



STATE OF WET TROPICS REPORT 2015-2016

*Ancient, Endemic, Rare and
Threatened Vertebrates
of the Wet Tropics*



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WET TROPICS IMAGES/MIKE TRENNERY

STATE OF WET TROPICS REPORT

2015-2016 : ANCIENT, ENDEMIC, RARE AND THREATENED VERTEBRATES OF THE WET TROPICS

*Ancient, Endemic, Rare and
Threatened Vertebrates of
the Wet Tropics*



STATE OF WET TROPICS REPORT
2015-2016

Purpose of the report

Each year the Wet Tropics Management Authority prepares a report on the administration of the Act during the year, financial statements for the year, and a report on the state of the Wet Tropics World Heritage Area. This State of Wet Tropics report satisfies the requirements of Queensland's *Wet Tropics World Heritage Protection and Management Act 1993* and the *Commonwealth's Wet Tropics of Queensland World Heritage Conservation Act 1994*.

Public availability

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Disclaimer

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Further information

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CONTENTS

Executive Summary	1
Introduction	7
Biodiversity Values of the Australian Wet Tropics	15
Diversity and endemism	15
Spatial patterns of vertebrate biodiversity	17
Antiquity and evolutionary distinctiveness.....	20
High conservation status.....	22
Elevational patterns of biodiversity.....	23
Understanding the Outstanding Universal Value	27
Evolutionary history	28
Ongoing evolution	28
Ecological processes.....	29
Climatic stability	30
Understanding extinction: using the past to inform the present and future.....	32
What species are most vulnerable to extinction?.....	33
Cultural values.....	35
Current Status, Trends and Threatening Processes.....	39
Climate change	39
Declines in specialised species.....	43
Habitat loss and fragmentation	47
Invasive species.....	48
Chytrid fungus and amphibian decline	48
Other invasive species.....	50
Unsustainable use of resources.....	52
Inappropriate fire regime	53
Future Outlook.....	55
Predicting future trends in Wet Tropics biodiversity	55
The value of long-term monitoring	59
Climate change, conservation planning and connectivity	59
References.....	67
Appendix.....	75



NORTHERN QUOLL
WET TROPICS IMAGES/BRUCE THOMPSON/SCOTT BURNETT

Executive Summary

The Wet Tropics World Heritage Area is a region of spectacular scenery and rugged topography with fast flowing rivers, deep gorges and numerous waterfalls. Mountain summits provide expansive vistas of the oldest surviving rainforest in the world. The Area is also culturally rich, comprising the lands of people from more than 18 Rainforest Aboriginal tribes who have been an integral part of the land and seascape—living in and around the World Heritage Area for thousands of years and using traditional practices to manage country.

Despite comprising a very small proportion of the Australian continent, the Wet Tropics supports the highest biodiversity of any region in Australia (45% of all vertebrate species). In 2014, the Wet Tropics World Heritage Area was ranked the second most irreplaceable natural terrestrial World Heritage site on Earth because of its unique concentration of endemic, rare and ancient species. The vertebrate fauna of the Wet Tropics has outstanding and exceptionally high levels of endemism and diversity with the highest concentration in the mountain rainforests.

More than a quarter of the region's vertebrate species (190 of 693) have significant conservation value. These include: species with restricted ranges and specialised habitat requirements; ancient species considered relicts from the time of the Gondwanan super continent; highly specialised species; or vulnerable and threatened species. Of particular note:

- 60% (151 of 257) of the region's rainforest vertebrate species are regarded as very important protected species for conservation
- the Wet Tropics fauna includes 31 species that are among the highest 10% of evolutionarily distinct taxa on the planet
- the cool, wet mountain-top rainforests of the region contain high concentrations of species that represent the last relicts of Australia's rainforest-dominated past.

These species are an important part of Australia's natural heritage and make a significant contribution to the Outstanding Universal Value of the Wet Tropics World Heritage Area.

Long-term monitoring indicates that the biodiversity of the World Heritage Area is declining, with many species already reduced in both distribution area and population size, despite being well-managed within protected areas. These impacts have been caused by diseases (frog declines and extinctions), climate change (many species of upland specialised endemic vertebrates, particularly ringtail possums and birds) and habitat fragmentation (localised declines in many species).

Declines are particularly obvious in the endemic, rare, ancient and rainforest specialised species that are the key components of the region's Outstanding Universal Value. Seven species of frogs have been heavily impacted by chytrid fungus with three probable extinctions and four species remaining classified as endangered. Climate change is already causing significant impacts with many species disappearing at the lower elevation, warmer part of their range, including ringtail possums. Approximately 50% of the rainforest birds already show changes in abundance and distribution in accord with expectations associated with climate change.

Understanding patterns of biodiversity, and what maintains them, is vital to making informed policy and management decisions aimed at managing natural ecosystems. The combination of long-term research, field-based monitoring and analysis of the region's vertebrate biodiversity over the last 20 years has provided detailed insights into the most significant drivers of the biodiversity, and include:

- the cool wet upland rainforests of the Wet Tropics region have been long-term evolutionary refugia and are critically important to the region's high biodiversity value
- many of the region's species are old, Gondwanan-derived species, and there is ongoing evolution
- there have been significant advances in understanding the processes of ongoing evolution. Many new, cryptic and previously unrecognised species have been discovered recently, particularly frogs and lizards—adding further to the region's outstanding biodiversity.
- significant advances have been achieved in understanding the relative resilience of each species, made possible by increased understanding of the distribution, abundance and ecology of rainforest species combined with detailed examinations of how species have responded to climatic change over the last 20,000 years.
- understanding how environmental change in the past has influenced current patterns of biodiversity and species extinction vulnerability is extremely valuable knowledge for making better management and policy decisions under scenarios of future climate change.

These advances in knowledge are important for prioritising species and places in the region now and in the future.

Future threats

It seems almost certain that the most significant future threat to the region is climate change. This threat is exacerbated by reduced resilience caused by habitat fragmentation, emerging diseases, changing fire regimes, increasing human population pressures and invasive pests. There is a very real potential for significant biodiversity loss, especially of the high conservation value species that the region was originally protected to preserve.

Major consequences include diminished biodiversity values, especially those that underpin heritage criteria, loss of ongoing evolutionary potential, and changes to food webs and ecological processes. There is a real danger of cascading impacts resulting in the loss of the natural assets that underpin the region's conservation value and the loss of the vitally important contribution these assets bring to a regional economy reliant on natural capital for tourism. Further, these assets provide direct and indirect economic benefit worth more than \$5.2 billion annually which includes provision of ecosystem services in the form of carbon sequestration, water and soil conservation and species protection.

Strategies to protect the region's Outstanding Universal Value

Adaptation strategies for conservation first require assessment of the problem, the vulnerabilities and opportunities for action. Significant advances have been made in this context within the Wet Tropics with advanced research on understanding species vulnerability and decision frameworks for adaptation.

The data is available to enable the selection of indicator species and to monitor sites and methods that are appropriate, logistically possible and cost effective. Researchers have developed models to predict future impacts of environmental change based on existing data on distributions and abundance. There is increased confidence in the predictions based on the testing of relative vulnerability of species against past climate change.

Minimising the impacts of future climate change will require a multi-faceted policy and management strategy that includes:

- targeted, systematic, region-wide monitoring to provide ongoing information on the region's Outstanding Universal Value to stakeholders
- special focus on vulnerable species identified in the Wet Tropics with emphasis on the endemic, specialised, ancient and rare species
- protection and management of the high priority refugia
- protecting and increasing habitat restoration in the places that will make the most significant contribution to both current and future connectivity, thereby maximising the potential for species to move with their required climate zones
- mitigating global emissions to prevent many species extinctions and

ongoing loss of evolutionary potential

- maximising ecosystem resilience by reducing non-climate stressors such as invasive species and habitat fragmentation
- supporting research and adaptive management to start testing potential adaptation strategies now so that we have the knowledge to act appropriately in the future.

These results highlight the importance of long-term monitoring in providing the knowledge for informed decision-making. Support for long-term research and monitoring has recently declined despite clear evidence that such monitoring has detected recent and ongoing species declines that specifically impact the Outstanding Universal Value of the Wet Tropics World Heritage Area. There is a critical need to re-establish this monitoring in line with recent support for the adjacent Great Barrier Reef World Heritage Area.

Resumption of targeted effort at this monitoring will provide the necessary knowledge to land managers in a timely fashion and afford them enough time to put in place restoration programs as well as implement changes to management and land-use practices.

Only through informed management and policy will the Australian and Queensland governments, through the Authority, be able to combat, adapt and mitigate threats and impacts to the Outstanding Universal Value of the Australian Wet Tropics.

Understanding patterns of biodiversity, and what maintains them, is vital to making informed policy and management decisions aimed at managing natural ecosystems.



LONG TAILED PYGMY POSSUM
WET TROPICS IMAGES/MIKE TRENERRY

Introduction

Tropical biodiversity is one of the wonders of our natural world. Understanding why the tropics has so many species has fascinated scientists for hundreds of years. Although the Australian Wet Tropics is not the biggest area of tropical rainforest, or the most diverse in the world, it was recently described as the second most irreplaceable World Heritage Area on Earth, because of the unique concentration of endemic, rare and ancient species.^[1]

Because it is also one of the most extensively studied rainforests globally, the Wet Tropics provides important insights into how tropical diversity is generated and sustained, and how it will fare into the future.

The Wet Tropics bioregion is located in the north-eastern coast of Australia (Figure 1). The landscape is composed of mixed tropical forest in an area of approximately 1.85 million hectares. The terrain is rugged and dominated by mountain ranges, tablelands, foothills and a lowland coastal plain. The elevation varies from sea level to highlands (1000m), with isolated peaks reaching up to 1620m.^[2-4] One of the distinctive features of the region is the high rainfall (between 1200mm to 8000mm per year). The wetter parts of the region are some of the wettest places in the world with the summit of Mount Bellenden Ker recording up to 12,461mm annually.^[5]

The Wet Tropics was declared a World Heritage Area in 1988, and was added to the Australian National Heritage List in May 2007 for its natural values and again in November 2012 for its Indigenous heritage values. It protects nearly 900,000 hectares or almost half the total area of the Wet Tropics bioregion. Although the bioregion is dominated by rainforest it also contains a diversity of other vegetation types (Figure 2).

The Wet Tropics is of immense scientific value to Australia as a natural learning landscape where we can increase our understanding of biodiversity and the environment. The biogeography of the region and the background of rich environmental research in the region provides a world-leading opportunity to examine some key environmental questions. Research opportunities include leaning about (i) endemism and unique fauna of global significance; (ii) the reasons that the tropics have such high biodiversity; (iii) the effects of climate and habitat fluctuations in the past; and (iv) the factors that determine the distribution, abundance and extinction propensity of species.



GOLDEN BOWERBIRD
WET TROPICS IMAGES/DARYN STORCH

Why is the Wet Tropics irreplaceable?

The Wet Tropics bioregion contains a rich variety of Australian animals and plants, many of which are endemic rare or threatened. The high levels of unique biodiversity and significance to understanding evolutionary history makes the region one of the most important and irreplaceable regions in the world.^[6-9]



The Wet Tropics World Heritage Area retains the largest area of rainforest in Australia and supports the highest level of biodiversity of any region in Australia.^[10] Although it represents only 0.12% of the total area of the Australian landmass, it is home to an exceptionally high proportion of the nation's biodiversity including:^[11, 12, 13]

36% of Australia's mammals
(30% of marsupials, 58% of bats and 25% of the rodents)

29% of Australia's frog species

23% of Australia's reptile species

50% of Australia's bird species

60% of Australia's butterfly species

41% of Australia's freshwater fish species

65% of Australia's fern species

30% of Australia's orchids.



A recent (2013-2014) State of the Wet Tropics Report ^[14] focused on the extraordinary plant diversity of the Wet Tropics. The key messages from that report were:

- the global significance of the Area, with hundreds of unique (endemic) species, and the highest representation of ancient lineages of flowering plants on the planet
- the importance of evolutionary refugia in shaping the evolution and persistence of this diversity through periods of past climate change
- the substantial number of threatened species, and likely impact of future climate change and invasive species on the maintenance of these biodiversity values.

Many of the same themes emerge in the following pages, with a focus on the rich vertebrate fauna of the Wet Tropics World Heritage Area—an area that supports many vertebrate species of exceptionally high conservation and scientific value globally.

The distribution of biodiversity and vertebrate species of high conservation significance (i.e. ancient, threatened, rare or endemic species) across the region is summarised. This is followed by a review of the current understanding of the evolutionary and ecological drivers of these patterns of diversity.

The report then presents current evidence for recent declines in vertebrate diversity and considers its future prospects, with recommendations for management actions and the research needed to underpin those actions.

Unfortunately, there has been a decline in rainforest research effort in the region just as signs of climate-induced stress are appearing. This lack of continuity in monitoring and knowledge building is particularly disturbing given the global significance of the Wet Tropics and the clear declines in the biodiversity values of the region.

Figure 1. Regional map showing biogeographic subregions and elevation zones

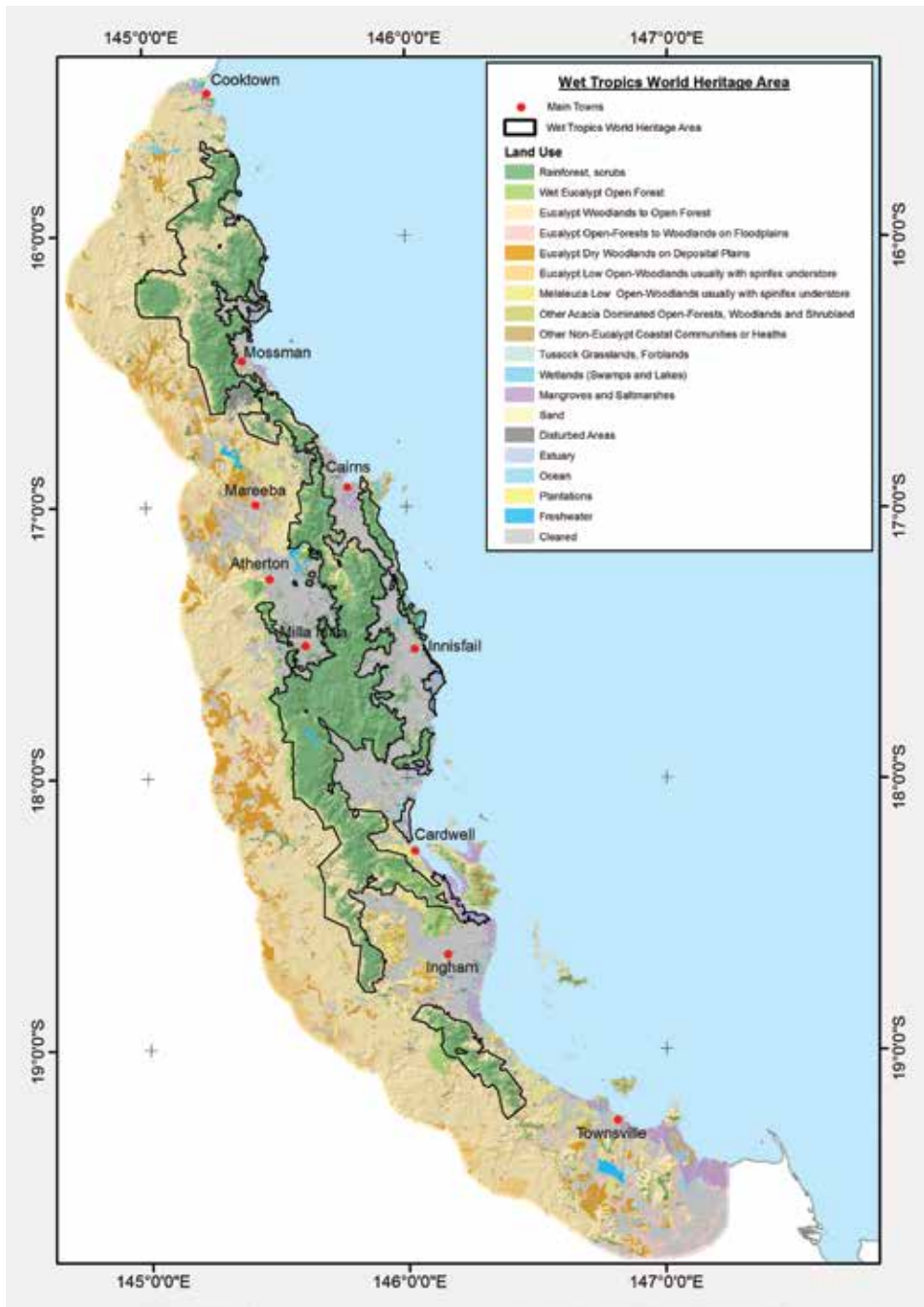
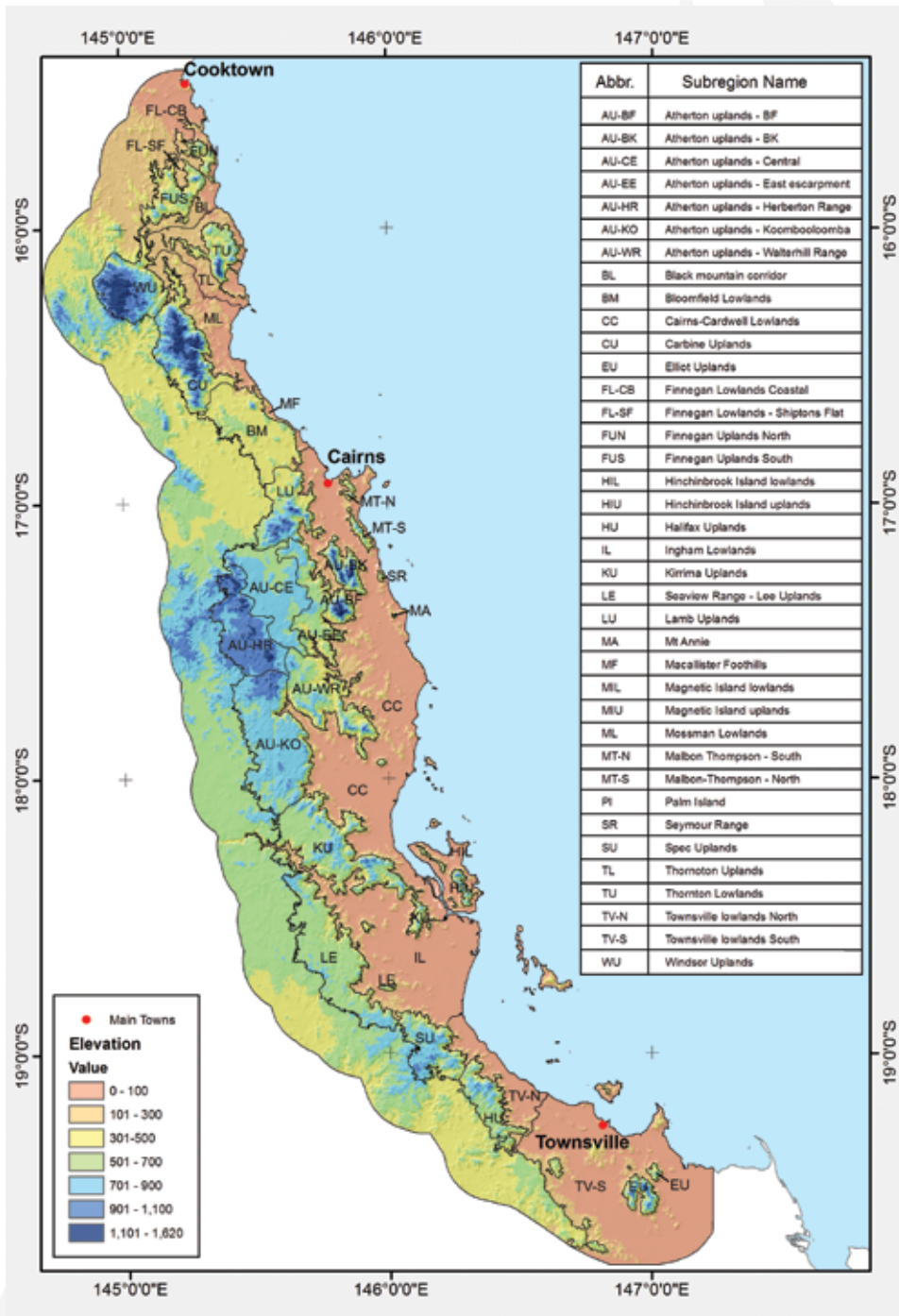


Figure 2. Vegetation map of the Wet Tropics region



ATHERTON ANTECHINUS [ATHERTON GODMANI]
WET TROPICS IMAGES/SCOTT BURNETT AND BRUCE THOMSON



Outstanding Universal Value of the Wet Tropics World Heritage Area and Very Important Species

The concept of Outstanding Universal Value (or OUV) underpins the whole World Heritage Convention and all activities associated with properties inscribed on the List. The definition of OUV, as set out in the Operational Guidelines for the implementation of the World Heritage Convention, states that 'Outstanding Universal Value means cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity'.

12

The Wet Tropics of Queensland World Heritage Area fulfills all four natural criteria for World Heritage listing, and fulfilling the necessary conditions of integrity. The Wet Tropics is considered to:

- ~ contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance - Criterion (vii)
- ~ be an outstanding example representing the major stages of Earth's history, including the record of life, and significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features - Criterion (viii)
- ~ be an outstanding example representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals - Criterion (ix)



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

The species that significantly contribute to the Outstanding Universal Value of the Wet Tropics World Heritage Area are ancient, endemic, threatened and/or rare.

In this report we designated such species as 'Very Important Protected Species (or VIPS) if they fulfill one, or more, of the following conditions:

- ~ endemic to the region, either as species or subspecies
- ~ ancient, or evolutionary distinct – any species in the top 10% most phylogenetically distinct species globally
- ~ ecologically rare - taking into account both geographic and abundance rarity (reflecting total population size)
- ~ classified as threatened by the Queensland *Nature Conservation Act (1992)*; the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)* and IUCN categories.



RUFOUS OWL
WET TROPICS IMAGES/JOHNATHAN MUNRO

Biodiversity values of the Australian Wet Tropics

The vertebrate fauna of the Wet Tropics has outstanding and exceptionally high levels of endemism and diversity. Many of these species have very restricted ranges and /or very specialised habitat requirements as well as ancient species considered to be relicts from the time of the Gondwanan super continent. However, these same characteristics that make the Wet Tropics vertebrate fauna unique have also resulted in a propensity for many species to be vulnerable and threatened. Additionally, many of these populations are already highly fragmented and becoming more so.^[15-20]

The distributions, habitat preferences and abundance of terrestrial vertebrate species have been thoroughly documented and subject to systematic and standardised surveys across the region over the last 20 years.^[21, 22] This report presents a quantitative description of the biodiversity of Wet Tropics vertebrate species. The endemic vertebrates, especially the frogs and lizards, have also been intensively studied to examine the evolutionary uniqueness of the region.^[23, 24]

Diversity and endemism

The Wet Tropics is home to approximately 669 species of vertebrate animals, half of which are birds. This represents approximately 45% of the total vertebrate diversity across the entire Australian continent (Table 1). Some 38% (254 of 669) of the Wet Tropics species commonly use rainforest and one in five (18%) are rainforest specialists. For its size, the region is especially rich in regional endemic species, with 90 species found nowhere else in the world.

The vast majority of regional endemics (83%) are strongly associated with rainforest. There are, however, there are some notable exceptions including three vertebrate species endemic to the mesic boulder habitats of Black Mountain (near Cooktown), as well as rock wallabies, the mahogany glider and the northern bettong. Endemism is highest for taxa with low dispersal potential such as reptiles (20%) and frogs (50%), and for rainforest specialists. Although there are many endemic subspecies, the level of taxonomic knowledge is not adequate enough to fully describe the fauna at that level, with numbers likely to be underestimated.

