the QPWS Centre for Tropical Restoration. Associated with these rehabilitation trials, the Rainforest CRC has established a monitoring program to assess the relative success of the methods being employed.
- The Rainforest CRC also has several other research projects directed at assessing and quantifying the ecological impacts associated with powerline clearings through rainforests, and the relative success of actions being taken to avoid or reduce these impacts.

Roads

- The commencement of the *Wet Tropics Management Plan* saw the prohibition of vehicle use of approximately 6,535 km of vehicle tracks in the Property. The majority of these were unformed logging tracks previously used by the timber industry.
- The Queensland Department of Main Roads (DMR) collaborated with the Authority in preparing a best practice manual on the planning, design, construction, maintenance and operation of roads (both sealed and unsealed) in the Wet Tropics region, with an emphasis on the minimisation of environmental harm [54].
- The Authority was closely involved with setting the terms of reference and with reviewing the Integrated Transport Study for the Kuranda Range Impact Assessment Study. This is the major transport link between Cairns and the Atherton Tablelands and has been identified in the *FNQ Regional Plan* as inadequate for projected regional growth needs.
- The Rainforest CRC has been undertaking a range of research aimed at identifying and separating the impacts of roads and their associated edge effects on wildlife from the impacts of traffic volume, noise and pollutants on wildlife [57].
- The Rainforest CRC has also been involved in establishing baseline data and a monitoring program to test the success of specially designed faunal underpasses, other engineering techniques and strategic revegetation works which have been incorporated into the design of a major upgrade to the East Evelyn Road near Millaa Millaa.
- The negative impacts of roads on the conservation of the cassowary is a major concern in the Mission Beach section of the Property, in particular. Studies were commissioned by DMR to assist in determining management options for the El Arish-Mission Beach and Tully-Mission Beach Roads [58]. A range of mitigation

strategies have been developed and implemented, as part of the permit conditions imposed by the Authority, and are currently being assessed for their effectiveness.

- In the Palmerston area, QPWS have completed trials on a range of techniques to rehabilitate wide, badly grass-degraded road verges. The aim is to incorporate some of these techniques into routine unsealed forest road maintenance schedules.

(v) Altered drainage patterns and flow regimes

Rainfall over the region, although the highest in Australia, is highly seasonal, with more than 90% of annual totals falling between November and April creating a need for water storages. Demand on the region's water resources is increasing as agricultural, urban and industrial needs expand in line with population growth and changing land-uses.

There are three dams in the Property: Copperlode Falls Dam, Paluma Dam and Koombooloomba Dam. The first two supply the urban water requirements of the Cairns and Townsville regions while Koombooloomba provides a water source for hydroelectric power generation. Eight local authorities have 22 intakes within the Property, each with associated pipelines, access roads and powerlines [3].

Dams, weirs and culverts are major landscape modifiers resulting in the direct loss of both terrestrial and aquatic habitats through drowning, in the introduction of water barriers to terrestrial fauna movement and acting as barriers to the upstream or downstream movement of fishes and aquatic invertebrates. Such barriers may also interfere with successful reproduction or recruitment of juveniles into adult habitats. Streams below impoundments often become choked with sediments due to altered flow dynamics.

Although there has been no increase in the number of impoundments on watercourses inside the Property since listing, there have been the following changes:

- 5ha enlargement to the Herberton water supply and
- increases in the off-take capacity for the Mossman, Cairns, Mission Beach, Cardwell and Crystal Creek water supplies.

There are also many impacts on stream flows originating from outside the Property which affect the condition of watercourses in the Property.

(vi) Examples of recent actions addressing the issue of altered drainage and flow regimes

- The Authority commissioned the preparation of a water infrastructure environmental code of practice and maintenance assessment guidelines [59] to mitigate potential impacts while establishing consistent and transparent permit assessment processes for development and maintenance activities.
- The Authority actively participates in the FNQ 2010 regional water infrastructure planning processes to ensure World Heritage interests are properly considered. Since 2000 the focus of options being considered for additional water supplies to

meet agricultural and urban demands in the Atherton-Barron-Cairns areas has now moved away from the Property.

- The Rainforest CRC has several projects examining a range of freshwater management issues including environmental flow requirements, visitor use impacts on water quality and ecology, stream biodiversity, stream health and riparian zone requirements, environmentally sensitive infrastructure design and the environmental goods and services provided by natural waterways. Of particular note is current research on culvert design aimed at reducing the fragmenting impact of traditional culvert designs on aquatic ecosystems.

(vii) Environmental Pests

The Wet Tropics is seen as particularly vulnerable to the threat of invasive pest species. For millions of years natural ocean barriers provided the isolation essential for the Wet Tropics' unique species and ecosystems to evolve. In just over a hundred years this natural barrier has been rendered partially ineffective and millions of years of biological isolation has inadvertently come to an end.

In the Property most pest invasions are closely related to human activity disturbances, particularly clearings associated with service corridors such as powerline easements and roads which act as both habitats and conduits for pest dispersal.

Pest Plants

Within the Wet Tropics region, 508 exotic plant taxa have been identified as having become naturalised [60], which amounts to almost 11% of the region's native flora and represents almost 39% of Queensland's naturalised alien plant species total [3]. About 40 of these regional naturalisations are currently considered environmental weeds within the Property.

The rate and magnitude of invasive plant naturalisation within the Wet Tropics over the last century is illustrated in **Figure 4**.

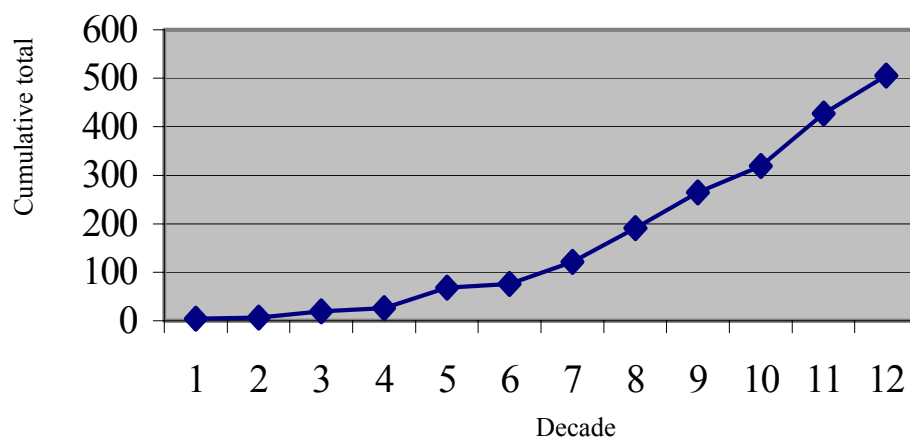


Figure 4. The total number of alien plant species recorded as naturalised in the Wet Tropics region during 10 year increments where Decade: 1 = pre 1900; 2 = 1900-09; 3 = 1910-19; 4 = 1920-29; 5 = 1930-39; 6 = 1940-49; 7 = 1950-59; 8 = 1960-69; 9 = 1970-79; 10 = 1980-89; 11 = 1990-99; 12 = unofficial records for the region compiled by Werren (2001).

Pest animals

Although the number of vertebrate pest species has remained stable for several years, their population numbers, distribution and ecological impacts are poorly understood. Harrison & Congdon [61] assessed the status of the 28 naturalised vertebrate species within the region and found that the current major vertebrate pests are the pig, cat, cane toad and dog/dingo. These species ranked high primarily due to their current levels of ecological impacts and because of the current lack of feasible control options. Pest species with substantial future impact potential include the fox and six exotic freshwater fish species. The translocation of large predatory native fish outside their natural range as part of regional recreational fish stocking projects is an emerging concern. In recent years deer have escaped from a number of deer farming operations and have established a number of breeding feral populations, notably in the Palmerston, Mena Creek and Bingal Bay sections of the region. The apparent rapid rate of population increase and spread of these feral deer populations and their potential to invade parts of the Property is also of concern.

(viii) Examples of recent actions addressing the issue of environmental pests

The Authority recognises the problem of invasive pest species and the risks associated with potential introductions of new species, as a Key Force of Change [33] and a priority for increased research and control effort.

Pest plants

- The Rainforest CRC was commissioned by the Authority to develop an environmental weed 'risk assessment system' (RAS) for the Wet Tropics region [60] designed to gauge the potential impact of weeds on World Heritage values. The system will be used to assist in focussing efforts on a small proportion of the enormous pool of potential weeds, determine the Authority's immediate to medium-term weed management priorities and funding needs and provide the decision-making framework for on-going management of the weed problem. The Authority's weed control efforts for the past decade have been focussed on the two environmental weeds: pond apple and harungana which had been identified in two studies as requiring the most urgent control. At present, after 14 years investment in control activities, it would appear that control of these two weeds are beyond the current resources available to the Authority.
- The Wet Tropics Road Maintenance Code of Practice [54] also attempts to improve road verge and associated roadside weed management. Similarly, the Code of Practice and Environmental Management Plans for the electricity supply industry [55] also aims to minimise the impact and spread of undesirable weeds.
- All local government jurisdictions within the region have developed Pest Management Plans under the *Rural Lands Protection Act 1985*, which identify and target the major environmental and agricultural weeds found within their section of the region. Declaration of a pest imposes legal responsibilities on all landholders, local governments and state government agencies to control the pest on lands under their jurisdiction.
- The Rainforest CRC is undertaking a program of research into the biology, ecology, and control methods of several major environmental weeds aimed at improving our knowledge of weeds, their effect on the environment, and the effect of weed

treatments on these environments. The research is currently focussed on pond apple, harungana, hymenachne, siam weed and tobacco weed.

- The Authority in collaboration with the Far North Queensland Local Government Pest Plan Advisory Committee and the Department of Natural Resources and Mines, and with financial assistance from the Natural Heritage Trust, produced a plain English *Weed Pocket Guide* for the region [62] to aid weed identification and awareness by the general public. Copies of the Guide have been distributed to all landowners within the Property and copies are available through each local government authority in the region. This guide is into its second printing due to a higher than anticipated demand.

Pest animals

- The Rainforest CRC has developed a Wet Tropics Vertebrate Pest Risk Assessment Scheme [61]. The objective of the scheme is to assist the Authority in making informed decisions on where to allocate and focus its pest animal management resources. The scheme was confined to exotic species and did not consider the translocation of native species outside their natural geographic range. In 2002 the Authority commissioned a report on fish stockings and translocations in the Wet Tropics [63] and as a result the Authority is developing a policy on these activities.
- In 2001 the feral pig was listed as a nationally threatening process. It has been estimated that there are in the vicinity of 27,000 feral pigs in the region (J. Mitchell *pers. com*). Control of the pig population within the Property is very difficult because of rugged terrain and major accessibility problems. Several studies by CSIRO and DNR have found that trapping is the safest and most effective control option at present, pending the development of biological control. Since 1993 the Authority has supported a coordinated regional feral pig trapping program which has resulted in a total of 6,500 pigs being trapped and destroyed between 1994 and 1999. The aim of the program is to reduce the impacts of feral pigs on the conservation values of the Property and upon the Property's neighbours and to encourage the adoption of humane techniques. The Authority also funded the construction of a pig enclosure fence to protect the only known population of the endangered tree, *Endiandra cooperana*, whose entire seed crop was being consumed by feral pigs.
- The Rainforest CRC has been undertaking several years of intensive research into the ecological impacts of feral pigs to natural communities. The proceedings of a Wet Tropics feral pig conference and workshop have been published by the Rainforest CRC [64].
- Recent escapes of deer from a farm in the Palmerston area, in particular, have raised concerns regarding their potential for establishing feral populations. It is feared that if these feral populations were to become established in the west of the Property, they could be major destructive pests. The Authority has allocated funds to conduct an initial survey of the extent of this regional problem.

(ix) Undesirable habitat alteration/degradation

Two processes with the potential to cause widespread habitat alteration in the Property include changes to historic fire regimes in non-rainforest ecosystems and forest dieback in the region's rainforests.

Fire

Most of the Wet Tropic's non-rainforest ecosystems evolved under the influence of fire and rely on particular fire regimes for their long-term persistence. Post-European alterations to fire regimes appear to be having an array of ecological impacts however, interpreting appropriate fire regimes to protect World Heritage values is proving difficult because of:

- the difficulties in determining pre-European fire regimes,
- the lack of scientific information on the effects of fire intensity, frequency and timing, or
- the impact of introduced species altering fuel loads and burning characteristics.

(x) Examples of recent actions addressing the issue of fire

- QPWS is responsible for fire management over the majority of the Property. QPWS drafted a state-wide fire policy in mid 2000 and fire management plans are being drawn up for individual protected areas. The protection of ecological systems is one of the two main purposes for these fire management plans, the other being the safeguarding of life and property. The Authority has provided input into plans for the Wet Tropics region to ensure ecological aspects associated with protection and conservation of the Property are addressed.
- Draft fire management coordination arrangements have been developed involving the establishment of regional planning groups including Aboriginal representatives. On-ground land managers' fire plans are being progressively implemented.
- Specific fire management plans and detailed monitoring programs are also a component of the Northern Bettong Recovery Plan process [65].

Forest Dieback

The Authority's ongoing vegetation mapping program (see also Section II.4h for more details) located numerous patches of rainforest dieback across parts of the Property. Species of *Phytophthora*, including *P. cinnamomi*, have been isolated from dieback patches throughout the Wet Tropics by researchers from the Rainforest CRC [66]. The effects of *P. cinnamomi* on the region's rainforests vary from no visible impact to slight loss of canopy leaves in susceptible species to the death of all plants in virulent outbreaks. The association of *P. cinnamomi* with patches of rainforest death in Wet Tropics represents a potentially serious problem, and a management issue of some concern. Where virulent outbreaks occur the anticipated consequences include:

- major disruptions to ecological community structure
- local extinctions of populations of some plant species
- a massive reductions in primary productivity
- loss or degradation of habitats for dependent plants and animals.

Over 200 patches of dead rainforest have so far been identified in the Mount Lewis, Lamb Range and Tully Falls areas. Based on preliminary findings, approximately 14

percent of the World Heritage Area may be susceptible and at risk from rainforest dieback [66]. At least five species of *Phytophthora* have been identified from dieback sites: *P. cinnamomi*, *P. heveae*, *P. katsuurae*, *P. palmivora* and another, as yet unidentified species.

(xi) Examples of recent actions addressing the issue of forest dieback

- The extent of threat of *Phytophthora* to Australia's native species and ecosystems is recognised in the 1996 National Strategy for the Conservation of Australia's Biodiversity, where it is the only pathogenic taxon specifically cited. The Commonwealth EPBC Act also lists the disease caused by *Phytophthora* as a key threatening process subject to a national threat abatement plan [67].
- The Authority has commissioned the Rainforest CRC to undertake a range of integrated research activities investigating the dieback outbreaks so that informed management decisions can be made. The Rainforest CRC research program has been designed to:
 - assess the long term ecological effects of past outbreaks
 - determine the impacts of the present outbreak
 - determine the extent, map current range of outbreaks and monitor their spread
 - establish whether there is any relationship with past or present roads or other human infrastructure or activity
 - recommend practical strategic planning and management options.

(xii) Threatened species

Many species in the Wet Tropics, particularly rainforest species, are naturally rare. Relative rarity is influenced by several factors that may influence a species total potential population size such as its geographic range, its local abundance, and its ubiquity of occurrence within its range. It is often the case that species with small geographic ranges also have low local abundance, and are often patchily distributed within their ranges. These characteristics, either independently or in combination, increase the potential for extinction and make such species sensitive to environmental change/disturbance.

In the tables that follow, the legal status of plants and animals are based on the lists contained within Queensland's wildlife legislation (*Nature Conservation (Wildlife) Regulation 1994*) [68].

Rare and threatened plants

Queensland's Wet Tropics has a total of 351 officially listed rare or threatened plant species (**Table 21**) [3]. Of the 29 recognised recent plant extinctions in Queensland [68], 17 were formally endemic to the Wet Tropics [3]. The presumed extinct species, in general, have not been recorded for over 50 years. The high proportion of the State's presumed extinct, endangered and vulnerable plants coming from the Wet Tropics highlights the vulnerability, small population size and restricted distribution of many of the region's plants and the pattern and extent of past habitat clearing.

