# STATE OF WET TROPICS REPORT 2015-2016

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

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

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RING- TAILED GECKOS
WET TROPICS IMAGES/MIKE TRENERRY

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

WET TROPICS
MANAGEMENT AUTHORITY

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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## Acknowledgments

We would like to thank Professor Steve Williams (Centre for Tropical Biology and Climate Change, James Cook University), Ms Laurina Falconi (James Cook University), Professor Craig Moritz (Australian National University) and Ms Jéssica Fenker Antunes (Australian National University) for preparing the draft report. We also acknowledge the contribution of Girringun Aboriginal Corporation and the Girramay Elders.

Much of the primary research in this report was collected with support from the Australian Government's Rainforest CRC, Marine and Tropical Sciences Research Facility (MTSRF), National Environment Research Program (NERP), Terrestrial Research Network (TERN) and National Climate Change Adaptation Research Facility (NCCARF).

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WET TROPICS MANAGEMENT AUTHORITY

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ISSN 978-1-921591-75-4

*THIS REPORT IS PRINTED ON 100% RECYCLED PAPER WITH ECO FRIENDLY UV INKS.*

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*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 relient 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

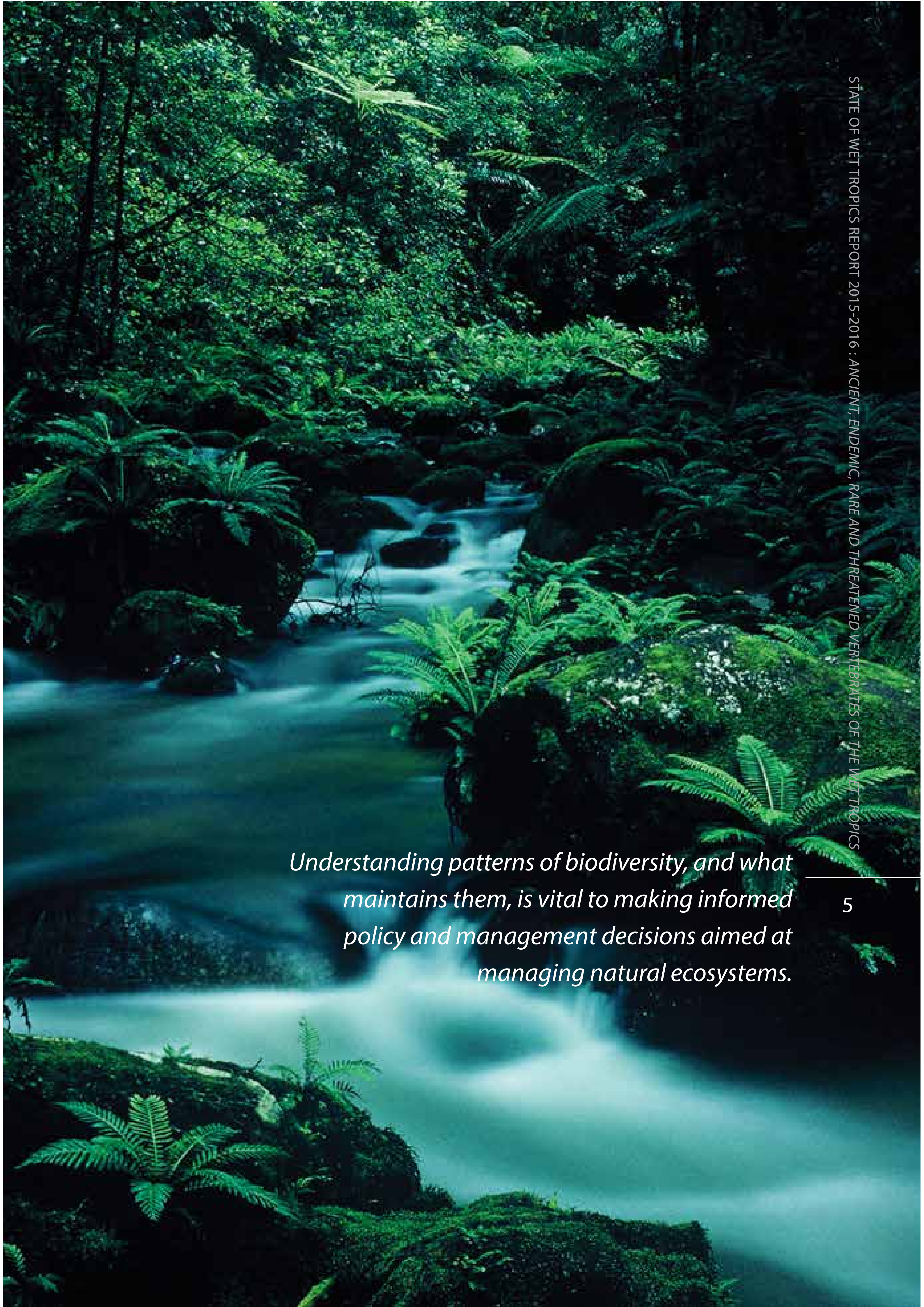
ongoing loss of evolutionary potential

- 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.

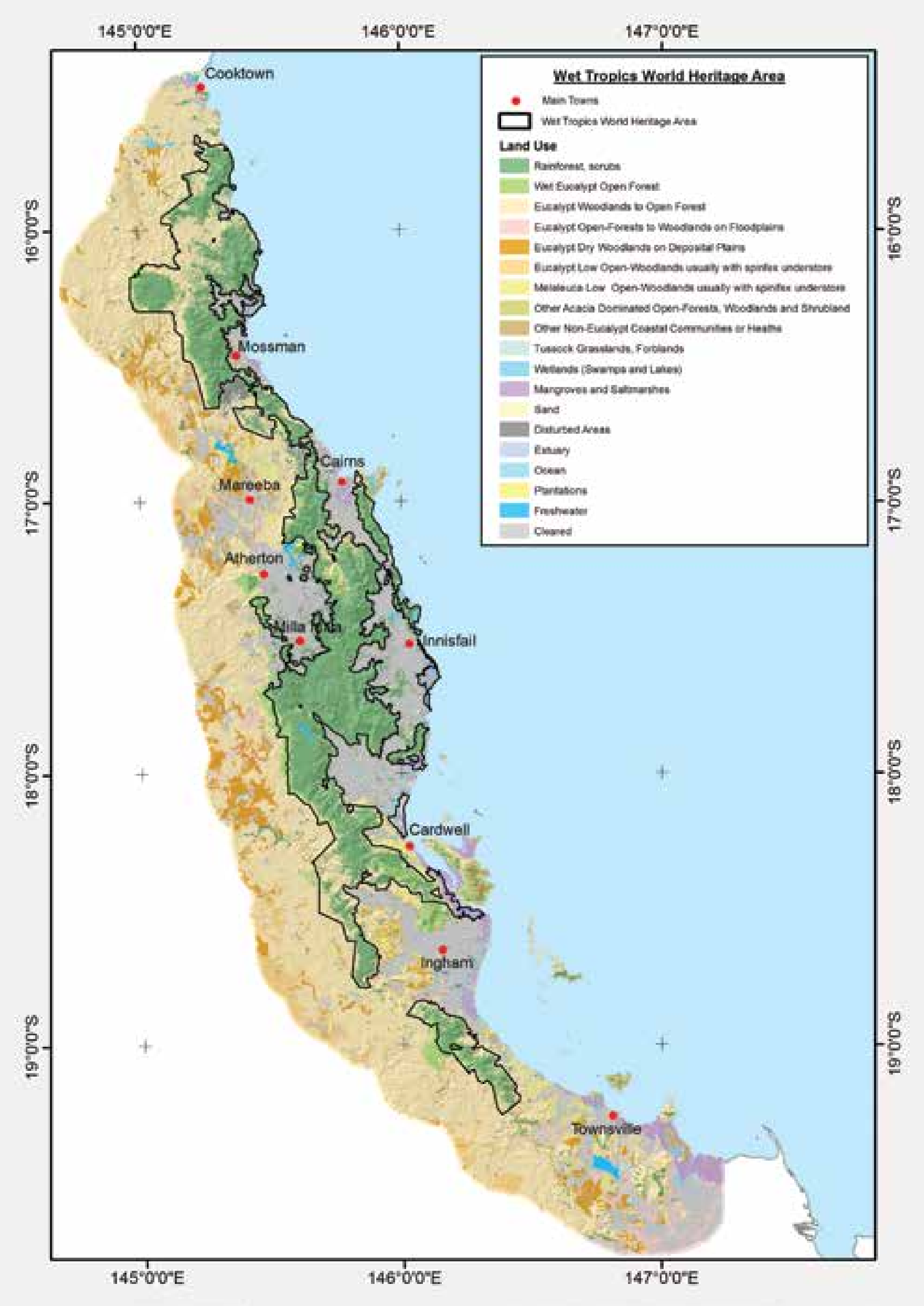
Many of the same themes emerge in the following pages, with a focus on the rich vertebrate fauna of the Wet Tropics World Heritage Area—an area that supports many vertebrate species of exceptionally high conservation and scientific value globally.