RED-THROATED RAINBOW-SKINK

WET TROPICS IMAGES/EPA QLD GOVERNMENT

Table 1. Summary of terrestrial vertebrate species richness in the Wet Tropics by taxonomic class

A list of all species in the Wet Tropics bioregion is provided at Appendix I. Data is based on a revised and updated version of Williams et al. 2010 with a 2016 revision of taxonomy, updated species distributions, updated field monitoring data and recalculated diversity mapping.

Endemic species - Levels of endemism are expressed as the number of species endemic to the Wet Tropics biogeographic region including the Mount Elliot outlier.

Conservation Status is represented by threatened categories and follows the Queensland *Nature Conservation Act (1992)*; the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)* and IUCN categories as available in 2016 (NT- near Threatened; CR- Critically Endangered; E-Endangered; V-Vulnerable; EX- Extinct). Threatened column is based on a collation of state, national and international conservation status.

Very Important Protected Species (or VIPS) are those species, or subspecies, that are the primary consideration in this report and include all taxa that are endemic to the Wet Tropics bioregion and/or have a threatened status and/or are an ancient lineage of global significance and/or are ecologically rare.

TAXA	BIRDS	MAMMALS	REPTILES	FROGS	TOTAL	
FAMILIES	79	22	13	4	118	
SPECIES	336	108	163	62	669	
ENDEMIC	12	12	21	21	66	
CONSERVATION STATUS	NT	2	6	0	1	9
	CR	0	1	1	2	4
	E	5	5	1	9	20
	V	4	12	11	5	32
	EX	0	0	0	1	1
	TOTAL	11	24	13	18	66
ANCIENT	10	2	0	4	16	
RARE	26	12	25	17	80	
VIPS	46	39	38	32	155	



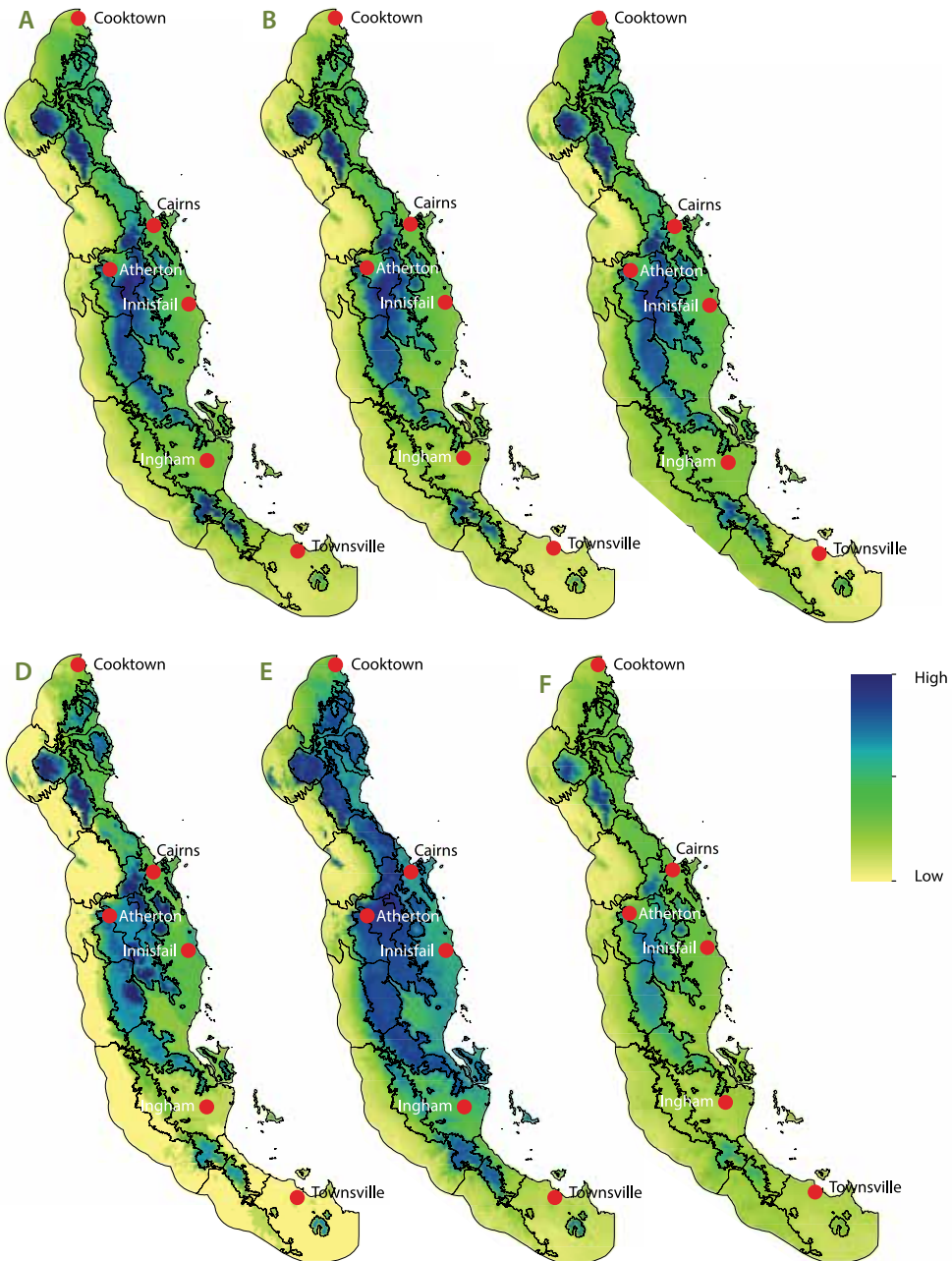
Spatial patterns of vertebrate biodiversity

In the Wet Tropics, vertebrate diversity in the rainforests is concentrated in the mountains. The highest biodiversity levels are found in the mountainous parts of the Mount Windsor, Carbine, Atherton, Bartle Frere, Bellenden Ker, Kirrama and Spec uplands (Figures 3 and 4). The central uplands around the Atherton Tableland are generally the most diverse, although the more unique species are in the higher elevations of the Mount Carbine, Bartle Frere/Bellenden Ker and Thornton Peak uplands. There is a far greater concentration of Very Important Protected Species (VIPS) in the mountain ranges in the northern part of the Wet Tropics. Diversity increases from lowlands to uplands, peaks at mid-upper elevation (~800-1200m) and declines towards the tops of the highest mountains. Scattered small areas of high diversity also occur in the north of the region (the Thornton and Finnegan uplands), on Hinchinbrook Island and the Mount Elliot uplands in the southern section of the Wet Tropics. Unlike plants, there is no peak of richness in the coastal lowlands adjacent to the Thornton or Bellenden Ker and Bartle Frere massifs.

The spatial distribution of diversity differs subtly among major taxonomic groups (Figure 3). Bird diversity is high across all of the hotspots mentioned above, as are the reptiles, but birds alone have modest diversity in the coastal lowlands and the southern uplands (Mount Spec, Mount Halifax and Hinchinbrook Islands). For mammals and frogs, diversity in the southern uplands is lower than for birds and reptiles, and frogs have especially high richness in the northern Carbine and Windsor uplands.

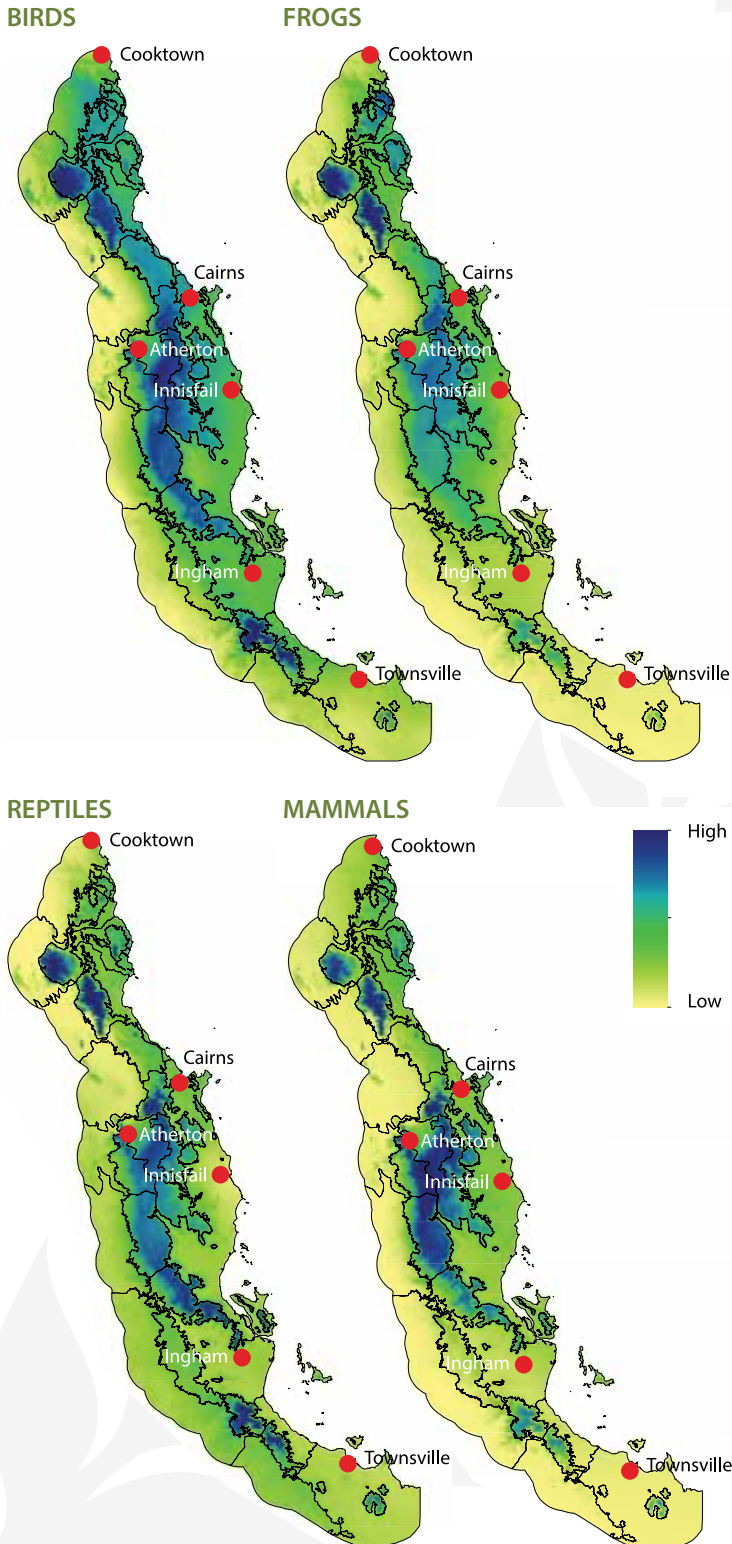
Figure 3. Biodiversity maps for all rainforest vertebrates

A: all vertebrate species; B: Very Important Protected Species (VIPS); C: Endemic Species D; endemism (range-weighted); E: evolutionary distinctiveness; and, F: ecologically rare species.



Species diversity is summed environmental suitability across all species in a grid cell based on the Maxent species distribution model™ for each species. It is the most ecologically robust indication of the spatial pattern of diversity as it essentially incorporates local abundance and is therefore a much more realistic indication of what you would see in any particular location. Evolutionary distinctiveness is based on the summed evolutionary distinctiveness in each grid cell based on the species present and their calculated evolutionary distinctiveness. For endemism, suitability for each species per 250m grid cell was weighted by the inverse of range size to emphasise areas of high richness of restricted range size endemics (or something similar).

Figure 4. Geographic patterns of biodiversity for each taxonomic group of rainforest vertebrates



In the central Wet Tropics, peak endemism shifts to the escarpment and more clearly highlights the mountains – Mount Bellenden Ker, Mount Bartle Frere and the higher elevation coastal hills of the Malbon-Thompson Range. In the northern Wet Tropics, the Thornton and Finnegan uplands have higher values for endemism than was evident looking at richness alone. Conversely, the Mount Spec uplands in the southern Wet Tropics have lower endemism than richness, reflecting the absence of vertebrate species endemic to this area. Despite lower richness, the southernmost Mount Elliot uplands, which lie outside the Wet Tropics World Heritage Area boundary, have several species of frogs and reptiles confined to this faunal subregion.

Antiquity and evolutionary distinctiveness

The Wet Tropics is renowned for its high representation of ancient species, especially flowering plants. From the vertebrate perspective, major Gondwanan groups of Australian vertebrates include song birds, marsupials, myobatrachid frogs and pygopodoid lizards. Important examples include the phylogenetically diverse assemblages of ringtail possums and bowerbirds, the musky rat-kangaroo (the ancient sister group to all kangaroos and wallabies), the highly divergent chameleon gecko, and the recently extinct *Taudactylus* frogs (Appendix I).

The Wet Tropics fauna includes 33 species that are among the highest 10% of evolutionarily distinct taxa on the planet.^[25] These include 18 endemic (and rainforest) species including 11 birds, two mammals, three frogs and two reptiles.



NORTHERN BARRED FROG
WET TROPICS IMAGES/EPA QLD GOVERNMENT

Ancient Lineages

The Wet Tropics contains one of the most complete and diverse living records of the major stages in the evolution of animals from the break-up of Gondwana.

The Wet Tropics contains several groups of animals that are relicts or early descendants of fauna that were around 60 million years ago after the dinosaurs became extinct. These include ancient lineages of frogs, geckos, legless lizards, dragons, skinks, cassowaries, scrubfowl, brush turkeys, songbirds, chowchillas, beetles, leafhoppers, cockroaches, spiders and land snails.

The Wet Tropics also contains some of the most primitive marsupials - the carnivorous dasuroids. These are thought to have evolved in rainforests about 40 million years ago and been the ancestors of Australia's dry-adapted marsupials. The musky rat-kangaroo (*Hypsiprymnodon moschatus*) is the most primitive kangaroo and is restricted to the Wet Tropics. It represents an early evolutionary stage of development from possum-like marsupials. Five of Australia's six ringtail possum species are in the Wet Tropics (four of them endemic) and are descended from a common ancestor.

The Wet Tropics of Queensland is the most important area for several lineages of Australo-Papuan songbirds such the bowerbirds, scrubwrens, thornbills and gerygones.

The frog genera *Taudactylus* and *Mixophyes* are derived from Gondwanan times. Two of Australia's six species of *Taudactylus* are found only in the Wet Tropics. *Mixophyes* is represented in the Wet Tropics by *Mixophyes schevilli*, the northern barred frog.

The Wet Tropics is also important because it contains a unique record of the mixing of Asian and Australian animals and plants when the continents collided about 15 million years ago. In some cases these plants and animals, some of common origin, had been separated for 80 million years. So some animal species of Gondwanan origin were able to take up residence in the Wet Tropics after a long absence. These included families of frogs, songbirds and rodents and bats. Many species from these lineages are now found only in the Wet Tropics.

Spatially, the diversity of ancient species is highest from the northern Atherton uplands through the Lamb uplands to the Carbine and Windsor Uplands (Figure 3).

Iconic, evolutionarily distinct species include the musky rat-kangaroo and ringtail possum; the spotted catbird, golden and tooth-billed bowerbirds, southern cassowary, chowchilla and grey-headed robin; and the chameleon gecko and the Bartle Frere skink. Tragically, two of the most globally significant Wet Tropics frogs - the sharp-snouted day frog and the northern tinkerfrog (*Taudactylus acutirostris* and *T. rheophilus*) are both now likely to be extinct. Further, of those that remain, the golden bowerbird and green ringtail possum are among the species most vulnerable to climate change. Evolutionarily distinct, but non-endemic species of note include the platypus and southern cassowary.

The vertebrate fauna of the Wet Tropics is exceptionally high in ecological function, species diversity and genetic diversity. In order to further evaluate the evolutionary value of the region's vertebrate fauna, researchers have assessed the phylogenetic diversity of the Wet Tropics rainforest marsupials, lizards and frogs relative to all Australian species. The Wet Tropics has from 4% to 16% of species (for which phylogenetic assessment is possible) of these taxa in Australia. For many groups (both the hylid and myobatrachid frogs, skinks and geckos), the Wet Tropics has twice as much phylogenetic diversity per species as the rest of Australia combined (Appendix I).

High conservation status

Using the criteria described above to identify species that are endemic, rare, threatened and ancient, more than a quarter of the vertebrate species in the Wet Tropics region have high conservation significance (Table 1). Even more telling, 60% (155 of 254) of rainforest species are regarded as 'Very Important Protected Species,' or VIPS (Appendix II).

Four taxa are classified as VIPS on all criteria. These are the southern cassowary, the Bartle Frere skink and both species of *Taudactylus* frogs. Many others meet three of the four criteria. Examples include multiple species of bowerbird, green ringtail possum and long-tailed pygmy possum, the microhylid frogs and several species of *Litoria* (the full species list is provided in Appendix I).

Prominent among the non-rainforest VIPS taxa are several species of gliders, the northern bettong, rock wallabies and several species endemic to the boulder habitats of Black Mountain in the northern part of the region.

No Wabu No Wuju No Gunday (No rainforest No bush food No cassowary)

By Girringun Aboriginal Corporation

We are the Rainforest Aboriginal people.
We have strong spiritual connections to our traditional
country – land, animals and plants.

They are part of who we are. Our
culture, environment and
people are one.

The cassowary is part of
us, the rainforest people.

Our people have lived
with cassowaries since
the dreamtime.

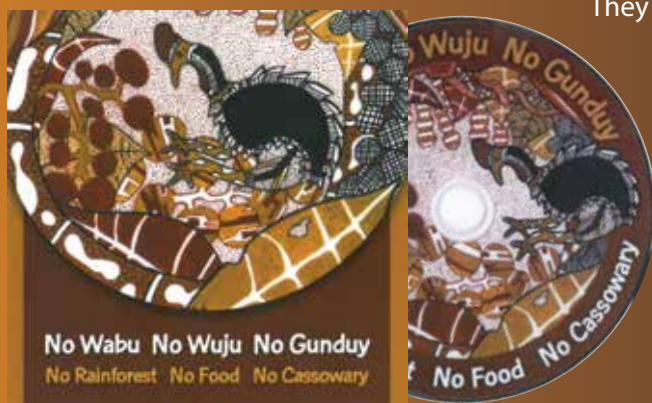
It's something to be saved.

Without the cassowary, our
culture will change.

Our cultural connection to the
cassowary is as strong today as it was in the dreamtime.

Our culture must be preserved to pass on to future generations.

Without strong action today, cassowaries will become extinct
in the future.

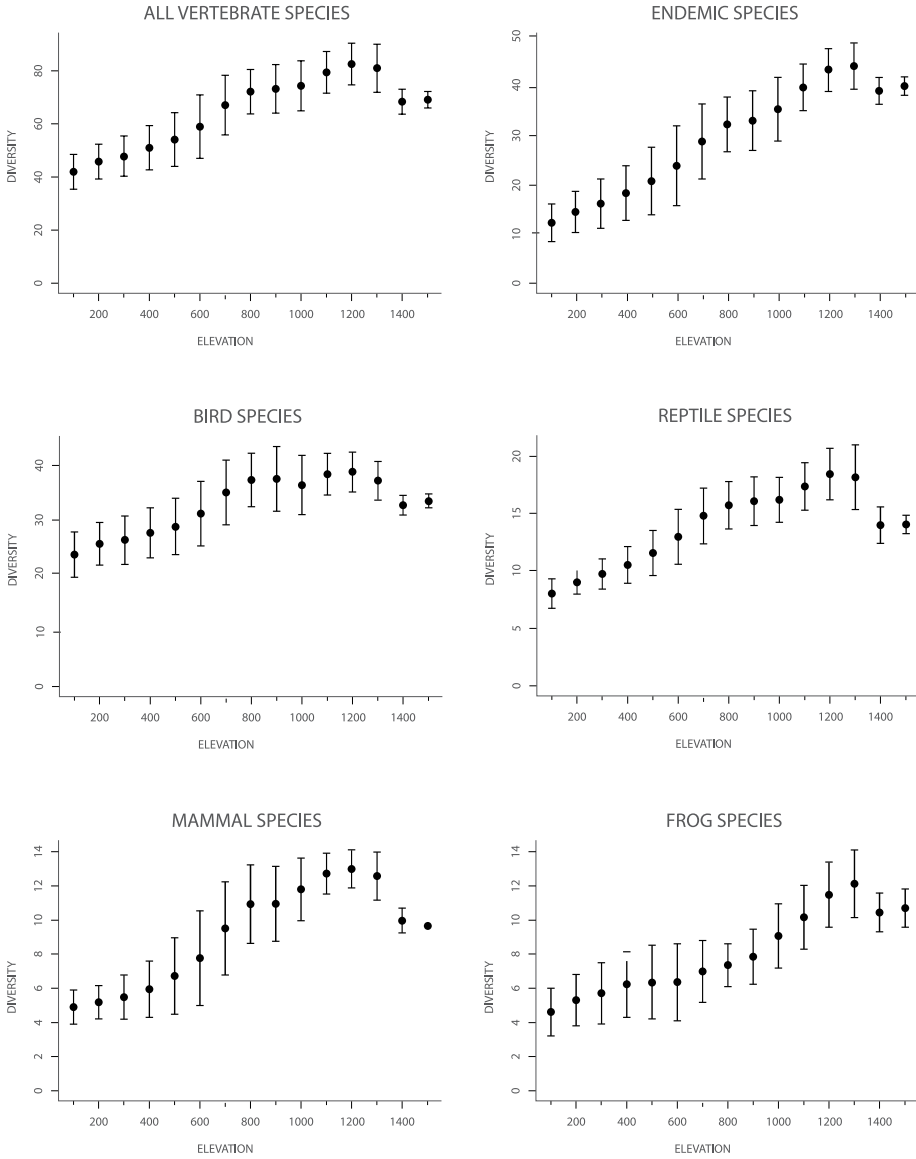


Elevational patterns of biodiversity

The cool wet rainforests in the uplands of the Wet Tropics region are critically important refuges for the region's high biodiversity value and one of the most important components of the Outstanding Universal Value of the region. The elevational gradient is one of the strongest climatic gradients in the region and almost every biological pattern and process systematically changes across this gradient.

Almost all patterns of biodiversity, indeed almost all the biodiversity values contributing to the regional Outstanding Universal Value, are influenced by elevation. For most vertebrate taxa, diversity is moderate in the lowlands, increasing steadily with elevation to be at its highest between 1000-1300m and then declines above 1300m (Figure 5). Birds have a slightly wider region of maximum diversity from 600-1200m compared to most other taxa. The conservation significance of the mountain tops are highlighted by the high proportion of species in the region that are of high conservation significance, the elevational patterns of VIPs, endemism, rarity, ancient and threatened species follows a similar pattern to overall diversity with maximum biodiversity values above 1000m but then declining above 1300m (Figure 6).