Table 21. Rare and threatened Wet Tropics plants [68], [3].

Status	Class	No. of species
Presumed Extinct (X)	fork ferns	1
	tassel ferns	2
	true ferns	5
	cycads	0
	conifers	0
	monocots	3
	dicots	6
	<i>subtotal</i>	<i>17</i>
Endangered (E)	Fork ferns	0
	tassel ferns	4
	true ferns	3
	cycads	0
	conifers	0
	monocots	16
	dicots	19
	<i>subtotal</i>	<i>42</i>
Vulnerable (V)	green algae	0
	fork ferns	0
	tassel ferns	4
	true ferns	8
	cycads	1
	conifers	0
	monocots	12
dicots	29	
	<i>subtotal</i>	<i>54</i>
Rare (R)	fork ferns	0
	tassel ferns	1
	true ferns	27
	cycads	0
	conifers	3
	monocots	37
	dicots	170
	<i>subtotal</i>	<i>238</i>
TOTAL		351

Rare and threatened animals

The Wet Tropics has a total of 98 animal species officially listed as either rare or threatened. Endangered fauna recorded from the Property include seven frog species, three marsupials and one bird (**Tables 22**). A further 16 vertebrate species found within the Property are classified as vulnerable [3].

Table 22. Rare and threatened Wet Tropics animals [68] [3].

Status	Mammals	Birds	Reptiles	Frogs	Fish	Total
Presumed Extinct	0	0	0	0	0	0
Endangered	3	1	0	7	0	11
Vulnerable	6	7	3	0	0	16
Rare	16	9	15	10	0	50
Total	25	17	18	17	0	82

(xiii) Examples of recent actions addressing the issue of threatened species

- State-listed rare and threatened species (*Nature Conservation (Wildlife) Regulation 1994*) [68] are afforded statutory protection under the *Nature Conservation Act 1992* [17].

- The Commonwealth's EPBC Act [12] lists nationally threatened species and provides for the development and implementation of species recovery plans. Environment Australia's Endangered Species Program is implemented through parallel programs run by the State. QPWS is the lead agency with respect to species recovery planning within Queensland. Recovery Plans comprehensively describe, schedule and cost actions assessed as necessary to support the recovery of threatened species. Recovery plans are presently in place for the following Wet Tropics species:
 - frogs (seven species) [69],
 - northern bettong [65],
 - mahogany glider [70]
 - cassowary [71]
 A draft Spotted-tailed Quoll Recovery Plan has also been prepared, but is not yet approved. The Authority is represented on the frogs, spotted tailed quoll and northern bettong Recovery Teams.
- The Cassowary Advisory Group is a community-based group provided with administrative support by the Authority. The group's focus has been in the three cassowary hotspots of Mission Beach, the Daintree lowlands and Kuranda. Intensive field surveys have been completed in these areas which have identified individual cassowaries and specific threats, if any, to each individual. The findings of these detailed surveys have formed the basis for a range of on-ground recovery actions implemented to minimise identified threats.
- The Rainforest CRC in collaboration with James Cook University, Environment Australia, WWF and several government bodies hosted a conference and workshop on amphibian diseases in August 2000. This conference brought together the world's leading authorities on this topic. Several very practical outcomes resulted including agreed and documented management strategies aimed at decreasing the risks to frogs due to communicable diseases [72]. These strategies have been adopted as acceptable field protocols for all researchers involved in handling stream-dwelling frogs in the Property.
- A range of road design (see Section II.5c (iv) for more details), land acquisition initiatives particularly in relation to the mahogany glider and the cassowary, Cooperative Management Agreements (eg Section II.4a(i) for more details), education, interpretation and awareness raising (eg Section II.4j(ii) for more details) are also targeting the conservation management of threatened species.

d. Visitor/tourism pressure

The tourism industry is recognised as a major presenter of World Heritage attributes. To improve communication with the industry, the Authority has established a Tourism Industry Liaison Group with representatives drawn from regional tourism associations. In August 2000 the Authority released *The Wet Tropics Nature Based Tourism Strategy* [73] to provide the basis for tourism management in the World Heritage Area. The Strategy divides the World Heritage Area into 12 tourism precincts according to their distinctive features and tourism focus. The overall aim is to encourage a dynamic, sustainable and professional nature-based tourism industry in the Wet Tropics. In November 2001 the Authority released the *Wet Tropics Walking Strategy* [74]. The

strategy identifies over 170 different walks in the region and aims to provide a coordinated approach to their management.

The Authority undertook a major study in collaboration with the tourism industry to develop a Marketing Action Plan which established a new brand for the Property and a framework to ensure appropriate and accurate images and text are used by tourism operators using the Property. A style manual, logo specifications and a range of approved images and text have been distributed to tourism operators in the region. Aboriginal people have been involved in commenting on appropriate images and text.

Increases in the resident and tourist population is placing greater demands on the Property for recreation and tourism pursuits particularly with regards road access, walking tracks, more developed visitor sites, camping grounds, picnic areas, lookouts and other visitor facilities.

In 2002 the Authority commissioned the Rainforest CRC to develop a *Wet Tropics Visitor Monitoring System*. The system will include a range of monitoring approaches at regional and site scales and is involving researchers, QPWS, the tourism industry, Aboriginal interests and the Authority. The monitoring system has been designed to assess both biophysical and psycho-social impacts and trends, as well as monitor the effectiveness of management and tourism industry in matching visitor expectations and behaviour with opportunities provided.

e. Illegal activity

In the largest illegal logging operation in the Property since listing, 15 logs were removed from the Herberton State Forest section of the Property in January 2001. The offender was charged under the *Wet Tropics World Heritage Protection and Management Act 1993* and in December 2001 was sentenced to 12 months imprisonment. The judge in his closing statement recognised both the criminal acts performed and the significant environmental harm caused to rainforest of international significance.

The first litigation under the EPBC Act was the Booth v Bosworth (the Flying Fox Case). The case concerned the electrocuting of thousands of spectacled flying foxes in the Wet Tropics, but outside of the Property, by a lychee farmer. The farmer used a series of 14 electric grids to protect his crop. When flying foxes collided with the grids they were electrocuted. It was reported that 300-500 spectacled flying foxes were killed per night on the grid. As a consequence of the court case, electric grid control of flying foxes is no longer allowed in Queensland. This case involved a number of key issues for the protection of World Heritage, including establishing that an action taken outside a World Heritage area can be regulated if it causes a significant impact on World Heritage values (in this case the spectacled flying fox and its ecological processes). The case also highlighted the importance of public interest litigation.

II.6. MONITORING

a. Current monitoring program

The Authority's major monitoring program is linked to its annual reporting requirements. State of the Wet Tropics reporting is a statutory requirement under the *Wet Tropics World Heritage Protection and Management Act 1993*. A set of key reporting themes were approved by the Board in 1999 [75] from which landscape scale indicators have been developed. The core indicators relate solely to measuring changes in natural values. Role in the life of the community socio-economic and cultural indicators are currently being developed in collaboration with the Rainforest CRC.

The generalised core reporting themes presently being employed by the Authority are summarised in **Table 23**.

Table 23. Summary of core reporting themes employed in annual State of the Wet Tropics Reporting

Status of natural values	Factors affecting natural values	Management of factors affecting natural values
<p>Biodiversity</p> <ul style="list-style-type: none"> ecological communities plant species vertebrate species invertebrate species rare & threatened ecosystems rare & threatened plants rare & threatened animals 	<p>Clearing</p> <ul style="list-style-type: none"> regional clearing external to Property clearing within Property <p>Fragmentation</p> <ul style="list-style-type: none"> external fragmentation (of Property isolates) internal fragmentation (within Property) <p>Habitat alteration/degradation</p> <ul style="list-style-type: none"> forest dieback altered fire regimes <p>Pests</p> <ul style="list-style-type: none"> environmental weeds vertebrate pests invertebrate pests exotic diseases <p>Altered flow regimes</p> <ul style="list-style-type: none"> impoundments water extraction <p>Community infrastructure</p> <ul style="list-style-type: none"> powerlines roads telecommunications <p>Tourism & recreation</p> <ul style="list-style-type: none"> visitor numbers economics of visitation <p>Regional demographics</p> <ul style="list-style-type: none"> subregional population patterns and trends 	<p>Statutes</p> <ul style="list-style-type: none"> State & Commonwealth Acts subordinate legislation <p>Policy</p> <ul style="list-style-type: none"> plans guidelines codes <p>Land ownership</p> <ul style="list-style-type: none"> State tenures protected area categories <p>Aboriginal interests in land</p> <ul style="list-style-type: none"> claims Aboriginal land ownership joint management <p>Rehabilitation</p> <ul style="list-style-type: none"> tree planting/landscape restoration species recovery programs

At the site level, the Authority in collaboration with the Rainforest CRC has designed, and is currently trialling, a visitor monitoring system incorporating both biophysical and psycho-social components.

b. Results of current monitoring program and of key indicator measurement

The following are some of the key issues and findings selected from the 2001-2002 State of the Wet Tropics Report which highlight some of the more significant and current issues or pressures affecting protection and management of the Property [3].

Regional population growth

Regional population growth is 1.5% which is greater than the national average. The annual population growth for the region over the next decade has been forecast at 1.9%. Between 1971 and 1996 the regional population more than doubled to 208,637 persons.

Tenure trends within Property

There has been a progressive conversion of land tenures within the Property to national park (eg from 14% at listing in 1988 to 32% in 2002) and a progressive reduction in the area of various lease tenures from 143,140 ha in 1992 to 90,146 ha in 2002. In November 2001 a further 259,382 ha of State Forest within the Property was converted to Forest Reserve, a protected area holding tenure before eventual conversion to national park. In addition, about 32,000 ha of state forest contiguous with, but adjacent to, the World Heritage boundary was also involved in this stage 1 tenure conversion.

The increase in higher order land protection within the Property has been significant since listing with an average increasing trend over the past eight years of 4,500 ha per year being added to the national park estate. Over this same period there was an average 3,300 ha per year increase in the area of state forests unencumbered by leases and an average reduction of 6,600 ha per year in the area of leases and freehold land within the Property.

In the Daintree section of the region a strategic freehold land acquisition program (Daintree Rescue Program) has been implemented. 2,500 hectares of land within and adjacent to the Property has been procured through voluntary surrender agreements or direct purchase.

The Authority has also been instrumental in the voluntary acquisition and conversion to national park of other strategically important parcels of land within the region in accordance with Board endorsed guidelines (notably in the Graham Range, Cardwell Gap, Tully-Murray and Brampton Beach areas).

Aboriginal interests and management agreements

Currently a total of 282,966 ha of the 894,000 ha Property is under claim. Land formally under indigenous management presently totals 26,453 ha.

The first management agreement with Aboriginal peoples in the Property was signed in 2000 with the Djabugay Tribal Aboriginal Corporation under section 42 of the *Wet Tropics Management Plan 1998*.

Visitation and tourism

Based on 1997 figures, tourism directly attributable to the Property, is estimated to generate over \$750 million each year.

The total number of visitors to the region is presently around 2.8 million per year. Visitor projections forecast an increase in total visitors to 4.5 million by 2016 with the increasing trend in the numbers of international visitors being a major contributing factor. 45.6% of visitors nominated rainforest experiences as one of their three main reasons for visiting the region.

In 1993 the number of visitors to 180 sites in the Property was 4.77 million visits (3.4 million visitor days). Of this, 1.5 million visits (32%) were by people on commercial tours. 48% of visits were made by local residents.

In 1998, 210 commercial tour companies were issued permits to visit the Property.

A survey of 6,917 visitors to the Property in 1993 indicated that 42% of visitors were 'extremely satisfied', only 0.1% were 'very unsatisfied', with the mean level of satisfaction being 'very satisfied' with their experience.

Clearing, fragmentation and landuse

Clearing of native vegetation outside the Property but within the Wet Tropics region remains a concern, however it has slowed from an average rate of 3,583ha per year between 1991-95 to 1,275ha per year between 1997-99. The largest areas cleared between 1997 and 1999 were on the upland tablelands as a consequence of expanding use of land for irrigated sugar cane production.

With the introduction of the *Wet Tropics Management Plan 1998* any clearing within the Property without a Wet Tropics Permit is now prohibited. Most existing clearings within the Property are related to activities and infrastructure which were in place at the time of listing. There are currently 2,406 ha of maintained linear clearings in the Property providing vehicle access and electricity distribution. A further 2,129 ha of clearing is due to artificial dams and impoundments which were present prior to World Heritage listing. Since listing there has been a total of 101 ha of new clearings, 85 ha on freehold land prior to the commencement of the Plan, with the remaining 16 ha associated with community infrastructure.

Community infrastructure

Ecological fragmentation associated with community service infrastructure is one of the major ecological impacts originating from within the Property. Electricity supply infrastructure is having the most significant fragmentation impact.

Logging has been a prohibited activity in the Property since 1987 and infrastructure associated with this industry has been phased-out, including the closing of over 6,500 km of logging roads and snigging tracks which had a combined cleared area footprint of approximately 2,070 ha.

There have been no clearings associated with new powerline or road construction within the Property since listing. Powerline upgrades have been designed to either straddle the Property or have been constructed on very tall towers negating the need for

maintenance clearing under the line, while allowing for the re-establishment of canopy connectivity across existing clearings.

An environmental impact study into the feasibility and environmental impacts of alternate routes for the upgrading of the Tully-Innisfail powerline has been undertaken and is presently at the public consultation stage. A coastal route avoiding the Property appears to be a prudent and feasible option, however it is apparent there is a degree of local community opposition to this option. The coastal route option would result in the eventual decommissioning and rehabilitation of at least 35km of an existing 132KV transmission line and its associated 60 metre wide swathe clearing which presently dissects the Palmerston section of the Property. This would be a major gain for the management of the Property, especially with respect to reduced ecological fragmentation.

The Flaggy Creek and Davies Creek water storage proposals which had direct impact implications for the Property have been rejected from further consideration in favour of more prudent and feasible alternatives remote from the Property. However the trend for increased water demand and consumption resulting from expanded irrigation on the Tablelands and increase in population of Cairns remains a concern if it results in impacts on the ecology of waterways within the Property.

Codes of practice have been prepared for management and maintenance of road, electricity and water infrastructure in the Property. These codes of practice generally appear to be successfully achieving their desired outcome.

Pest species

The rapid increase in naturalised plant species in the Wet Tropics region is of concern. In the past decade the number of recorded naturalised species has increased from 320 to over 500. A risk assessment has identified 27 terrestrial and 7 aquatic introduced plant species which are considered to be of particular concern to the ecological integrity of the Property.

The number of vertebrate pest species has remained stable for several years. Population numbers, distribution and ecological impacts of these 28 species are very poorly understood. The feral pig, cat, dog and cane toad are the current major threats. Non-native species with substantial future impact potential include the fox and six exotic freshwater fish species. The translocation of large predatory native fish outside their natural range as part of recreational fish stocking projects is an emerging management concern. The Authority supported regional feral pig trapping program destroyed a total of 6,500 pigs between 1994 and 1999. It has been estimated that there are in the vicinity of 27,000 feral pigs in the region.

In addition to the feral pig problem, the Authority is developing policies and determining appropriate responses to native fish translocations, cattle grazing and feral deer.

Rainforest dieback

Rainforest dieback, attributable to *Phytophthora cinnamomi* now appears to be much more widespread than previously expected. Over 200 patches of rainforest dieback have so far been mapped. Although individual dieback patches are small in area (eg.

generally <1ha in areal extent), preliminary findings suggest that up to 14 percent of the Property may be at risk.

Threatened species

Although covering only about 1 percent of Queensland, the Wet Tropics region was home to 59% of the State's presumed extinct plants, and is presently the habitat for 28% of Queensland's endangered plants, 19% of its vulnerable plants and 34% of its rare plants. The Property has a total of 98 animal species listed as rare or threatened, including seven endangered frog species, and the endangered cassowary, mahogany glider, northern bettong, spotted tail quoll and two butterflies. A further 16 vertebrate species are classified as vulnerable.