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.

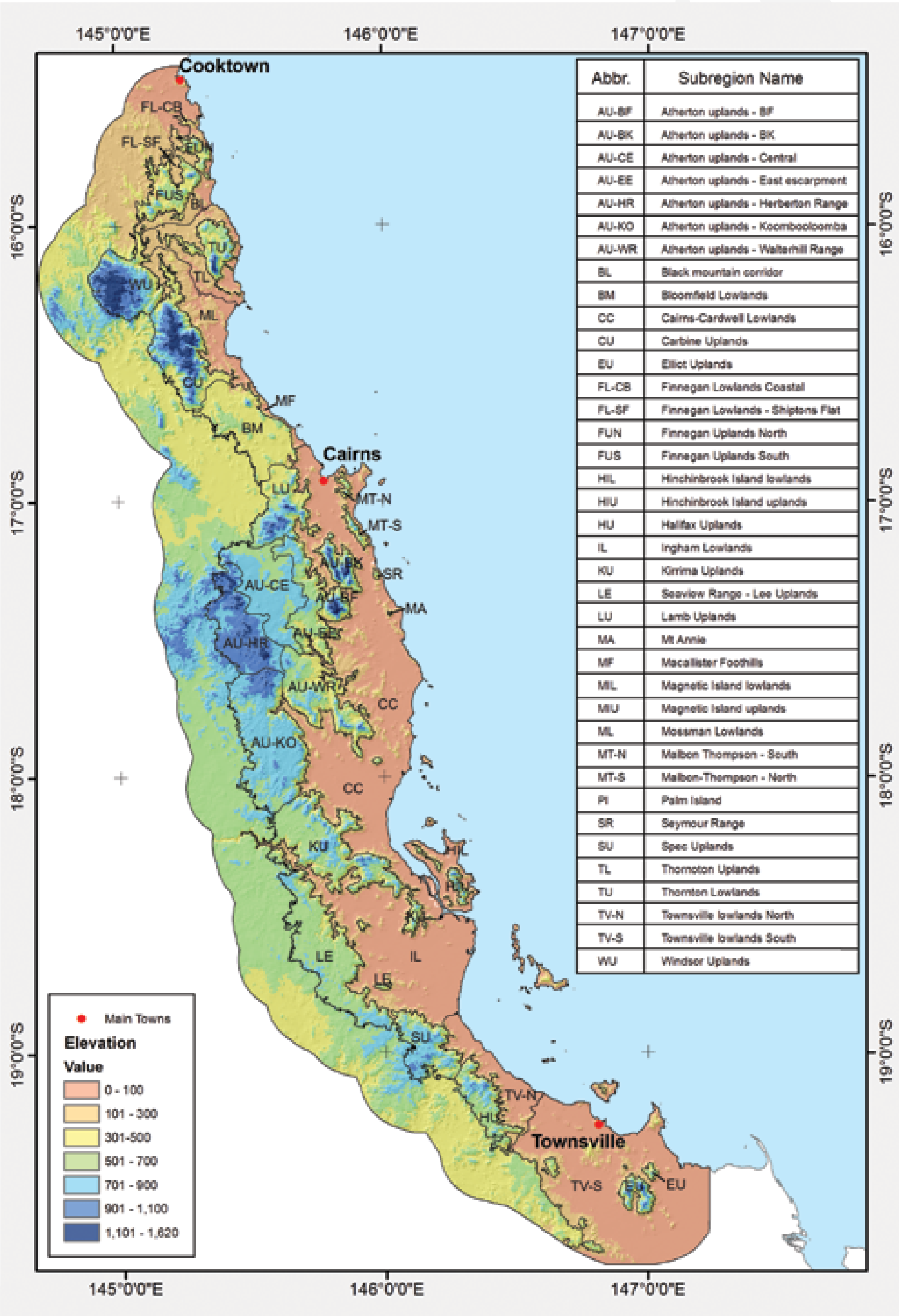
The report then presents current evidence for recent declines in vertebrate diversity and considers its future prospects, with recommendations for management actions and the research needed to underpin those actions.

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




| Abbr. | Subregion Name |
|---|---|
| AU-BF | Atherton uplands - BF |
| AU-BK | Atherton uplands - BK |
| AU-CE | Atherton uplands - Central |
| AU-EE | Atherton uplands - East escarpment |
| AU-HR | Atherton uplands - Herberton Range |
| AU-KO | Atherton uplands - Koombooloomba |
| AU-WR | Atherton uplands - Walterhill Range |
| BL | Black mountain corridor |
| BM | Bloomfield Lowlands |
| CC | Cairns-Cardwell Lowlands |
| CU | Carbine Uplands |
| EU | Elliot Uplands |
| FL-CB | Finnegan Lowlands Coastal |
| FL-SF | Finnegan Lowlands - Shiptons Flat |
| FUN | Finnegan Uplands North |
| FUS | Finnegan Uplands South |
| HIL | Hinchinbrook Island lowlands |
| HIU | Hinchinbrook Island uplands |
| HU | Halifax Uplands |
| IL | Ingham Lowlands |
| KU | Kirrima Uplands |
| LE | Seaview Range - Lee Uplands |
| LU | Lamb Uplands |
| MA | Mt Annie |
| MF | Macallister Foothills |
| MIL | Magnetic Island lowlands |
| MIU | Magnetic Island uplands |
| ML | Mossman Lowlands |
| MT-N | Malbon Thompson - South |
| MT-S | Malbon-Thompson - North |
| PI | Palm Island |
| SR | Seymour Range |
| SU | Spec Uplands |
| TL | Thornoton Uplands |
| TU | Thornton Lowlands |
| TV-N | Townsville lowlands North |
| TV-S | Townsville lowlands South |
| WU | Windsor Uplands |

*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'.