Figure 5. Vertebrate biodiversity across elevation for taxonomic groups, endemic species and all vertebrate species

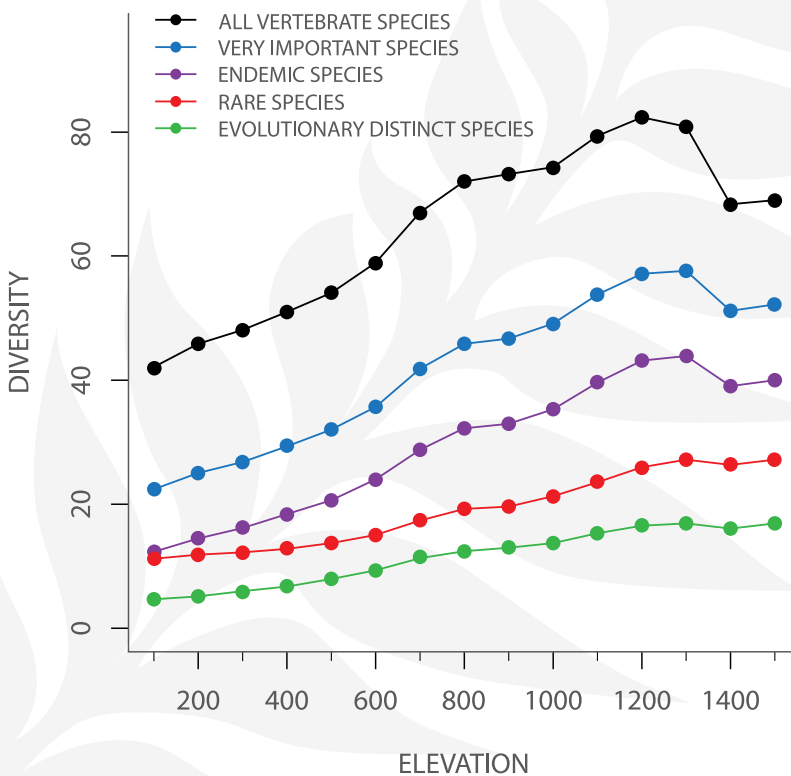


The cool wet rainforests of the uplands are the critical element in understanding patterns of biodiversity in the region and represent the most critical hotspots of vertebrate biodiversity. The stability of the environment over the long-term (i.e. since the last ice-age ~20 000 years ago) and the short-term (e.g. annual/seasonal changes) is highly correlated with elevation—with upland areas being generally more buffered and stable.

Higher elevation areas have a more consistent water availability due to less variable monthly rainfall, cloud stripping inputs and lower evaporation rates associated with lower temperatures.^[26, 27] Long-term stability over evolutionary time scales (millions of years) is greater in the uplands in general.

Annual productivity varies across elevation with lower overall primary productivity in higher elevation areas that are limited by cooler temperatures and high levels of cloud cover (reducing energy input via solar radiation) and limited by greater seasonality and harsher dry seasons in lowland and more southern/northern peripheral areas.^[28-30]

Figure 6. Biodiversity across elevation for all vertebrate species, endemic species and Very Important Protected Species, Endemic Species, Rare Species, and Evolutionary Distinctive Species.



STATE OF WEST TROPICS REPORT 2015-2016: ANIMALS AND PLANTS, RARE AND THREATENED VEGETATION OF THE WET TROPICS



MAREEBA ROCK WALLABY
WET TROPICS IMAGES/DARYN STORCH

Understanding the Outstanding Universal Value

Understanding patterns of biodiversity, and what supports and maintains these patterns is vital to making informed policy and management decisions aimed at protecting that biodiversity. It requires knowledge of the factors that determine the distributions of species including the influences of evolutionary processes, current environment, past environments, biogeographic barriers, pests and various types of vegetation disturbance.

Observed patterns of distribution for any species are influenced by its evolutionary history, its intrinsic biological characteristics and the landscape context and structure. Drivers of spatial and temporal patterns of biodiversity are complex, and the relative importance of the various influences varies enormously across taxa, ecosystems, spatial scale and the level of biodiversity being considered.

Tropical rainforests globally have extraordinary species richness, and are often associated with high levels of endemism. Since Darwin and Wallace, scientists have sought explanations for this high diversity, with debates around whether rainforests are 'museums' or 'cradles' of biodiversity, or both. The museum hypothesis emphasises longer-term persistence of ancient diversity, whereas the cradle concept proposed high rates of ongoing speciation. The Australian Wet Tropics are both a museum and a cradle and are of the utmost importance to Australia and the world.^[31, 32, 33]

The Wet Tropics rainforest and its biota is small by global standards, yet it has the same features as larger systems—relatively high diversity and endemism. Because it is geographically isolated, yet complex and diverse, as well as relatively accessible the Wet Tropics has emerged as an important natural laboratory, a "learning landscape", providing an exceptional opportunity to understand the ecological and evolutionary drivers of tropical biodiversity.

^[34] This makes the Wet Tropics one of the most globally-important regions for biodiversity conservation based on both its inherent value in preserving a unique biodiversity and its value as a learning landscape.

Managing and protecting the natural environment and Australia's natural capital relies on being able to make informed decisions on policy and management based on sound knowledge.

The history of dedicated research over the last two decades has provided a data-rich backdrop that has enabled researchers to delve deeper into understanding of the patterns and processes driving biodiversity than perhaps anywhere in the world. There are other places where there has been more intense research in a small area but nowhere that we are aware of has the extensive, multidisciplinary knowledge across a whole regional ecosystem

as in the Wet Tropics. This has incalculable value for science, the region and for Australia.

Evolutionary history

To understand the evolutionary foundations of current vertebrate biodiversity of the Wet Tropics, we need to consider the broader picture of Australian rainforests in space and time. Both plant and fossil evidence demonstrate that rainforests were much more widespread on the continent up to the mid Miocene (~15 million years ago, or mya) and progressively retracted to the mesic east coast as the continent dried and rainfall became more seasonal from ~10–5 mya and again in the late Pliocene (3.5–2.3 mya). Unlike plants, animal fossil records over this time are rare—the exception being the fossil deposits of the Riversleigh World Heritage in the now arid north-west of Queensland. Here, there is evidence of a diverse rainforest assemblage, including relatives of the musky rat-kangaroo and ringtail possums at ~20 mya, and their replacement by more arid-adapted faunas from the mid Miocene onwards.^[35] A diverse assemblage of rainforest vertebrates persisted on the central Queensland coast (Rockhampton) to just ~300 mya, after it was replaced by an arid assemblage, never to return.^[36]

That evolutionary rainforest lineages such as ringtail possums, rat-kangaroos and geckos, myobatrachid frogs and bowerbirds (as well as many lineages of ancient flowering plants) have persisted in the Wet Tropics illustrates the value of the region in both protecting these ancient relicts and in continuing to increase our knowledge on the evolution of Australian biodiversity.

However, other common components of the Wet Tropics rainforest fauna have Asian, not Gondwanan, ancestry, having colonised the continent some ~25–15 mya.^[37] Even more recently, the rodents invaded in two waves: the ‘old’ endemic rodents some 3 mya (including *Uromys* sp. and *Melomys* spp.) and *Rattus* sp. ~1 mya.^[38]

For many high dispersal (including all endemic birds) or large-bodied vertebrates, the Wet Tropics is too small an area to sustain substantial in-situ radiations of species. Several marsupial lineages, especially possums, tree-kangaroos and quolls, have close relatives in New Guinea^[39] as do some birds. Thus, as with plants, the long-running debate about Gondwanan versus immigrant origins of Australian rainforest diversity has been resolved—both are true.

Ongoing evolution

Although most taxa in the region are old, Gondwanan-derived species, there is evidence that demonstrates that the Wet Tropics is an important region for recent and ongoing evolutionary processes—another important component of the Outstanding Universal Value of the World Heritage Area. The closest living relatives of many Wet Tropics endemic rainforest birds, frogs and some lizards occur in the rainforests of Cape York, central or south-east

Queensland and north-east NSW. One notable example of recent speciation is within the red-throated rainforest skink, which has two highly divergent but morphologically indistinguishable lineages in the region. There is a southern lineage that is most closely related to a blue throated species in rainforests to the south whilst the northern lineage is closest to a recently discovered and drably coloured species from the rainforests of Cape Melville.^[40]

For rainforest frogs in particular, there is evidence for considerable geographic speciation within the Wet Tropics. This includes multiple species of barred frogs (*Mixophyes* spp.^[41, 42]) and a small radiation of torrent frogs (*Litoria nannotis*, *rheocola* and *nyakalensis*). The most spectacular radiation is in the tiny, direct-developing microhylid frogs (*Cophixalus* spp.)^[43] This radiation of 19 species has six species in Cape York, mostly in coastal boulder fields and 13 endemic to the Wet Tropics. The Wet Tropics rainforest taxa in particular, exemplify geographic speciation with several closely related and ecologically similar taxa restricted to montane rainforests in the northern Wet Tropics, and another set of closely related species split between the northern and southern Wet Tropics and Hinchinbrook Island.^[44]

A major feature of low dispersal vertebrates in the Wet Tropics rainforests, as elsewhere in the tropics is the presence of deep genetic divisions within species, with many intraspecific lineages meeting in a cryptic 'suture zone' in the central Wet Tropics. The Wet Tropics rainforest and its fauna provide one of the best examples globally to answer fundamental questions about the evolution of rainforest diversity because of the well documented history of late Pleistocene rainforest contraction, the linear arrangement of disjunct refugia, and the many detailed genetic studies of the fauna.

As one example, detailed studies of the green-eyed treefrog at the Barron River in the Black Mountain corridor^[45, 46] yielded clear evidence of the process of 'reinforcement' which has been controversial among evolutionary biologists. Here, two very divergent lineages meet, but when crossed in the lab their offspring die. In response the females have developed strong preference for their own type, along the way generating a new locally endemic species, the Kuranda treefrog.^[47]

Ecological processes

Intensive field-based monitoring and analysis of the region's vertebrate biodiversity over the last 20 years has provided detailed insights into the most significant drivers of biodiversity, with broad implications for understanding biodiversity and ecology in general.

Most of the traditionally considered factors that drive diversity patterns are still relevant and important in the Wet Tropics context. Factors such as habitat area, environmental heterogeneity, primary productivity, biotic interactions and habitat fragmentation all contribute to the current observed patterns of biodiversity. However, the dominating factor that is consistently important in explaining biodiversity pattern in the Wet Tropics is the interaction between



the relative resilience of each species (relative extinction proneness) and environmental stability. This is manifested in both current patterns of species abundance and distribution patterns that are driven by climatic changes in the past.

Climatic stability

Environmental stability comes in many shapes and forms. As discussed above there is long-term stability involved in speciation at the scale of millions of years and there is medium-term stability at the scale of tens of thousands of years (e.g. late Pleistocene stability of rainforest over the last 20,000 years). Further, there is stability of climate and productivity at ecological time scales of years to months that strongly affects localised patterns of abundance and distributions.

Consistently important in all analyses examining the regional patterns of diversity (both phylogenetic and ecological) is the signature of localised biogeographic extinction (at the subregion level) over the last 20,000 years and the importance of within-year annual stability in climate.^[48-49] Dry season rainfall is a critical variable linked to physiological limitation of many species distributions and in determining the dry season bottleneck in local ecological productivity that limits the distributions and abundance patterns of many species across all taxonomic groups.^[50]

Understanding extinction: using the past to inform the present and future

Understanding how environmental change in the past, particularly climatic change, has influenced current patterns of biodiversity and species extinction vulnerability is extremely valuable knowledge for making better management and policy decisions under scenarios of future climate change. Informed prioritisation of species, places and adaptive action will produce the most cost effective solutions with the best long-term environmental outcomes for maintaining and managing the Outstanding Universal Value of the Wet Tropics.

With few exceptions, the recognised rainforest-dependent species in the Wet Tropics were formed through climate-driven isolation even before the large fluctuations between warm-wet and cold-dry climate kicked in during the last 500,000 years. The impact of the last glacial maximum (~18,000 years ago) and the transition to the Holocene (<10,000 years ago) on the Wet Tropics biota has been studied in detail, using pollen cores and macrofossils for plants and genetics and modeling for the fauna.^[55-59]

Despite the large scale of the climate fluctuations, there is little evidence of large-scale extinction in the plant fossil record, though some taxa did disappear from the region.^[60] For the vertebrates, these historical contractions of rainforest have left an enduring signature in spatial patterns of both genetic and species diversity. Historical climatic stability of rainforest explains spatial variation in species richness across the Wet Tropics better than does the current environment, especially for vertebrates with low dispersal ability.

The severe climate fluctuations over the past 20,000 years, in addition to the previous oscillations stretching back millions of years, have had a profound effect on the diversity of the fauna of the Wet Tropics and on how it has evolved and persisted across the landscape.^[61-65]

Knowledge of how past climatic change has influenced evolution and biodiversity in the region provides significant insight into the relative vulnerability of species, thereby vastly improving the capacity to sensibly prioritise species and places for adaptive management in the future.

For example, genetic analyses suggest that Mixophyes frogs have been highly sensitive to past climate change. Further, the results indicate that protecting high priority 'evolutionary' refugia and identifying the most effective corridors and/or restoration sites to maximise connectivity to them will help to protect biodiversity both now and into the future.



What species are most vulnerable to extinction?

All species have an inherent resilience (or vulnerability) to extinction, based on their life history traits and ecology. Resilience in this way is influenced by the species reproductive biology, environmental specialisation and potential for dispersal. In the Wet Tropics, researchers^[66] used this information to rank 163 Wet Tropics vertebrate species on the basis of their potential to recover from environmental disturbance, considered in light of both contemporary and historical influences.^[67-69]

There is higher biodiversity and endemism in areas that have been stable over the last 20,000 years.^[70, 71] Historical habitat stability can be as important, and for endemic low-dispersal taxa even more important than current habitat area in explaining spatial patterns of species richness. These long-term, upland refugia are a major component of the region's Outstanding Universal Value, and protection of these refugia is critical to the long-term protection of the region's biodiversity.

Understanding the relative resilience of each species, that is, its extinction proneness is important knowledge for prioritising management and policy actions and enables more robust predictions about the future.

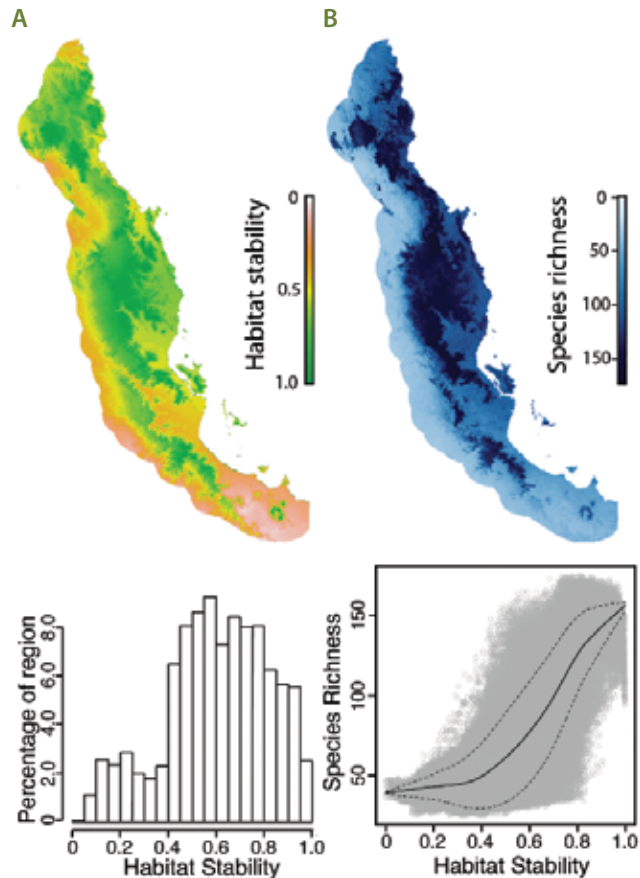
The rich background of information about the historical climate changes in the region makes it possible to test predictions about future resilience because the impacts of past climatic change should be predictable based on the relative resilience of each species. Basically, species that are very vulnerable (low resilience) should have been the most impacted in the past and only be present in areas of high stability, while resilient species should be present in a wider range of places now. Figure 7 demonstrates that this is indeed the case with areas of low historical climate stability having, on average, more species with higher resilience. This suggests that historical climatic fluctuations and low stability have filtered out vulnerable species, leaving a community assemblage dominated by species with high resilience.

This hypothesis suggests that the distribution of resilience across species should be determined by historical extinction filtering, that is, in areas of low stability it should be skewed towards having more species with higher resilience and in high stability areas there should be a more normal distribution of species with a range of resilience levels. Indeed, the skewed distribution of species resilience indicated that extinction filtering has influenced current biodiversity patterns in accordance with the hypothesis.

For instance, areas of low habitat stability have a community dominated by highly resilient species, whereas areas of high habitat stability, had a more normal distribution of resilience scores (Figure 7). These analyses confirm that species with low, medium, and high resilience persisted in areas of high habitat stability, however the low stability areas were dominated by high resilience species, supporting the historical filtering hypothesis.

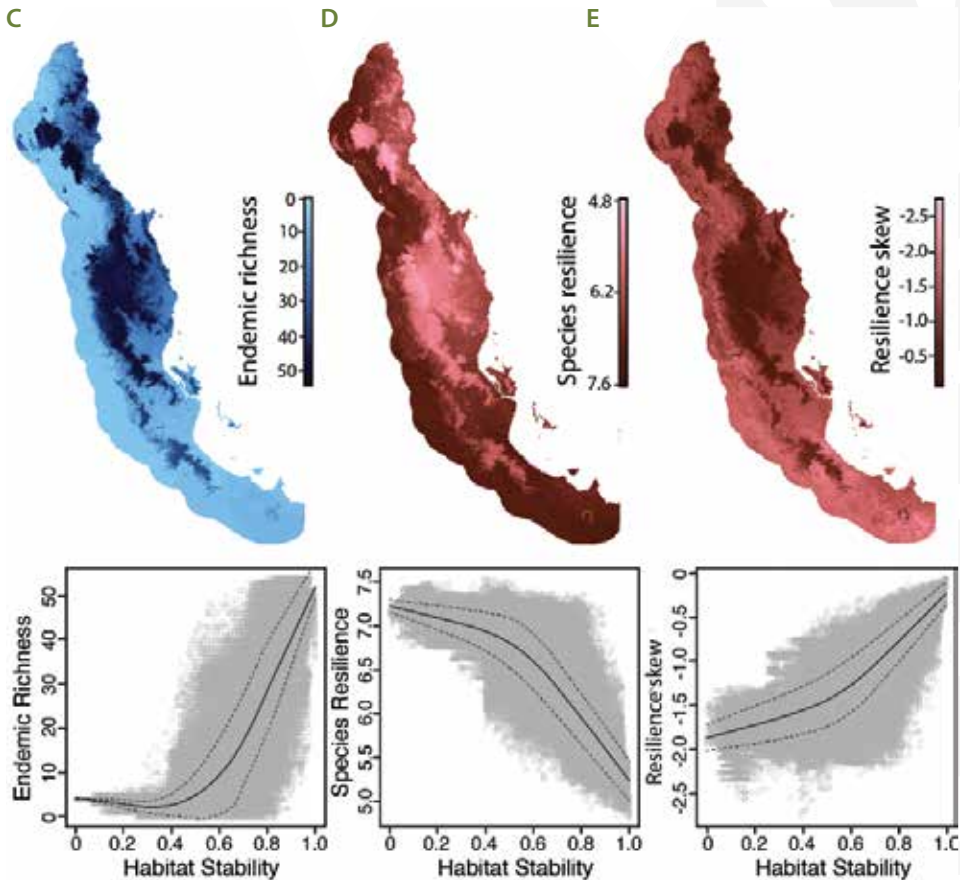
Figure 7. Spatial patterns of vertebrate biodiversity, habitat stability and species resilience in the Australian Wet Tropics region.

Maps show spatial patterns in: (a) habitat stability (b) species richness, (c) endemic richness, (d) mean species resilience, and (e) mean species resilience skew from a normal distribution. Also shown is the frequency of stable habitats in the region, and the relationship of the richness and resilience variables with habitat stability. Points in the scatter plots come from spatial modelling using 500k base points covering the region (lines show best fit from non-linear regression around 95% confidence interval). Resilience analysis is based on all species with valid distribution models and sufficient biological trait data.



Unfortunately, many of the species that are of greatest significance in the region (VIPs) have low resilience and are concentrated in the stable upland refugia. This has important implications for future climate change, as we show that areas with high biodiversity and rare species comprise of highly stable habitats (historically). However, the concentration of low resilience species in these areas could lead such species to be highly vulnerable to change, and extinction. This is especially relevant as predicted climate change exceeds the rate and scope of historical climate fluctuations.^[72, 73]

The species of the Wet Tropics will undoubtedly pass through yet another extinction filter event. If past climate change can strongly influence species distributions, as seen in the strong spatial signature of environmental stability and present day species patterns, then future climate change will undoubtedly have similar effects on species distributions with dire consequences for the region's Outstanding Universal Value.^[74]



Cultural values

Before European settlement, the Wet Tropics rainforests were one of the most populated areas of Australia, and the only area where Australian Aboriginal people lived permanently in rainforest. The Area's rainforests provided Rainforest Aboriginal people with spirituality, identity, social order, shelter, food and medicine. Aboriginal people also utilised an economic system that involved the bartering of resources amongst different tribal groups.^[134]

Rainforest Aboriginal people have a close relationship with the Wet Tropics land and sea country which is imbedded in customary law. For Rainforest Aboriginal people natural and cultural heritage is inextricably interconnected. Their cultural and spiritual assets include landscapes, places, materials and animals which provide story places and are important food sources. In supporting Rainforest Aboriginal values they also provide cultural well-being.

Cassowary got culture

*This is a dreamtime story of how the Gunday/
Gundulu (cassowary) came to be. Provided by
Girramay Elders*

This cassowary, he was a human being in the beginning.

He used to kill a lot of people. He was a very bad guy. People used to go out hunting, and he would follow them and kill them in bush. And even the kids, he would kill the kids. They wanted to know how they could get rid of this fellow. This cassowary man he was full of head lice. He used to have someone look at his head and get rid of the headlice. And one day they asked him, do you want someone to come and look at your head and kill all the head lice. And the cassowary man said yes and said 'what about tomorrow, it will be alright tomorrow?'

While they were getting ready to look at his with all the lice on his head, they got a stone axe and made it all nice and sharp. They had to get rid of this fellow. They were going to cut him.

They said we are ready to look at your head now, for the head lice.

Come over here and lay down here. Two ladies looked at his hair and killed all the lice. Then the man went to sleep with his arms stretched out. Two blokes sneaked up with a stone axe and cut his arm off. When they cut his arm the man took off. He took off to the bush. And when he took off into the bush he turned into cassowary, or Gundulu (in language). That is the dream time story and that is why cassowary has short little arms and cannot fly.





LUMHOLTZ TREE KANGAROO
WET TROPICS IMAGES/MIKE TRENERRY

Current status, trends and threatening processes

Many of the biodiversity assets of the region have already been damaged and are continuing to decline. Many of the unique vertebrate species that are endemic, rare, ancient and/or of biocultural significance have recently declined, and their ranges contracted. These results demonstrate that the Outstanding Universal Value of the region is being eroded, despite being within a well-managed and protected World Heritage Area. In this section, we outline some of the observed changes and impacts to the region's Outstanding Universal Value that have already occurred and are continuing to threaten this beautiful and unique region.

Climate change

More than 10 years ago, catastrophic impacts on the endemic vertebrate fauna of the region were predicted over the coming century with a potential for more than 50% of these species to go extinct.^[77] At a global scale, estimates of total species extinctions vary considerably between ecosystems, taxa and methods of analysis^[78] with tropical mountain systems being particularly vulnerable.^[79, 80] However, in all studies the potential for significant impacts is disturbing, with potential loss of between 15-35% of all species.^[81, 82] The potential threat of projected climate change is very high and extremely serious. The obvious questions to ask is—Are these impacts already happening and observable; and, are the future projections realistic and robust?

Unfortunately, the answer to both questions is 'yes'. There is now quantitative evidence, based on the long-term monitoring of vertebrates across the entire bioregion for significant declines and shifts in the spatial distribution of populations. Field monitoring clearly demonstrates that the projected future impacts are not only happening, but are perhaps happening sooner and more severely than originally predicted.

Possums in peril

Possums are in peril. Ringtail possum species have declined at the lower elevational limits of their ranges - Lemuroid ringtail possums (*Hemibelideus lemuroides*) and Herbert River ringtail (*Pseudochirulus herbertensis*) have both disappeared from sites at 600m since 2006 and 2008 respectively, although they remain common at 800m and above. The southern population of Lemuroid ringtail possums increased at a site at 1000m elevation on the southern Atherton Tableland between the early 1990s and 2004 but since 2004 has exhibited a steady decline in abundance.