Of the endangered species, recovery plans are currently being implemented for seven frog species, the northern bettong, mahogany glider and cassowary. A draft spotted-tail quoll Recovery Plan has also been prepared. The Authority is represented on the frog, spotted tailed quoll and northern bettong recovery teams.

Of particular concern is the dramatic decline in population numbers of seven species of frogs over recent years. These frogs are endemic to the Wet Tropics and have disappeared from streams above 450 metres altitude in seemingly pristine environments over the last two decades. Recent research findings attribute the decline to the amphibian fungus, *Batrachochytrium dendrobatidis*. Agreement on management strategies aimed at decreasing the risk of communicable diseases to amphibians was one of the practical outcomes of a recent conference on amphibian diseases.

Population numbers of the Southern Cassowary also appear to be in decline with estimates of fewer than 1,500 adult cassowaries remaining in the Wet Tropics region. A recent study in the Mission Beach area identified a total of 110 cassowaries (49 adults) with an average loss of 2% of the adult population per year since 1988. Of these deaths, one bird was shot, six died from disease, 13 were killed by dogs and 42 died in collisions with vehicles on the roads. An additional pressure is loss of habitat, with the estimated clearing of 18% of available cassowary habitat in the Mission Beach district between 1992-1998.

There is concern that the spectacled flying fox (*Pteropus conspicillatus*), found in and around the rainforests of the Property is in serious decline, with recent field surveys estimating the total number of spectacled flying foxes to have declined from 113,960 in November 1998 and to only 79,980 in November 2000 with anecdotal evidence suggesting that total numbers may have declined from 800,000 during the 1980s.

Community attitudes survey

A repeat community attitude survey is presently being undertaken (2002), the results of which are not currently available. The only previous surveys were conducted in 1992, one year after the establishment of the Wet Tropics Management Authority and 1993, of both the regional community and in three of Australia's largest cities, Sydney, Melbourne and Brisbane. Some of the findings from the early surveys were:

- Awareness of the Property as a World Heritage listed area rose significantly both regionally and in the cities. Regionally awareness increased from 71% in 1992 to 87% in 1993. The cities showed an 12% increase, from 31 to 43%.

- Only 45% were satisfied with information provided on the Property, however this was an increase from 35% in 1992.
- Support for World Heritage listing of the Property remained stable in the cities, from 70% support in 1992 to 72% in 1993. Regionally, support rose from 74% to 80% indicating an increasing trend in support for listing
- Attracting tourists and environmental protection were seen as the primary benefits of listing.
- Loss of jobs and losses to the timber industry were the most cited disadvantage of listing.
- One third of residents in the region believed listing would mean a positive effect in their community, however the largest proportion believed that it would not have any effects on their communities.
- Satisfaction with progress in decision making was low, but increased from 31% in 1992 to 37% in 1993.

Landholders and neighbours survey

In August 1999 the Authority commissioned an independent survey of immediate neighbours of the Property. The telephone survey involved 500 neighbours. The results showed 66% were satisfied with being an immediate neighbour with just 15% dissatisfied. Those less likely to be satisfied or supportive included the owners of properties larger than 40ha (52% support), owners of multiple properties (55%), non-resident property owners (52%), primary producers (47%), owners of properties for more than 20 years (52%) and those over 55 years of age (56%). The groups most supportive included owners of properties of less than 4ha (77%), owners of the property for less than 10 years (75%), less than 55 years old (70% for 18-39 years, 74% for 40-54 years), female (76%) and owners of residential land (78%).

c. Report on outcomes of World Heritage Committee or Bureau State of Conservation Reports

Refer to Section II.6.d. below.

d. Report on outcome of ACIUCN Reactive Monitoring reports

In November 2000, the WH Bureau noted the ACIUCN Report on the state of conservation of the Property. The report identified four priority action areas:

- (i) the need to support site management, particularly to ensure adequate resources to effectively implement the Wet Tropics Management Plan and the Authority's Strategic Plan;
- (ii) the need to closely monitor the management of native and introduced species, in particular the control of feral and exotic species;
- (iii) the need to ensure complementary management of land use and human impacts within and beyond the boundaries of the World Heritage area. ACIUCN recommended a particular focus on industrial and tourism developments, as well

- as the need to carefully assess electricity options in the region, which may impact the World Heritage area, and
- (iv) consideration of a number of strategic issues, including indigenous involvement on management, the recognition of cultural values in any review of boundaries to enhance site management.

The Commonwealth has finalised its response to the ACIUCN Report which will be a basis for monitoring the implementation of the focused recommendations related to priority action areas identified in the ACIUCN Report.

II.7. CONCLUSIONS AND RECOMMENDED ACTION

a. Main conclusions regarding the state of the World Heritage values of the Property (see items II.2. and II.3. above)

Improved knowledge of the significance and values of the Property has increased markedly since listing due largely to a concerted scientific research effort by the Rainforest CRC, an earlier Authority funded research grants scheme and annual information collection and collation for State of the Wet Tropics reporting.

Overall it is concluded that the state of the Property's World Heritage values have been maintained since listing and that a wide range of management activities have been implemented to achieve progressive enhancement of these values in the longer-term.

Logging and associated forestry operations was the only major extractive industry in the Property at the time of listing but has been prohibited since 1987. Infrastructure, such as roads, associated with this industry has been progressively phased out resulting in reduced impacts through their use and maintenance. There has also been improvements in canopy connectivity associated with infrastructure corridors resulting from the closure of forestry roads and improved design and maintenance of electricity supply lines straddling the Property.

A statutory management plan for the Property is in place which strictly regulates activities within the Property including improved management and maintenance practices of community infrastructure resulting in reduced environmental impacts.

Significant gains have been achieved in the Daintree lowlands in complementary habitat protection and consolidation through a large-scale voluntary freehold land acquisition program. This has seen 2,500 ha of land adjacent to the Property procured.

Recovery plans are being progressively implemented for the most threatened species of fauna in the Property.

b. Main conclusions regarding the management and factors affecting the Property (see Items II.4 and II.5. above)

Specific statutory protective measures for the Property are now in place. The *Wet Tropics World Heritage Protection and Management Act 1993* together with its subordinate statute, the *Wet Tropics Management Plan 1998* provide the legal framework and statutory mechanisms for management of the Property by regulating activities within the Property that have the potential to impact on World Heritage

values. A range of other legislation and regional planning instruments is assisting in conservation management in areas surrounding the Property.

Three major management strategies undertaken by the Authority complement the Wet Tropics Management Plan: a) *Nature Based Tourism Strategy* (implementation phase), b) *Walking Strategy* (implementation phase) and c) *Conservation Strategy* (development phase). The Authority's *Research and Information Needs* report complements these strategies by identifying key research priorities in these management areas. These strategies will assist in determining relative management priorities and allocations of resources.

The proportion of the Property in protected area tenures has increased significantly, while the area of leasehold and freehold has been reduced.

Native title and Indigenous land use negotiations will continue to emerge as a major area of management focus with 80% of the Property potentially claimable under the *Native Title Act 1993*.

The establishment of the Rainforest CRC as a national centre for understanding rainforest ecology and management, and its partnership arrangements with the Authority, has resulted in a major increase in applied research effort being directed at management issues.

The substantial increases in tourism since listing is a major contributor to the regional economy. Management partnerships, which have been developed with the tourism industry, recognise the important role the industry can play in presenting the values of the Property. The *Nature Based Tourism Strategy* and visitor monitoring system are attempts to maximise the benefits while minimising the impacts associated with visitation.

A wide range of initiatives have been developed aimed at fostering a role of the Property in the life of the community - ranging from actual involvement of the community in management, the establishment of stakeholder advisory and liaison groups, to the production and distribution of educational, interpretative and awareness raising materials.

Ultimately, regional growth, development and population increase will be a major causal agent of direct and indirect pressures on the Property. The rapid growth rate of the regional population surrounding the Property has led to clearing for urban and agricultural expansions, greater demands for energy supplies and their distribution, the upgrading and duplication of transport corridors, increased demands for high quality water supplies for domestic, agricultural and industrial uses, increases in the number and spread of pest species and greater demands for recreation and tourism facilities.

Internal fragmentation (and its array of impacts on ecological integrity, ecosystems and evolutionary processes) is considered a major threatening process to the World Heritage values of the Property. In recognition of this, wherever feasible and opportunities arise, obsolete infrastructure has been phased-out, and considerable efforts have been invested in improving management and maintenance practices through the use of codes of environmental practice and detailed environmental management plans. The Rainforest CRC is undertaking adaptive management research designed to test current

management practices; to provide the baseline data necessary for designing robust monitoring systems; and to provide prescriptions for improved management.

The other major potential pervasive threats to the Property include global warming and invasive plant, animal and disease species.

Preliminary research suggests that the rainforests of the Wet Tropics are extremely sensitive to rapid climate change, with predictions of up to 66% of all the Property's endemic vertebrate faunal species being at extreme risk of extinction over the next 50 to 100 years. The impacts of internal fragmentation as barriers to movement and migration are expected to exacerbate this impact in addition to assisting accelerated pest invasions and providing conduits for increases in fire risk. Management strategies to deal with the threat of global warming at the regional or Property scale have not as yet been determined.

The threat posed by invasive plants, animals and diseases is considered to be greater now than at the time of listing. The rate of increase in the naturalisation of introduced species within the region is a concern. Several invasive environmental pest species, such as pond apple, harungana, several grasses, feral pigs, cats and cane toads, are already beyond our management capacity to effectively and sustainably control given present resources and knowledge.

The health of some areas of rainforest within the Property has been affected to varying degrees by Phytophthora induced canopy dieback. The cause or trigger of these recent outbreaks is presently unknown.

Limited financial resources may severely hamper the rate of implementation of strategies designed to address these issues.

c. Proposed future action/actions

Following completion of the Wet Tropics Management Plan, the development, completion and implementation of specific management strategies has been an Authority priority. The *Wet Tropics Nature Based Tourism and Walking Strategies* are at the implementation stage. The *Wet Tropics Conservation Strategy* is under development and will be used as the framework for developing strategic approaches to the management of issues such as pests, climate change, fragmentation and rehabilitation.

Negotiated outcomes with Aboriginal peoples associated with the Property through processes such as the Interim Negotiating Forum and management agreements will continue to be a priority for the Authority.

The finalisation of the Authority's long-term regional vegetation and geology mapping project is due for completion in 2004.

The establishment of the Australian Tropical Forest Institute (ATFI) is a high priority. The institute would enable a continuation of the applied management research presently provided by the Rainforest CRC whose funding only continues until 2006. The ATFI concept is to establish a self-funding institute.

d. Responsible implementing agency/agencies

All of the above actions are the responsibility of the Wet Tropics Management Authority. ATFI is a joint initiative between the Authority, Rainforest CRC, James Cook University and a number of commercial partners.

e. Timeframe for implementation

Priority initiatives identified in the Authority's management strategies will be introduced over the term of this Periodic Report subject to adequate resourcing.

f. Needs for international assistance. N/A

g. Experience relevant to other states parties

Development of rule-based management zoning schemes, and the use of GIS as a tool in decision making.

Cooperative approaches to management with research institutions, Indigenous communities, infrastructure agencies and stakeholder groups.

Commitment to the development of better on-ground practices by infrastructure agencies.

Commitment to coordinated planning and land management on a whole of region basis.

APPENDICES

Appendix 1: Update of original 1987 nomination dossier

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APPENDIX 1

Update of Original Wet Tropics of Queensland Nomination Dossier

Description and Inventory

The Wet Tropics of Queensland World Heritage Area covers 894,420 ha and extends from just south of Cooktown to just north of Townsville.

The rainforests of the Wet Tropics of Queensland are a relict of a vegetation type which was once much more widespread. Fossil pollen records have indicated that the whole of Australia was covered by closed forests some 50 to 100 million years ago. Today the Australian rainforests are restricted to a series of discontinuous pockets extending for more than 6000 km across northern Australia and along the east coast to Tasmania. Representatives of the sub-tropical and temperate rainforests are included in the Central Eastern Rainforests Reserve in New South Wales and south east Queensland and the cool temperate rainforests are included in the Tasmania Wilderness World Heritage Area.

Australia has a total native forest area of almost 156 million hectares (National Land & Water Resources Audit 2001). With a land area of almost 769 million hectares, only about 20 per cent of the continent is forested. It is estimated that Australia's rainforests today cover just over 3.0 million hectares (National Land & Water Resources Audit 2001). The largest area of remaining rainforest in Australia is located in the Wet Tropics region (27.6%) where most of the larger contiguous blocks are contained within the boundaries of the Property (**Table 1**). Due to its landscape diversity and latitudinal position, the Wet Tropics supports a range of tropical, subtropical, temperate and monsoonal rainforest types found elsewhere in Australia, but nowhere else is the full range of these broad climatic rainforest types represented.

Table 1. Distribution of rainforest in Australia (km²)¹

ACT	SA	Vic	WA	NSW	NT	Tas	Qld	Australia	Wet Tropics ²	WHA ²
0	0	407	16	2218	977	7055	19558	30231	8340	6690
0	0	1.3%	0.1%	7.3%	3.2%	23.3%	64.7%	100%	27.6%	22.1%

Source:¹National Land & Water Resources Audit 2001, ²Authority GIS

(i) Climate and hydrology

Many of the distinctive features of the region relate to the high rainfall and diverse terrain. The mean annual rainfall ranges from about 1200 to over 4000 millimetres with some sites having much higher falls. The wettest region lies between Cairns and Tully on the coast and subcoastal ranges where the mean annual rainfall is generally over 3000 millimetres.

Even in the wettest areas between Tully and Cairns there is a distinctly seasonal precipitation regime with over 60 per cent falling in the summer months (December to March) followed by a relatively dry season in mid-year. Tropical low pressure cells and

cyclones that develop in the monsoonal trough commonly produce more than 250 millimetres of rain in a day during the wet season. Mt Bellenden Ker has received 1140 millimetres of rain in a 24-hour period.

By comparison with other tropical rainforest areas in the world, the wetter parts of the region lie at the 'wet' to 'extremely wet' end of the hydrological spectrum. During the wet season when soil profiles are often saturated, high intensity rainfall may not be absorbed by the soil, and widespread overland flow can occur even on relatively steep slopes. The common occurrence of widespread overland flow, as distinct from highly localised saturation overland flow in valley bottoms, channel margins and stream head locations, appears to be rare in other wet tropical rainforests of the world; indeed its absence has been regarded as characteristic. In this respect, the rainforests of the Wet Tropics appear to be exceptional (Walsh 1980).

On the coast, mean daily temperatures range from a maximum of 31°C to a minimum of 23°C. During winter the mean daily maximum and minimum temperature, are about 5°C lower. The tablelands and uplands are cooler, with mean daily summer temperatures ranging from a maximum of 28°C to a minimum of 17°C. During winter, the mean daily maximum and minimum temperatures are 22°C and 9°C respectively. Coastal humidity during the summer months is on average 78 per cent, but there are numerous days when it reaches into the high nineties.

(ii) Geology and geomorphology

The Property straddles three major geomorphic regions:

- tablelands of the Great Divide;
- coastal lowlands; and
- intermediate Great Escarpment.

The undulating tablelands are remnants of an elevated and warped landscape. The highlands rise to altitudes of 900 m with isolated peaks up to 1622 m. To the east, the Great Escarpment marks the limit of headwards erosion into these tablelands from the coastal plain. It is a zone of rugged topography, rapid geomorphic processes and diverse environments. The escarpment is deeply incised by many gorges, and there are numerous waterfalls.

The geological history can be divided into three parts:

- formation of a relatively rigid and impermeable continental basement in the Palaeozoic;
- initiation of a north-west drainage in the Mesozoic; and
- intensified doming to the east in the late-Mesozoic-Cainozoic, culminating in continental rifting, ocean formation, partial foundering of the new continental margin with the coast retreating to its present position in the late-Tertiary.