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 |
| | ENDEMICS | 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 |



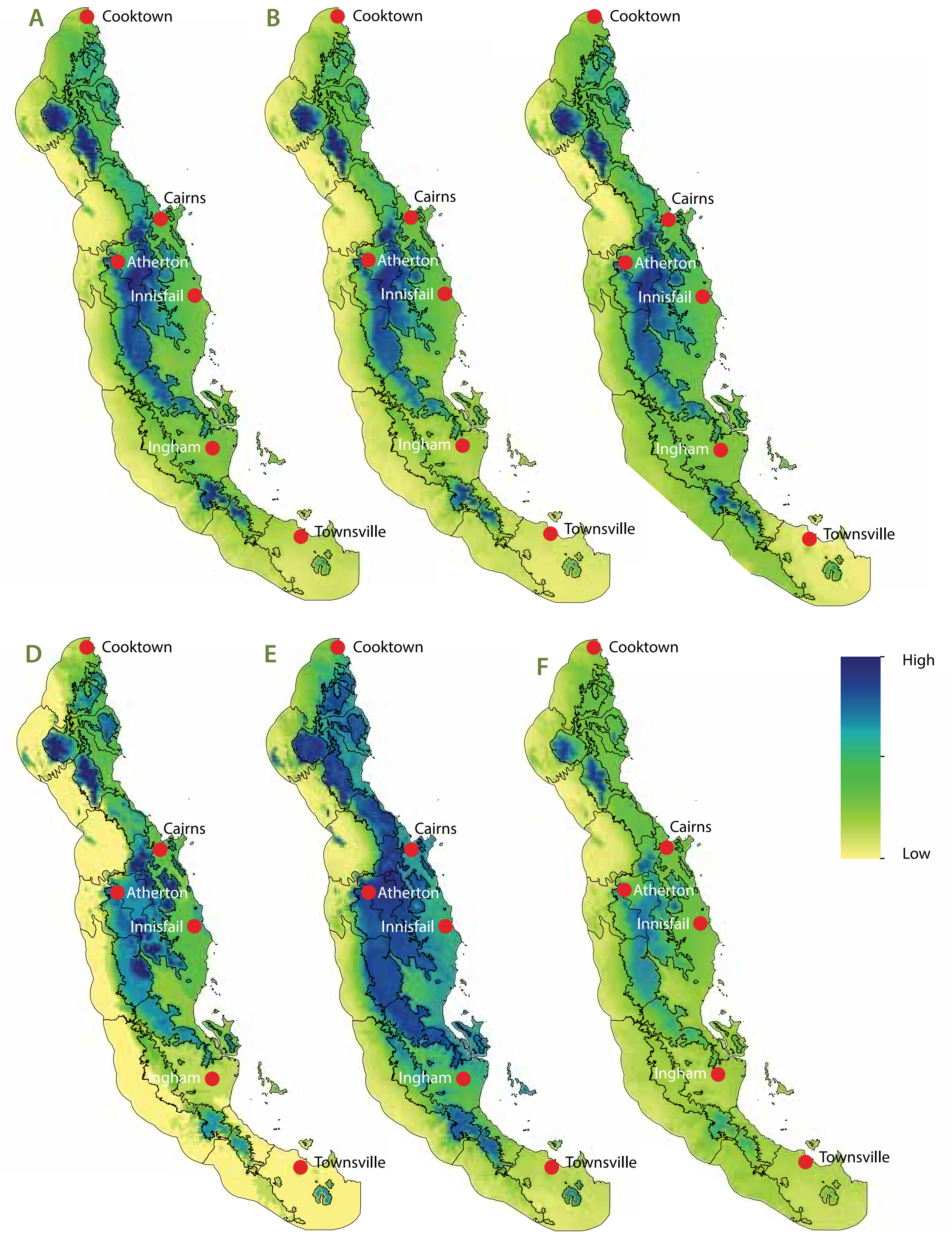
## Spatial patterns of vertebrate biodiversity

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.

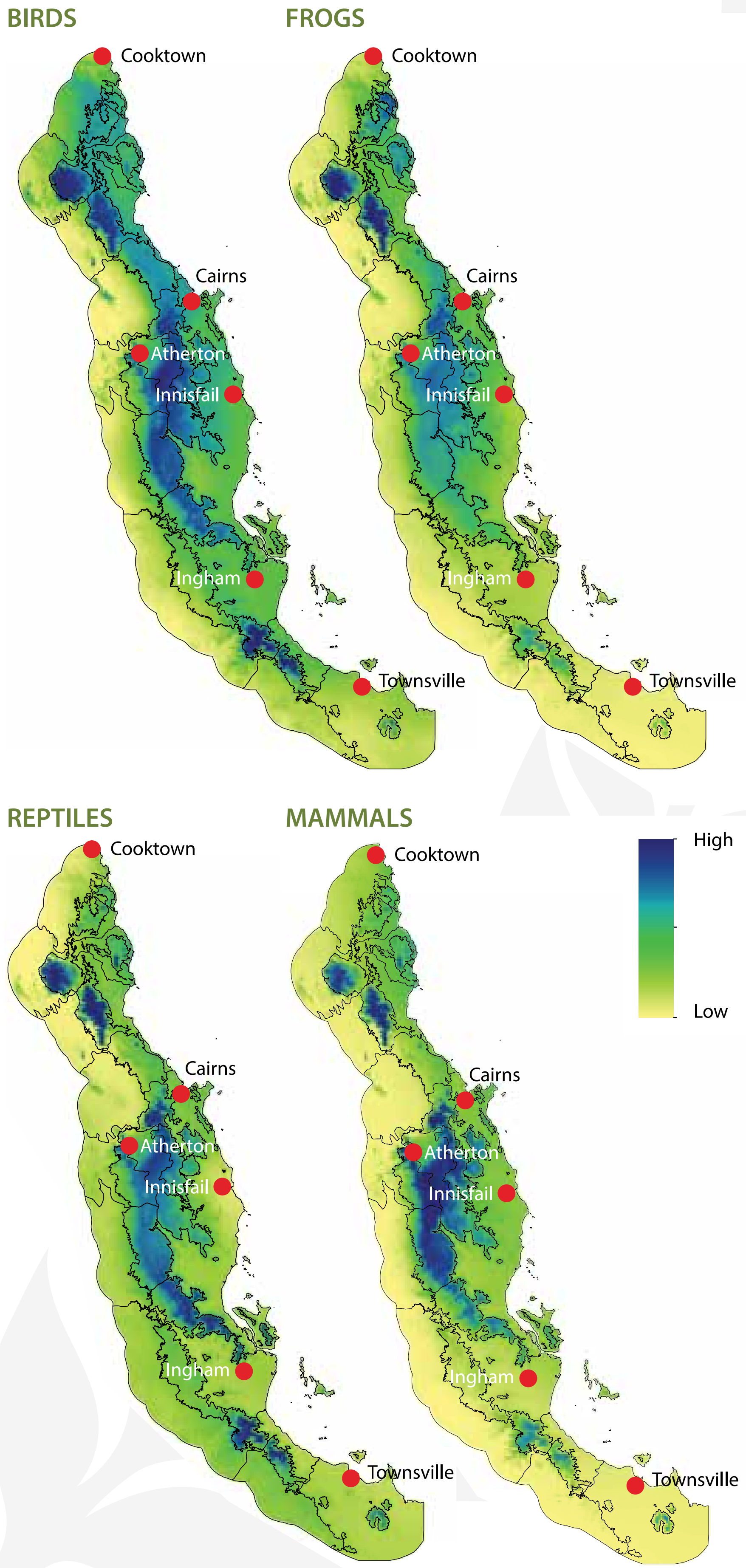
## Figure 3. Biodiversity maps for all rainforest vertebrates

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, reseachers 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

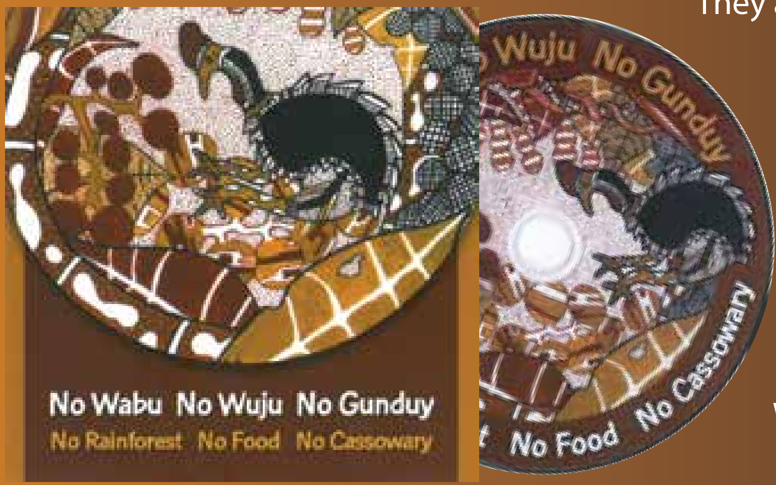
Using the criteria described above to identify species that are endemic, rare, threatened and ancient, more than a quarter of the vertebrate species in the Wet Tropics region have high conservation significance (Table 1). Even more telling, 60% (155 of 254) of rainforest species are regarded as 'Very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