Additionally, the northern population of Lemuroid ringtails (Mount Lewis) severely declined after the 2005 heat waves that coincided with extreme low rainfall and an absence of cloud cover. No individuals were seen for a number of years although some individuals are now regularly sighted. This population seems to have undergone a severe decline in 2005 followed by a slow recovery.

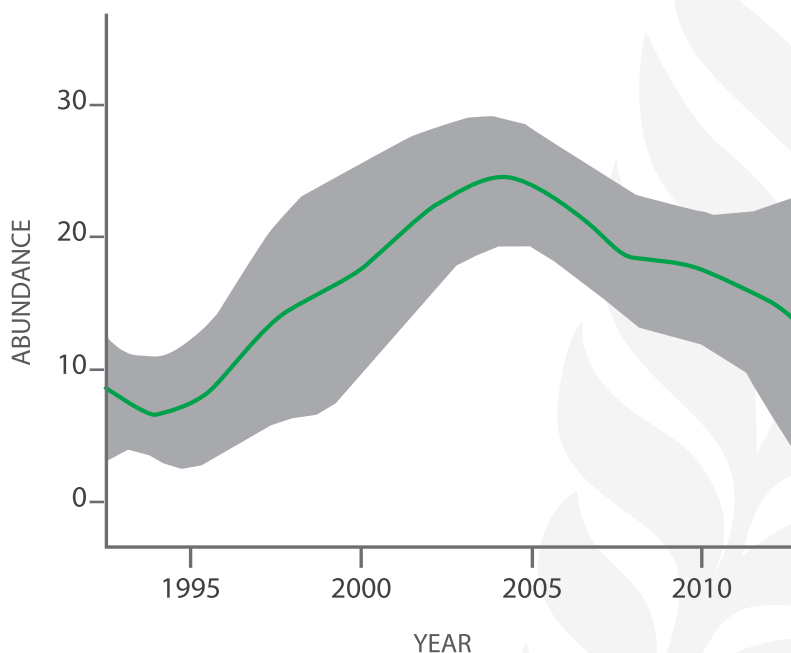
The abundance of Daintree ringtails (*Pseudochirulus cinereus*) on Mount Lewis has increased at sites above 1000m in recent years although it is unknown if this is being driven by warming temperatures or the decline in Lemuroids at these same sites. The green ringtail possum (*Pseudochirops archeri*) has significantly increased in numbers at the upper limits of their elevational ranges although they show declining numbers at their lower elevational limits. In summary, the observed changes in ringtail possum populations and distributions are in accordance with projected changes due to climate change.



DAINTREE RIVER RINGTAIL POSSUM
WET TROPICS IMAGES/MIKE TRENERRY

Figure 8: Observed abundance change for the Lemuroid ringtail possum (*Hemibelideus lemuroides*)

At 1000m on the Atherton Tableland showing initial population increase then subsequent decline after 2005. Shaded area indicated confidence intervals for the abundance data (S.E. Williams / A. Anderson, unpublished data)



Williams' Wet Tropics monitoring program^[83] recently re-analysed the status and trends of Wet Tropics vertebrates using measurements of species abundance and distributions from over twenty years of field and monitoring data. The team tested for significant changes in abundance over time and at different elevations. Their results are revealing several disturbing trends.

Of 56 bird species with sufficient abundance data for statistical analysis, 28 species show significant shifts upwards in elevation, often associated with significant declines in overall population size (Figure 9). These results are consistent with modelled predictions of upward shifts in population abundance published more than 10 years ago.^[84] The results are also in accordance with expectations under a warming climate and knowledge of the physiological tolerances of these species to maximum temperature.

Using measurements of species abundance from the monitoring program, the team completed analyses of changes in total population size on approximately 100 species of vertebrates to assess which species have undergone significant changes in total population size. At least 32 species of birds and possums have undergone significant changes in their population size over the last two decades. Worryingly, many of the upland endemic species have undergone significant declines and the species that have increased are predominantly lowland generalist, widespread species. Indeed, these may be the first signs of climate driven changes in species distributions.

Figure 9. Observed change in bird total population size over the last 15 years of standardised bird surveys.

Based on Williams vertebrate database and analyses and data from Alex Anderson PhD.



SPOTTED-TAILED QUOLL

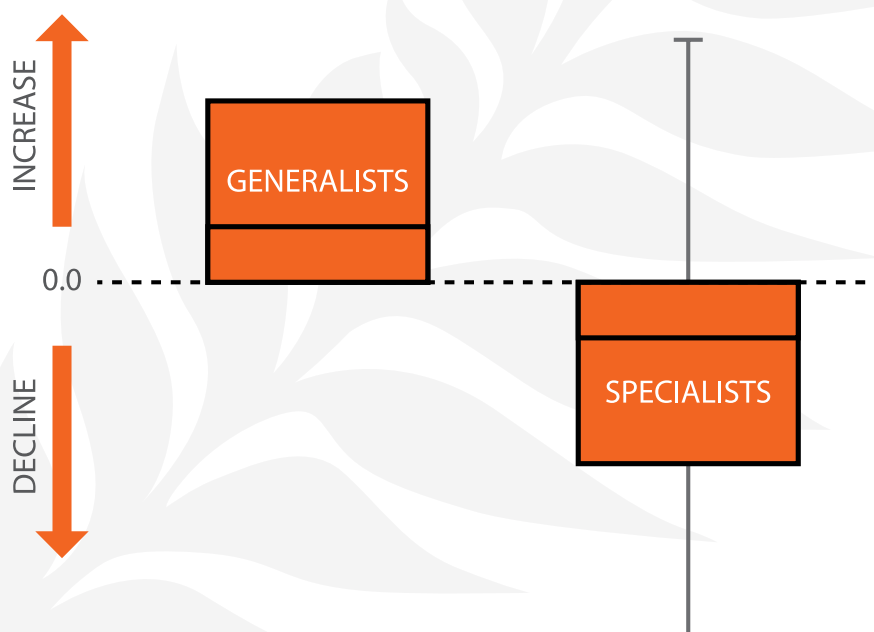
WET TROPICS IMAGES/BRUCE THOMPSON AND SCOTT BURNETT

Declines in specialised species

Another worrying trend is the greater level of population decline in the rainforest-specialist bird species (Figure 10). Broadly distributed species have, on average, increased their population size. Rainforest specialists (which include many in the VIPS category) have, on average declined, especially those species that are rainforest obligates. One such example is the tooth-billed bowerbird (Figure 11). This trend emphasises that the very species the World Heritage Area was designed to protect, the endemic rainforest upland specialists, are in great danger. They have already experienced severe, observed declines in population size and distribution area and these trends are projected to become much more severe in the future.

Figure 10: Average change in total population size of bird species pre- and post- 2008 that are rainforest specialists and species that are generalists.

On average specialised species have declined while generalist species have increased (Williams and Anderson, unpublished data).



What can we do about climate change?

Minimising the impacts of climate change on natural ecosystems requires consideration of two factors that are not entirely independent:

- **Mitigation** – the degree that greenhouse gases in the atmosphere can be minimised via reduced emissions and/or carbon storage
- **Adaptation** - actions that increase resilience or reduce exposure to the changing conditions.

Wet Tropics researchers^[85] have developed a decision framework aimed at guiding managers and policy makers in a way that takes into account the various adaptation options ranging from the least expensive and most likely to have benefits to the more costly and risky actions (Figure 12). It is important to stress that many of the traditional environmental management practices such as control of invasive species, appropriate fire regimes, and minimising fragmentation, are all important for maintaining future resilience. Once relative vulnerability of species has been estimated, the decision framework helps guide potential actions.

The identification and preservation of refugia areas will be essential in the long-term conservation of species in the region.^[86] Climatically buffered microhabitats within pristine rainforests will likely serve as another line of defense against extreme weather events. These small microhabitats remain cool and wet during hot conditions and should provide conditions that species can survive, at least over short time frames, for example a heat wave.^[87]

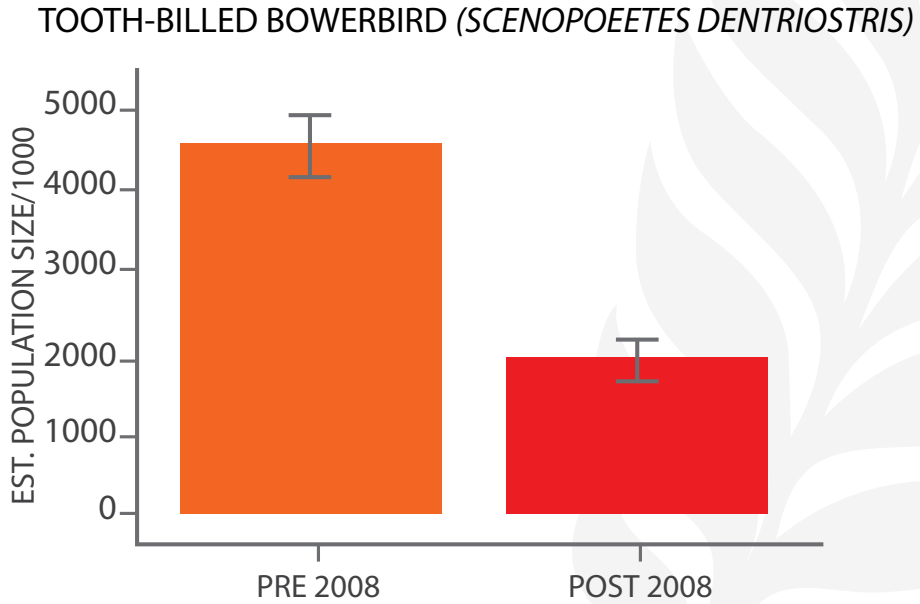
Large-scale refugial areas will, however, ultimately be required for successful long-term conservation of populations. These areas can be identified using spatially explicit modeling approaches that capitalise on long-term data of species distributions and climate modeling in the region. The utilisation of existing genetic adaptive potential needs further exploration.^[88] In this context it is notable that some species of rainforest lizards in this system have substantial variation of physiological tolerances.^[89, 90] Much of this variation appears plastic, but some could also be genetic, suggesting options for intervention by utilising these 'tougher' individuals to augment the resilience of other populations of that species.

Lastly, and the least desirable, is the consideration of assisted colonisation and *ex-situ* conservation, both of which are likely to be highly expensive, fraught with ethical dilemmas and least likely to succeed. However, in order to make these options a viable potential in the future, research is required now on the methodology and efficacy of these more extreme actions.

In order to fully understand the consequences of long-term climate change and in order to respond accordingly to population decline, more long-term monitoring of populations will be required. Long-term data is paramount for informing and triggering successful management actions in the region.

Figure 11: Tooth-billed bowerbirds are an example of an ancient, endemic, specialised and rare species that is one of the iconic birds of the region.

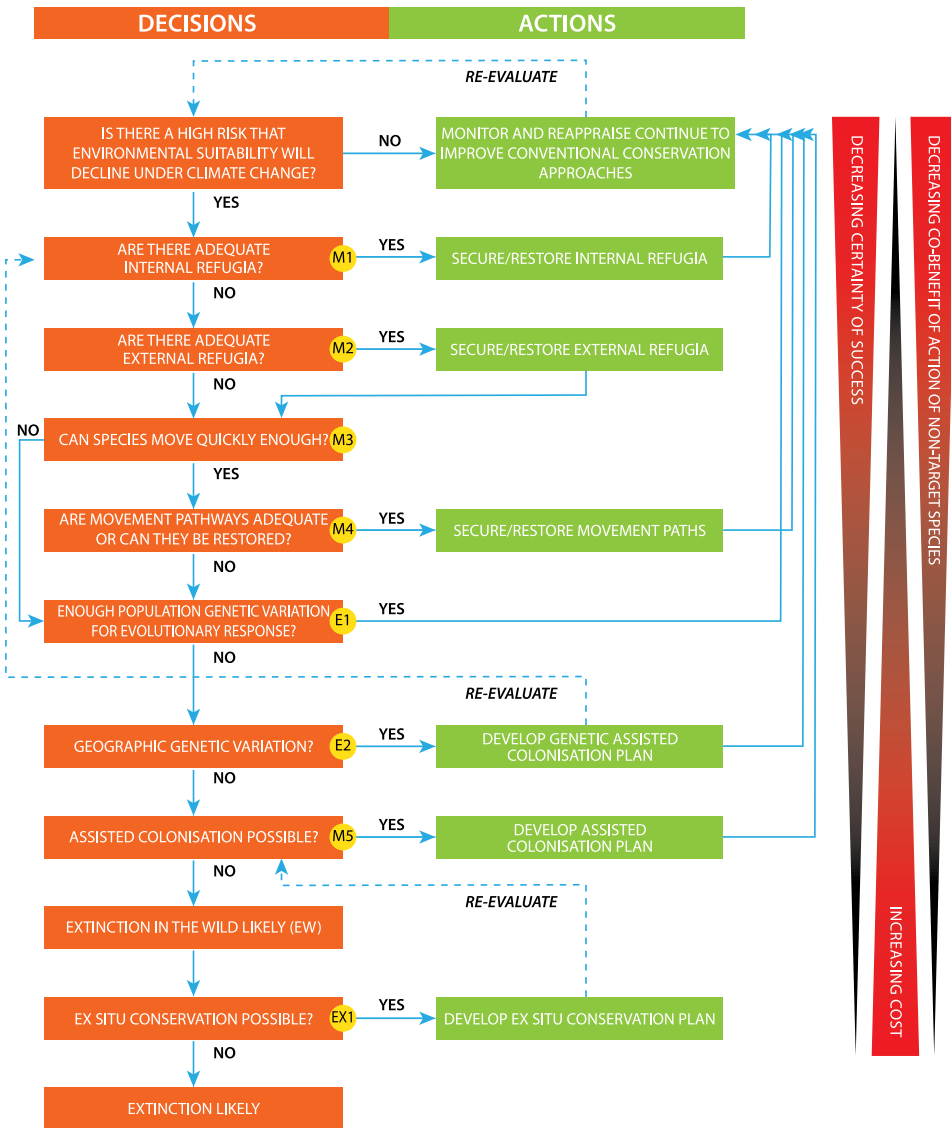
Toothbills have declined in overall population size and the distribution has retracted uphill (based on Williams et al. 2010 [81]; Anderson et al. in press)



TOOTH-BILLED BOWERBIRD
WET TROPICS IMAGES/IAN MONTGOMERY



Figure 12: Decision Framework



SPOTTED CATBIRD

WET TROPICS IMAGES/DARYN STORCH

**Habitat loss and fragmentation**

Habitat loss and fragmentation has been the main cause of biodiversity loss around the world thus far.^[91] It has been identified as the principal threat to 85% of the world's biodiversity. In the Wet Tropics bioregion, rainforests and wet forests in the lowlands between Townsville and Mossman, and in the upland basalt tableland areas of the central Wet Tropics, were heavily cleared in previous centuries, primarily for agriculture and residential settlement.^[92]

The region currently experiences less pressure due to ongoing habitat loss and degradation in comparison with other areas of Australia and around the world. Increasing human populations will continue to create pressure to develop community service infrastructure corridors that may exacerbate habitat fragmentation.^[93-94]

There are marked differences between the assemblages of animals and plants present in intact forest compared to those in patchy fragmented forest,^[95] while more subtle effects can be seen in morphological and genetic diversity of affected species.^[96, 97] Fragmentation can, and does, cause impacts including changing forest microclimates, especially closer to cleared edges. This can have a variety of impacts on the species and ecological processes near these edges. Potentially, the largest ongoing threat associated with habitat loss and fragmentation is the interaction between previous clearing and fragmentation. This includes the enhancement and spread of invasive weed species, and the problems they pose as barriers to faunal movement and dispersal under a changing climate.

Cyclones are a natural disturbance that can cause significant habitat loss and/or degradation. The impact of cyclones is likely to become more severe in the future with the average increase in intensity of cyclones predicted under climate change.



KURANDA TREEFROG [*LITORIA MYOLA*]: CRITICALLY ENDANGERED
WET TROPICS IMAGES/CONRAD HOSKIN

Invasive species

Invasive species are defined as species that are not native to a specific environment, often with a population that is beyond normal density and represents a threat to an ecosystem and/or an economic activity such as agriculture.^[98, 99] The impacts of invasive species on natural ecosystems includes reduction of productivity, direct and indirect impacts on native species, land/soil degradation, biodiversity loss, habitat loss and fragmentation.^[100]

The Wet Tropics bioregion is particularly vulnerable to invasive species due to the high density of human disturbances in the region such as power lines, agriculture, roads, and service corridors, which facilitate the movement of invasive species into natural ecosystems.^[101]

Chytrid fungus and amphibian decline

Over the last few decades the catastrophic decline in amphibian species globally has been a sobering reminder that simply being inside a protected area does not make a species immune from extinction. Chytridiomycosis, caused by the pathogen *Batrachochytrium dendrobatidis*, has been the primary cause of frog declines and disappearances around the world.^[102-103] The amphibian chytrid fungus (Chytridiomycosis) has caused population declines and extinctions around the globe since 1980 with 32.5% of all frogs now considered to be threatened and 122 species already potentially extinct.^[104] Many of these impacts have occurred inside protected areas.

The Wet Tropics World Heritage Area has not been exempt from these impacts with at least eight species of frogs suffering massive declines^[105-108], particularly in the uplands where environmental conditions promote the disease. Four species were thought to have gone extinct including *Litoria lorica*, *L. nyakalensis*, *Taudactylus acutirostris* and *T. rheophilus*. However, one species, *L. lorica*, was subsequently rediscovered surviving in an isolated population on the western edge of the region where warmer, drier conditions enhanced their resilience.^[109]

Frog chytrid fungus

There are a variety of diseases which affect frogs in the Wet Tropics. Chytrid fungus (or Chytridiomycosis) occurs in upland and lowland stream dwelling frogs in the Wet Tropics. Several species of upland frogs are now presumed to be extinct. It has been listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act). In response, the Australian and Queensland governments have prepared a Recovery Plan for stream dwelling rainforest frogs in the Wet Tropics.^[110]

Frog chytrid fungus was discovered in 1999, but may be responsible for frog population declines in the region dating back to the 1970s. The spores of the fungus grow inside the outer layers of the frogs' skin, resulting in keratin damage that may kill frogs within 10 to 18 days. The exact mechanism by which chytrid fungus kills infected frogs is still unknown.

Spores of the chytrid fungus are transported via water and wet soil. Wet or muddy boots and tyres, and other equipment, may be contributing to the spread of the disease, as may feral and native animals. The seven frog species listed as endangered under the EPBC Act are:

- sharp-snouted dayfrog (*Taudactylus acutirostris*)
- northern tinkerfrog (*Taudactylus rheophilus*)
 - armoured mistfrog (*Litoria lorica*)
 - waterfall frog (*Litoria nannotis*)
- mountain mistfrog (*Litoria nyakalensis*)
 - common mistfrog (*Litoria rheocola*)
- Australian lacelid (*Nyctimystes dayi*)

These declining species are all associated with rainforest streams in upland areas. Some have not been seen for many years and may be extinct, but there has been some good news. Some, like the common mistfrog and the Australian lacelid have disappeared from higher elevations, but can still be found at lower altitudes. The little waterfall frog was previously known from only four upland rainforest sites in the Wet Tropics and had disappeared from all these sites by 1991.

In 2008, a healthy population was located in dry forest on the western Carbine Tableland. It is now only known to occur in this one location along a two kilometre stretch of the McLeod River.

Despite, intense searching by many experienced field biologists and a targeted field program in open areas to the west of the rainforest, none of the other three species have been found and are believed to now be extinct. Three other species were observed to undergo significant declines especially in upland rainforests, resulting in them now being listed as endangered (*L. nannotis*, *L. dayi*, *L. rheocola*). Additionally, *L. serrata* initially declined but seems to have largely recovered.^[109, 110] Susceptibility to the disease is mediated by the ecological characteristics of the frog species. Species that occur in the cool wet uplands where chytrid is most virulent, that have close contact with streams and have lower reproductive outputs are the most vulnerable species.

The decline and extinction of such a high proportion of endemic frog species has been a significant impact on the region's Outstanding Universal Value. These regionally endemic species are the backbone of the World Heritage listing. To have so many species disappear in a protected area is cause for great concern.

Other invasive species

The number of vertebrate invasive species present in the bioregion have been stable for many years, however, the knowledge on population distributions and density, and ecological impacts of the 28 invasive vertebrate species has not been well documented and studied.^[111]

The invasive vertebrate species currently causing the highest levels of concern include feral pigs, cats, cane toads, dogs, gambusia (mosquito fish) and tilapia.^[112, 113] These species represent a major threat. Control initiatives to reduce population numbers of these species have not been feasible to date across the region although some local control measures have been successful.

Invertebrate invasive species have been, and continue to be, a significant threat in the region especially for the primary industry sector. The potential major environmental pests are the palm leaf beetle and tramp ants, (including yellow crazy ants and electric ants).

Exotic earthworms also have impacts on the region's ecosystems, on the processes of soil nutrient availability and on the composition of the native rainforest earthworm fauna, however there is little knowledge about their broader ecological. Honeybees also represent a threat to ecosystem processes by competing with native bee species that are more efficient plant pollinators. Honey bees reduce fruit set, which changes the reproductive performance of select native fauna and flora that depend on bee pollination for food.^[115] Recent incursions of the Asian honeybee can impact on native vertebrate fauna as they compete with birds and small mammals for tree hollows.

Stamp out yellow crazy ant

Information from article "Too Much to Lose ~ Yellow Crazy Ants in the Wet Tropics" Dr Lori Lach and Dr Conrad Hoskin of James Cook University.

Yellow crazy ants (*Anoplolepis gracilipes*) are a major threat to the Wet Tropics World Heritage Area.

They are a serious environmental and agricultural pest, recognised among the world's 100 most invasive species.

Yellow crazy ants have invaded over 200 hectares of rainforest in and adjacent to the Wet Tropics World Heritage Area near Cairns and Kuranda and over 500 hectares of adjacent residential land and cane farms.

Based on impacts elsewhere, the ecology of the ants, small amounts of research in the region, and estimations, researchers anticipate that if the invasion is thorough, much of the Wet Tropics fauna will be affected.

Direct impacts will come through predation and harassment, and indirect impacts through removal of invertebrate prey, and disruption of ecological processes such as decomposition, pollination, and seed dispersal.

The potential for knock-on effects in a system as complex and interconnected as the Wet Tropics rainforest is very high.^[114]

In 2013 the Wet Tropics Management Authority was funded \$2 million over five years by the Caring for Our Country program to eradicate a large infestation of up to 400ha in the Edmonton area. In 2016 the State and Commonwealth governments have committed to providing another \$3 million and \$7.5 million over the next five years to continue to fund the eradication program.





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WET TROPICS IMAGES/STEVEN NOWAKOWSKI

Unsustainable use of resources

The unsustainable use of natural resources is a relatively minor threat to the Outstanding Universal Value of the region, especially when compared to climate change and invasive species. However, the human population of North Queensland is predicted to continue to grow rapidly with the associated increase in threats related to urban/agricultural development, powerline/road corridors, increased recreational pressure and use of resources such as fresh water. Careful monitoring and management of these threats is vital to avoid or minimise negative impacts.



Inappropriate fire regime

Fire is a major factor in determining the distribution of rainforests^[116]. There is a hotly debated and controversial argument about the most appropriate fire regime for the sclerophyll forests that border rainforests across the region. The location and type of ecotone between the rainforest and the drier forests (particularly on the western edge of the region) is a balance between rainfall patterns, fire regimes and topography. Therefore, the fire regime can play a highly significant role in the expansion or contraction of various rainforest edge vegetation types.