The bulk of the underlying rocks are marine Silurian, Devonian and Carboniferous sediments of the Hodgkinson Basin and Broken River Embayment. The greatest concentrations of volcanics and granite occurs at the southern end of the Basin at its intersection with the trend of the Broken River Embayment.

Many of the granites were probably exposed by the end of the Palaeozoic of the beginning of the Mesozoic. Uplift of the tablelands shed drainage north-west during the Jurassic to the Tertiary period. Climatic change and geomorphic processes during the Quaternary led to repeated coastal retreat and marine submergence. These events influenced the reversal of stream flow to the east.

Stepwise coastal retreat and formation of the present juvenile upland coast has led to stream reversal and slope failure. One of the most striking elements of the landscape is the Great Escarpment, which has retreated to its present position as a result of catastrophic erosion and slope failure of poor soils. Only where basalt flows have run down valleys have the gradients of the Escarpment been locally reduced. In the Johnstone River valley system the escarpment is breached by a ramp of moderate slope. The vulcanism of the Atherton Tablelands and adjacent volcanic provinces is characterised by scoria cones, lava cones and maars. Lakes Eacham and Barrine occupy the youngest maars. The tablelands and some coastal areas were greatly disturbed by basalt flows throughout the Pliocene-Pleistocene. However, the high nutrient status of the developing basalt soils may have proved advantageous to the rainforest in resisting stresses during the fluctuating climatic conditions associated with the Pleistocene glacial cycles.

(iii) Fringing reefs

Fringing reefs are extensively developed between the Daintree and Bloomfield rivers. The association between coastal rainforest and fringing coral reef to the extent that is manifest off Cape Tribulation appears to be undocumented elsewhere in the world and is thought to be a unique feature. The reefs are part of the Great Barrier Reef World Heritage Site.

(iv) Vegetation types

The major vegetation type in the Property is tropical rainforest but this is fringed and to some extent dissected by sclerophyll forests and woodlands, mangroves and swamps. The vegetation types in the region are described below.

Rainforests

The rainforests of the Wet Tropics of Queensland occur across a diverse range of rainfall, soil type and drainage, altitude and evolutionary history. As a result there is a spectrum of rainforest plant communities and habitats recognised as being floristically and structurally the most diverse in Australia (Tracey 1982).

The rainforests of the wet tropics were classified into 13 major structural types including two which have sclerophyll (*Eucalyptus* and *Acacia*) components. The major types have further been classified into 27 broad communities correlating with climatic zones and soil parent material (Tracey & Webb 1975; Tracey 1982). All these communities occur in the Property and are listed in Appendix 3. The wet tropical region comprises a mosaic of rainforest types reflecting the environmental conditions. The floristic composition within the types varies from place to place; therefore it is important to conserve the types throughout the Wet Tropics in order to ensure preservation of all species.

On the slopes and summits of the high peaks where there is frequent cloud cover and strong winds there exist the wet submontane forests known as simply microphyll vine-fern forests and thickets. There is a high regional endemism of species in the floristic composition of these upland areas. Above 1500 m on the Bellenden Ker Range the canopy, sometimes with the endemic *Leptospermum wooroonoran* dominant, is often low and dense and shows the streamlining effects of strong winds. On the summits there are many narrowly restricted species including *Dracophyllum sayeri*, *Cinnamomum propinquum*, *Rhododendron lochae*, *Flindersia oppositifolia*, *Orites fragrans* and *Uromyrtus metrosideros*,

The montane forests of the Mt Lewis and Mt Spurgeon area are also classified as simple microphyll vine-fern forests. However these forests, having many of their own endemics, differ floristically from those of the Bellenden Ker area. These include in the family Proteaceae, *Helicia recurva* and *Austromuelleria trinervia*; *Prumnopitys ladei* in the family Podocarpaceae; the striking pink-flowered *Aceratium ferrugineum* in the family Elaeocarpaceae and the Mt Lewis palm *Archontophoenix purpurea*.

Floristically, the upland simple microphyll vine-fern forests and thickets are very different to the other rainforest types in the Wet Tropics, but they show a floristic affinity with the Australian temperate rainforests at higher latitudes and with montane rainforests of New Guinea and Indonesia. Shared genera with southern Australia include *Trochocarpa* and *Eucryphia*. *Rhododendron* and *Agapetes*, which are each represented in the Wet Tropics by a single species, are shared with New Guinea and Indonesia.

The most highly developed Australian rainforests occur on the wet lowlands. These complex mesophyll vine forests on colluvial footslopes and alluvial soils, are represented in the Wet Tropics by small patches between Innisfail and Cape Tribulation. Characteristic trees include *Acmena graveolens*, *Backhousia bancroftii*, *Argyrodendron peralatum* and *Ristantia pachysperma*. Local endemism and disjunctions are common and are exemplified by *Storkiella australiensis* and *Idiospermum australiense*.

One of the most striking rainforest types is that dominated by the endemic Fan Palm, *Licuala ramsayi*. The type is restricted to small patches on poorly drained soils on the lowlands. Most has been cleared for sugar-cane farming and only 780 ha remain. Small patches (totalling 420 ha) of these palm forests are included in the World Heritage Area near Cowley Beach, Mission Beach, Yarrabah and north of the Daintree River.

Complex notophyll vine forests on the basalt soils of the Atherton Tablelands have by now been mostly cleared. What remains includes restricted and disjunct species such as *Athertonia diversifolia*, *Austromuelleria trinervia* and *Austrobaileya scandens*. The drier remnant of the type is conserved in the World Heritage Area at the Curtain Fig (State Forest 452) and Severin Creek (State Forest 185). The wetter type is accessible at Mt Hypipamee - The Crater National Park. The overlap of the wet and dry types are preserved in National Parks at Lake Barrine and Lake Eacham.

Complex mesophyll vine forest on very wet lowlands on beach sands is now extremely rare. The major occurrences at Kurrimine Beach and near the mouth of the Daintree River and at Noah Creek near Cape Tribulation have all been included in the World Heritage Area. Palms found in this type include *Arenga appendiculata*,

Archontophoenix alexandrae, *Hydriosteles wendlandiana*, *Licuala ramsayi*, *Ptychosperma elegans* and in the Noah Creek area the narrowly restricted endemic *Normanbya normanbyi*. Conspicuous trees in the type include *Calophyllum inophyllum* on the beach front; *Calophyllum sil*, *Syzygium forte*, *Acmena hemilampra* and *Podocarpus grayi* on the dunes; and in the wetter swales *Dillenia alata*, *Syzygium angophoroides* and *Randia fitzalani*. *Backhousia hughesii* is common in the community at Noah Creek.

In addition to these rarer forest types the World Heritage Area contains outstanding and extensive occurrences of mesophyll vine forests and simple notophyll vine forests of the moist uplands and highlands.

Non rainforest components

The inclusion of various forest types that are not strictly rainforests represent the drier end of the rainforest spectrum and because of the influence of fire, act as a transition between rainforest and non-rainforest vegetation. Such zones are dynamic and important in terms of long-term management, climate change, and for certain rainforest fauna that use sclerophyll forests on a seasonal basis. These ecotones are important not only for their intrinsic interest but as additional insurance of integrity under fluctuating climates. Their inclusion also adds to the overall biodiversity values of the Property.

Tall Open Forests

Adjacent to the rainforest on the western margin of the World Heritage Area are the tall open forests (wet sclerophyll forests) dominated by *Eucalyptus grandis* (Rose Gum), - *E. resinifera* (Red Stringybark), *E. acmenioides* (White Stringybark), *E. intermedia* (Pink Bloodwood), *Lophostemon confertus* (Brush Box) and *Syncarpia glomulifera* (Turpentine). Variation in species composition and concentration within these forests correlate with soil type, rainfall and fire frequency; as well these factors are reflected in understoreys of different compositions ranging from well developed rainforest elements to dense grass.

There is a striking contrast in the structure of the adjoining rainforest and wet sclerophyll forests of north Queensland. This extraordinary ecological situation is very different from rainforests and “campos cerrados” of Brazil and the moist evergreen-dry deciduous forests of India (Webb and Tracey 1981).

The narrow strip of tall open forest where it occurs adjacent to rainforest is important for the conservation of one of the mammals restricted to the World Heritage Area, the endangered *Bettongia tropica* (Northern Bettong) and the northern population of two other species of mammals restricted to this forest type - *Petaurus australis* (Fluffy or yellow-bellied Glider), and *Rattus lutreolus* (Swamp Rat).

Medium and Low Woodlands

Areas of medium and low eucalypt woodlands have been included in the World Heritage Area. These are examples of widespread vegetation types found today over most of tropical Australia. Their inclusion will preserve the ecotones between rainforest and sclerophyll elements. The species compositions of both canopy and understorey

differ in response to rainfall, soil type, fire frequency and vegetation history over the long term.

Paperbark Swamps

Melaleuca spp. (paperbarks) occur as the dominant tree species in poorly drained lowland coastal areas where the water table is near to or above ground level for most of the year. They usually occur as components of vegetation mosaics reflecting specific habitats including the *Melaleuca leucodendra* and *M. dealbata* complex in freshwater and brackish swales in old beach ridge systems; *M. quinquenervia* dominant in fresh water swamps; and *M. viridiflora* on sodic and saline sand plains. Their inclusion in the World Heritage Area preserves the pattern of their evolution in relation to the rainforest of North-east Australia. The *Melaleuca* communities often have distinct species including the epiphytes *Dischidia*, *Hydrophytum* and the Tea Tree Orchid, *Dendrobium canaliculatum*.

Mangroves

A high degree of species diversity of mangroves trees and shrubs (c. 30 species) occurs in North-east Australia, comparable to the diversity of those of New Guinea and Southeast Asia which are acclaimed as some of the richest mangrove areas in the world. Major areas include the Hinchinbrook Channel, the north bank of the Daintree River and Alexandra Bay north of the Daintree River, all of which are included in the World Heritage Area.

The rainforest intergrades with the mangroves, sharing many species at the interface including *Diospyros littorea*, a species found only on the landward side of the mangroves.

The mangrove zone has a rich and varied epiphytic flora including ferns of the genus *Drynaria* and orchids of the genus *Dendrobium* and the Ant Plant, *Myrmecodia beccarii*. The ant *Iridomyrmex cordatus* which inhabits the *Myrmecodia* tends the larvae of the endangered butterfly *Hypochrysops apollo*.

(v) Flora

Within the Wet Tropics there over 3000 species of vascular plants, representing 1164 genera and 210 families. Of the genera, 75 are endemic to Australia and 43 are restricted to Queensland's Wet Tropics. More than 700 species, or 23 per cent of the total, are found only in this area.

The Wet Tropics of Queensland World Heritage Area plays a vital role in the conservation of the Australian members of the Southern Hemisphere family Proteaceae. At least 29 genera (some of which are still to be described) out of a world total of 76 occur in the Wet Tropics and over 40 species are restricted to the Property. The rainforest members of the Proteaceae, living or extinct, are claimed (Johnson and Briggs 1975) to be the ancestors of the sclerophyll species such as *Grevillea* and *Persoonia* that today form such an important part of the Australian vegetation. *Placospermum coriaceum*, one of the most primitive plants of the Proteaceae, occurs only in the- Wet Tropics.

Many examples of isolated populations of tree species occur throughout the rainforests of the World Heritage Area, both on the lowlands and in the uplands. Species included on the lowlands are *Storkiella australiensis* and *Noahdendron nicholasii* which are restricted to near Cape Tribulation; *Idiospermum australiense* and *Lindsayomyrtus brachyandrus* have a disjunct distribution between the Cape Tribulation area and the Harveys Creek–Russell River area south of Cairns, both very wet humid tropical lowland areas. On the uplands *Sphalmium racemosum* and *Stenocarpus davalloides* have populations restricted to the Mt Carbine Tableland in the northern section of the World Heritage Area, whereas *Lomatia fraxinifolia*, *Darlingia darlingiana* and *Cardwellia sublimis* are widespread. Much is yet unknown of the species distribution patterns in the tropical rainforests of the Wet Tropics.

The Property has a rich orchid flora. Of some 150 species present, about 59 have a restricted distribution with 43 having an extremely small range. *Dendrobium fleckeri*, *D. adae*, *D. carrii* with its creeping rhizome, *Bulbophyllum boonjie* and *Saccolabiopsis rectifolia* are a few examples of the restricted epiphytic orchids. Terrestrial orchids are also represented in the Property. The endemic Jewel Orchid, *Anoectochilus yatesiae*, is only found in the darkest, dense upland rainforests of this region.

The Property is also the home of one of the world's largest cycads, as well as one of the smallest. *Lepidozamia hopei* may grow to a height of about 20m. Its population today is scattered and disjunct. The small fern-like cycad, *Bowenia spectabilis*, is common in the understorey of rainforest-associated communities.

The richest concentrations of ferns and fern allies in Australia are found in the Wet Tropics. Of more than 250 species occurring in these rainforests, 46 are entirely restricted to the Property. Some 17 species have extremely restricted distributions within the Property. Of the five Australian endemic fern genera (Page and Clifford 1981), four occur in the Wet Tropics (*Coveniella*, *Neurosoria*, *Pteridoblechnum* and *Platyzoma*). *Pteridoblechnum* is the only endemic fern genus restricted to the tropical area of northeast Australia and is represented by *P. acuminatum* at Mt Spurgeon and Mossman Gorge and the widely distributed *P. neglectum*.

(vi) Fauna

Although the Wet Tropics of Queensland World Heritage Area represents only about 0.1 per cent of the land surface of the continent, it has a large and diverse fauna. Within the Property occur 35 per cent of Australia's mammal species (including 30 per cent of the marsupial species, 58 per cent of the bat species and 25 per cent of the rodent species), 40 per cent of the bird species, 29 per cent of the frog species, 20 per cent of the reptile species, 42 per cent of the freshwater fish species and about 58 per cent of the butterfly species of Australia. There are at least 70 species of vertebrate animals unique to the Wet Tropics. In addition, there are numerous invertebrate species endemic to the Property. In terms of species diversity and endemism, no area in Australia appears to have greater biological significance than the tropical rainforest of north Queensland (Switzer 1991, Williams *et al* 1996, WTMA 2001).

Mammals

The mammal fauna includes 2 monotremes, 41 marsupials, 15 rodents and 36 bats.

Of the thirteen endemic species, only the Mahogany Glider and Tropical Bettong are not rainforest dependent. Most of the rainforest-dependent endemics are restricted to the uplands and, as a consequence, they occur as a number of isolated populations (Winter 1991). One example is the Lemuroid Ringtail Possum which occurs only above 550 m with the larger population in the Atherton Uplands and a smaller population on Mt Carbine Tableland, the two being separated by the Black Mountain Corridor. The Mt Carbine Tableland population of the Lemuroid Ringtail Possum occurs only above about 1000 m and is characterised by a much higher proportion of pale-furred individuals ('white' lemuroids)(Trenerry and Werren 1993). The endemic species include one antechinus (Atherton Antechinus, *Antechinus godmani*), four ringtail possums (Lemuroid Ringtail Possum, *Hemibelideus lemuroides*; Green Ringtail Possum, *Pseudochirops archeri*; Herbert River Ringtail Possum, *Pseudocheirus herbertensis*; Daintree River Ringtail Possum, *P. cinereus*), one glider (Mahogany Glider, *Petaurus gracilis*), one rat-kangaroo (Musky Rat-kangaroo, *Hypsiprymnodon moschatus*), Australia's only two tree-kangaroos (Lumholtz's Tree-kangaroo, *Dendrolagus lumholtzi*; Bennett's Tree-kangaroo, *D. bennettianus*), one bettong (Northern Bettong, *Bettongia tropica*) and one rodent (Masked white-tailed Rat, *Uromys hadrourus*).

Winter *et al.* (1984) defined two distinct sub-regions for the distribution of the endemic rainforest mammals of The Wet Tropics, the southern one centred on the Atherton Uplands and the northern one on Thornton Peak, with Mt Carbine Tableland representing an overlap area. The Atherton Antechinus occurs only in the southern sub-region as does the Herbert River Ringtail Possum, though the latter also has an isolated population on the Seaview Range towards the southern end of the World Heritage Area. The Daintree River Ringtail Possum occurs in the northern sub-region and on Mt Carbine and Mt Windsor Tablelands. The distributions of the two tree-kangaroos do not overlap. *Dendrolagus lumholtzi* occurs in the southern sub-region and on Mt Carbine Tableland, while *D. bennettianus* occurs in the northern sub-region and on Mt Windsor Tableland.