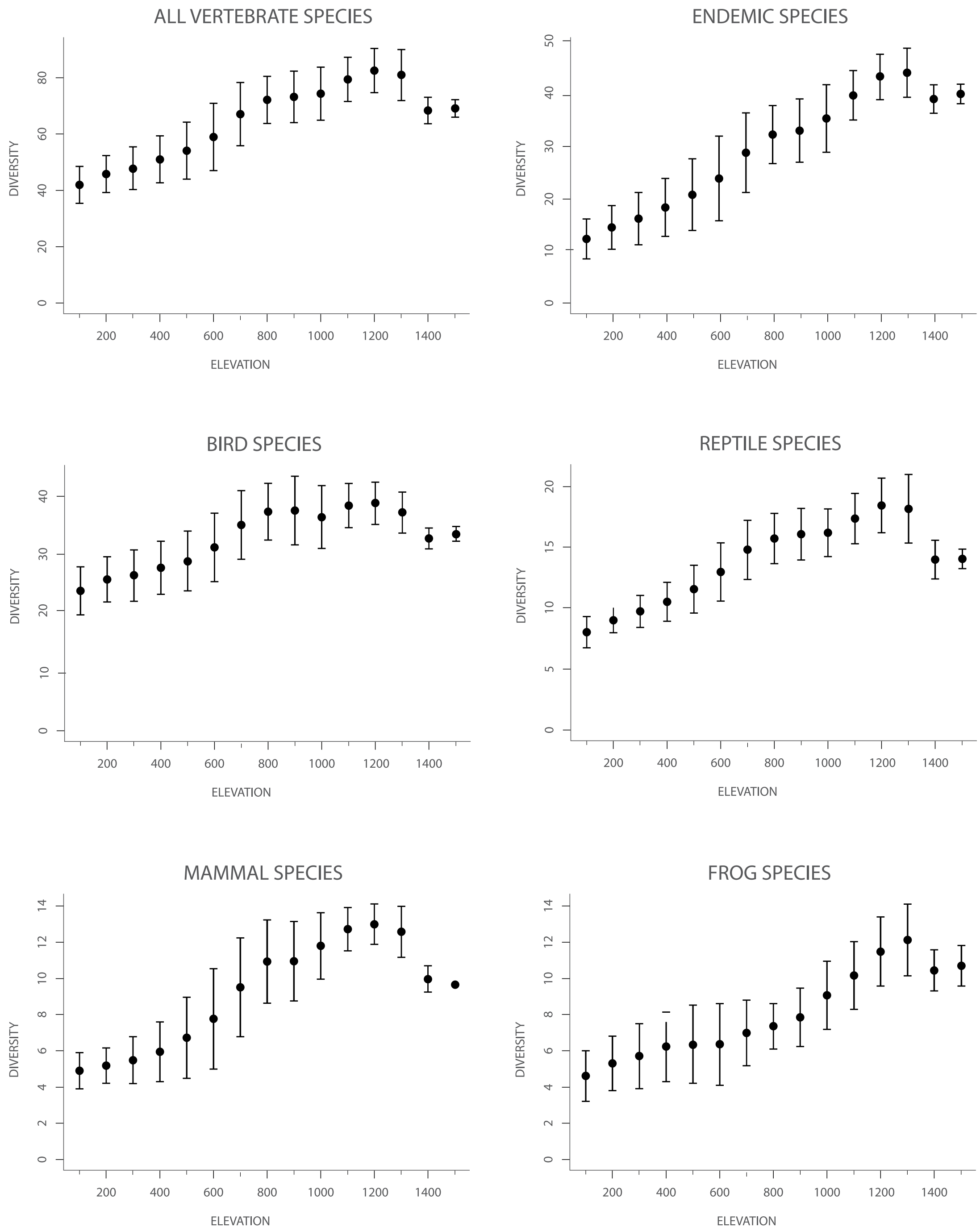
Without strong action today, cassowaries will become extinct in the future.

## 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

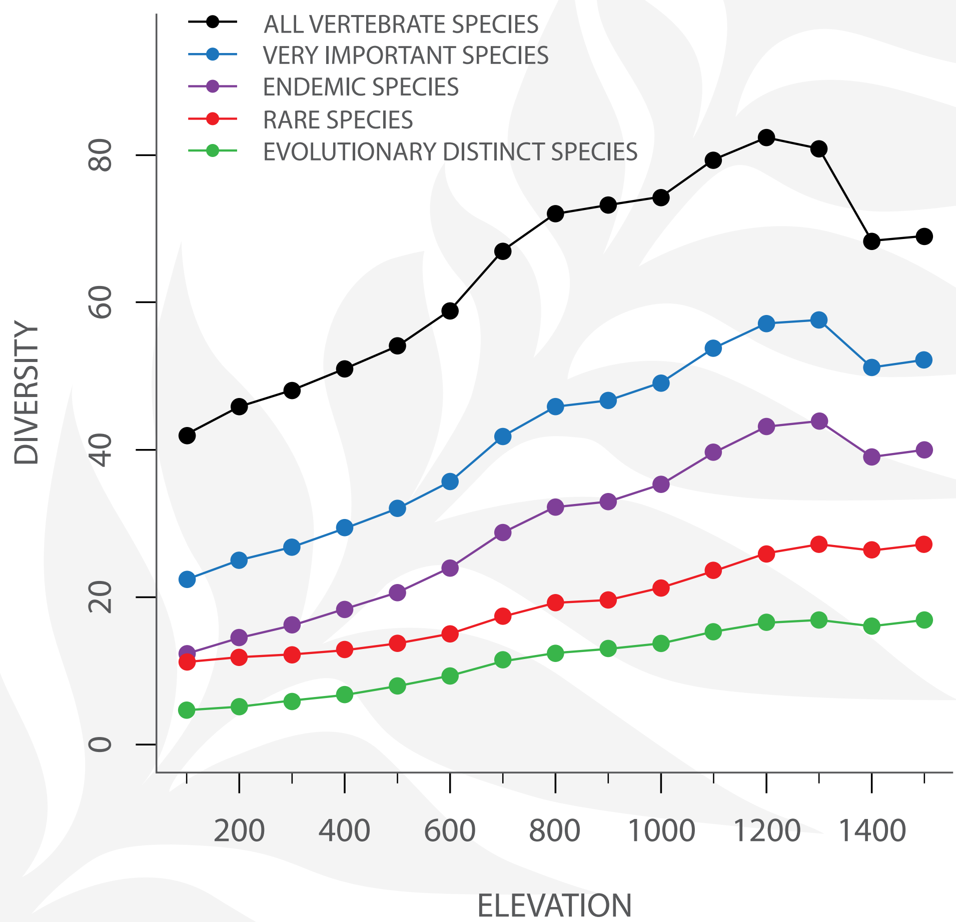


The cool wet rainforests of the uplands are the critical element in understanding patterns of biodiversity in the region and represent the most critical hotspots of vertebrate biodiversity. The stability of the environment over the long-term (i.e. since the last ice-age ~20 000 years ago) and the short-term (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.**



*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 milion 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]

## Why are the uplands more diverse?

Vertebrate biodiversity in the Wet Tropics is consistently greater in the uplands, with most evidence suggesting that environmental stability is the main reason. Generally, environmental stability is lower in the lowlands and in the more peripheral subregions in the far north and south of the region. Both species richness and abundance is highest in the mid to high elevational areas between 600-1200m across the region (Figures 3-6). These mid-elevation areas are characterised by high and relatively consistent environments promoting stable productivity of resources for vertebrates. Lower elevations (below 600m) have significantly lower species richness in almost all faunal groups and mostly have much lower local abundance as well. This is despite the fact that estimated overall productivity based on annual temperature and rainfall is highest in the lowlands.[51] This indicates that the annual stability of the productivity, climate and resources has a bigger influence on determining both richness and abundance than does the overall annual levels of productivity.