Fire is probably not currently a significant threat to the area's Outstanding Universal Value, however, the interaction with climate change and the potential for synergies with increasing cyclone intensity does pose a significant future potential threat. The increase in temperature, and therefore evaporation, increasing dry season length and severity, and increasingly open canopies from high intensity cyclones has the potential to vastly increase fuel loads, fire danger and frequency—potentially triggering structural, floristic and faunal changes to entire ecosystems. This carries a risk of fire becoming a real threat to the rainforest.^[117, 118]



Future outlook

Predicting future trends in Wet Tropics biodiversity

Climate change is probably the most significant threat to biodiversity globally^[119] and is of particular concern to the Outstanding Universal Value of the Wet Tropics bioregion.^[120] Changes predicted in the region include: an increase in annual temperature, increasing frequency and duration of temperature extremes (heat waves), rainfall becoming more variable including longer dry seasons, and an increase in the frequency of extreme events such as flooding rains and cyclones.^[121]

In the Wet Tropics bioregion climate models predict an increase in the annual mean temperature of between 0.5 and 1.4 degrees Celsius by 2030 (although it is already hotter by approximately 0.8 degrees), changes in rainfall patterns with an increasingly drier and longer dry season, and an increase in the number of extreme events.^[122-124]

Changes in water availability and increased seasonality will be exacerbated by the reduction in cloud capture by the canopy in mountain rainforests—caused by the increase in average height of the orographic cloud layer.^[125, 126] As noted above, this cloud-stripping reduces seasonality of water availability, hence productivity, and so could have significant negative effects on the endemic and rare mountain-top species.

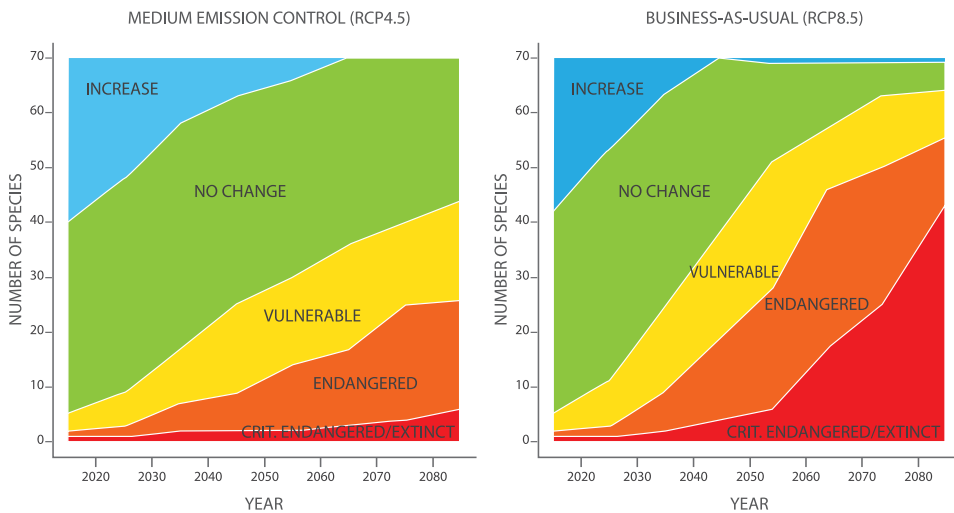
The Intergovernmental Panel on Climate Change (IPCC) fifth assessment report^[127] used future climate scenarios to predict future climate change impacts on biodiversity (Williams and VanDerWal unpublished data). Available data restricted the analysis to include 202 species across taxonomic groupings of birds, reptiles, amphibians and mammals. The climate change impacts on individual species and biodiversity as a whole was assessed against the latest IPCC emission scenarios (representative concentration pathways or RCPs) for decadal time steps from 2015 to 2085. The results of this modelling can help define species and areas of rainforest in North Queensland most at risk from climate change impacts, as well as understanding the ecology behind any changes.

The 'business-as-usual' (RCP8.5) scenario predicts high levels of species loss would occur by 2085 with 92% of the 70 species of Wet Tropics endemic vertebrates becoming vulnerable, or worse; 79% of these species would incur a >70% population loss (thus becoming endangered) and 59% would incur a >90% population loss (thus becoming critically endangered or extinct). As most low-dispersal species include multiple genetic lineages^[128, 129], the loss of genetic diversity can be expected to be even more severe in this scenario.

Contrastingly, reasonable mitigation of greenhouse gases would lead to substantial reduction of this impact, potentially saving many species from extinction; the 'medium emission control' (RCP4.5) scenario shows only 9% of the 70 endemic vertebrate species with >90% population loss (as opposed to 59% in the 'business-as-usual' scenario). Regardless, even with 'medium emission control' 63% of these endemic vertebrates are predicted to be vulnerable, or worse, by 2085 (including 37% in danger of extinction) (Figure13).

Figure 13. Future projected changes in population size and conservation status of regionally endemic species.

Following exposure to a (a) mitigation emission scenario (RCP4.5) and (b) business-as-usual emission scenario (RCP8.5). Data comes from species distribution modeling with the mean from 18 global climate models for each scenario. The count of species within population change categories (relative to baseline 1990 with first prediction at 2015) as follows: Blue - Increase in population; Green - no change; Yellow - Vulnerable 50-70% population lost; Orange - Endangered 70-90% lost; Red - Critically endangered/Extinct 90-100% population lost. Changes in population size was based on regionally endemic species where the extent of modelled area contains species entire population (N=70). See Table 2 for results for all species in the Wet Tropics (Williams and Vanderwal, unpublished data).



Habitat fragmentation and the ability of a species to disperse within and across habitats will influence the relative vulnerability of a species. In order to assess the future population fragmentation of each species in the future, researchers have estimated the effects of future climate warming on the fragmentation and connectivity of future species distribution in the region. Their models suggest that future populations of species will not only decline in area and total population size but be dramatically more fragmented than contemporary distributions. This means that future population distributions will be dramatically more fragmented than in contemporary landscapes. Under a more severe “business-as-usual” scenario (RCP8.5), fragmentation initially increases and then starts to decrease because as entire populations of each species disappear, (leaving only the main blocks of rainforest still surviving), the indices of fragmentation decline again.

Together these analyses not only clearly outline the threats to iconic species in the future for this region, but also stresses the importance of greenhouse gas mitigation now in order to protect the region’s Outstanding Universal Value.

Table 2. Predicted number of species in each IUCN threat category based on loss of total population size by 2085 under a medium emission control scenario (RCP4.5) and for the “business as usual” (scenario (RCP8.5) for 202 rainforest vertebrates. The count of species and % of species predicted to move into each IUCN threat category is shown.

IUCN CATEGORY	MEDIUM EMISSION REDUCTION (RCP4.5)		BUSINESS-AS-USUAL (RCP8.5)	
	#	%	#	%
TOTAL POPULATION (% CHANGE)				
Increase (+)	33	16.3	28	13.9
No change (0)	99	49	35	17.3
Vulnerable (50-70% loss)	40	19.8	31	15.3
Endangered (70-90% loss)	23	11.4	50	24.8
Critically endangered/Extinct (90-100% loss)	7	3.5	58	28.7
Total Threatened [V, EN, CR]	70	34.7	139	68.8

The rate at which Wet Tropics populations change is faster under the RCP8.5 scenario than the RCP4.5 scenario. Specifically, there is an approximate 20-year lag in population change between the mid-level RCP4.5 and the business-as-usual RCP8.5 emission scenario. This lag effect is less than the global average of approximately 30 years^[130], again highlighting that the fauna of the Australian Wet Tropics is particularly vulnerable.

As species attempt to survive under severe changes in future climate, they will have to do so under a landscape that is inhospitable to dispersal and migration. It is anticipated that species with highly fragmented populations will become increasingly threatened. This is supported by the historical link between habitat connectivity, stability and species turn-over across the Wet Tropics. Mitigation scenarios such as RCP4.5 will provide an additional 20-30 years for environmental managers and policy-makers to design and implement adaptation strategies aimed at minimising impacts on natural ecosystems.

Combining the analyses of impacts on species distributions and total population size presented above, with the biological traits of each species, enables a more reliable estimate of relative vulnerability of each species (see discussion and analyses in Section 3). The list of species presented below (Table 3) lists the 15 species most threatened by future climate change based on these integrated spatial and ecological models.

Table 3: List of the top 15 species most vulnerable to future climate change in the Wet Tropics based on combination of species distribution modelling and species characteristics. All of these species are included in the VIPS category.

TAXA	SPECIES	COMMON NAME	Rank
FROG	<i>Taudactylus rheophilus</i>	northern tinkerfrog	1
BIRD	<i>Amblyornis newtoniana</i>	golden bowerbird	2
BIRD	<i>Sericornis kerri</i>	Atherton scrubwren	3
FROG	<i>Cophixalus aenigma</i>	yapping nursery frog	4
FROG	<i>Cophixalus exiguus</i>	dainty nurseryfrog	5
FROG	<i>Cophixalus hosmeri</i>	rattling nurseryfrog	6
FROG	<i>Cophixalus neglectus</i>	Bellenden Ker nurseryfrog	7
MAMM	<i>Dasyurus maculatus</i>	spotted-tailed quoll	8
FROG	<i>Mixophyes carbinensis</i>	Carbine barred frog	9
BIRD	<i>Acanthiza katherina</i>	Mountain thornbill	10
BIRD	<i>Colluricincla boweri</i>	Bower's shrike thrush	11
BIRD	<i>Oreoscopus gutturalis</i>	fernwren	12
FROG	<i>Cophixalus monticola</i>	mountain nurseryfrog	13
FROG	<i>Cophixalus concinnus</i>	beautiful nursery frog	14
REPT	<i>Techmarscincus jigurru</i>	Bartle Frere skink	15

The value of long-term monitoring

A comprehensive review of regional literature and a workshop of regional stakeholders identified long-term monitoring data as the most important knowledge gap in the region.^[131] Maintaining and significantly improving a regional-scale, long-term environmental monitoring program is essential in order to track status and trends of biodiversity in the wet tropical regions of Australia. Such a program provides biodiversity and environmental data that has a demonstrated value to a wide range of users including the research community and land management agencies. This data is also valuable when developing conservation policy and for national and international data infrastructure initiatives (for example the Atlas of Living Australia and Terrestrial Ecosystems Research Network).

Data collected and maintained over the last 20 years under a variety of government initiatives, including, the Rainforest-Cooperative Research Centre (Rainforest CRC), Marine and Tropical Science Research Facility (MTSRF) and the National Environmental Research Program (NERP), was critical to our current understanding of the Wet Tropics Outstanding Universal Value.

Unfortunately, research funding support for monitoring has ended and there is no current monitoring at the regional scale. The observed trends in species populations reported will, if continued as predicted, impact strongly on the Wet Tropics Outstanding Universal Value. This clearly identifies that dedicated funding to continue this monitoring is urgent and important. As it has been acknowledged by the State and Commonwealth governments, for the Great Barrier Reef, ongoing monitoring and research is critical to long term management of World Heritage values.^[133]

By maintaining standardised methodology over the 20-year period, there is now data that drives results and outcomes at a local regional level, across the state and Australia and has significantly influenced international policy and planning. Long-term monitoring of rainforest species demonstrates how well this kind of research can advance and gain results for stakeholders—as long as vision is maintained and research and monitoring is supported in a way where the knowledge can be exported successfully to stakeholders.

Climate change, conservation planning and connectivity

Making good decisions on environmental management is almost always about making choices about which species should be protected, which areas need the most active management, what places are the most important to protect and where are the scarce available resources are most needed, or the most effective. Prioritisation is a critical step in making effective decisions and producing desirable outcomes.^[134] Identifying areas that will protect the highest species richness or endemism is often a key conservation goal. Systematic conservation planning aims to provide managers and policy makers with the capacity to make sensibly prioritised decisions. Conservation prioritisation software enables objective, spatially-explicit prioritisation tailored to the specific values that need protection.

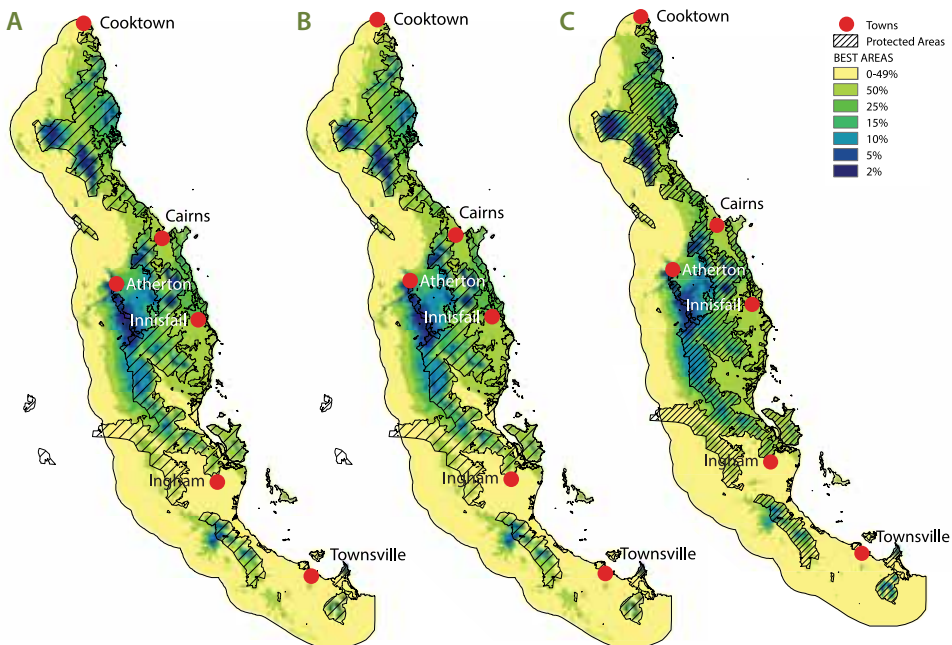
To support management decision making with the aim of increasing climate change resilience, it is important to identify those areas within the Wet Tropics that are the highest priority for protecting the biodiversity of the region, both now and into the future.

To do this researchers produced spatial prioritisation maps based on species richness that are weighted by the conservation significance of each species. [135, 136] This indicates which areas in the landscape are the most likely to be the most important in the future and finally, consider the required connectivity across the landscape that will enable species to move to where they need to be in the future.

High priority areas are often the same for current and future and therefore represent “no regret” targets for high priority management and long-term protection and monitoring (Figure 14). The most important areas that fulfill all of these conservation goals (current, future, connectivity, species biology) are shown. There is some good news in that many of these areas are already in the protected area estate, and the fact that the most important areas are the same for current and future analyses represents a solid “no regrets” strategy of priority areas.

Figure 14. Highest priority areas of the region.

Based on spatial patterns of species richness with each species weighted for conservation significance and down-weighted for uncertainty based on variation across 17 climate models, for a. current species distributions, b. future species distribution and c. combination of current, future and connectivity across time



Making connections

Important movement pathways are needed between the central Atherton uplands for species to move east into the higher elevation mountains of the Bartle Frere uplands and west into the Herberton uplands. Unfortunately, the existing large blocks of rainforest on the escarpment of Wooroonooran National Park are below the elevational limits for many species in the future and will not be as useful as might be intuitively assumed.

Though many of the most important areas both now and in the future are the same and are already well protected, modelling has identified some highly important areas outside of the protected area estate. Therefore, there are many important areas for management consideration to help minimise future biodiversity impacts and damage to the region's Outstanding Universal Value, including:

- some important future connectivity areas are not inside current protected areas
- the connectivity required to facilitate future movement between these areas is broken by the highly modified and fragmented forest on the Atherton Tableland and resilience would benefit from habitat restoration and revegetation in these areas
- significant intact forest currently connects some of these areas, however, it is at lower elevation that will become increasingly unsuitable for many of the species of concern
- strategies are needed to include conservation actions outside current protected areas and take advantage of landscape design features such as stepping stones and corridor revegetation.



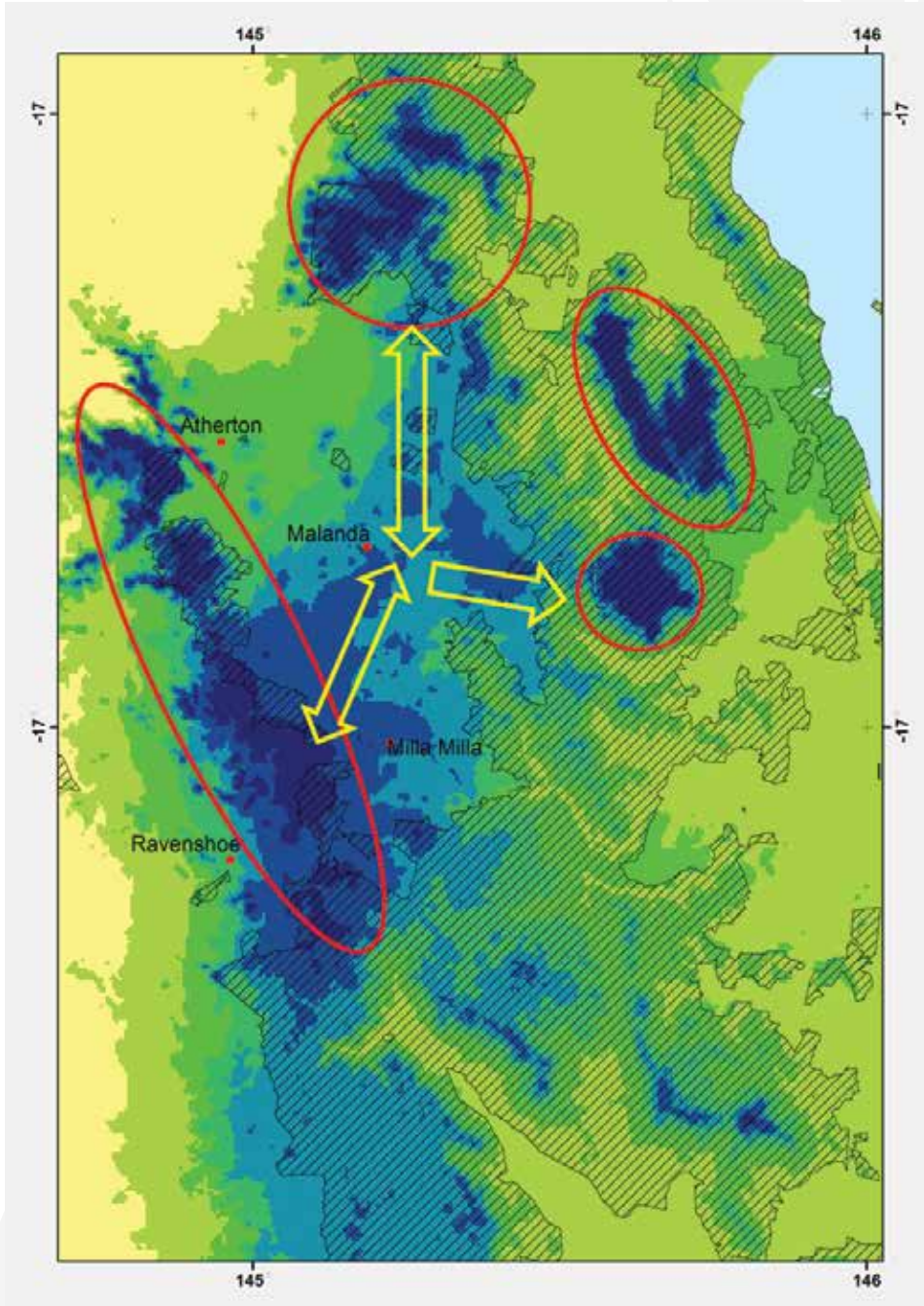
BLOSSOM BAT
WET TROPICS IMAGES/MIKE TRENNERY

The analysis also highlights some important areas for connecting current and future biodiversity hotspots. Some of the large intact areas of rainforest identified as future preferred habitats for many species and the best connections to climate change refugia, are in areas that are currently disconnected from the protected area estate or are fragmented. Significant areas for important corridors for connectivity are outside the current protected areas and offers the potential to design multi-stakeholder conservation plans to help increase future connectivity (Figure 15).



Figure 15. Close-up of the conservation prioritisation for the central Wet Tropics.

Critical biodiversity refugia for protection are circled in red. Examples of important corridors for connectivity are highlighted in yellow. This analysis considers the location of current biodiversity, future biodiversity, the dispersal capability of each species, and the uncertainty of future climate projections based on multiple climate models.

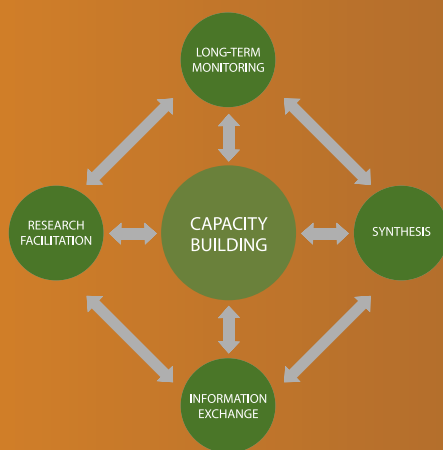


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From biodiversity science to new national parks for climate change

There is widespread recognition and concern that climate change will have a devastating impact on global biodiversity. The question is what can we do about it? It comes down to two things including mitigation and adaptation.


Effective adaptation and mitigation both rely on the capacity of people to make wise decisions on environmental policy and management, informed by the best available knowledge. Acquiring this knowledge requires environmental monitoring, strategic research, synthesis of data into useable information and effective communication.



There has been a long history of environmental research and management in the rainforests of the Australian Wet Tropics. Science is additive and so the execution of one project is directly linked to the outputs from those projects that preceded it. Biodiversity research under the Rainforest-CRC informed climate change impacts research in the MTSRF program that improved our understanding of which parts of the landscape might protect

the most species.^[127] Specifically, this research identified areas with significant biodiversity that coincide with areas that will remain cooler than average under climate change due to buffering of temperature by cloud, forest canopy and the natural topography of the landscape.

This information directly informed conservation plans and priorities and contributed to a new national park in the Wet Tropics being gazetted.



Land managers, in collaboration with the scientists, landholders, community groups and the Australian Government Caring for our Country program used this knowledge to identify which parts of the landscape should have the highest priority for revegetation— that would increase both current and future resilience.

The award winning community backed revegetation “Making Connections” project resulted from this collaboration and application of knowledge. The project participants have been actively revegetating and connecting rainforest patches in an area that will provide the most effective increase in resilience for the region’s biodiversity.

Subsequently, the above biodiversity research was adopted nationally, facilitated by the National Climate Change Adaptation Research Facility (NCCARF), to produce an Australia-wide analysis of future biodiversity refugia.^[138] The Queensland Government then used this knowledge to make informed decisions about how to increase the Queensland protected area estate in a way that would enhance the resilience of Queensland’s biodiversity into the future.

This was achieved by identifying the most climate-resilient places across Queensland that would help protect the most species—a combination of using species distribution mapping, climate change projections, existing vegetation maps and the existing protected areas network. The outcomes of this work resulted in the selection and subsequent purchase of seven new national parks across Queensland that are specifically chosen to maximise the resilience of Queensland’s biodiversity under a changing climate.^[139] These examples clearly emphasise how networks of people and strategic research, in partnership with stakeholder groups, can have a real and positive influence on producing on-the-ground adaptation actions that will reduce the impacts of climate change on biodiversity.