The Musky Rat-kangaroo is of particular interest. It is the smallest and, in many respects, the most primitive of the kangaroo group, and represents an early stage in the evolution of kangaroos from an arboreal possum-like stock.

The endangered Mahogany Glider (*Petaurus gracilis*) was rediscovered in 1989 after having been essentially forgotten for more than a century (Van Dyck 1993). It has been found only at a few localities in lowland woodland between Ingham and Tully. Over 80% of its habitat had been cleared for sugar cane, plantation pine, bananas and cattle. There are estimated to be only 2000 – 3000 Mahogany Gliders left in the wild (http://www.qmuseum.qld.gov.au/features/endangered/animals/mag_glider.asp)

The endangered Northern Bettong (*Bettongia tropica*) was once widely distributed in a range of tall and medium sclerophyll habitats in the uplands of the Wet Tropics region but are known to currently occur at only three locations: Mt Carbine Tableland (a very small, restricted and low density population), Lamb Range (including the Davies Creek, Emu Creek and Tinaroo sub-populations which are genetically distinct but geographically close)(Pope 2000) and Coane Range (a recently discovered small disjunct population in the southern section of the region. A total north-south spread of 340km.

In addition to the endemic species, there are at least eight subspecies of mammals restricted to the region (Werren 1992). These include the Yellow-footed Antechinus, *Antechinus flavipes rubeculus*, Brown Antechinus, *A. stuartii adustus*, Common Dunnart, *Sminthopsis murina tatei*, Godman's Rock-wallaby, *Petrogale godmani godmani*, Swamp Wallaby, *Wallabia bicolor mastersii*, Bush Rat, *Rattus fuscipes coracius*, Cape York Rat, *Rattus leucopus cooktownensis* and Swamp Rat, *Rattus lutreolus lacus*. In addition, a subspecies of the Long-tailed Pygmy-possum, *Cercartetus caudatus macrurus*, a tiny marsupial with a head and body length of about 10 cm, is restricted to the Wet Tropics with another subspecies occurring in New Guinea (Atherton and Haffenden 1991).

Diversity in the Australian bat fauna reaches its peak in The Wet Tropics (Richards 1991). At least 36 species have been recorded (Williams et al 1996), virtually all of which make use of rainforest for roosting or foraging or both (Richards 1991). Several species are considered endangered or vulnerable.

An outstanding example of disjunct occurrence is provided by the White-footed Dunnart, *Sminthopsis leucopus*, which has been recorded from the Atherton Uplands. It is otherwise found only in south-eastern Australia and Tasmania.

Birds

The avifauna of the Wet Tropics is regarded as diverse. More than 310 species have been recorded of which more than 110 species principally inhabit rainforests, in addition to other less rainforest-dependent species. Twenty-three species are either endemic to the region or have their Australian distributions largely confined to the region. The majority of the thirteen endemic species are confined to the upland rainforests. These include the Tooth-billed Bowerbird (*Scenopoeetes dentirostris*), Golden Bowerbird (*Prionodura newtoniana*), Bridled Honeyeater (*Lichenostomus frenatus*), Fernwren (*Oreoscopus gutturalis*), Atherton Scrubwren (*Sericornis kerri*), Mountain Thornbill (*Acanthiza katherina*), Grey-headed Robin (*Heteromyias albispecularis*), Northern Logrunner or Chowchilla (*Orthonyx spaldingii*) and Bower's Shrike-thrush (*Colluricincla boweri*).

Another four bird species that are restricted to the the Wet Tropics but not confined to higher altitudes are the Lesser Sooty Owl (*Tyto multipunctata*), Macleay's Honeyeater (*Xanthotis macleayana*), Victoria's Riflebird (*Ptiloris victoriae*) and the Pied Monarch (*Arses kaupi*).

It has been noted that the number of bird species endemic to Wet Tropics belies the richness of the avifauna (Crome and Nix 1991). Many other species have most of their range within the Property and at least another ten birds have subspecies restricted to the Wet Tropics. These include the 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*), Grey Fantail (*Rhipidura fuliginosa frerei*), Eastern Whipbird (*Psophodes olivaceus lateralis*), Brown Gerygone (*Gerygone mouki mouki*), Spotted Catbird (*Ailuroedus melanotis maculosus*), Satin Bowerbird (*Ptilonorhynchus violaceus minor*) and Boobook Owl (*Ninox novaeseelandiae lurida*).

Included among the birds of the World Heritage Area is one of the largest birds in the world, the flightless *Casuarius casuarius johnsonii*, the Australian subspecies of the Southern Cassowary. Standing up to two metres in height, it is one of only three species of cassowary in the world, all of which occur in New Guinea. The majority of the Australian distribution is in the Wet Tropics with a lesser occurrence in Cape York Peninsula. The cassowary is an important 'keystone' species, being responsible for dispersal of many large-fruited rainforest plants (Crome and Moore 1988). It is considered.

The Golden Bowerbird is the only Australian member of a small group of bowerbirds, otherwise restricted to New Guinea, that build 'maypole' bowers. The bower is based around two towers that may be up to three metres high and one metre apart with a display pole perched between them (Frith 1976).

Many of the birds of the Wet Tropics have close relatives in New Guinea. One such species is the Grey-headed Robin which is often considered to be conspecific with *Heteromyias (Poecilodryas) albispectus*, the Ashy Robin of the central highlands of New Guinea (Sibley and Monroe 1990).

There are just two members of the logrunner family, Orthonychidae. *Orthonyx spaldingii* is restricted to the Wet Tropics while *O. temminckii* occurs in New Guinea and in central eastern Australia, the two sites being around 2500 kilometres apart. A similar pattern is seen in the case of the Lesser Sooty Owl, one of the Wet Tropics endemics, and the Sooty Owl (*Tyto tenebricosa*) which occurs in New Guinea and southeastern Australia.

One species shared with New Guinea is the Buff-breasted Paradise-Kingfisher (*Tanysiptera sylvia*) which migrates in the wet season to breed in Australia, where it is largely restricted to the Wet Tropics and Cape York Peninsula.

Frogs and Reptiles

The Wet Tropics of Queensland has the highest frog and reptile species endemism known for any part of Australia (Covacevich and McDonald 1993). At least 51 species are endemic to the region, the majority of which are rainforest-dependent.

There are about 58 species of frogs found in the Wet Tropics, giving it the highest diversity in Australia. Thirty-one species are rainforest-dependent. Twenty-four species, or about 12 per cent of Australia's frogs, are endemic to the Wet Tropics, giving the Property the highest level of endemism of any vertebrate group in the Australian rainforests (McDonald 1991). All but two of the endemic species are rainforest-dependent; the exceptions are the Black Mountain Frog (*Cophixalus saxatilis*) and the Magnificent Brood Frog (*Pseudophryne covacevichae*). *Cophixalus saxatilis* inhabits the granite boulder areas of the Black Trevelyan Range while *Pseudophryne covacevichae* has a very restricted distribution and is only found in seepage areas in open eucalypt forest near Ravenshoe. Of the rainforest frogs found in the region, 76 per cent are endemic. Included among these are some very restricted species. One species of tree-frog, *Litoria lorica*, has been recorded only from about 450 m altitude in the Thornton Peak area. One of the Narrow-mouthed Frogs, *Cophixalus neglectus*, occurs only on the Bellenden Ker Range while *C. bombiens* is restricted to the Mt Windsor Tableland; *C. hosmeri* is restricted to the Carbine Tableland and *C. exiguus* to the Mt

Finnigan area. Another rare frog *Taudactylus rheophilus* is found only on the Bellenden Ker Range, Lamb Range, Mt Carbine Tableland and Thornton Peak. Adding to the level of endemism, the myobatrachid frog *Mixophyes shevilli* has been shown to represent three species although the work has not yet been formally published.

There are about 151 species of reptiles within the Property (Williams *et al* 1996; WTMA 2002). Twenty-seven species are endemic to the region. They include 20 of the 30 rainforest species, giving a level of endemism of 66 per cent within this group which is “extremely high by Australian standards” (Covacevich 1993).

Fishes

The Wet Tropics region has a greater diversity of freshwater fishes than any other in Australia (Trennery and Werren 1991). Of around 190 species in Australia, over 80 occur in streams of the Wet Tropics (Pusey 2001; WTMA 2002). To date, nine endemic species have been identified. The endemic species cover a wide range of taxa including: rainbowfish (*Cairnsichthys rhombosomoides*, *Melanotaenia eachamensis*), catfishes (*Tandanus* sp.), grunters (*Hephaestus tulliensis*), cod (*Guyu wujalwujalensis*), and gobies (*Stiphodon allen*, *Glossogobius* sp. and *Schismatogobius* sp.) Many species are yet to be formally described (Pusey 2001).

Invertebrates

The Wet Tropics has the richest insect fauna in Australia. A transect of five sites along an altitudinal gradient on the Bellenden Ker Range found more than 4000 species (Monteith and Davies 1991). Of particular biogeographic interest is the fauna preserved in the upland rainforests of the Property, where the climate is relatively cool and commonly moist. Many of the taxa occurring in these sites show links with southern hemisphere taxa that suggest Gondwanan origins. There are many primitive, relict species that are isolated from their nearest relatives by at least 1500 kilometres. One species, the large stag beetle, *Sphaenognathus queenslandicus*, which is found only on Mt Lewis and Mt Windsor Tableland, has its closest relatives in South America.

The highly diverse and numerous moth fauna of the Property includes many rainforest endemic species including the brilliantly coloured *Aenetus monabilis*, one of the largest moths with a wing span up to 18cm, and the very restricted *Douea xanthopygs* and *Polyeuta callimorpha* which are only known from several collections. The most spectacular of Australia’s moths, the Hercules Moth (*Coscinocera hercules*), one of the largest moths in the world with a wing span up to 25 cm, occurs in the Wet Tropics and further north to Iron Range.

There are more than 230 species of butterflies recorded from the Wet Tropics, including many restricted species such as the evening flying Purple Brown Eye (*Chaetocneme porphyropis*) and the Australian Hedge Blue (*Udara tenella*). The Cairns Birdwing, *Troides priamus*, which occurs in the Wet Tropics, the mid-eastern coast of Queensland and on Cape York Peninsula, is the largest butterfly in Australia.

The insects show clearly a striking phenomenon of the montane biota of the Wet Tropics, namely, the restriction of many species to specific mountain massifs such that each mountain top has its own unique suite of species. Studies on the flightless carabid beetles have been particularly significant in identifying important mountain systems

(Monteith 1994, 1996). The Bellenden Ker Range and the Mt Carbine Tableland have been identified as particularly significant (Monteith 1996).

The Wet Tropics is also an outstanding area for wetas or giant king crickets. Twenty-six species occur in the region which is half of the Australian total. Four of the nine genera found in the Wet Tropics, involving eight species, are endemic to the Property. All the known winged species, including the two most primitive in the world, occur in the Wet Tropics (Johns 1994).

The spider fauna of the Wet Tropics is also diverse. The transect of the Bellenden Ker Range referred to above found more than 300 species of spiders (Monteith and Davies 1991). The spiders show a similar distribution to that of the insects and other fauna with numerous species restricted to mountain tops. For example, species restricted to the Bellenden Ker Range include the 'trapdoor' spiders *Namea nebulosa*, *N. olympus* and *Ozicrypta wrightae*, a new species (and new genus) in the family Barychelidae (Raven 1994), and the 'true' spiders *Spinanapis ker*, *S. frere*, *Otira summa*, *O. aquilonaria*, *Manjala pallida*, *Bakala episinoides*, *Jacksonoides distinctus*, *Sondra variabilis*, *Tauala alveolatus*, *T. lepidus*, *Australomimetes andreae*, *Mimetes hannemanni*, *M. catulli* and *Tasmanoonops septentrionalis*.

Among the 'true' spiders of the Wet Tropics there are some particularly primitive species, including *Tarlia daviesae*, *T. simipes* and *Macrogradungula moonyia*. Apart from some taxa in southeast Australia, the nearest relatives are in South America and New Zealand.

The invertebrate fauna of the freshwater streams of the Wet Tropics is not well known. Studies on crayfish show there are at least six species of crayfish restricted to cool, permanent streams above 800 m in the Property. *Eastacus fleckeri* is found only above 1000 m on Mt Carbine Tableland, *E. robertsi* above 1000 m on Mt Finnigan and Thornton Peak, *E. balanensis* on the Bellenden Ker Range and Lamb Range, and *E. yigara*, *Cherax parvus* and an undescribed species of *Macrobrachium* all in the upper Tully River on the Cardwell Range (Morgan 1991, Short and Davie 1993).

Land snails form an extraordinarily diverse group within the fauna of the Wet Tropics. An analysis by the Queensland Museum identified 217 native species, of which 185 (85 per cent) are endemic to the region (Stanisic *et al.* 1994). More than half the species occur in the Atherton Uplands. Predictably, other centres of diversity include Mt Carbine Tableland and Thornton Peak, but also less predictably Malbon Thompson Range and Mt Bakers Blue.

Justification

Cultural property

(note: the Wet Tropics of Queensland was only listed as a natural property)

Natural property

The Wet Tropics of Queensland fulfils all four criteria described for inclusion of properties on the World Heritage List as a 'natural heritage' as defined under the World Heritage Convention.

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

The Australian wet tropics region conserves in its biota elements that relate to 8 major stages in the earth's evolutionary history: (a) The Age of the Pteridophytes, (b) The Age of the Conifers and Cycads, (c) The Age of the Angiosperms, (d) the final break-up of Gondwana, (e) the origins of the Australian sclerophyll flora and marsupial fauna, (6) the origin and radiation of the songbirds, (7) the mixing of the continental biota of the Australian and Asian continental plates and (8) the extreme effects of the Pleistocene glacial periods on tropical rainforest vegetation. It contains the most complete and diverse living record of the major stages in the evolutionary history of land plants (from the very first plants on land to the higher plants, the Gymnosperms and the Angiosperms), as well as one of the most important living records of the history of the marsupials and the world's songbirds.

(a) **The Age of the Pteridophytes**

One of the most significant evolutionary events on this planet was the adaptation in the Palaeozoic (or Ancient) Era of plants to life on the land (White 1986). 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 clubmosses (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 Property (Clifford and Constantine 1980; Jones and Clemesha 1980).

These include all but one of the surviving genera of the ancient Classes of Psilotopsida (*Psilotum*, *Tmesipteris*) and Lycoposida (Lycopodiaceae, Selaginellaceae and Isoetaceae) that represent the earliest living ancestors of the two main branches of land plants. *Huperzia squarrosom*, the most primitive living lycopod most closely resembles *Baragwanathia longifolia*, the 415-million-year-old Silurian fossil lycopod from the famous Baragwanathia Flora at Yea in Victoria (Sporne 1975; White 1986). The Wet Tropics is a major centre of endemism and diversity for lycopods and the Selaginellaceae in Australia. Most *Huperzia* species in the Wet Tropics are now endangered or vulnerable to extinction.