A caveat to this is perhaps the commonly-observed pattern of low abundance and diversity on the tops of mountains. This is consistent across taxonomic group (Figures 3-6). Here, it is likely that the levels of diversity and abundance are directly related to the lower environmental productivity in these cool, wet environments (often coupled with poor, shallow, leached soils).

There are exceptions to this pattern, with some taxonomic groups being highly adapted to these cool, wet uplands and therefore exhibiting a different biodiversity pattern with increasing abundance and species richness with elevation (for example microhylid frogs and carabid beetles).[52, 53]

An alternative hypothesis related to the lower diversity and abundance of birds in the lowlands is that it is an indirect effect of temperature enabling higher loads of blood parasites. There is a strong relationship between the prevalence of blood parasites and temperature, and this potentially limits bird abundance in the lowlands.[54] It is possible that lower richness, endemism and abundance in the lowland rainforests is a combination of extinction-filtering during the last ice-age, more severe dry season bottlenecks in resources and higher parasite load.

## 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.

*SQUIRREL GLIDER*
WET TROPICS IMAGES/MIKE TRENERRY

## 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.

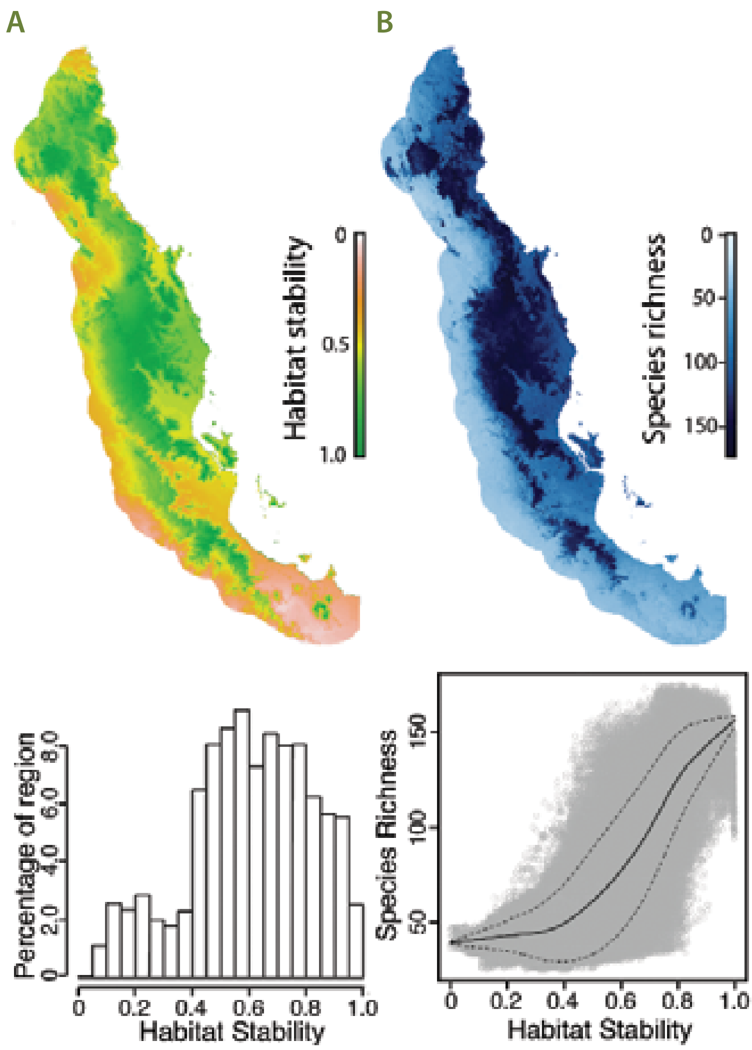
Understanding the relative resilience of each species, that is, its extinction proneness is important knowledge for prioritising management and policy actions and enables more robust predictions about the future.

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.

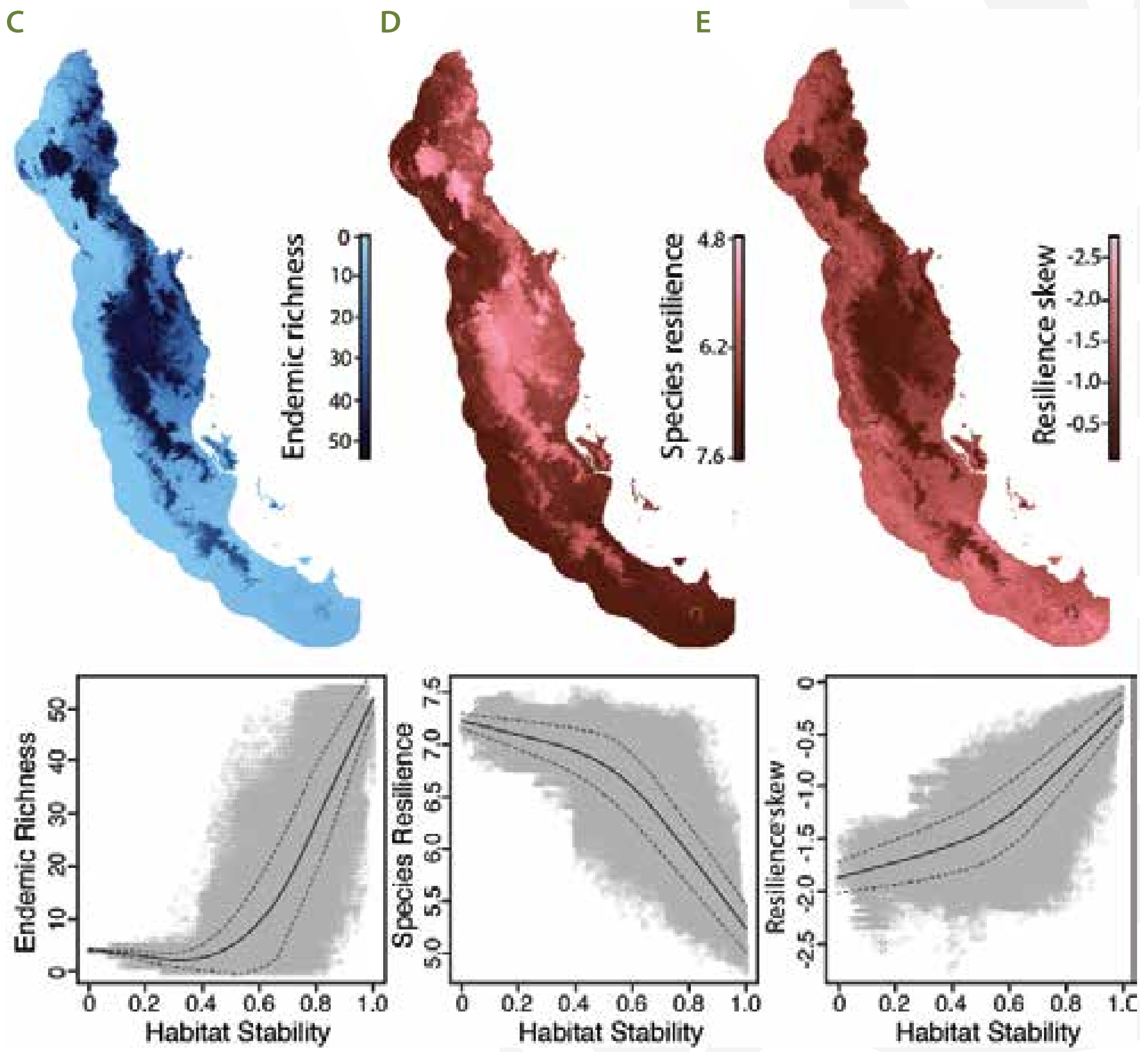
## Figure 7. Spatial patterns of vertebrate biodiversity, habitat stability and species resilience in the Australian Wet Tropics region.