SATIN BOWERBIRD
WET TROPICS IMAGES/STEVEN NOWAKOWSKI

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BOYD'S FOREST DRAGON
WET TROPICS IMAGES/MARTIN COHEN

Appendix 1

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
MAMMALS								
Ornithorhynchidae	<i>Ornithorhynchus anatinus</i>	platypus			1	20 - 1072	18.3 - 24.4	1265 - 3307
Tachyglossidae	<i>Tachyglossus aculeatus</i>	short-beaked echidna						
Dasyuridae	<i>Antechinus adustus</i>	rusty antechinus	2		1	557 - 1034	18.7 - 21	1554 - 2627
Dasyuridae	<i>Phascogale tapoatafa</i>	brush-tailed phascogale			1			
Dasyuridae	<i>Antechinus flavipes</i>	yellow-footed antechinus	3		1	40 - 1229	17.7 - 24.2	1246 - 3482
Dasyuridae	<i>Planigale ingrami</i>	long-tailed planigale						
Dasyuridae	<i>Planigale maculata</i>	common planigale						
Dasyuridae	<i>Sminthopsis leucopus</i>	white-footed dunnart	3	VU	1	780 - 939	19 - 19.8	1854 - 2164
Dasyuridae	<i>Sminthopsis macroura</i>	stripe-faced dunnart						
Dasyuridae	<i>Dasyurus maculatus</i>	spotted-tailed quoll	3	EN	1	20 - 1494	16 - 24.5	1642 - 6995
Dasyuridae	<i>Dasyurus hallucatus</i>	northern quoll		EN	1			
Dasyuridae	<i>Sminthopsis murina</i>	common dunnart						
Dasyuridae	<i>Sminthopsis virginiae</i>	red-cheeked dunnart						
Dasyuridae	<i>Antechinus godmani</i>	Atherton antechinus	2	NT	1	644 - 1540	15.7 - 20.4	1707 - 7413
Peramelidae	<i>Isoodon peninsulae</i>	Cape York brown bandicoot						
Peramelidae	<i>Isoodon macrourus</i>	northern brown bandicoot						
Peramelidae	<i>Perameles pallescens</i>	northern long-nosed bandicoot				0 - 1294	17.4 - 24.5	1127 - 4677
Phascolarctidae	<i>Phascolarctos cinereus</i>	koala		VU	1			
Petauridae	<i>Petaurus australis</i>	yellow-bellied glider		VU	1			
Petauridae	<i>Petaurus norfolcensis</i>	squirrel glider						
Petauridae	<i>Petaurus gracilis</i>	mahogany glider	1	EN	1			
Petauridae	<i>Petaurus brviceps</i>	sugar glider						
Petauridae	<i>Dactylopsila trivirgata</i>	striped possum				3 - 1181	18 - 24.5	928 - 4051
Pseudocheiridae	<i>Pseudocheirops archeri</i>	green ring-tailed possum	2		1	103 - 1220	17.7 - 24	1257 - 3266
Pseudocheiridae	<i>Pseudocheirus peregrinus</i>	eastern ringtail possum						
Pseudocheiridae	<i>Pseudochirulus herbertensis</i>	Herbert River ring-tailed possum	2		1	436 - 1443	16.2 - 21.5	1246 - 6556
Pseudocheiridae	<i>Pseudochirulus cinereus</i>	Daintree River ring-tailed possum	2		1	419 - 1260	17.5 - 22.1	1274 - 2759
Pseudocheiridae	<i>Hemibelideus lemuroides</i>	lemuroid ring-tailed possum	2	NT	1	520 - 1222	17.6 - 21.1	1438 - 3252
Pseudocheiridae	<i>Petauroides minor</i>	northern greater glider		VU	1			
Phalangeridae	<i>Trichosurus vulpecula</i>	common brush-tailed possum						
Phalangeridae	<i>Trichosurus vulpecula j.</i>	coppery brush-tailed possum	3		1	620 - 1044	18.4 - 20.9	1478 - 2966
Burramyidae	<i>Cercartetus caudatus</i>	long-tailed pygmy possum			1	10 - 1100	18.3 - 24.6	1718 - 4133
Acrobatidae	<i>Acrobates frontalis</i>	broad-toed feather-tailed glider		1				
Potoroidae	<i>Bettongia tropica</i>	northern bettong	2	EN	1			
Potoroidae	<i>Aepyprymnus rufescens</i>	rufous bettong						
Hypsiprymmodontidae	<i>Hypsiprymmodon moschatius</i>	musky rat-kangaroo	2		1	20 - 1283	17.4 - 24.5	1221 - 4032
Macropodidae	<i>Petrogale godmani</i>	Godman's rock-wallaby	1		1			
Macropodidae	<i>Notamacropus parryi</i>	whiptail wallaby						
Macropodidae	<i>Osphranter antilopinus</i>	antilopine kangaroo						
Macropodidae	<i>Thylogale stigmatica</i>	red-legged pademelon				3 - 1274	17.5 - 24.4	1151 - 4677
Macropodidae	<i>Lagorchestes conspicillatus</i>	spectacled hare-wallaby						
Macropodidae	<i>Wallabia bicolor</i>	swamp wallaby	3		1			
Macropodidae	<i>Dendrolagus lumholtzi</i>	Lumholtz's tree-kangaroo	2		1	19 - 1437	16.2 - 24.4	1265 - 6505
Macropodidae	<i>Macropus giganteus</i>	eastern grey kangaroo						
Macropodidae	<i>Petrogale mareeba</i>	Mareeba rock-wallaby	1		1			
Macropodidae	<i>Petrogale assimilis</i>	allied rock-wallaby						
Macropodidae	<i>Notamacropus agilis</i>	agile wallaby						
Macropodidae	<i>Osphranter robustus</i>	common wallaroo						
Macropodidae	<i>Petrogale sharmani</i>	Sharman's rock-wallaby	2	VU	1			
Macropodidae	<i>Dendrolagus bennettianus</i>	Bennett's tree-kangaroo	2	NT	1	20 - 1260	17.5 - 24.5	1982 - 3576
Pteropodidae	<i>Pteropus scapulatus</i>	little red flying-fox						
Pteropodidae	<i>Macroglossus minimus</i>	northern blossom-bat						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Pteropodidae	<i>Pteropus conspicillatus</i>	spectacled flying-fox		VU	1	3 - 1165	18 - 24.7	947 - 3892
Pteropodidae	<i>Pteropus alecto</i>	black flying-fox				0 - 388	21.8 - 24	817 - 3004
Pteropodidae	<i>Syconycteris australis</i>	eastern blossom-bat						
Pteropodidae	<i>Nyctimene robinsoni</i>	eastern tube-nosed bat				20 - 1081	18.3 - 24.5	1137 - 4157
Megadermatidae	<i>Macroderma gigas</i>	ghost bat		VU	1			
Emballonuridae	<i>Saccolaimus flaviventris</i>	yellow-bellied sheath-tailed bat						
Emballonuridae	<i>Saccolaimus saccolaimus</i>	bare-rumped sheath-tailed bat		CR	1			
Emballonuridae	<i>Taphozous australis</i>	coastal sheath-tailed bat		NT	1			
Emballonuridae	<i>Taphozous georgianus</i>	common sheath-tailed bat						
Molossidae	<i>Austronomus australis</i>	white-striped free-tailed bat						
Molossidae	<i>Chaerephon jobensis</i>	northern free-tailed bat						
Molossidae	<i>Mormopterus ridei</i>	eastern free-tailed bat						
Molossidae	<i>Mormopterus halli</i>	Cape York free-tailed bat						
Molossidae	<i>Mormopterus lumsdenae</i>	greater northern free-tailed bat						
Rhinolophidae	<i>Rhinolophus robertsi</i>	large-eared horseshoe bat						
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	eastern horseshoe-bat				4 - 1140	18.1 - 24.4	1065 - 3987
Hipposideridae	<i>Hipposideros semoni</i>	Semon's leaf-nosed bat		EN	1			
Hipposideridae	<i>Hipposideros diadema ariemos</i>	diadem leaf-nosed bat		NT	1			
Hipposideridae	<i>Hipposideros ater</i>	dusky leaf-nosed bat						
Hipposideridae	<i>Hipposideros cervinus</i>	fawn leaf-nosed bat		VU	1			
Miniopteridae	<i>Miniopterus schreibersii oceanensis</i>	eastern bent-winged bat						
Miniopteridae	<i>Miniopterus orianae</i>	large bent-winged bat		NT	1			
Vespertilionidae	<i>Vespertilio pumilus</i>	eastern forest-bat						
Vespertilionidae	<i>Murina florium</i>	tube-nosed insectivorous bat		VU	1	240 - 1140	18.1 - 22.8	1786 - 2389
Vespertilionidae	<i>Scotorepens balstoni</i>	inland broad-nosed bat						
Vespertilionidae	<i>Chalinolobus morio</i>	chocolate wattled bat						
Vespertilionidae	<i>Myotis macropus</i>	large-footed myotis				179 - 657	20.6 - 22.9	1261 - 3307
Vespertilionidae	<i>Nyctophilus bifax</i>	eastern long-eared bat						
Vespertilionidae	<i>Scotorepens greyii</i>	little broad-nosed bat						
Vespertilionidae	<i>Vespertilio troughtoni</i>	eastern cave bat						
Vespertilionidae	<i>Scoteanax rueppellii</i>	greater broad-nosed bat			1			
Vespertilionidae	<i>Nyctophilus geoffroyi</i>	lesser long-eared bat						
Vespertilionidae	<i>Nyctophilus gouldi</i>	Gould's long-eared bat						
Vespertilionidae	<i>Kerivoula papuensis</i>	golden-tipped bat			1			
Vespertilionidae	<i>Scotorepens sanborni</i>	northern broad-nosed bat						
Vespertilionidae	<i>Chalinolobus nigrogriseus</i>	hoary wattled bat						
Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled bat						
Muridae	<i>Rattus fuscipes</i>	bush rat				5 - 1443	16.2 - 23.9	1257 - 6556
Muridae	<i>Rattus lutreolus</i>	swamp rat	3		1			
Muridae	<i>Mus musculus</i>	house mouse						
Muridae	<i>Mesembriomys gouldii</i>	black-footed tree-rat		VU	1			
Muridae	<i>Pogonomys mollipilosus</i>	tree mouse			1	340 - 1073	18.5 - 22.6	1347 - 3246
Muridae	<i>Uromys caudimaculatus</i>	giant white-tailed rat				4 - 1186	17.9 - 24.8	1242 - 3934
Muridae	<i>Rattus norvegicus</i>	brown rat						
Muridae	<i>Rattus rattus</i>	black rat						
Muridae	<i>Leggadina lakedownensis</i>	Lakeland Downs mouse						
Muridae	<i>Rattus leucopus</i>	Cape York rat	3		1	0 - 1443	16.2 - 24.6	1725 - 6556
Muridae	<i>Pseudomys patrius</i>	eastern pebble-mound mouse						
Muridae	<i>Melomys burtoni</i>	grassland melomys						
Muridae	<i>Zyromys argurus</i>	common rock-rat						
Muridae	<i>Xeromys myoides</i>	water mouse		VU	1			
Muridae	<i>Hydromys chrysogaster</i>	water rat						
Muridae	<i>Uromys hadrourus</i>	masked white-tailed rat	2	VU	1	361 - 1154	18 - 22.2	1652 - 3187
Muridae	<i>Pseudomys gracilicaudatus</i>	eastern chestnut mouse						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Muridae	<i>Pseudomys delicatulus</i>	delicate mouse						
Muridae	<i>Melomys cervinipes</i>	fawn-footed melomys				0 - 1443	16.2 - 24.8	1023 - 6556
Muridae	<i>Rattus tunneyi</i>	pale field rat						
Muridae	<i>Rattus sordidus</i>	canefield rat						
Leporidae	<i>Lepus europaeus</i>	European brown hare						
Leporidae	<i>Oryctolagus cuniculus</i>	rabbit						
Canidae	<i>Canis familiaris</i>	dingo				2 - 1437	16.2 - 24.5	828 - 6505
Canidae	<i>Vulpes vulpes</i>	red fox						
Felidae	<i>Felis catus</i>	domestic cat						
Equidae	<i>Equus caballus</i>	horse						
Suidae	<i>Sus scrofa</i>	pig						
BIRDS								
Casuariidae	<i>Casuarius casuarius</i>	southern cassowary	3	EN	1	0 - 1215	17.7 - 24.9	1227 - 4106
Casuariidae	<i>Dromaius novaehollandiae</i>	emu						
Megapodiidae	<i>Alectura lathami</i>	Australian brush turkey			1	1 - 1449	16.2 - 24.5	877 - 6602
Megapodiidae	<i>Megapodius reinwardt</i>	orange-footed scrubfowl				0 - 1362	16.8 - 24.7	1202 - 4901
Phasianidae	<i>Coturnix pectoralis</i>	stubble quail						
Phasianidae	<i>Excalfactoria chinensis</i>	king quail						
Phasianidae	<i>Coturnix ypsilophora</i>	brown quail						
Anatidae	<i>Chenonetta jubata</i>	Australian wood duck						
Anatidae	<i>Anas rhynchotis</i>	Australasian shoveler						
Anatidae	<i>Malacorhynchus membranaceus</i>	pink-eared duck						
Anatidae	<i>Cygnus atratus</i>	black wwan						
Anatidae	<i>Nettapus coromandelianus</i>	cotton pygmy-goose						
Anatidae	<i>Dendrocygna arcuata</i>	wandering whistling-duck						
Anatidae	<i>Aythya australis</i>	hardhead						
Anatidae	<i>Anas castanea</i>	chestnut teal						
Anatidae	<i>Nettapus pulchellus</i>	green pygmy-goose						
Anatidae	<i>Anas superciliosa</i>	pacific black duck						
Anatidae	<i>Dendrocygna eytoni</i>	plumed whistling-duck						
Anatidae	<i>Tadorna radjah</i>	radjah shelduck						
Anatidae	<i>Anas gracilis</i>	grey teal						
Anseranatidae	<i>Anseranas semipalmata</i>	magpie goose						
Podicipedidae	<i>Podiceps cristatus</i>	great-crested grebe						
Podicipedidae	<i>Poliocephalus poliocephalus</i>	hoary-headed grebe						
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australian grebe						
Anhingidae	<i>Anhinga novaehollandiae</i>	Australasian darter						
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	little pied cormorant						
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	great cormorant						
Phalacrocoracidae	<i>Phalacrocorax varius</i>	pied cormorant						
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	little black cormorant						
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian pelican						
Ardeidae	<i>Ardea pacifica</i>	white-necked heron						
Ardeidae	<i>Ardea intermedia</i>	intermediate egret						
Ardeidae	<i>Butorides striatus</i>	striated heron						
Ardeidae	<i>Egretta novaehollandiae</i>	white-faced heron						
Ardeidae	<i>Egretta sacra</i>	eastern reef egret						
Ardeidae	<i>Ardea sumatrana</i>	great-billed heron						
Ardeidae	<i>Ardea alba modesta</i>	eastern great egret						
Ardeidae	<i>Egretta garzetta</i>	little egret						
Ardeidae	<i>Bubulcus ibis</i>	cattle egret						
Ardeidae	<i>Ixobrychus flavicollis</i>	black bittern						
Ardeidae	<i>Ixobrychus dubius</i>	Australian little bittern						

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Ardeidae	<i>Nycticorax caledonicus</i>	nankeen night-heron						
Ardeidae	<i>Egretta picata</i>	pieb heron						
Threskiornithidae	<i>Threskiornis molucca</i>	Australian white ibis						
Threskiornithidae	<i>Threskiornis spinicollis</i>	straw-necked ibis						
Threskiornithidae	<i>Plegadis falcinellus</i>	glossy ibis						
Threskiornithidae	<i>Platalea flavipes</i>	yellow-billed spoonbill						
Threskiornithidae	<i>Platalea regia</i>	royal spoonbill						
Ciconiidae	<i>Ephippiorhynchus asiaticus</i>	black-necked stork		NT	1			
Accipitridae	<i>Hieraaetus morphnoides</i>	little eagle						
Accipitridae	<i>Erythrotriorchis radiatus</i>	red goshawk		EN	1			
Accipitridae	<i>Hamirostra melanosternon</i>	black-breasted buzzard						
Accipitridae	<i>Circus approximans</i>	swamp harrier						
Accipitridae	<i>Aviceda subcristata</i>	pacific baza						
Accipitridae	<i>Accipiter novaehollandiae</i>	grey goshawk			1	0 - 1437	16.2 - 24.4	1124 - 6505
Accipitridae	<i>Circus assimilis</i>	spotted harrier						
Accipitridae	<i>Accipiter cirrocephalus</i>	collared sparrowhawk						
Accipitridae	<i>Lophoictinia isura</i>	square-tailed kite			1			
Accipitridae	<i>Haliastur sphenurus</i>	whistling kite						
Accipitridae	<i>Accipiter fasciatus</i>	brown goshawk						
Accipitridae	<i>Elanus axillaris</i>	black-shouldered kite						
Accipitridae	<i>Haliaeetus leucogaster</i>	white-bellied sea-eagle						
Accipitridae	<i>Milvus migrans</i>	black kite						
Accipitridae	<i>Aquila audax</i>	wedge-tailed eagle						
Accipitridae	<i>Haliastur indus</i>	brahminy kite						
Pandionidae	<i>Pandion cristatus</i>	eastern osprey						
Falconidae	<i>Falco subniger</i>	black falcon						
Falconidae	<i>Falco longipennis</i>	Australian hobby						
Falconidae	<i>Falco cenchroides</i>	nankeen kestrel						
Falconidae	<i>Falco hypoleucos</i>	grey falcon		VU	1			
Falconidae	<i>Falco peregrinus</i>	peregrine falcon						
Falconidae	<i>Falco berigora</i>	brown falcon						
Gruidae	<i>Grus rubicundus</i>	brilga						
Gruidae	<i>Grus antigone</i>	sarus crane		VU	1			
Rallidae	<i>Fulica atra</i>	Eurasian coot						
Rallidae	<i>Amaurornis cinerea</i>	white-browed crane						
Rallidae	<i>Lewinia pectoralis</i>	Lewin's rail						
Rallidae	<i>Porzana tabuensis</i>	spotless crane						
Rallidae	<i>Gallinula tenebrosa</i>	dusky moorhen						
Rallidae	<i>Porzana fluminea</i>	Australian spotted crane						
Rallidae	<i>Gallirallus philippensis</i>	buff-banded rail						
Rallidae	<i>Tribonyx ventralis</i>	black-tailed native-hen						
Rallidae	<i>Amaurornis moluccana</i>	pale-vented bush-hen						
Rallidae	<i>Porphyrio porphyrio</i>	purple swamphen						
Rallidae	<i>Rallina tricolor</i>	red-necked crane			1	13 - 943	19.2 - 24.5	1297 - 4032
Rallidae	<i>Porzana pusilla</i>	Ballon's crane						
Otididae	<i>Ardeotis australis</i>	Australian bustard						
Turnicidae	<i>Turnix olivii</i>	buff-breasted button-quail		EN	1			
Turnicidae	<i>Turnix velox</i>	little button-quail						
Turnicidae	<i>Turnix pyrrhorthorax</i>	red-chested button-quail						
Turnicidae	<i>Turnix varius</i>	painted button-quail						
Turnicidae	<i>Turnix maculosus</i>	red-backed button-quail						
Scolopacidae	<i>Tringa nebularia</i>	common greenshank						
Scolopacidae	<i>Calidris acuminata</i>	sharp-tailed sandpiper						
Jacaniidae	<i>Irediparra gallinacea</i>	comb-crested jacana						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Burhinidae	<i>Burhinus grallarius</i>	bush stone-curlew						
Burhinidae	<i>Esacus magnirostris</i>	beach stone-curlew		VU	1			
Haematopodidae	<i>Haematopus fuliginosus</i>	sooty oystercatcher						
Recurvirostridae	<i>Himantopus leucocephalus</i>	black-winged stilt						
Charadriidae	<i>Vanellus miles</i>	masked lapwing						
Charadriidae	<i>Vanellus tricolor</i>	banded lapwing						
Charadriidae	<i>Erythronyx cinctus</i>	red-kneed dotterel						
Charadriidae	<i>Charadrius ruficapillus</i>	red-capped plover						
Charadriidae	<i>Charadrius veredus</i>	oriental plover						
Charadriidae	<i>Euseyornis melanops</i>	black-fronted dotterel						
Glareolidae	<i>Stiltia isabella</i>	Australian pratincole						
Laridae	<i>Hydroprogne caspia</i>	caspian tern						
Laridae	<i>Chlidonias hybrida</i>	whiskered tern						
Columbidae	<i>Geophaps scripta</i>	squatter pigeon						
Columbidae	<i>Phaps chalcoptera</i>	common bronzewing						
Columbidae	<i>Geopelia placida</i>	peaceful dove						
Columbidae	<i>Chalcophaps indica</i>	grey-capped emerald dove			1	2 - 1294	17.4 - 24.6	1059 - 4157
Columbidae	<i>Phaps histrionica</i>	flock bronzewing						
Columbidae	<i>Ducula bicolor</i>	pied imperial-pigeon				0 - 1110	18.1 - 24.6	1005 - 4149
Columbidae	<i>Ptilinopus magnificus</i>	wet tropics wompoo fruit-dove	3		1	9 - 1246	17.6 - 24.6	1137 - 4141
Columbidae	<i>Lopholaimus antarcticus</i>	topknot pigeon			1	3 - 1540	15.7 - 24.6	1170 - 7408
Columbidae	<i>Columba leucomela</i>	white-headed pigeon				18 - 1350	16.7 - 24.5	1241 - 5825
Columbidae	<i>Streptopelia chinensis</i>	spotted turtle-dove						
Columbidae	<i>Ocyphaps lophotes</i>	crested pigeon						
Columbidae	<i>Ptilinopus superbus</i>	superb fruit-dove				8 - 1540	15.7 - 24.5	1131 - 7413
Columbidae	<i>Ptilinopus regina</i>	rose-crowned fruit-dove				0 - 1090	18.2 - 24.7	1028 - 3675
Columbidae	<i>Geopelia humeralis</i>	bar-shouldered dove						
Columbidae	<i>Geopelia cuneata</i>	diamond dove						
Columbidae	<i>Macropygia amboinensis</i>	brown cuckoo-dove				9 - 1372	16.6 - 24.5	1052 - 5493
Cacatuidae	<i>Cacatua sanguinea</i>	little corella						
Cacatuidae	<i>Nymphicus hollandicus</i>	cockatiel						
Cacatuidae	<i>Eolophus roseicapillus</i>	galah						
Cacatuidae	<i>Calyptorhynchus banksii</i>	red-tailed black cockatoo						
Cacatuidae	<i>Cacatua galerita</i>	sulphur-crested cockatoo				0 - 1437	16.2 - 24.8	814 - 6505
Cacatuidae	<i>Calyptorhynchus lathami</i>	glossy black cockatoo			1			
Psittaculidae	<i>Cyclopsitta diophthalma</i>	Coxen's fig-parrot	3	VU	1	0 - 1210	17.7 - 24.6	1230 - 4157
Psittaculidae	<i>Trichoglossus chlorolepidotus</i>	scaly-breasted lorikeet				0 - 1300	17.3 - 24.6	893 - 4047
Psittaculidae	<i>Parvipsitta pusilla</i>	little lorikeet						
Psittaculidae	<i>Aprosmictus erythropterus</i>	red-winged parrot						
Psittaculidae	<i>Trichoglossus haematodus</i>	rainbow lorikeet				0 - 1294	17.2 - 24.9	812 - 5252
Psittaculidae	<i>Melopsittacus undulatus</i>	budgerigar						
Psittaculidae	<i>Platycercus elegans</i>	crimson rosella				360 - 1437	16.2 - 22.5	1321 - 6505
Psittaculidae	<i>Alisterus scapularis</i>	Australian king-parrot	3		1	20 - 1540	15.7 - 23.9	1202 - 7408
Psittaculidae	<i>Platycercus adscitus</i>	pale-headed rosella						
Cuculidae	<i>Cacomantis castaneiventris</i>	chestnut-breasted cuckoo				20 - 612	20.7 - 24.3	2036 - 2397
Cuculidae	<i>Eudynamys orientalis</i>	eastern koel			1	0 - 1110	18.1 - 24.6	938 - 3915
Cuculidae	<i>Chalcites minutillus</i>	Gould's bronze-cuckoo			1	0 - 979	18.9 - 24.7	1061 - 4149
Cuculidae	<i>Chalcites minutillus</i>	little bronze-cuckoo			1	0 - 1260	17.5 - 24.8	1039 - 3915
Cuculidae	<i>Scythrops novaehollandiae</i>	channel-billed cuckoo			1	0 - 1110	18.1 - 24.6	812 - 4074
Cuculidae	<i>Chalcites osculans</i>	black-eared cuckoo						
Cuculidae	<i>Cuculus optatus</i>	oriental cuckoo				7 - 902	19.3 - 24.5	989 - 3091
Cuculidae	<i>Chalcites basalis</i>	Horsfield's bronze-cuckoo						
Cuculidae	<i>Cacomantis pallidus</i>	pallid cuckoo						
Cuculidae	<i>Chalcites lucidus</i>	shining bronze-cuckoo (golden)				12 - 1215	17.7 - 24	928 - 4157