The majority of today's ferns do not appear in the fossil record before the angiosperms (Kramer 1993). Only seven families of true ferns from the world's existing flora of about 36 families can be traced back to the earliest fossil record in the Early Carboniferous when most land lay in the tropical and subtropical zones within the one continent, Pangea (Scott *et al.* 1985, Galtier and Scott 1985). The greatest evolutionary diversity for these seven ancient families (Lycopodiaceae, Selaginellaceae, Ophioglossaceae, Marattiaceae, Osmundaceae, Schizaeaceae and Gleicheniaceae) occurs in the Wet Tropics. Eighteen out of the 27 genera from all seven families are represented in the region by 41 species. These include the most primitive members of ancestral or ancient orders of ferns (Class Pteropsida) such as the Marattiales (*Angiopteris*, *Marattia*), Ophioglossales (*Botrychium*, *Helminthostachys*, *Ophioglossum*) and Osmundales (*Leptopteris*, *Todea*). The Osmundales is the sole survivor of the two true fern orders first detectable in the fossil record and is considered to have originated in the Australian portion of Pangea (Dettman and Clifford 1991). This extremely ancient order which occupies an isolated position among the ferns (Sporne 1975, Clifford and Constantine 1980) has survived relatively unchanged to the present day. Two of the three genera in the order are restricted to the Southern Hemisphere. *Leptopteris* comprises seven species restricted to western Pacific countries originally part of Gondwanan Australia or its Pacific terranes (Polynesia, New Zealand, New Guinea and eastern Australia). The single Australian species, *L. fraseri* (Filmy King Fern) is restricted to the summit of Mt Bellenden Ker in the Wet Tropics and isolated warm temperate rainforests in New South Wales and Victoria.

The homosporous Ophioglossaceae are considered by some scientists to be living progymnosperms and part of an evolutionary line leading to flowering plants via the gymnosperms (Kato 1988, 1990, 1991). Three of the four surviving genera occur in the Wet Tropics. The Ophioglossaceae appear in the Australian fossil record in the Late Tertiary (Dettman and Clifford 1991).

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 Wet Tropics. *Actinostachys* is the most primitive genus in the Schizaeaceae and has a relict distribution in the Wet Tropics of Australia and Madagascar as well as occurring in tropical Asia. It first appears in the Australian fossil record in the Late Cretaceous. The Gleicheniaceae appears earlier in the Australian fossil record in the Middle Triassic (Dettman and Clifford 1991).

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

The level of diversity and endemism among East Gondwanan fern taxa is exceptional. East Gondwanan fern genera include the monotypic endemic genus *Coveniella*, *Lastreopsis*, *Polystichum* (Aspleniaceae), the monotypic endemic genera *Pteridoblechnum* and *Steenisioblechnum* (Blechnaceae), *Oenotrichia* (Dennstaedtiaceae), *Leptopteris*, *Todea* (Osmundaceae), *Tmesipteris* (Tmesipteridaceae/Psilotaceae), and the Australian endemics *Lycopodiella* and *Huperzia* (Lycopodiaceae). The Wet Tropics is the major centre of endemism for

Huperzia with 9 of the 12 known species occurring there. 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*.

The Wet Tropics of Queensland is therefore one of the most significant centres of evolutionary diversity and survival for the most primitive and relict members of ancestral or ancient orders of spore-producing plants. As such the fern assemblages contribute the earliest chapter to one of the most complete living records of the evolution of land plants.

(b) The Age of the Conifers and Cycads

The origin of seed plants over 320 million years ago (Farjon *et al.* 1993) was one of the most significant events in the evolution of terrestrial vegetation, an adaptive breakthrough that allowed colonization 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 (Rothwell and Erwin 1987). 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 (White 1986; Norstog 1987). 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*.

The World Heritage area is a major centre of survival for the cycads. Ten genera and 121 species in four families of cycads are all that remain of a group that has been in existence relatively unchanged for at least 200 million years with the majority of species now considered as rare and threatened (Sporne 1965, Norstog 1987, Jones 1993).

Cycads as a group are thought to have originated in the East Gondwanan sector of Pangaea prior to its breakup. The cycads contain more primitive features than any other living group of gymnosperms. Cycads are the only gymnosperm known to fix nitrogen from the atmosphere which is achieved through a symbiotic relationship with blue-green algae in specialized root structure called coralloid roots (Jones 1993). The production of motile sperm cells is unique to cycads and one other gymnosperm, *Ginkgo biloba*. The discovery of this feature in 1896 was hailed as one of the most exciting botanical discoveries of all time, since it provided the missing link between gymnosperms and the ferns and fern allies (Jones 1993). 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, Anthribidae (mortar and carpenter bees), Boganiidae and Nitidulidae (Jones 1993). *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.

Three of the four cycad families (Boweniaceae, Cycadaceae, Zamiaceae) and three genera (*Bowenia*, *Cycas* and *Lepidozamia*) occur in the World Heritage area representing the highest diversity of cycad genera in Australia and the greatest diversity of major cycad groups anywhere in the world.

The genus *Cycas* is the most primitive of all the known cycads (Chase *et al.* 1993) with earliest fossils dated from the Lower Permian. It separated very early from other cycad genera as a distinct and isolated line of evolution. Australia has the highest diversity of *Cycas* species in the world with about 20 of the world's total of 30 species occurring there (Hill 1992). The most species rich area is along the east coast of Queensland north from Rockhampton. About 10 species occur in China and with single species in Malesia, Japan and south-east Asia, and in Polynesia, Madagascar and East Africa (Hill 1992). Most *Cycas* species are geographically isolated. All but two of the 9 *Cycas* species occurring in Queensland are rare (2) or vulnerable to extinction (5). One species occur within the Wet Tropics World Heritage area (*C. media*). Warm humid environments are thought to be the ancestral habitat of *Cycas*. Seasonally dry habitats are regarded as more recent.

The palm-like *Lepidozamia hopei*, restricted to the World Heritage area, is the tallest of all living cycads growing to heights of 20 metres (Johnston 1959; Clifford and Constantine 1980). A rare assemblage of *Lepidozamia hopei*, podocarp (*Podocarpus grayi*) and the araucarian, *Agathis robusta* in the World Heritage area represents the closest living counterpart of Jurassic forests fossilised remains of which are found in the Talbragar Fish Beds of New South Wales (White 1986). The Southern Cassowary, believed to have evolved in the Early Tertiary, is known to be significant for long distance dispersal of *Lepidozamia hopei*.

The fauna associated with these modern-day Jurassic forest analogues are equally ancient mostly dating from the same era. Larvae of the very "primitive" south-west Pacific moth family Agathiphagidae (kauri moths), the only surviving family within the entire suborder Aglossata, feed only on the seeds of *Agathis* (Robinson and Tuck 1976). Only two species survive - *A. queenslandicus* restricted to eastern Queensland, and *A. vitiensis* in the south-west Pacific. An endemic Australian subfamily of cynipoid wasps (Austrocynipinae) is associated with the seeds of *Araucaria*. A group of 'primitive' southern hemisphere weevils (Nemonychidae: Rhinorhynchinae) feed on the pollen of Araucariaceae and Podocarpaceae (Kuschel 1983, 1994). This family, the most primitive of the weevils, is now relict after having been the dominant group amongst all phytophagous beetles in the Upper Jurassic some 200 million years ago. The rainforests of the Wet Tropics and those of south-east Queensland contain the greatest known evolutionary diversity within this group. Members of the Tribe Rhinorhynchini within the subfamily Rhinorhynchinae resemble almost unchanged their fossil counterparts of the Upper Jurassic (Kuschel 1994).

Beetles of the subfamily Paracucujinae (family Boganiidae) are restricted to the Cycadaceae, feeding on pollen as both larvae and adults.

One of the smallest cycads in the world, restricted to rainforest and wet sclerophyll forests in the World Heritage area and McIlwraith Range on Cape York, 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 (Jones 1993). The family is endemic to Australia.

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 or southern conifers. Both the Araucariaceae and Podocarpaceae dominate the Australian pre-Tertiary fossil record with a great diversity of species in the Jurassic and Cretaceous (Dettman 1994). They are regarded as the ancestral core of present-day perhumid rainforests which arose through progressive addition of angiosperms throughout the Cretaceous and Early Tertiary (Dettmann 1994).

Only two araucarian genera survive today. The greatest diversity of surviving evolutionary lineages of *Araucaria* and *Agathis* occur in the Property. Two species of *Agathis* endemic to the World Heritage area are rare. 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. At least 50 per cent of species in these two genera world wide are now rare or at serious risk of extinction. The three endemic species of *Prumnopitys* and *Podocarpus* in the Wet Tropics area are considered rare with very small ranges and at therefore at risk (Farjon and Page 1993).

(c) The Age of the Angiosperms

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 this planet. By 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 represents 88.7 per cent of all plant species on earth (Raven 1987). The majority of flowering plants are dicotyledons (class Magnoliopsida), with 180000 species in six subclasses — the Magnoliidae, Hamamelidae, Caryophyllidae, Dilleniidae, Rosidae and Asteridae (Cronquist 1988). According to the classification of Cronquist dicotyledons are organised into 321 families in 64 orders and the 55 000 species of monocotyledons (class Liliopsida) are arranged within five subclasses containing about 66 families in 19 orders (Cronquist 1988) although the actual organisation of many families between the subclasses is still in a state of flux (Liden 1992).

The origin of these flowering plants is one of the major unsolved questions of botany. East gondwanan countries are known to contain the greatest concentration of archaic and relict taxa relating to the origins of flowering plants (Takhtajan 1987). 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 Australian 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 (Raven and Axelrod 1974). 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 (Schuster 1972, 1976). 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.

However, distributed throughout the Indo-Pacific regions are numerous fragments, or terranes, derived from the northern margin of the Australian section of Gondwana (Audley-Charles 1987, 1988, 1990, 1991; Hutchison 1989; Burrett *et al.* 1991; Harbury *et al.* 1990; Metcalf 1990; Veevers 1991a, 1991b). These fragments now form parts of South-east Asia, Indonesia and some Pacific islands. Audley-Charles (1987) has suggested that those terranes that rifted during the Cretaceous when angiosperms first evolved, acted as 'Noah's Arks', carrying with them an evolving Gondwanan angiosperm flora.

(i) *The richest assemblage of families of primitive flowering plants*

The first recognizable angiosperm pollen was *Clavatipollenites hughesii* described from the late Barremian and Aptian (Early Cretaceous) of southern England (Couper 1958) and has been found in southern Australia from the same time period at Koonwarra (Dettman 1986). It closely resembles that of the living New Caledonian genus *Ascarina* of the Chloranthaceae (Walker and Walker 1984) and *Austrobaileya* of the Austrobaileyaceae, a monotypic family found only in the Wet Tropics (Endress and Honegger 1980). 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 (Walker 1976), 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; Atherospermataceae, Gyrocarpaceae, Hernandiaceae, Idiospermaceae, Lauraceae and Monimiaceae of the order Laurales.

(ii) *Species belonging to small, relict primitive angiosperm families*

The Australian Wet Tropics has the highest concentration of small, relict and virtually extinct, primitive angiosperm families in the world (Endress 1983). 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 (the Moluccas) respectively. They are probably 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.

(iii) *Orders occupying nodal positions in the evolution of the angiosperms*

Higher dicotyledonous angiosperms form five major groups accounting for 70 per cent of all living flowering plants (Cronquist 1981). The initial major radiation of these groups occurred in the Cretaceous with ancient members of the sub-classes Hamamelidae and Rosidae being especially important (Crane *et al.* 1986). The orders Hamamelidales, Rosales, Euphorbiales, Dilleniales, Violales, Theales, Celastrales and Gentianales, are considered to occupy major nodal positions in the evolution of the angiosperms (Takhtajan 1980; Cronquist 1981). 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.

(iv) *Gondwanan Angiosperm families of Cretaceous origin*

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 (Crowley and North 1991, Collinson 1990, Wolfe 1990). However, East Gondwana in the southern hemisphere was relatively unaffected (Muller 1984, Collinson 1990), 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 survive in the Australian Wet Tropics. Cretaceous families include the Cunoniaceae, Proteaceae, Winteraceae, Myrtaceae, Monimiaceae (Raven and Axelrod 1974, Carpenter and Buchanan 1993), Rutaceae, Platanaceae, Sapindaceae, Aquifoliaceae, Callitrichaceae, Chloranthaceae, Gunneraceae, Trimeniaceae, Epacridaceae, Olacaceae and Loranthaceae (Dettman 1994).

Pollen similar to that of *Syzygium* and *Eugenia* (Myrtaceae) occurs in Campanian and Maastrichtian sediments on the Antarctic Peninsula (Dettman 1989) and the Paleocene of Australia (Dettman 1994). *Eugenia* is now represented in Australia by a single species endemic to the Wet Tropics. 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 endemic to the Property. Australia is also the outstanding centre of diversity and endemism for the entire family (73 of the world's 140 genera and 1361 out of the world's total of 3350 species). The Myrtaceae family are now represented in the Wet Tropics by 41 genera and 124 species. Four mono- or ditypic genera are endemic to the wet tropics — *Barongia* (1 sp.), *Sphaerantia* (2 spp.) and two undescribed monotypic genera.

(v) *East Gondwanan Families or Genera*

East Gondwana which included 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 Australian wet tropics has 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 .

(d) The Final Break-up of Gondwana

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 (Kemp 1978). When Australia was still attached to Antarctica, warm equatorial currents reaching polewards 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 the Australian 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 of Queensland is the only large part of the entire Australasian region where rainforests have persisted continuously since Gondwanan times (Barlow 1986), preserving in the living flora the closest modern-day counterpart of the Gondwanan forests (Christophel, Collinson 1992).

Several groups regarded as likely relicts or early descendents of the Gondwanan fauna at the time of the final break-up are represented in the Wet Tropics. [Note that the flora that fall into this category have been included in parts (c) or (d).]

Of Australia's four families of frogs, the Myobatrachidae and Hylidae are believed to have had Gondwanan origins (Duellman and Trueb 1986; Tyler 1989, Roberts and Watson 1993). Close relatives are found in South America. Fossils from both families are found in Oligo-Miocene deposits at Riversleigh in northwestern Queensland.

Molecular studies suggest that the major generic-level splits in the Australian frog fauna are very old (Roberts and Maxson 1985, 1989). Among the oldest lineages are *Mixophyes* and *Taudactylus* (Heyer and Liem 1976).

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* had been recorded only from the Bellenden Ker Range, Lamb Range, Carbine Tableland and Thornton Peak, all recognised refugial areas but has suffered massive declines over its entire former range. Prior to 1988, *T. acutirostris* occurred in upland streams throughout the World Heritage Area. However, it has since suffered a dramatic decline in numbers and its status is considered critical (Ingram and McDonald 1993)[See below, Criterion (iv)].

The catastrophic amphibian declines which have occurred in the Wet Tropics has recently been attributed to an amphibian fungal disease caused by *Batrachochytrium dendrobatidis*. *Mixophyes* is represented in the Wet Tropics by *M. schevilli*, the Northern Barred Frog. Molecular studies have shown *M. schevilli* to represent three species, each well differentiated (Donnellan *et al.* 1993).

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.

Fossils from the Riversleigh deposits show that dragons were present in Australia at least 15–20 million years ago (Covacevich *et al.* 1990). Australian dragons form two groups, one adapted to more mesic environments on the eastern coast and including *Hypsilurus* and *Physignathus*, and the other adapted to drier conditions including arid inland environments. Molecular studies suggest that the split between these two groups probably occurred between 15 and 20 million years ago with Australian *Hypsilurus* and *Physignathus* diverging at about the same time (Baverstock and Donnellan 1990). The fossil evidence shows that extant *P. lesueurii* has changed little from forms living in the rainforests of the Riversleigh area about 20 million years ago (Covacevich *et al.* 1990). *P. lesueurii*, the Eastern Water Dragon, occurs along the eastern Australian coast and is recorded from many locations in the Wet Tropics.

Hypsilurus, of which Australian species were formerly considered to belong to the predominantly Asian genus, *Gonocephalus*, and *Physignathus* are among the Australian dragons considered to have had an Asian origin. However, immunological studies of plasma albumin suggest that Australasian *Hypsilurus* are more closely related to other Australian dragons than to Asian *Gonocephalus* (Baverstock and Donnellan 1990). When considered together with the evidence from Riversleigh fossils, these data provide support for an Australian origin for *Hypsilurus* and *Physignathus* from a Gondwanan ancestor. There are just two species of *Hypsilurus* in Australia: Boyd's Forest Dragon, *H. boydii*, is confined to the Wet Tropics and the Southern Angle-headed Dragon, *H. spinipes*, is endemic to the rainforests of the central Australian coastal region. Other species occur in New Guinea, Moluccas and Solomon Islands.