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 Univeral 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 Gunduy/ 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.

*CASSOWARY*
WET TROPICS IMAGES/LIZ GALLIE


*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 Univeral 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.

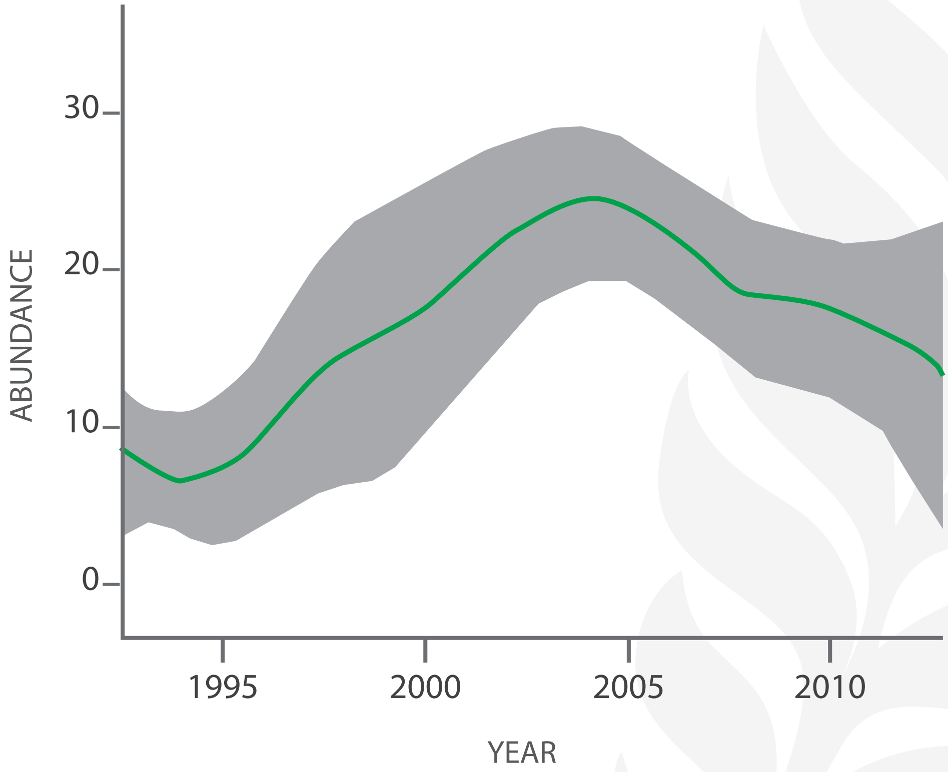
Additionally, the northern population of Lemuroid ringtails (Mount Lewis) severely declined after the 2005 heat waves that coincided with extreme low rainfall and an absence of cloud cover. No individuals were seen for a number of years although some individuals are now regularly sighted. This population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

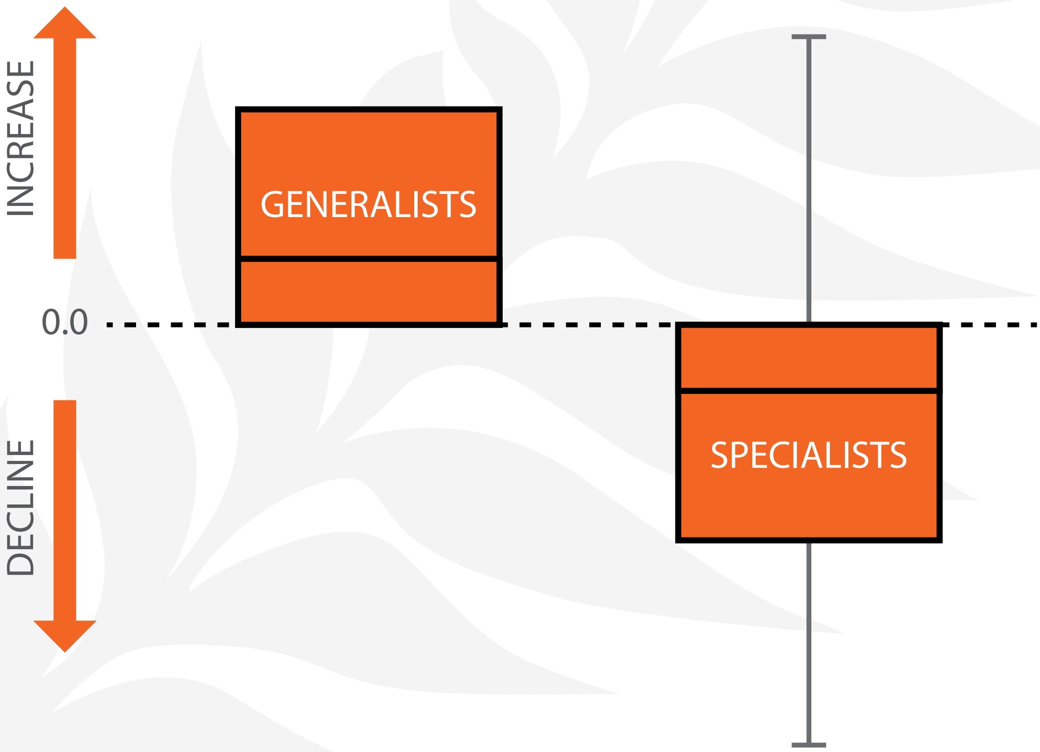


## Declines in specialised species

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]

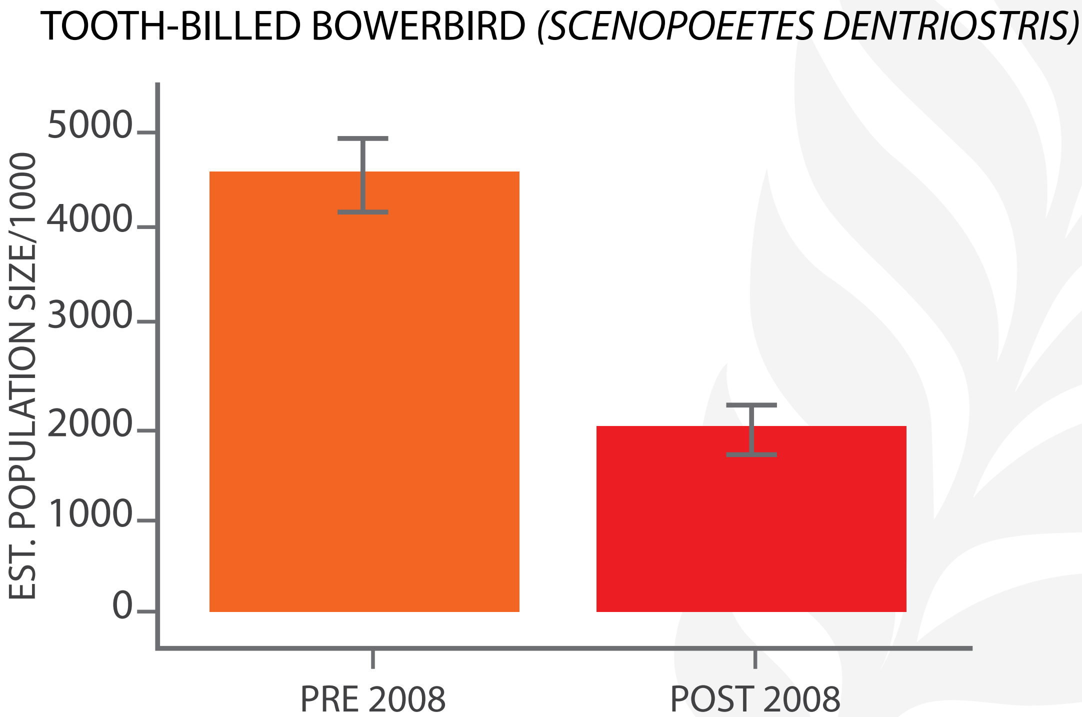
Large-scale refugial areas will, however, ultimately be required for successful long-term conservation of populations. These areas can be identified using spatially explicit modeling approaches that capitalise on long-term data of species distributions and climate modeling in the region. The utilisation 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.