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Cuculidae	<i>Cacomantis variolosus</i>	brush cuckoo			1	1 - 1181	18 - 24.6	886 - 3915
Cuculidae	<i>Cacomantis flabelliformis</i>	fan-tailed cuckoo				0 - 1507	15.9 - 24.3	828 - 7109
Cuculidae	<i>Centropus phasianinus</i>	pheasant coucal						
Strigidae	<i>Ninox boobook</i>	wet tropics boobook	3		1	4 - 1443	16.2 - 23.9	828 - 6556
Strigidae	<i>Ninox rufa</i>	rufous owl			1	5 - 1140	18.2 - 24.4	1057 - 2784
Strigidae	<i>Ninox connivens</i>	barking owl						
Tytonidae	<i>Tyto delicatula</i>	eastern barn owl						
Tytonidae	<i>Tyto multipunctata</i>	lesser sooty owl	2		1	23 - 1215	17.7 - 24.3	1202 - 4677
Tytonidae	<i>Tyto longimembris</i>	eastern grass owl						
Tytonidae	<i>Tyto novaehollandiae</i>	masked owl						
Podargidae	<i>Podargus strigoides</i>	tawny frogmouth			1			
Podargidae	<i>Podargus papuensis</i>	Papuan frogmouth			1	4 - 1198	17.8 - 24.6	1356 - 3908
Caprimulgidae	<i>Eurostopodus argus</i>	spotted nightjar						
Caprimulgidae	<i>Eurostopodus mystacalis</i>	white-throated nightjar						
Caprimulgidae	<i>Caprimulgus macrurus</i>	large-tailed nightjar						
Aegothelidae	<i>Aegotheles cristatus</i>	Australian owlet-nightjar						
Apodidae	<i>Aerodramus vanikorensis</i>	uniform swiftlet						
Apodidae	<i>Apus pacificus</i>	fork-tailed swift						
Apodidae	<i>Hirundapus caudacutus</i>	white-throated needletail			1	3 - 1414	16.4 - 24.4	950 - 5805
Apodidae	<i>Collocalia esculenta</i>	glossy swiftlet						
Apodidae	<i>Aerodramus terraereginae</i>	Australian swiftlet				0 - 1317	17.1 - 24.7	924 - 4157
Apodidae	<i>Apus affinis</i>	house swift						
Alcedinidae	<i>Todiramphus sordidus</i>	Torresian kingfisher						
Alcedinidae	<i>Todiramphus sanctus</i>	sacred kingfisher						
Alcedinidae	<i>Todiramphus pyrrhopygius</i>	red-backed kingfisher						
Alcedinidae	<i>Ceyx azureus</i>	azure kingfisher			1	2 - 1080	18.2 - 24.7	817 - 4157
Alcedinidae	<i>Dacelo leachii</i>	blue-winged kookaburra						
Alcedinidae	<i>Dacelo novaeguineae</i>	laughing kookaburra						
Alcedinidae	<i>Ceyx pusilla</i>	little kingfisher			1	1 - 880	19.4 - 24.7	817 - 3727
Alcedinidae	<i>Todiramphus macleayii</i>	forest kingfisher						
Alcedinidae	<i>Tanyiptera sylvia</i>	buff-breasted paradise-kingfisher			1	0 - 934	19 - 24.7	1087 - 3915
Meropidae	<i>Merops ornatus</i>	rainbow bee-eater				0 - 1280	17.4 - 24.8	814 - 4157
Coraciidae	<i>Eurystomus orientalis</i>	dollarbird						
Pittidae	<i>Pitta versicolor</i>	noisy pitta				2 - 1160	18 - 24.6	1044 - 3915
Climacteridae	<i>Climacteris picumnus</i>	Cape York brown treecreeper						
Climacteridae	<i>Cormobates leucophaea</i>	white-throated treecreeper			1	20 - 1537	15.7 - 24.3	1202 - 7392
Climacteridae	<i>Climacteris picumnus</i>	north-eastern brown treecreeper						
Maluridae	<i>Malurus melanocephalus</i>	red-backed fairy-wren						
Maluridae	<i>Malurus amabilis</i>	lovely fairy-wren						
Pardalotidae	<i>Pardalotus striatus</i>	striated pardalote						
Pardalotidae	<i>Pardalotus punctatus</i>	spotted pardalote						
Pardalotidae	<i>Pardalotus rubricatus</i>	red-browed pardalote						
Acanthizidae	<i>Gerygone palpebrosa</i>	Cape York fairy gerygone				0 - 950	19 - 24.8	812 - 3915
Acanthizidae	<i>Gerygone magnirostris</i>	large-billed gerygone				1 - 840	19.4 - 24.6	1031 - 4149
Acanthizidae	<i>Gerygone palpebrosa</i>	southern fairy gerygone						
Acanthizidae	<i>Acanthiza nana</i>	yellow thornbill						
Acanthizidae	<i>Oreoscopus gutturalis</i>	fernwren	2		1	115 - 1540	15.7 - 23.9	1288 - 7408
Acanthizidae	<i>Gerygone olivacea</i>	white-throated gerygone						
Acanthizidae	<i>Sericornis magnirostra</i>	large-billed scrubwren	3		1	2 - 1540	15.7 - 24.6	1170 - 7413
Acanthizidae	<i>Sericornis kerri</i>	Atherton scrubwren	2		1	133 - 1480	16 - 23.8	1282 - 6879
Acanthizidae	<i>Sericornis citreogularis</i>	yellow-throated scrubwren	3		1	115 - 1537	15.7 - 23.9	1170 - 7392
Acanthizidae	<i>Acanthiza reguloides</i>	buff-rumped thornbill						
Acanthizidae	<i>Gerygone mouki</i>	brown gerygone	3		1	18 - 1239	17.6 - 24.4	814 - 4157
Acanthizidae	<i>Acanthiza katherina</i>	mountain thornbill	2		1	560 - 1540	15.7 - 20.9	1309 - 7413

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Acanthizidae	<i>Smicronis brevirostris</i>	weebill						
Acanthizidae	<i>Gerygone levigaster</i>	mangrove gerygone						
Acanthizidae	<i>Sericornis frontalis</i>	white-browed scrubwren				60 - 1168	17.6 - 23.6	1170 - 2635
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	eastern spinebill			1	200 - 1540	15.7 - 23	1237 - 7408
Meliphagidae	<i>Myzomela obscura</i>	dusky honeyeater				0 - 1110	18.1 - 24.8	812 - 4149
Meliphagidae	<i>Philemon buceroides</i>	helmeted friarbird				0 - 1054	18.5 - 24.8	893 - 4149
Meliphagidae	<i>Manorina flavigula</i>	yellow-throated miner						
Meliphagidae	<i>Meliphaga notata</i>	yellow-spotted honeyeater	3		1	0 - 1147	18 - 24.8	893 - 4157
Meliphagidae	<i>Caligavis chrysops</i>	yellow-faced honeyeater	3		1			
Meliphagidae	<i>Ptilotula flavescens</i>	yellow-tinted honeyeater						
Meliphagidae	<i>Meliphaga gracilis</i>	wet tropics graceful honeyeater	3		1	0 - 950	19 - 24.7	1173 - 4149
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's honeyeater				9 - 1300	17.2 - 24.8	989 - 5252
Meliphagidae	<i>Ptilotula fusca</i>	fuscous honeyeater						
Meliphagidae	<i>Philemon citreogularis</i>	little friarbird						
Meliphagidae	<i>Lichmera indistincta</i>	brown honeyeater						
Meliphagidae	<i>Bolemoreus frenatus</i>	bridled honeyeater	2		1	20 - 1537	15.7 - 24.5	1170 - 7392
Meliphagidae	<i>Ramsayornis fasciatus</i>	bar-breasted honeyeater						
Meliphagidae	<i>Cissomela pectoralis</i>	banded honeyeater						
Meliphagidae	<i>Stomiopera flava</i>	yellow honeyeater						
Meliphagidae	<i>Gavicalis versicolor</i>	varied honeyeater						
Meliphagidae	<i>Trichodere cockerelli</i>	white-streaked honeyeater						
Meliphagidae	<i>Philemon corniculatus</i>	noisy Friarbird						
Meliphagidae	<i>Melithreptus albogularis</i>	white-throated honeyeater						
Meliphagidae	<i>Stomiopera unicolor</i>	white-gaped honeyeater						
Meliphagidae	<i>Conopophila rufogularis</i>	rufous-throated honeyeater						
Meliphagidae	<i>Myzomela sanguinolenta</i>	scarlet honeyeater			1	7 - 1140	18.1 - 24.3	817 - 3395
Meliphagidae	<i>Melithreptus lunatus</i>	white-naped honeyeater						
Meliphagidae	<i>Acanthagenys rufogularis</i>	spiny-cheeked honeyeater						
Meliphagidae	<i>Ramsayornis modestus</i>	brown-backed honeyeater						
Meliphagidae	<i>Phylidonyris niger</i>	white-cheeked honeyeater						
Meliphagidae	<i>Gavicalis fasciogularis</i>	mangrove honeyeater						
Meliphagidae	<i>Xanthotis macleayanus</i>	Macleay's honeyeater	2		1	2 - 1198	17.5 - 24.7	1202 - 4901
Meliphagidae	<i>Plectorhyncha lanceolata</i>	striped honeyeater						
Meliphagidae	<i>Melithreptus gularis</i>	black-chinned honeyeater						
Meliphagidae	<i>Entomyzon cyanotis</i>	blue-faced honeyeater						
Meliphagidae	<i>Manorina melanocephala</i>	noisy miner						
Meliphagidae	<i>Philemon argenticeps</i>	silver-crowned friarbird						
Petroicidae	<i>Tregellasia capito</i>	pale-yellow robin	3		1	9 - 1294	17.4 - 24.4	920 - 4047
Petroicidae	<i>Peneonthe pulverulenta</i>	mangrove robin						
Petroicidae	<i>Eopsaltria australis</i>	north-eastern yellow robin						
Petroicidae	<i>Heteromyias cinereifrons</i>	grey-headed robin	3		1	20 - 1540	15.7 - 24.5	1170 - 7408
Petroicidae	<i>Microeca flavigaster</i>	lemon-bellied flycatcher						
Petroicidae	<i>Microeca fascians</i>	jacky winter						
Petroicidae	<i>Poecilodryas superciliosa</i>	white-browed robin				0 - 691	20.2 - 24	1005 - 1718
Orthonychidae	<i>Orthonyx spaldingii</i>	chowchilla	2		1	20 - 1430	16.3 - 24.5	1227 - 5900
Pomatostomidae	<i>Pomatostomus temporalis</i>	grey-crowned babbler						
Psophodidae	<i>Psophodes olivaceus</i>	wet tropics eastern whipbird	3		1	20 - 1540	15.7 - 24.4	1202 - 7413
Neosittidae	<i>Daphoenositta chrysoptera</i>	varied sittella						
Falcunculidae	<i>Falcunculus frontatus</i>	crested shrike-tit						
Pachycephalidae	<i>Pachycephala rufiventris</i>	rufous whistler						
Pachycephalidae	<i>Colluricincla megarrhyncha</i>	little shrike-thrush			1	0 - 1180	17.9 - 24.6	1005 - 4157
Pachycephalidae	<i>Pachycephala simplex</i>	grey whistler				2 - 1215	17.6 - 24.6	1230 - 4074
Pachycephalidae	<i>Pachycephala pectoralis</i>	golden whistler				2 - 1527	15.8 - 24.5	1170 - 7292
Pachycephalidae	<i>Colluricincla harmonica</i>	grey shrike-thrush						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Pachycephalidae	<i>Colluricincla boweri</i>	Bower's shrike-thrush	2		1	55 - 1480	16 - 24	1237 - 6879
Pachycephalidae	<i>Pachycephala melanura</i>	mangrove golden whistler						
Dicruridae	<i>Dicrurus bracteatus</i>	north-eastern spangled drongo				0 - 1211	17.8 - 24.8	814 - 4157
Monarchidae	<i>Myiagra cyanoleuca</i>	satin flycatcher						
Monarchidae	<i>Grallina cyanoleuca</i>	magpie lark						
Monarchidae	<i>Arses kaupi</i>	pieb monarch	2		1	0 - 1183	17.9 - 25	1202 - 3869
Monarchidae	<i>Myiagra rubecula</i>	leaden flycatcher						
Monarchidae	<i>Myiagra inquieta</i>	restless flycatcher						
Monarchidae	<i>Monarcha frater</i>	black-winged monarch						
Monarchidae	<i>Carternornis leucotis</i>	white-eared monarch			1	0 - 940	19 - 24.5	1226 - 3915
Monarchidae	<i>Myiagra ruficollis</i>	broad-billed flycatcher						
Monarchidae	<i>Symposiarchus trivirgatus</i>	wet tropics spectacled monarch	3		1	0 - 1300	17.3 - 24.8	933 - 4157
Monarchidae	<i>Monarcha melanopsis</i>	black-faced monarch				1 - 1527	15.8 - 24.5	1091 - 7292
Monarchidae	<i>Myiagra alecto</i>	shining flycatcher						
Machaerirhynchidae	<i>Machaerirhynchus flaviventer</i>	yellow-breasted boatbill	3		1	5 - 1280	17.4 - 24.6	1202 - 4020
Rhipiduridae	<i>Rhipidura rufifrons</i>	rufous fantail				0 - 1437	16.2 - 24.5	973 - 6505
Rhipiduridae	<i>Rhipidura albiscapa</i>	grey fantail	3		1	0 - 1346	16.7 - 24.8	715 - 5372
Rhipiduridae	<i>Rhipidura rufiventris</i>	northern fantail						
Rhipiduridae	<i>Rhipidura leucophrys</i>	willie wagtail						
Campephagidae	<i>Coracina papuensis</i>	white-bellied cuckoo-shrike						
Campephagidae	<i>Lalage leucomela</i>	varied triller				0 - 1110	18.1 - 24.8	1005 - 4149
Campephagidae	<i>Coracina lineata</i>	barred cuckoo-shrike				18 - 1260	17.5 - 24.5	1017 - 3915
Campephagidae	<i>Coracina maxima</i>	ground cuckoo-shrike						
Campephagidae	<i>Coracina tenuirostris</i>	cicadabird						
Campephagidae	<i>Lalage tricolor</i>	white-winged triller						
Campephagidae	<i>Coracina novaehollandiae</i>	black-faced cuckoo-shrike						
Oriolidae	<i>Oriolus sagittatus</i>	olive-backed oriole				3 - 960	19 - 24.5	886 - 4020
Oriolidae	<i>Sphecotheres vieillotii</i>	Australasian figbird				0 - 1110	18.1 - 24.8	886 - 4157
Oriolidae	<i>Oriolus flavocinctus</i>	yellow oriole	3		1	0 - 900	19.3 - 25	1147 - 4149
Artamidae	<i>Cracticus quoyi</i>	black butcherbird				0 - 1200	17.8 - 24.7	1090 - 4157
Artamidae	<i>Artamus minor</i>	little woodswallow						
Artamidae	<i>Strepera graculina</i>	wet tropics pied currawong	3		1	4 - 1540	15.7 - 24.5	828 - 7413
Artamidae	<i>Artamus leucorhynchus</i>	white-breasted woodswallow			1	0 - 1211	17.8 - 24.6	763 - 4032
Artamidae	<i>Cracticus tibicen</i>	Australian magpie						
Artamidae	<i>Cracticus torquatus</i>	grey butcherbird						
Artamidae	<i>Cracticus nigrogularis</i>	pieb butcherbird						
Artamidae	<i>Artamus cyanopterus</i>	dusky woodswallow						
Artamidae	<i>Artamus cinereus</i>	black-faced woodswallow						
Artamidae	<i>Artamus personatus</i>	masked woodswallow						
Artamidae	<i>Artamus superciliosus</i>	white-browed woodswallow						
Paradisaeidae	<i>Ptiloris victoriae</i>	Victoria's riflebird	2		1	20 - 1280	17.2 - 24.5	1170 - 4032
Corvidae	<i>Corvus coronoides</i>	Australian raven						
Corvidae	<i>Corvus orru</i>	Torresian crow						
Corcoracidae	<i>Corcorax melanorhamphos</i>	white-winged chough						
Ptilonorhynchidae	<i>Amblyornis newtonianus</i>	golden bowerbird	2		1	464 - 1540	15.7 - 21.4	1253 - 7408
Ptilonorhynchidae	<i>Ailuroedus melanotis</i>	spotted catbird	3		1	10 - 1527	15.8 - 24.5	1186 - 7292
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	wet tropics satin bowerbird	3		1	267 - 1490	16 - 22.7	1356 - 6950
Ptilonorhynchidae	<i>Scenopoetes dentirostris</i>	tooth-billed bowerbird	2		1	70 - 1362	16.6 - 23.7	1170 - 5447
Ptilonorhynchidae	<i>Ptilonorhynchus nuchalis</i>	Horsefield's great bowerbird						
Alaudidae	<i>Mirafra javanica</i>	wet tropics horsefield bushlark	3		1			
Motacillidae	<i>Anthus novaeseelandiae</i>	Australasian pipit						
Passeridae	<i>Passer domesticus</i>	house sparrow						
Nectariniidae	<i>Nectarinia jugularis</i>	olive-backed sunbird						
Dicaeidae	<i>Dicaeum hirundinaceum</i>	mistletoebird				0 - 1527	15.8 - 24.8	899 - 7292