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 (Hutchinson 1992). The Riversleigh fossils indicate that the Australian skink fauna has arisen from evolution within Australia rather from a series of invasions as has been previously proposed. The fossil evidence, together with that from serum albumin studies (Baverstock and Donnellan 1990), suggest that the three major groups of skinks arose in the early Tertiary, around 60 million years ago. The *Egernia* and *Eugongylus* groups, which are almost entirely confined to the Australian region, may have arisen in Australian Gondwana (Hutchinson and Donnellan 1993). Hutchinson (1992) has compared the Riversleigh skink fauna with those of the rainforests of northeastern and southeastern Queensland. All three faunas are dominated by the *Sphenomorphus* group with the *Egernia* group present as a minor component. Of interest is the presence of the slender *Sphenomorphus* type at Riversleigh. Living members of this type have been

placed in the genus *Glaphyromorphus* and, with one exception, they are confined to northern coastal Australia. Seven of the fourteen species occur in the Wet Tropics region and two species, *G. fuscicaudis* and *G. mjobergi*, are endemic to the World Heritage area. The similarity of the Riversleigh fossil of this type with *G. mjobergi* has been noted (Hutchinson 1992).

Of the birds occurring in the rainforests of the Wet Tropics, those with accepted Gondwanan origins include the Southern Cassowary (one of the world's few surviving giant flightless birds, the ratites) and the megapodes (mound-builders). Fossil records show that cassowaries were once much more widespread across Australia, but they are now restricted to north-east Australia and New Guinea. 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*).

Songbirds of the Wet Tropics belonging to groups of likely Gondwanan origin are considered under (f) below.

Many primitive insects have been conserved in the Wet Tropics as relicts of the Gondwanan fauna, mainly in the upland areas. The moss bug, *Hackeriella taylori*, belongs to a small family found only in eastern Australia, New Zealand, New Caledonia and South America. The wingless water bug, *Austrovelia queenslandica*, is known only from Mt Sorrow–Mt Pieter Botte. The only other species in the genus is in New Caledonia (Malipatil and Monteith 1983). The relict wingless genus of bark bugs, *Kumaressa*, which belongs to the small primitive subfamily Chinamyersiinae, is confined to Australia. *K. storeyi* occurs on Mt Bellenden Ker, Mt Bartle Frere and Mt Carbine Tableland. Two other species occur in the rainforests of central eastern Australia. The nearest relatives are in New Zealand. An ancient origin for the large stag beetle, *Sphaenognathus queenslandicus*, found only on Mt Lewis and Mt Windsor Tableland, is indicated by the occurrence of its closest relatives in South America. The flightless leaf-hopper genus, *Myerslopella*, known only from a few mountain tops in the Wet Tropics, belongs to a tribe otherwise known only from Madagascar, New Zealand and Juan Fernandez (Evans 1977). The small cockroach genus, *Tryonicus*, is represented in the Wet Tropics by the endemic species, *T. mackerrasae* and *T. montheithi*. *T. parvus* is found in the central eastern rainforests of Australia and the only other members of the genus are in New Caledonia.

The present-day distribution of most of these insects suggest their origins pre-date the separation of Australia and New Caledonia and New Zealand about 80 million years ago.

Even more ancient origins are indicated for a water beetle, *Terradessus caecus*, found only on Mt Sorrow and Thornton Peak and adapted for a terrestrial life (Watts 1982). The only other recorded occurrences of similarly adapted water beetles are in the highland forests of the Southern Himalayas and in the montane moss forests of New Caledonia (Brancucci 1985).

The presence of these ancient, relict insect taxa demonstrates the great antiquity of uninterrupted rainforest habitat in the Wet Tropics (Kikkawa *et al.* 1981).

The spider fauna of the Wet Tropics also includes many relict Gondwanan taxa. Australian spiders belong to two infra-orders, the Mygalomorphae ('trapdoor' spiders)

and Araneomorphae ('true' spiders). Apart from one group now restricted to southeast Asia, the mygalomorphs are considered to be the most ancient and primitive group of spiders (Platnick and Sedgwick 1984). Of the 55 or so genera of 'trapdoor' spiders in Australia, more than 35 inhabit rainforest. Seventeen are recorded from the Wet Tropics. They include *Sason*, *Trittame*, *Cethegus*, *Masteria*, *Namirea*, *Cataxia*, *Homogona*, *Aname*, *Ixamatus*, *Namea*, *Xamiatus*, *Idioctis*, *Idiommata*, *Zophorame* and the newly described genera (Raven 1994), *Mandjelia*, *Moruga* and *Ozicrypta*.

Among the most primitive of the 'true' spiders (Araneomorphae) are members of the family Gradungulidae which is known only from New Zealand and Australia (Forster *et al.* 1987). The nearest relatives occur in South America. Of the twelve species in the family, three are restricted to the Wet Tropics. *Tarlina daviesae* is known only from Mt Finnigan at more than 1000 metres. *T. simipes* has been found at a few elevated sites between Cairns and Ravenshoe. The monotypic *Macrogradungula* is known only from Boulder Creek on the Walter Hill Range (*M. moonya*).

Another relict genus of 'true' spiders of likely Gondwanan origin is *Otira*. Six species occur in New Zealand, one in Tasmania and two (*O. summa* and *O. aquilonaria*) are recorded only from Bellenden Ker Range above 1000 m altitude (Davies 1986).

The Wet Tropics land snail fauna contains remarkably high numbers of the Gondwanan family Charopidae which occurs in southeastern Australia, New Zealand and some subantarctic islands (Stanisic 1990). There are 86 species in the Wet Tropics (77 are undescribed), mainly in the cool uplands and especially on the mountain tops (Stanisic 1994). The refugial role of upland sites in the Property is indicated by a number of major disjunctions among relict taxa. The genus *Lenwebbia* contains just two species, one from the Bulburin area in southeastern Queensland and the recently described *L. paluma* known only from the type locality in Mt Spec National Park in the Wet Tropics. Of the three species in the genus *Hedleyoconcha*, *H. ailaketoae* is recorded from Mt Bellenden Ker, while *H. delta* occurs at a number of sites from the central New South Wales coast to the Bunya Mountains and *H. addita* is found only on Lord Howe Island (Stanisic 1990).

(e) Biological evolution and radiation during 35 million years of isolated rafting of the Australian continental plate

Australia was an isolated landmass during several million critical years when the extant flora was being shaped (Hill 1993, Truswell 1993). Climate change was a major influencing factor. 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 region 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 (the Tumbunan avifauna)(Schodde 1982). [The passerine avifauna is considered in Section (f).]

Whilst sclerophylly *per se* originated from rainforest stock during the early Tertiary as an adaptation to infertile soils (Barlow 1981) evolution of features related to aridity and fire did not appear in the fossil record until the Middle to Late Miocene (Martin 1994)

Primitive genera of the Proteaceae, the remnants of ancient Gondwanan origins, are found in the Wet Tropics. In this family that now comprises a very important component of Australia's sclerophyll flora, 42–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.

The important Casuarinaceae family which has its centre of diversity in Australia occupies habitats ranging from beaches to arid regions, with one genus occurring in rainforest. Fossil evidence indicates that the ancestral form was the East Gondwanan rainforest genus *Gymnostoma*, which was widespread in Australia during the early Tertiary (Hill 1987). *Gymnostoma* now has a relict distribution in Australia with just one species that is restricted to the Roaring Meg–Alexandra and Noah Creek valleys in the Wet Tropics. The earliest evidence of sclerophyll communities involving Casuarinaceae date from the Early–Middle Miocene (Macphail *et al.* 1994).

Most of the primitive members of the large Rutaceae family (150 genera, 1800 species) occur in rainforests (Stace *et al.* 1993). The family is considered to have originated in Gondwana (Armstrong 1983) before the Tertiary (Smith-White 1954, 1959). 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 (Waterman and Grundon 1983). There are 245 Australian species in the Boronieae which now so characterise this continent's sclerophyllous heathlands (Morley and Toelken 1983). Five species of the small genus *Euodia* together with the endemic genus *Medicosma* (5 species) occurring in the Wet Tropics from within the Zanthoxyleae Tribe have closest affinities to the ancestors of *Boronia* the largest and most widespread genus in the tribe Boronieae all 15 members of which have radiated out into open forest and heathland communities around Australia (Waterman and Grundon 1983, Stace *et al.* 1993).

The most primitive of the Australian marsupials are the dasyuroids, a basically carnivorous group that, probably, are preceded in the evolutionary history of the marsupials only by the didelphoids of South America. Immunological studies of abumins suggest that this group diverged from the diprotodont marsupials about 40 million years ago (Baverstock *et al.* 1990). 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 (Van Dyck 1982).

It has been proposed that the earliest marsupials evolved in 'rainforests' on the basis that extant rainforest-dependent species are among the most primitive of their respective groups (Schodde and Calaby 1972). This is now generally accepted and the Oligo-Miocene rainforests have been described as the "Green Cradle" for Australia's dry-adapted marsupials (Archer *et al.* 1989). 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*, *Cercatetus*, *Pseudochirops* and *Trichosurus* (Archer *et al.* 1989).

The Musky Rat-kangaroo, *Hypsiprymnodon moschatus*, which is restricted to the World Heritage Area, is 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 (Johnson and Strahan 1982).

The Wet Tropics area is particularly significant for the ringtail possums. Of the six species in Australia, five occur in the Wet Tropics World Heritage Area and the four rainforest-dependent species are all found only there. 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 (Baverstock *et al.* 1990).

Birds confined to upland forests of eastern Australia and New Guinea (the Tumbunan fauna) are considered to include forms ancestral to dry-adapted species. Such ancestral forms occurring in the-Wet Tropics include the Southern Cassowary, Australian Brush-turkey, Emerald Dove and Australian King-Parrot (Schodde 1982).

(f) The origin and radiation of the songbirds (oscine passerines)

On the basis of protein electrophoretic studies, Christidis and Schodde (1991) speculate 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).

DNA–DNA hybridisation studies by researchers at Yale University have led to a new classification that divides the oscine passerines into two major groups (parvorders), Corvida and Passerida. The 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 (Sibley and Ahlquist 1985). As discussed earlier, the vegetation of Australasian Gondwana was then dominated by rainforest.

The Corvida includes 40 per cent of the world's songbird families. Most of the living members are confined to Australia and New Guinea. However, groups such as crows, jays, shrikes and cuckoo-shrikes have radiated to Eurasia and the Americas.

The Wet Tropics of Queensland 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 (Slater 1974). There are about twenty species of bowerbirds, eight of which are endemic to Australia, ten to New Guinea and two shared. Five species are found in the Wet Tropics giving the region the highest diversity for the bowerbirds of any area in Australia. Two species, the Golden Bowerbird (*Prionodura newtoniana*) and Tooth-billed Bowerbird (*Ailuroedus dentirostris*), are endemic to higher altitude areas in the Wet Tropics. *Ailuroedus* may be the most

ancient genus; the DNA-DNA hybridisation data suggest that *Ailuroedus* diverged from *Ptilonorhynchus* and *Chlamydia* more than 20 million years ago, although no data were provided for the other genera (Sibley and Ahlquist 1985).

The scrubwrens, mouse-warblers, gerygones and thornbills have generally been placed in the family Acanthizidae, but Sibley and Moore (1990) place them in the Pardalotidae (subfamily Acanthizinae). There are about 60 species, most being confined to Australia. Kikkawa (1991) lists 16 species as inhabiting closed forests. Ten of these occur in the Wet Tropics which is more than twice the number found in any other area in Australia. Three are endemic to uplands of the Property: the Fernwren (*Oreoscopus gutteralis*), Atherton Scrubwren (*Sericornis keri*) and Mountain Thornbill (*Acanthiza katherina*).

A likely relict species endemic to the Wet Tropics is the Chowchilla or Northern Logrunner, *Orthonyx spaldingii*. The only other species in the genus, *O. temminckii*, is found only in the rainforests of Central Eastern Australia and the highlands of New Guinea. On the basis of DNA-DNA hybridisation studies, *Orthonyx* has been placed in a separate family (Sibley and Ahlquist 1990, Sibley and Monroe 1990). Fossils of *Orthonyx* have been found in late Oligocene deposits (~25 million years) at Riversleigh in north-west Queensland (Boles 1993).

The Wet Tropics of Queensland is also of major importance in understanding the origins of the diverse bird fauna of New Guinea. 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.

(g) The mixing of the continental biota of the Australian and Asian plates after 80 million years of separation

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.

Unlike New Guinea, parts of the Australian wet tropics represent a stable fragment of Gondwana in which rainforest has existed continuously and whose extant flora, together with fossil pollen deposits of unparalleled continuity and resolution, 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*, *Gardinia*, *Leea*, *Lethedon*, *Melia*, *Oreodendron*, *Phaleria*, *Securinega*, *Trema* (Truswell et al., in press).

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. Views are divided on the origins of the Australian microhylids. Savage (1973) proposed a Gondwanan origin with radiation in Australia and subsequent invasion of Asia via New Guinea, followed by extinction in Australia and a Pliocene reinvasion of northern Australia from New Guinea. Tyler (1979) proposed an Asian origin and entry into Australia via New Guinea. Australian microhylids are from two genera, *Cophixalus* and *Sphenophryne*. Not surprisingly, fifteen of the sixteen species are confined to northeastern Australia with one species in the Northern Territory. Twelve species are endemic to the Wet Tropics region, although one (*C. mcdonaldi*) is restricted to Mt Elliott which lies just to the south of the World Heritage Area. All but one are rainforest species, the exception being *Cophixalus saxatilis* which lives among the boulder piles of the Black Trevelyan Range.

The only Australian member of the cosmopolitan family Ranidae is *Rana daemeli* which is restricted to Cape York Peninsula and eastern Arnhem Land and occurs throughout lower altitude areas in the Wet Tropics.

Recent reassessment of the origins of Australia's native birds suggest that only a few groups (other than migratory birds) have entered from Asia. Those belonging to this category are the Yellow-bellied Sunbird, Singing Bushlark, Mistletoe Bird, Metallic Starling, Silvereye, Pale White-eye, Yellow White-eye and White's Thrush (Schodde 1986; Schodde and Christidis 1987). With the exception of the Pale White-eye which occurs on islands of the Torres Strait, all are recorded from the Wet Tropics.

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. *Melomys* has four species in Australia although one of these, found only on Bramble Cay in Torres Strait, may only be a variant of the Cape York *Melomys* which occurs only around the tip of Cape York Peninsula. The other two species occur in the Wet Tropics. *Pogonomys* and *Uromys* have only one and two species respectively in Australia. The Giant White-tailed Rat, *U. caudimaculatus*, occurs on the eastern side of Cape York Peninsula including the Wet Tropics. The Prehensile-tailed Rat, *P. mollipilosis*, occurs as two disjunct populations, one in the Iron Range area on Cape York Peninsula and the other in the Wet Tropics.

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

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, speciations and profound distributions of plants and animals (Livingstone and van der Hammen 1978). Fossil-based data from Southern Hemisphere continents suggest that the effects of Pleistocene glacial periods were greatest in Australia (Kershaw 1984).

Fossil pollen records going back over 200 000 years, of unparalleled continuity and resolution for this period, from three sites within the Wet Tropics region, Butcher's Creek, Lynch's Crater and Lake Euramoo, indicate that the rainforest underwent severe contractions during the Pleistocene glacial periods. Uniquely among tropical rainforest areas, there were 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 of Queensland World Heritage Area today include the Araucariaceae (5 species) and Podocarpaceae (7 species) and Casuarinaceae (1 species, *Gymnostoma*).

The peak of glaciation occurred at 18 000 BP, sea levels were at their lowest for the past 150 000 years (Kershaw 1989).

(2) *Outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial ecosystems and communities of plants*

Geological history involving the separation and drifting of continents, vulcanism, mountain building and erosion has profoundly influenced the evolutionary history of life on earth. The tropical rainforests, in particular, are one of the most significant biomes harbouring the majority of the earth's genetic diversity (Raven 1983, Walker 1986).

Processes resulting in areas of exceptional species richness or of high endemism are of outstanding scientific interest.