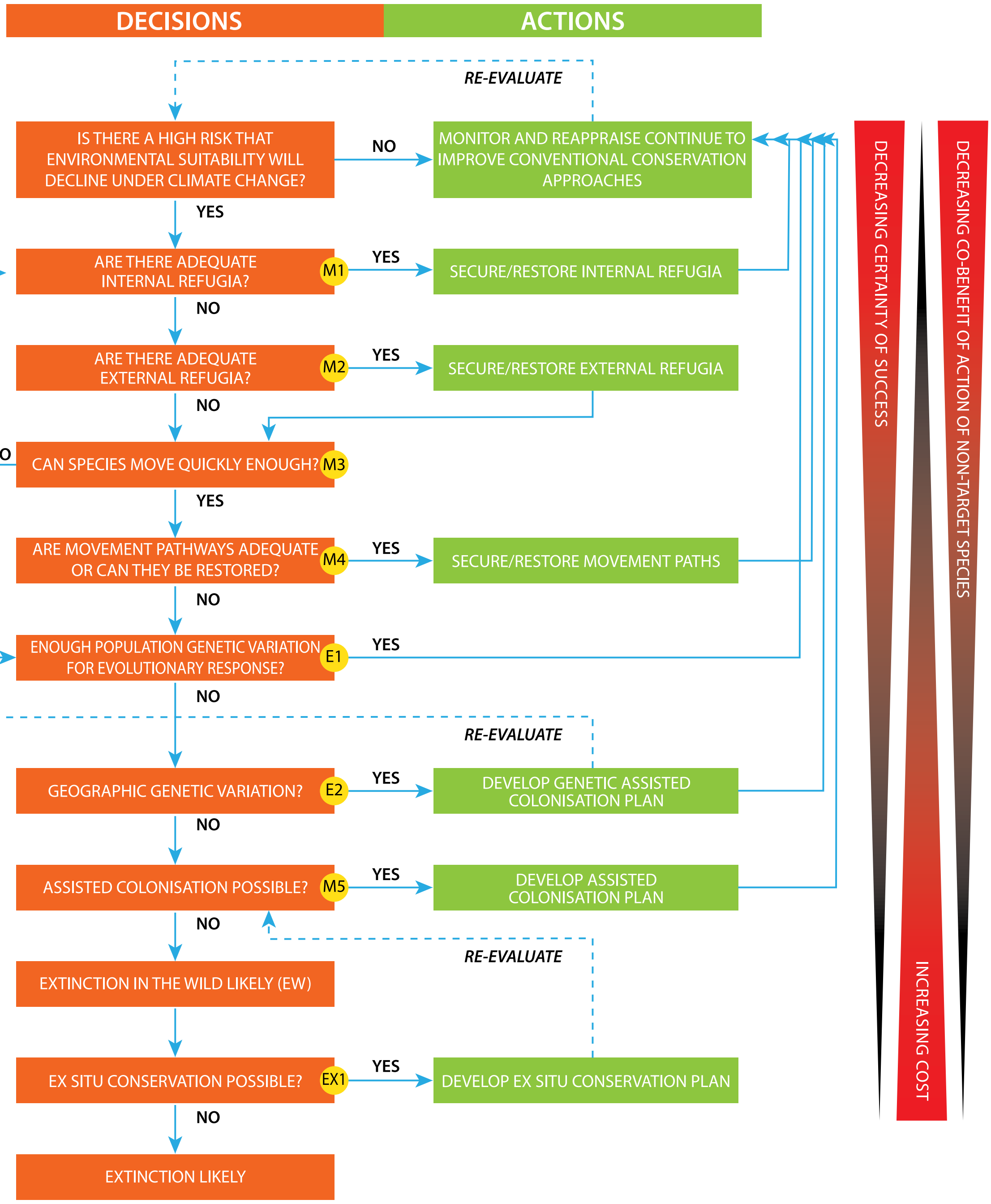
Toothbills have declined in overall population size and the distribution has retracted uphill (based on Williams et al. 2010 [81]; Anderson et al. in press)





*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.

*YELLOW CRAZY ANT*
WET TROPICS IMAGES/JURGEN FREUND

*LEAF TAILED GECKO*
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.

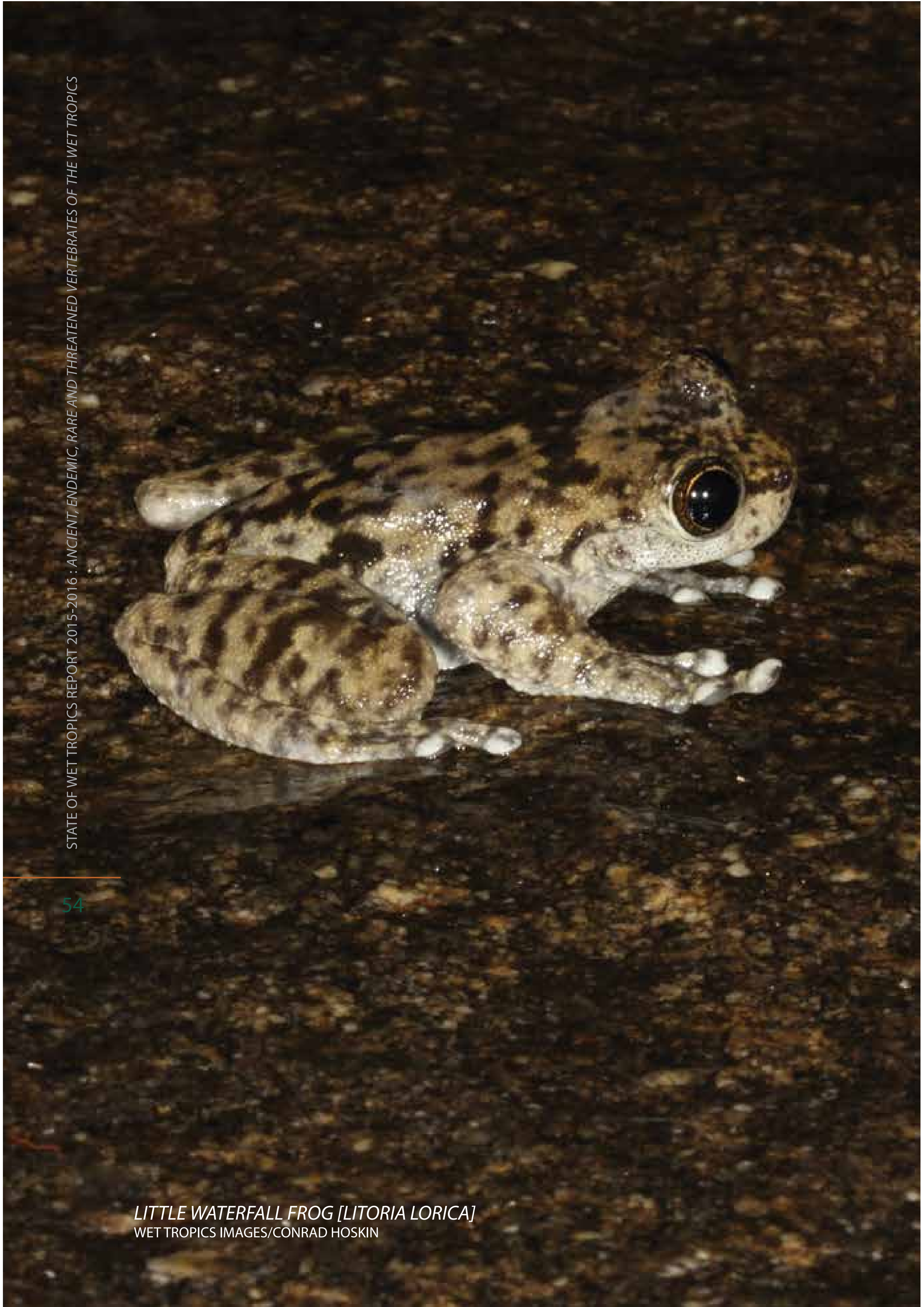




## Inappropriate fire regime

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]