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Hirundinidae	<i>Petrochelidon ariel</i>	fairy martin						
Hirundinidae	<i>Cecropis daurica</i>	red-rumped swallow						
Hirundinidae	<i>Hirundo neoxena</i>	welcome swallow						
Hirundinidae	<i>Petrochelidon nigricans</i>	tree martin						
Hirundinidae	<i>Hirundo rustica</i>	barn swallow						
Acrocephalidae	<i>Acrocephalus australis</i>	Australian reed-warbler						
Acrocephalidae	<i>Acrocephalus orientalis</i>	oriental reed-warbler						
Locustellidae	<i>Megalurus timoriensis</i>	tawny grassbird						
Locustellidae	<i>Cinclorhamphus cruralis</i>	brown songlark						
Locustellidae	<i>Megalurus gramineus</i>	little grassbird						
Locustellidae	<i>Cinclorhamphus mathewsi</i>	rufous songlark						
Cisticolidae	<i>Cisticola exilis</i>	golden-headed cisticola						
Zosteropidae	<i>Zosterops lateralis</i>	silveryeye				0 - 1500	15.9 - 24.6	1044 - 7067
Turdidae	<i>Zoothra lunulata</i>	wet tropics bassian thrush	3		1	600 - 1480	16 - 20.8	1270 - 6879
Turdidae	<i>Zoothra heinei</i>	russet-tailed thrush			1			
Sturnidae	<i>Acridotheres tristis</i>	common myna						
Sturnidae	<i>Aplonis metallica</i>	metallic starling				0 - 1208	17.7 - 24.6	1239 - 4157
Estrildidae	<i>Taeniopygia bichenovii</i>	double-barred finch						
Estrildidae	<i>Neochmia phaeton</i>	crimson finch						
Estrildidae	<i>Neochmia modesta</i>	plum-headed finch						
Estrildidae	<i>Neochmia ruficauda</i>	star finch		EN	1			
Estrildidae	<i>Poephila personata</i>	masked finch						
Estrildidae	<i>Poephila cincta</i>	black-throated finch		EN	1			
Estrildidae	<i>Lonchura punctulata</i>	nutmeg mannikin						
Estrildidae	<i>Taeniopygia guttata</i>	zebra finch						
Estrildidae	<i>Neochmia temporalis</i>	red-browed finch						
Estrildidae	<i>Lonchura castaneothorax</i>	chestnut-breasted mannikin						
Estrildidae	<i>Erythrura trichroa</i>	blue-faced parrot-finch		NT	1	20 - 1140	18.1 - 24.4	1371 - 3151
REPTILES								
Crocodyliidae	<i>Crocodylus johnstoni</i>	Australian freshwater crocodile						
Crocodyliidae	<i>Crocodylus porosus</i>	estuarine crocodile		VU	1			
Chelidae	<i>Eiseya irwini</i>	Johnston River snapping turtle						
Chelidae	<i>Emydura macquarii</i>	Kreff's river turtle						
Chelidae	<i>Chelodina oblonga</i>	northern snake-necked turtle						
Chelidae	<i>Wollumbinia latisternum</i>	saw-shelled turtle						
Gekkonidae	<i>Nactus cheverti</i>	Chevert gecko			1	7 - 668	20.5 - 25	1281 - 3423
Gekkonidae	<i>Phyllurus gulbaru</i>	Gulbaru gecko	1	CR	1	366 - 538	21.3 - 22.1	1137 - 1176
Gekkonidae	<i>Heteronotia binoei</i>	Bynoe's gecko						
Gekkonidae	<i>Nephurus asper</i>	spiny knob-tailed gecko						
Gekkonidae	<i>Hemidactylus frenatus</i>	house gecko						
Gekkonidae	<i>Strophurus williamsi</i>	replace with soft-spined gecko						
Gekkonidae	<i>Gehyra dubia</i>	dubious dtella						
Gekkonidae	<i>Gehyra nana</i>	northern spotted rock dtella						
Gekkonidae	<i>Gehyra versicolor</i>	tree dtella						
Gekkonidae	<i>Oedura coggeri</i>	northern spotted velvet gecko						
Gekkonidae	<i>Nactus galgajuga</i>	black mountain gecko	1	VU	1			
Gekkonidae	<i>Lepidodactylus lugubris</i>	mourning gecko						
Gekkonidae	<i>Carphodactylus laevis</i>	chameleon gecko	2		1	115 - 1079	18.4 - 23.9	1453 - 4083
Gekkonidae	<i>Cyrtodactylus tuberculatus</i>	tuberculated ring-tailed gecko						
Gekkonidae	<i>Oedura castelnaui</i>	northern velvet gecko						
Gekkonidae	<i>Saltuarius cornutus</i>	northern leaf-tailed gecko	2		1	19 - 1512	15.9 - 24.5	1205 - 6380
Gekkonidae	<i>Phyllurus amnicola</i>	Mt. Elliot leaf-tail gecko	1		1	157 - 644	20.4 - 23.1	982 - 1315
Gekkonidae	<i>Lucasium steindachneri</i>	Steindachner's gecko						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Gekkonidae	<i>Amalosia rhombifer</i>	zig-zag gecko						
Gekkonidae	<i>Oedura monilis</i>	ocellated velvet gecko						
Pygopodidae	<i>Delma tincta</i>	excitable delma						
Pygopodidae	<i>Lialis burtonis</i>	Burton's legless lizard						
Pygopodidae	<i>Pygopus robertsi</i>	Cape York scaly-foot						
Pygopodidae	<i>Pygopus schraderi</i>	eastern hooded scaly-foot						
Pygopodidae	<i>Delma labialis</i>	striped-tailed delma		VU	1			
Pygopodidae	<i>Delma mitella</i>	Atherton delma	2	VU	1			
Agamidae	<i>Diporiphora australis</i>	tommy roundhead						
Agamidae	<i>Pogona barbata</i>	bearded dragon						
Agamidae	<i>Chlamydosaurus kingii</i>	frilled lizard						
Agamidae	<i>Diporiphora bilineata</i>	two-lined dragon						
Agamidae	<i>Diporiphora nobbi</i>	nobbi dragon						
Agamidae	<i>Lophosaurus boydii</i>	Boyd's forest dragon	2		1	0 - 1130	18 - 24.6	1347 - 4032
Agamidae	<i>Intellagama lesueurii</i>	eastern water dragon				20 - 1200	17.8 - 24.5	934 - 4157
Varanidae	<i>Varanus storri</i>	Storr's monitor						
Varanidae	<i>Varanus panoptes</i>	yellow-spotted monitor						
Varanidae	<i>Varanus tristis</i>	black-tailed monitor						
Varanidae	<i>Varanus varius</i>	lace monitor				10 - 1121	18.1 - 24.5	933 - 2880
Varanidae	<i>Varanus scalaris</i>	spotted tree monitor				40 - 1029	18.5 - 24.2	910 - 4157
Varanidae	<i>Varanus semiremex</i>	rusty monitor						
Scincidae	<i>Carlia rhomboidalis</i>	blue-throated rainbow-skink				97 - 522	21.1 - 23.4	1042 - 1396
Scincidae	<i>Cryptoblepharus litoralis</i>	coastal snake-eyed skink						
Scincidae	<i>Cryptoblepharus virgatus</i>	striped snake-eyed skink						
Scincidae	<i>Ctenotus brevipes</i>	short-footed ctenotus						
Scincidae	<i>Ctenotus eutaeniis</i>	black-backed yellow-lined ctenotus						
Scincidae	<i>Bellatorias frerei</i>	major skink			1	0 - 885	19.3 - 24.5	1301 - 3553
Scincidae	<i>Ctenotus monticola</i>	Atherton ctenotus	2	VU	1			
Scincidae	<i>Lampropholis robertsi</i>	grey-bellied sunskink	2		1	685 - 1540	15.7 - 20.5	1778 - 7408
Scincidae	<i>Carlia longipes</i>	closed-litter rainbow-skink						
Scincidae	<i>Liburnascincus mundivensis</i>	outcrop rainbow-skink						
Scincidae	<i>Carlia munda</i>	shaded-litter rainbow-skink						
Scincidae	<i>Ctenotus nullum</i>	nullum ctenotus						
Scincidae	<i>Cyclodomorphus gerrardii</i>	pink-tongued lizard			1	60 - 928	19.1 - 23.3	1503 - 3477
Scincidae	<i>Ctenotus spaldingi</i>	straight-browed ctenotus						
Scincidae	<i>Calyptotis thorntonensis</i>	Thornton Peak calyptotis	1	VU	1			
Scincidae	<i>Carlia rostralis</i>	black-throated rainbow-skink						
Scincidae	<i>Carlia rubrigularis</i>	red-throated rainbow-skink	2		1	14 - 1300	17.3 - 24.6	1137 - 4157
Scincidae	<i>Carlia schmeltzii</i>	Schmeltz's rainbow-skink						
Scincidae	<i>Ctenotus taeniolatus</i>	copper-tailed skink						
Scincidae	<i>Ctenotus terrareginae</i>	Hinchinbrook ctenotus	2		1			
Scincidae	<i>Cryptoblepharus metallicus</i>	metallic snake-eyed skink						
Scincidae	<i>Carlia jarnoldae</i>	lined rainbow skink						
Scincidae	<i>Cryptoblepharus adamsi</i>	Adams' snake-eyed skink						
Scincidae	<i>Liburnascincus scirtetis</i>	Black Mountain skink	1		1			
Scincidae	<i>Carlia vivax</i>	tussock rainbow-skink						
Scincidae	<i>Coeranoscincus frontalis</i>	limbless snake-toothed skink	2		1	40 - 1042	18.4 - 23.4	1644 - 3236
Scincidae	<i>Lampropholis "Elliot"</i>	Mount Elliot lampropholis	1		1			
Scincidae	<i>Ctenotus robustus</i>	robust ctenotus						
Scincidae	<i>Lampropholis mirabilis</i>	saxicoline sunskink	1	EN	1	47 - 604	20.6 - 23.7	977 - 1356
Scincidae	<i>Glaphyromorphus mjobergi</i>	Atherton Tableland mulch-skink	2		1	600 - 1275	17.1 - 20.8	1583 - 5386
Scincidae	<i>Glaphyromorphus nigricaudis</i>	black-tailed bar-lipped skink						
Scincidae	<i>Eremiascincus pardalis</i>	lowlands bar-lipped skink						
Scincidae	<i>Glaphyromorphus pumilus</i>	dwarf mulch-skink						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Scincidae	<i>Glaphyromorphus punctulatus</i>	fine-spotted mulch-skink						
Scincidae	<i>Gnypetoscincus queenslandiae</i>	prickly forest skink	2		1	20 - 1443	16.2 - 24.5	1265 - 6556
Scincidae	<i>Egernia hosmeri</i>	Hosmer's skink						
Scincidae	<i>Lygisaurus aeratus</i>	large-disk litter-skink						
Scincidae	<i>Lampropholis delicata</i>	dark flecked garden sunskink						
Scincidae	<i>Lygisaurus laevis</i>	rainforest edge litter-skink	2		1			
Scincidae	<i>Lygisaurus tanneri</i>	Endeavour River litter-skink		VU	1			
Scincidae	<i>Pygmaeascincus timlowi</i>	dwarf litter-skink						
Scincidae	<i>Glaphyromorphus fuscicaudis</i>	brown-tailed bar-lipped skink	2		1	20 - 1300	17.3 - 24.5	1256 - 4032
Scincidae	<i>Lampropholis coggeri</i>	rainforest sunskink	2		1	20 - 1300	17.3 - 24.5	975 - 4141
Scincidae	<i>Lygisaurus zuma</i>	sun-loving litter-skink						
Scincidae	<i>Lerista zonulata</i>	girdled slider						
Scincidae	<i>Morethia taeniopleura</i>	eastern fire-tailed skink						
Scincidae	<i>Menetia greyii</i>	common dwarf skink						
Scincidae	<i>Pygmaeascincus koshlandae</i>	fine-browed dwarf skink						
Scincidae	<i>Pygmaeascincus sadleri</i>	Magnetic Island dwarf skink	1	VU	1			
Scincidae	<i>Proablepharus tenuis</i>	northern soil-crevice skink						
Scincidae	<i>Saprosincus basiliscus</i>	basilisk shadeskink	2		1	20 - 1215	17.7 - 24.6	1137 - 4157
Scincidae	<i>Saprosincus czechurai</i>	wedge-snouted shadeskink	2		1	606 - 1540	15.7 - 21	1445 - 7408
Scincidae	<i>Saprosincus lewisi</i>	Cooktown shadeskink	2		1	14 - 700	20.4 - 24.5	2056 - 3534
Scincidae	<i>Saprosincus tetradactylus</i>	four-fingured shadeskink	2		1	40 - 1181	17.9 - 24.1	1227 - 4157
Scincidae	<i>Techmarsincus jigurru</i>	Bartle Frere cool-skink	1	VU	1	1452 - 1600	15.4 - 16.2	6003 - 6717
Scincidae	<i>Tiliqua scincoides</i>	eastern blue-tongue lizard						
Scincidae	<i>Cryptoblepharus pannosus</i>	ragged snake-eyed skink						
Scincidae	<i>Egernia rugosa</i>	yakka skink		VU	1			
Scincidae	<i>Glaphyromorphus cracens</i>	slender mulch-skink						
Scincidae	<i>Glaphyromorphus clandestinus</i>	Mt Elliot skink	1		1	495 - 500	21.2 - 21.2	1193 - 1196
Scincidae	<i>Eulamprus quoyii</i>	eastern water skink				27 - 1110	18.1 - 24.3	1056 - 4020
Scincidae	<i>Concinnia frerei</i>	Bartle Frere bar-sided skink	1		1	1437 - 1600	15.4 - 16.2	6169 - 6717
Scincidae	<i>Anomalopus gowi</i>	speckled worm-skink						
Scincidae	<i>Lygisaurus foliorum</i>	tree-base litter-skink						
Scincidae	<i>Concinnia tigrina</i>	yellow-blotched forest-skink	2		1	11 - 1317	17.1 - 24.6	1482 - 4157
Scincidae	<i>Concinnia sokosoma</i>	stout bar-sided skink						
Scincidae	<i>Concinnia brachysoma</i>	Cape York bar-side skink				82 - 1073	18.5 - 23.5	982 - 3359
Scincidae	<i>Egernia striolata</i>	tree skink						
Scincidae	<i>Glaphyromorphus crassicaudus</i>	Cape York mulch-skink						
Typhlopidae	<i>Anilius torresianus</i>	north-eastern blind snake			1	94 - 660	20.5 - 23.4	1494 - 4020
Typhlopidae	<i>Anilius unguirostris</i>	claw-snouted blind snake						
Typhlopidae	<i>Anilius robertsi</i>	Roberts' blind snake	2		1			
Typhlopidae	<i>Anilius proximus</i>	proximus blind snake						
Typhlopidae	<i>Anilius affinis</i>	small-headed blind snake						
Typhlopidae	<i>Anilius broomi</i>	faint-striped blind snake						
Typhlopidae	<i>Anilius ligatus</i>	robust blind snake						
Pythonidae	<i>Liasis mackloti</i>	water python						
Pythonidae	<i>Morelia amethystina</i>	amethystine python				4 - 1110	18.3 - 24.9	1094 - 4032
Pythonidae	<i>Antaresia maculosa</i>	spotted python						
Pythonidae	<i>Antaresia stimsoni</i>	Stimson's python						
Pythonidae	<i>Aspidites melanocephalus</i>	black-headed python						
Pythonidae	<i>Morelia spilota</i>	jungle carpet python	3		1	9 - 1190	17.5 - 24.6	1005 - 4194
Pythonidae	<i>Morelia spilota</i>	coastal carpet python						
Acrochordidae	<i>Acrochordus granulatus</i>	little file snake						
Colubridae	<i>Dendrelaphis calligastra</i>	northern tree snake				11 - 1073	18.5 - 24.9	1033 - 3534
Colubridae	<i>Dendrelaphis punctulatus</i>	green tree snake				2 - 950	19 - 24.4	999 - 3377
Colubridae	<i>Stegonotus cucullatus</i>	slaty-grey snake				11 - 1166	18 - 24.4	1272 - 3445

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Colubridae	<i>Boiga irregularis</i>	brown tree snake				15 - 1110	18.1 - 24.5	1003 - 4177
Colubridae	<i>Tropidonophis mairii</i>	freshwater snake				2 - 817	19.7 - 24	1023 - 2861
Homalopsidae	<i>Pseudoferania polylepsis</i>	MacLeay's water snake						
Elapidae	<i>Cryptophis nigrostriatus</i>	black-striped snake						
Elapidae	<i>Cryptophis nigrescens</i>	eastern small-eyed snake				16 - 1214	17.6 - 24.4	934 - 3872
Elapidae	<i>Cryptophis boschmai</i>	Carpentaria whip snake						
Elapidae	<i>Antaioserpens albiceps</i>	north-eastern plain-nosed burrowing snake						
Elapidae	<i>Suta suta</i>	myall snake						
Elapidae	<i>Tropidechis carinatus</i>	rough-scaled snake				20 - 1238	17.5 - 23.7	1342 - 3374
Elapidae	<i>Vermicella annulata</i>	bandy-bandy				530 - 1000	18.7 - 21.3	1272 - 1513
Elapidae	<i>Cacophis squamulosus</i>	golden crowned snake						
Elapidae	<i>Cacophis churchilli</i>	northern dwarf crowned snake	2		1	71 - 1214	17.6 - 23.6	1372 - 2933
Elapidae	<i>Hemiaspis signata</i>	black-bellied swamp snake			1	10 - 1225	17.6 - 24.3	934 - 3339
Elapidae	<i>Hoplocephalus bitorquatus</i>	pale-headed snake						
Elapidae	<i>Acanthophis praelongus</i>	northern death adder						
Elapidae	<i>Acanthophis antarcticus</i>	common death adder		VU	1			
Elapidae	<i>Demansia papuensis</i>	greater black whipsnake						
Elapidae	<i>Demansia psammophis</i>	yellow-faced whipsnake				58 - 961	18.9 - 24.3	1102 - 3243
Elapidae	<i>Furina barnardi</i>	yellow-naped snake						
Elapidae	<i>Demansia vestigiata</i>	lesser black whipsnake						
Elapidae	<i>Pseudonaja textilis</i>	eastern brown snake						
Elapidae	<i>Furina tristis</i>	brown-headed snake				12 - 157	23.6 - 24.9	1723 - 3339
Elapidae	<i>Furina ornata</i>	orange-naped snake				56 - 600	20.8 - 23.6	934 - 2064
Elapidae	<i>Furina diadema</i>	red-naped snake						
Elapidae	<i>Oxyuranus scutellatus</i>	coastal taipan						
Elapidae	<i>Pseudechis australis</i>	king brown snake / mulga snake						
Elapidae	<i>Pseudechis porphyriacus</i>	red-bellied black snake				80 - 1280	17.4 - 23.9	934 - 4157
Elapidae	<i>Demansia torquata</i>	collared whipsnake		DD				
FROGS								
Hylidae	<i>Litoria nigrofrenata</i>	tawny rocketfrog						
Hylidae	<i>Litoria nasuta</i>	striped rocketfrog						
Hylidae	<i>Litoria caerulea</i>	common green treefrog						
Hylidae	<i>Litoria serrata</i>	tapping green-eyed treefrog	2	VU	1	11 - 1443	16.2 - 24.6	1111 - 6556
Hylidae	<i>Litoria nannotis</i>	waterfall frog	2	EN	1	60 - 1214	17.7 - 24.2	1079 - 4157
Hylidae	<i>Litoria inermis</i>	bumpy rocketfrog						
Hylidae	<i>Litoria infrafronata</i>	white-lipped treefrog				4 - 1013	18.8 - 24.9	1057 - 4157
Hylidae	<i>Litoria jungguy</i>	northern stony-creek frog	2		1	14 - 1431	16.3 - 24.7	981 - 5879
Hylidae	<i>Litoria latopalmeta</i>	broad-palmed rocketfrog						
Hylidae	<i>Litoria lorica</i>	little waterfall frog	1	EN	1	240 - 1302	17.2 - 23	2584 - 3008
Hylidae	<i>Litoria bicolor</i>	northern sedgefrog						
Hylidae	<i>Litoria myola</i>	Kuranda treefrog	1	EN	1			
Hylidae	<i>Litoria fallax</i>	eastern sedgefrog				0 - 1065	18.3 - 24.5	838 - 3726
Hylidae	<i>Litoria nyakalensis</i>	mountain mistfrog	2	CR	1	10 - 1015	18.6 - 23.9	1211 - 3846
Hylidae	<i>Litoria pallida</i>	pallid rocketfrog						
Hylidae	<i>Litoria revelata</i>	whirring treefrog	3		1	768 - 1194	17.6 - 19.8	1323 - 2850
Hylidae	<i>Litoria rheocola</i>	common mistfrog	2	EN	1	15 - 1122	18.2 - 24.6	953 - 4168
Hylidae	<i>Litoria rothii</i>	northern laughing treefrog						
Hylidae	<i>Litoria rubella</i>	ruddy treefrog						
Hylidae	<i>Litoria wilcoxii</i>	eastern stony-creek frog						
Hylidae	<i>Litoria xanthomera</i>	orange thighed treefrog	2		1	36 - 1300	17.3 - 24.4	953 - 3519
Hylidae	<i>Litoria dayi</i>	Australian lacelid	2	EN	1	18 - 1214	17.7 - 24.5	953 - 4168
Hylidae	<i>Litoria microbelos</i>	javelin frog						
Hylidae	<i>Litoria gracilenta</i>	graceful treefrog						

Family	Species	Common Name	WT End.	Con Stat.	VIS	Elev. Range	Temp. Range	Precip. Range
Hylidae	<i>Cyclorana alboguttata</i>	greenstripe frog						
Hylidae	<i>Cyclorana brevipes</i>	superb collared-frog						
Hylidae	<i>Cyclorana novaehollandiae</i>	eastern snapping-frog						
Myobatrachidae	<i>Mixophyes schevilli</i>	northern barred frog	2		1	26 - 1437	16.2 - 23.5	889 - 6505
Myobatrachidae	<i>Notaden melanoscaphus</i>	brown shovelfoot						
Myobatrachidae	<i>Crinia deserticola</i>	chirping froglet						
Myobatrachidae	<i>Crinia remota</i>	northern froglet						
Myobatrachidae	<i>Mixophyes carbinensis</i>	Carbine barred frog	2		1			
Myobatrachidae	<i>Mixophyes coggeri</i>	mottled barred frog	2		1	26 - 1437	16.2 - 23.5	889 - 6505
Myobatrachidae	<i>Pseudophryne covacevichae</i>	magnificent broodfrog	2	VU	1			
Myobatrachidae	<i>Limnodynastes convexiusculus</i>	marbled frog						
Myobatrachidae	<i>Uperoleia mimula</i>	mimicking gungan						
Myobatrachidae	<i>Uperoleia littlejohni</i>	Einiasleigh gungan						
Myobatrachidae	<i>Uperoleia lithomoda</i>	stonemason gungan						
Myobatrachidae	<i>Taudactylus rheophilus</i>	northern tinkerfrog	2	EN	1	704 - 1527	15.8 - 20.5	1429 - 7292
Myobatrachidae	<i>Taudactylus acutirostris</i>	sharp-snouted dayfrog	2	EX	1	33 - 1302	17.2 - 23.8	1174 - 4405
Myobatrachidae	<i>Platyplectrum ornatum</i>	ornate burrowing frog						
Myobatrachidae	<i>Limnodynastes peronii</i>	striped marsh frog			1	15 - 1194	17.6 - 23.9	866 - 4081
Myobatrachidae	<i>Limnodynastes tasmaniensis</i>	spotted marsh frog						
Myobatrachidae	<i>Limnodynastes terraereginae</i>	scarlet-sided pobblebonk						
Myobatrachidae	<i>Uperoleia altissima</i>	Tableland gungan						
Microhylidae	<i>Cophixalus infacetus</i>	creaking nurseryfrog	2		1	20 - 1037	18.4 - 24.3	1583 - 4157
Microhylidae	<i>Cophixalus bombiens</i>	buzzing nurseryfrog	2		1	42 - 1280	17.4 - 24.4	1851 - 3320
Microhylidae	<i>Cophixalus ornatus</i>	northern ornate nurseryfrog	2		1	15 - 1512	15.9 - 24.3	1219 - 7036
Microhylidae	<i>Cophixalus concinnus</i>	beautiful nurseryfrog	1	CR	1	913 - 1279	17.3 - 19.2	2756 - 3456
Microhylidae	<i>Cophixalus exiguus</i>	dainty nurseryfrog	1	VU	1	320 - 700	20.4 - 22.5	2226 - 2939
Microhylidae	<i>Cophixalus hosmeri</i>	rattling nurseryfrog	1	NT	1	704 - 1302	17.2 - 20.5	1429 - 3008
Microhylidae	<i>Cophixalus australis</i>	southern ornate nurseryfrog	2		1			
Microhylidae	<i>Austrochaperina pluvialis</i>	white-browed whistlefrog	2		1	10 - 1293	17.4 - 24.6	1289 - 4157
Microhylidae	<i>Austrochaperina robusta</i>	robust whistled frog	2		1	26 - 1517	15.8 - 23.7	1242 - 7212
Microhylidae	<i>Cophixalus monticola</i>	mountain nurseryfrog	1	EN	1	1134 - 1240	17.6 - 18.1	2469 - 2758
Microhylidae	<i>Cophixalus aenigma</i>	tapping nurseryfrog	2	VU	1	372 - 1317	17.1 - 22	1477 - 3550
Microhylidae	<i>Cophixalus mcdonaldi</i>	Mount Elliot nurseryfrog	1	EN	1	465 - 780	19.7 - 21.4	1170 - 1459
Microhylidae	<i>Cophixalus hinchinbrookensis</i>	Hinchinbrook Island nurseryfrog	1		1			
Microhylidae	<i>Cophixalus neglectus</i>	Bellenden Ker nurseryfrog	1	EN	1	765 - 1585	15.5 - 19.7	3437 - 7417
Microhylidae	<i>Austrochaperina fryi</i>	peeping whistlefrog	2		1	0 - 1302	17.2 - 24.6	1362 - 3555
Microhylidae	<i>Cophixalus saxatilis</i>	Black Mountain boulderfrog	1	VU	1			
Ranidae	<i>Papurana daemeli</i>	Australian woodfrog				10 - 618	20.9 - 24.7	917 - 3987
Bufoidea	<i>Rhinella marina</i>	cane toad						

Appendix 2

More detailed summary of terrestrial vertebrate species richness in the Wet Tropics by taxonomic class presented in Table 1 in the main text. For full details of every species and data see full species list in Appendix 1. Data is based on revised version of data from Williams *et al.* 2010 with 2016 complete revision of taxonomy, updated species distributions, updated field monitoring data and recalculated diversity mapping.

Endemic species: Levels of endemism are expressed as the number of species endemic to the Wet Tropics biogeographic region including the Mount Elliot outlier. Restricted endemics are Wet Tropics endemics that have very small distributions within the Wet Tropics, usually confined to a single mountain range or subregion.

Rainforest species are represented by number of species that utilize rainforest to varying degrees in the Wet Tropics:

0= does not occur in rainforest; 1= occasionally recorded in rainforest; 2 = uses rainforest as sub-optimal/marginal habitat; 3 = commonly recorded in rainforest but not the species' core habitat; 4 = rainforest is a main habitat however also common in other forest environments; 5= rainforest is core habitat however also occur in wet sclerophyll forests; 6= rainforest obligate.

Conservation status is represented by threatened categories and follow the Queensland's *Nature Conservation Act 1992*, IUCN and EPBC as available in 2016 (NT= Near Threatened; CR= Critical Endangered; E= Endangered; V= Vulnerable; EX= Extinct).

Very Important Species (VIS) are those species or subspecies that are the primary consideration in this report and includes all taxa that are endemic to the Wet Tropics bioregion and/or have a threatened status and/or are an ancient lineages of global significance and/or are ecologically rare.

Ancient species are those species that are in the top 5% or 10% most phylogenetically unique species globally.

Rare species are those species that are either geographically restricted and/or have low local abundance.

	TAXA	BIRDS	MAMMALS	REPTILES	FROGS	TOTAL
	FAMILIES	79	22	13	4	118
	SPECIES	336	108	163	62	669
ENDEMIC SPECIES	REGIONAL ENDEMIC	12	12	21	21	66
	RESTRICTED REGIONAL ENDEMIC	0	3	11	10	24
	TOTAL ENDEMIC	12	15	32	31	90
	ENDEMIC SUBSPECIES	23	7	1	1	32
RAINFOREST SPECIES	RAINFOREST SPECIES [3-6]	104	43	73	34	254
	RAINFOREST SPECIALIST SPECIES [5,6]	46	21	23	29	119
CONSERVATION STATUS	NT	2	6	0	1	9
	CR	0	1	1	2	4
	E	5	5	1	9	20
	V	4	12	11	5	32
	EX	0	0	0	1	1
	THREATENED SPECIES	11	24	13	18	66
ANCIENT LINEAGES	ANCIENT 5%	10	2	0	4	16
	ANCIENT 10%	22	5	2	4	33
RARITY	ECOL. RARE	26	12	25	17	80
	VIS	46	39	38	32	155