Much of the world's humid tropics is of 'recent origin', the newly expanding environments generating areas of exceptional species richness such as in the equably wet, lowland humid regions of peninsular Malaysia, New Guinea, the African Cameroons and the north-western and eastern foothills of the Andes (Ashton 1981). Endemism in these areas of species richness is surprisingly low.

However, the long-isolated ancient floras of New Caledonia, Madagascar and the Australian wet tropics have exceptionally high levels of endemism. These centres of endemism are not only historically important but also 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 and ongoing continental drift.

The Australian 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.

The level of endemism within the rainforest flora of the Australian wet tropics (43 genera and 500 species 7 000 square kilometres of rainforest)(White 1983). The Australian wet tropics is second only to New Caledonia in the number of endemic genera conserved per unit area (Webb and Tracey 1981, Morat *et al.* 1986, 1993). The former suffered the greater degree of Pleistocene extinctions which was exacerbated by

the Aboriginal use of fire (Kershaw 1984). 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 (Keto 1986). All 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 (Nix 1980).

The rapid and ongoing ecological, biological and geological processes occurring in the Australian 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 may be regarded as potential examples of ongoing evolution.

Among the plants, genera best exhibiting allopatric (occupying different areas) speciation include *Haplostichanthus*, *Pseuduvaria*, *Elaeocarpus*, *Ceratopetalum*, *Polyosma*, *Endiandra*, *Uromyrtus*, *Pilidiostigma*, *Buckinghamia*, *Orites*, *Stenocarpus*, *Sarcotoechia*, *Bubbia*, *Planchonella* and *Symplocos*. Some outstanding examples of disjunctions that may eventually lead to new species are *Denhamia viridissima* (Mts Lewis, Bellenden Ker and Bartle Frere), *Elaeocarpus linsmithii* (Mts Lewis and Bartle Frere), *E. thelmae* (Alexandra Creek and Mt Windsor Tableland), *Trochocarpa bellendenkerensis* (Thornton Peak, Mts Bellenden Ker and Bartle Frere), *Glochidion pruinosum* (Thornton Peak and Mt Bellenden Ker), *Flindersia oppositifolia* (Thornton Peak and Mt Bellenden Ker), *Endiandra* sp. 'Boonjie' (Mt Lewis and the Boonjie area), *Litsea* sp. 'Mt Lewis' (Thornton Peak and Carbine Tableland), *Orites fragrans* (Thornton Peak, Mts Lewis, Bellenden Ker and Bartle Frere, and Boonjie), *Triuna montana* (Mts Spurgeon, Lewis, Bellenden Ker and Bartle Frere), *Wendlandia connata* (Mts Hemmant and Spurgeon), *W. urceolata* (Thornton Peak, Mts Spurgeon and Bartle Frere), *Bubbia queenslandica* subspecies *queenslandica* (Noah Creek, Mts Spurgeon and Lewis) and *Symplocos ampulliformis* (Mt Hemmant, Mt Windsor Tableland and Mts Spurgeon and Lewis).

Several species of fauna restricted to the Wet Tropics also occur as two or more disjunct populations: the Mountain Mistfrog, *Litoria nyakalensis*, has been recorded from a number of localities between the McDowall Range and Kirrama Range, all at altitudes above about 400 metres; the Northern Tinkerfrog, *Taudactylus rheophilus*, occurs as four allopatric populations on Thornton Peak, Carbine Tableland, Lamb Range and Bellenden Ker Range, all at altitudes above 900 metres (*L. nyakalensis* and *T. rheophilus* were not found at any site during a survey in 1991–92.); the Lemuroid Ringtail Possum (*Hemibelideus lemuroides*) occurs on the Atherton Uplands and Mt Carbine Tableland and differences between these isolated populations have been noted (Trenerry and Werren 1993); Lumholtz's Tree-kangaroo (*Dendrolagus lumholtzi*) also occurs on the Atherton Uplands and at Mt Carbine Tableland; the Thornton Peak Melomys (*Melomys hadrourus*) occurs at Thornton Peak and Mt Carbine Tableland.

Species with disjunct populations outside the wet tropics similarly have potential for allopatric speciation. There are numerous examples among the plants including, *Maytenus bilocularis*, *Cassia marksiana*, *Pseudoweinmannia lachnocarpa*, *Polliia crispata*, *Dysoxylum fraserianum*, *Premna lignum-vitae*, *Ixora beckleri*, *Euodia micrococca*, *Ripogonum discolor*, *R. elseyanum* and *Phaleria chermsideana*. 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 (*Dasyrurus maculatus gracilis*)
Koala (*Phascolarctus cinereus adustus*)
Fluffy Glider (*Petaurus australis reginae*)
Long-tailed Pygmy-possum (*Cercatetus caudatus macrurus*)
Red-legged Pademelon (*Thylogale stigmata*)
Little Cave Bat [*Vespadelus (Eptesicus) pumilus*]
Golden-tipped Bat (*Kerivoula papuensis*)
Bush Rat (*Rattus fuscipes coracius*)
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*)

Recent studies have shown a surprising level of genetic diversity within the Prickly Forest Skink, *Gnypetoscincus queenslandiae*. The studies were directed at determining the level of variation within mitochondrial DNA and a range of enzymes from specimens collected at seven different sites throughout the species range of 275 kilometres. The results show a major genetic break, clearly separating it into northern (Cape Tribulation to Mt Lewis) and southern (Mt Bartle Frere to Mt Sullivan) populations (Moritz *et al.* 1993). The authors conclude that the northern and southern populations “appear to represent very distinct evolutionary lineages that should be considered separately in any analyses of ecology, biogeography and conservation status”. The magnitude of the genetic difference between the two populations is of such an order that geographic separation probably occurred more than 5 million years ago (Moritz *et al.* 1993). There is every reason from a management point of view to consider the two populations as separate species.

Also conserved in Wet Tropics are communities of forests considered to be early segregates from rainforests. 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 (Gill *et al.* 1985). The first appearance of these wet sclerophyll forests in the fossil record was by the late Miocene (Truswell 1993).

Within the listed area, especially at the Cowley–Kurramine 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.

The Wet Tropics of Queensland includes variations in elevation above sea level and changes in topography and soil types and thus conserves the full diversity and complexity of the rainforest and associated communities present.

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

The Wet Tropics of Queensland World Heritage Area 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 (Webb 1984).

Northern Australia has been postulated as a major centre of evolution of rainforest flora (Kershaw *et al.* 1984). The living history of this evolution is best conserved in the listed area.

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. Considering the extent of the fringing reef, adjacent as it is to a rainforested continental coastline, this rainforest–reef association is probably unique in the world.

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 the magnificent 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 and have become popular with canoeists.

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.

The winding channels of the Hinchinbrook Channel contain the most extensive mangroves in the region, providing a rich visual mosaic of rainforest and mangroves. The view to the east from this part of the Wet Tropics is backed by the magnificent scenery of Hinchinbrook Island, part of the Great Barrier Reef World Heritage Area.

(4) *The most important and significant habitats for 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*

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 accounting for only 0.26 percent of the Australian continent, the Wet Tropics conserves much of Australia's biodiversity (Table *).

Table *. Importance of the Wet Tropics to Australia's biodiversity

Taxonomic group	Percentage of Australia's total
Plants	
fern species	65
cycad species	21
conifer species	37
orchid species	30
vascular plant species	30
Animals	
mammal species including:	35
• marsupials	30
• bats	58
• rodents	25
bird species	48
frog species	26
reptile species	17
freshwater fish species	45
butterfly species	58
dung beetle species	42
barkbug species	46
weta species	50

Within the Wet Tropics there are over 4,660 known species of vascular plants, representing 1,164 genera and 210 families. Seventy-five genera are endemic to Australia and 43 are restricted to the Wet Tropics. Over 700 species are restricted to the Wet Tropics of Queensland. The outstanding significance of the Property is that it contains many taxa representing long, distinct lineages preserving a greater degree of evolutionary heritage than places with a similar number of species but containing a succession of closely allied forms. This is reflected in the very high plant diversity at the higher taxonomic levels such as numbers of plant genera and families represented in the Wet Tropics.

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 geographically rare and/or threatened. 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. Of the 49 monotypic genera in the Property (represented by a single surviving species), 19 are considered rare.

The Wet Tropics has a total of 351 plant species that are officially listed as rare or threatened under Queensland legislation (Table *). They are listed in Appendix 9. Of the 29 recognised recent plant extinctions in Queensland, 17 were formally endemic to the Wet Tropics. The presumed extinct species, in general, have not been recorded for over 50 years.

Table *. Rare and threatened Wet Tropics plants¹.

Class	Extinct	Endangered	Vulnerable	Rare
Whisk ferns	1	0	0	0
Ferns	5	3	8	27
Club mosses	2	4	4	1
Cycads	0	0	1	0
Conifers	0	0	0	3
Dicots	6	19	29	170
Monocots	3	16	12	37
<i>Total</i>	<i>17</i>	<i>42</i>	<i>54</i>	<i>238</i>

¹Nature Conservation (Wildlife) Regulation 1994 (includes all amendments up to SL No. 354 of 2000)

Included in the list are many rare and very restricted species belonging to the primitive angiosperm families referred to earlier in relation to The Age of the Angiosperms. These include *Idiospermum australiense* (Idiospermaceae), eight undescribed species of *Haplostichanthus* (Annonaceae), *Wilkiea wardelli* and *Tetrasynandra* 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. As noted earlier, 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 *Austromuellera trinervia*, *Baileyoxylon lanceolatum*, *Barongia lophandra*, *Crispiloba disperma*, *Hexaspora pubescens*, *Kuntheria pedunculata*, *Lenbrassia australiana*, *Mitrantia bilocularis*, Gen. nov. Q2, *Neostrearia fleckeri*, *Noahdendron nicholasii*, *Normanbya normanbyi*, *Oreodendron biflorum*, *Ostrearia australiana*, *Spahlmium racimosum* and *Whyanbeelia terraereginae*. 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 *Alloxylon flammeum*, *Helicia blakei*, *H. recurva*, and undescribed species of *Carnarvon*, *Orites* and two entirely new genera.

There are at least 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.

The outstanding biological diversity of the Wet Tropics in regard to the fauna has been described in the 'Description and Inventory' section. The Property 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.

Most of the Wet Tropic's endemic faunal complement are confined to the cooler, upland rainforests and many are considered to be relicts from formerly widespread temperate environments (Switzer 1991). At least 663 terrestrial vertebrate species have been recorded (DASETT, 1987; Williams *et al* 1996) which represents 32% of Australia's terrestrial vertebrate fauna (Table *).

Table *. Comparative Wet Tropics vertebrate diversity

Vertebrate Group	No. of Wet Tropics species	% of Australian total	No of endemic species	Level of regional endemism
Mammals	109	35%	13	12%
Birds	370	48%	13	4%
Reptiles	131	17%	27	21%
Frogs	53	26%	24	40%
Freshwater fish	78	41%	8	10%
Total	741	33%	85	11%
Terrestrial Total	663	32%	77	12%

Source: Williams *et al.* (1996), DASETT (1987), Pussey & Kennard (1994), EPA (1999)

A breakdown of the number of endemic species in each habitat is presented in Table*. Although the dry sclerophyll forests contain the highest overall diversity of vertebrate species, there is low proportional regional endemism (4%). In contrast, the rainforest fauna includes 66 species which are found only in the Wet Tropics or 25% of the rainforest terrestrial vertebrate species are endemic to the region (Williams *et al.* 1996).

Table *. Number of Wet Tropics bioregional terrestrial faunal species by broad habitat type.

	closed forest	wet sclerophyll	dry sclerophyll forest & woodland	grassland	rocky outcrops	caves	freshwater	mangroves
mammals	51	43	71	13	8	9	3	8
birds	112	107	174	48	3	-	73	63
reptiles	65	61	108	24	27	1	16	14
frogs	31	16	35	20	1	-	30	2
total	259	227	388	105	39	10	124	87
% regional endemism	25%	7%	4%	0%	21%	0%	4%	2%

(after Williams *et al.*, 1996).

Of the thirteen 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 Property. The Property contains the habitats of 35% of Australia's mammal species, including 30% of Australia's marsupial species, 58% of Australia's bat species and 25% of Australia's rodent species.

More than 370 bird species are either confined to, or have part or most of their range in the region (Dasett, 1987). Of these, 112 are principally rainforests rainforest specialist species. The majority of the thirteen endemic species are confined to the upland rainforests. A further ten species have their Australian distributions largely confined to the region and at least another ten bird subspecies are restricted to the Wet Tropics. Of the 13 endemic species, nine are restricted to the uplands, with the remaining four being widespread throughout the region. All 13 endemic species have close relatives in the highlands of New Guinea. The Property contains the habitats of 48% of Australia's bird species

The Wet Tropics contains the most diverse rainforest frog assemblage in Australia with very high levels of regional endemism. Upland areas between 600 and 1,000 metres are particularly important. There are 53 species of frog in the region, 24 of which are regional endemics. Twenty-one of the 26 rainforest dependent frogs are only found in the Wet Tropics. The Property contains the habitats of 26% of Australia's frog species,

The Wet Tropics reptile fauna consists of a mixture of old endemics (Gondwanic) and recent invaders from New Guinea. There are about 131 species of reptiles within the Wet Tropics. About 50 species of reptile have been recorded in rainforests. Of these, 29 are rainforest specialists with 20 species being endemic to the region, making the level of reptile endemism in the Wet Tropics the highest in Australian rainforests. The skinks are a particularly diverse group within the Wet Tropics with sixteen locally endemic species (Covacevich & Couper, 1994). The Property contains the habitats of 17% of Australia's reptile species.

The Wet Tropics region has a greater diversity of freshwater fishes 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 70 per cent of the continent's fish genera and 70 per cent of Australia's 35 freshwater fish families (Pusey 2001). This extraordinary diversity reflects the diversity of stream habitats and the highly variable but predictable seasonal flow rates. Nine endemic freshwater fish species have been identified (Pusey 2001). The Property contains the habitats of 45% of Australia's freshwater fish species.

Although the invertebrate fauna of the Wet Tropics is relatively poorly studied it is undoubtedly the richest of any comparable region in Australia. This is demonstrated by statistics which are available for certain diverse groups of insects such as the butterflies, for which the Wet Tropics has about 230 species or about 58% of all Australian species; the dung beetles, for which the Wet Tropics has 135 species or about 42% of all Australian species; the barkbugs, for which the Wet Tropics has 42 species, or 46% of the continent's total. Twenty-six species of wetas (giant king crickets) occur in the Property which is half of the Australian total. Four of the nine genera found in the Wet Tropics, involving eight species, are endemic to the Property. There are at least six species of crayfish restricted to cool, permanent streams above 800 m altitude. Certain invertebrate groups have diversified greatly in the Wet Tropics, for example the carabid beetle genus *Philipis* has 33 species in the Wet Tropics while only two elsewhere. The richest overall insect fauna yet studied in Australia lies in the Bellenden Ker Range where an intensive survey yielded 4,029 species of insects including 1,514 species of beetles alone (Monteith 1994) in addition to more than 300 species of spiders. Land snails form an extraordinarily diverse group within the fauna of the Wet Tropics. An analysis by the Queensland Museum identified 217 native species, of which 185 (85%) are endemic to the region (Stanisic *et al.* 1994). Two Wet Tropics streams, Yuccabine Creek and Birthday Creek, have recorded the highest diversity of stream invertebrates anywhere on earth (Pearson pers. com).

The Wet Tropics has a total of 82 animal species officially listed as either rare or threatened. Endangered fauna include seven frog species, three marsupials, one bird and two butterflies (Table *). A further 16 vertebrate species are classified as vulnerable.

Table *. Rare and threatened Wet Tropics animals¹.

Status	Mammals	Birds	Reptiles	Frogs	Fish	Butterflies	Total
Endangered	3	1	0	7	0	2	13
Vulnerable	6	7	3	0	0	2	18
Rare	16	9	15	11	0	0	51
Total	25	17	18	18	0	4	82

¹ *Nature Conservation (Wildlife) Regulation 1994* (including all amendments up to SL No. 354 of 2000), *EPA Wildnet (2001)*