*LITTLE WATERFALL FROG [LITORIA LORICA]*
WET TROPICS IMAGES/CONRAD HOSKIN

# 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.

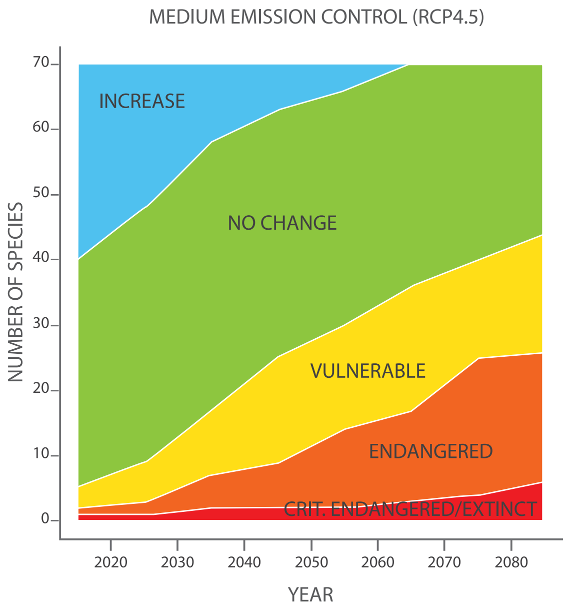
The Intergovernmental Panel on Climate Change (IPCC) fifth assessment report[127] used future climate scenarios to predict future climate change impacts on biodiversity (Williams and VanDerWal unpublished data). Available data restricted the analysis to include 202 species across taxonomic groupings 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.

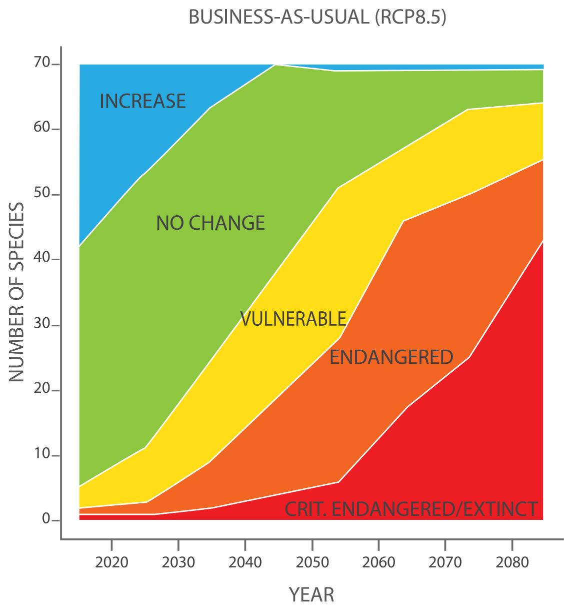
The 'business-as-usual' (RCP8.5) scenario predicts high levels of species loss would occur by 2085 with 92% of the 70 species of Wet Tropics endemic vertebrates becoming vulnerable, or worse; 79% of these species would incur a >70% population loss (thus becoming endangered) and 59% would incur a >90% 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 | *Taudactylus rheophilus* | northern tinkerfrog | 1 |
| BIRD | *Amblyornis newtoniana* | golden bowerbird | 2 |
| BIRD | *Sericornis keri* | Atherton scrubwren | 3 |
| FROG | *Cophixalus aenigma* | yapping nursery frog | 4 |
| FROG | *Cophixalus exiguus* | dainty nurseryfrog | 5 |
| FROG | *Cophixalus hosmeri* | rattling nurseryfrog | 6 |
| FROG | *Cophixalus neglectus* | Bellenden Ker nurseryfrog | 7 |
| MAMM | *Dasyurus maculatus* | spotted-tailed quoll | 8 |
| FROG | *Mixophyes carbinensis* | Carbine barred frog | 9 |
| BIRD | *Acanthiza katherina* | Mountain thornbill | 10 |
| BIRD | *Colluricincla boweri* | Bower's shrike thrush | 11 |
| BIRD | *Oreoscopus gutturalis* | fernwren | 12 |
| FROG | *Cophixalus monticola* | mountain nurseryfrog | 13 |
| FROG | *Cophixalus concinnus* | beautiful nursery frog | 14 |
| REPT | *Techmarscincus jigurru* | 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.

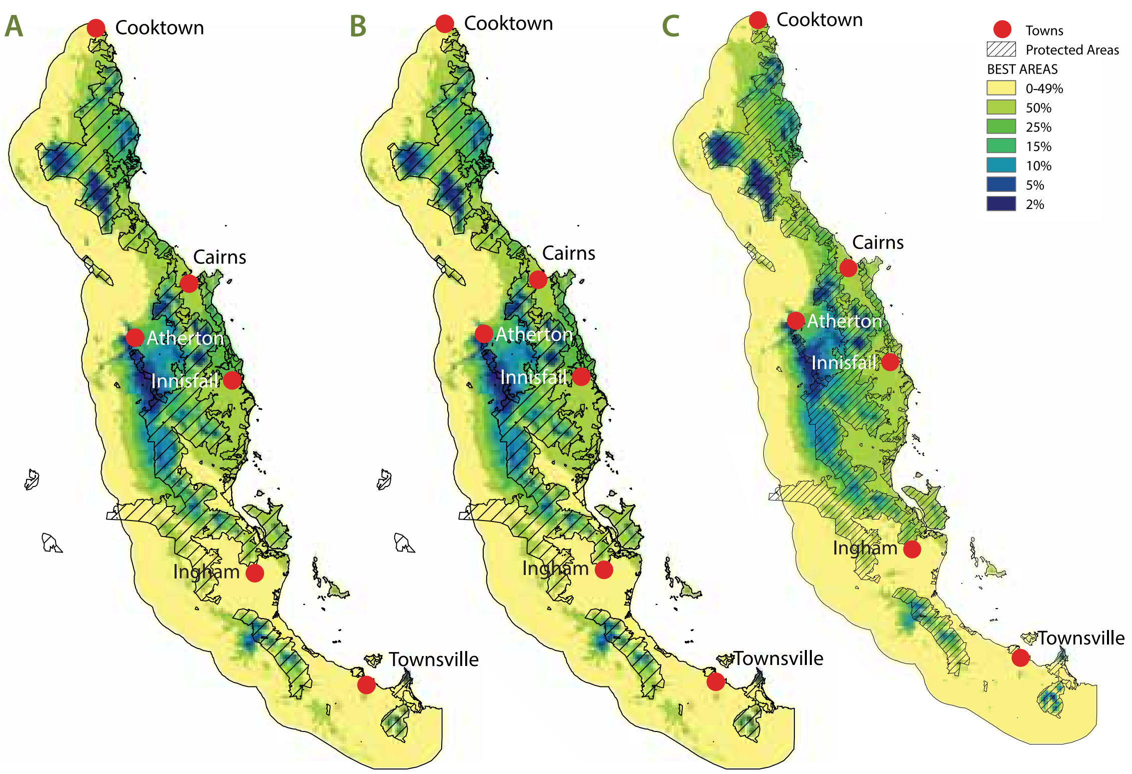
To support management decision making with the aim of increasing climate change resilience, it is important to identify those areas within the Wet Tropics that are the highest priority for protecting the biodiversity of the region, both now and into the future.

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



*BLOSSOM BAT*
WET TROPICS IMAGES/MIKE TRENERRY

## 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:

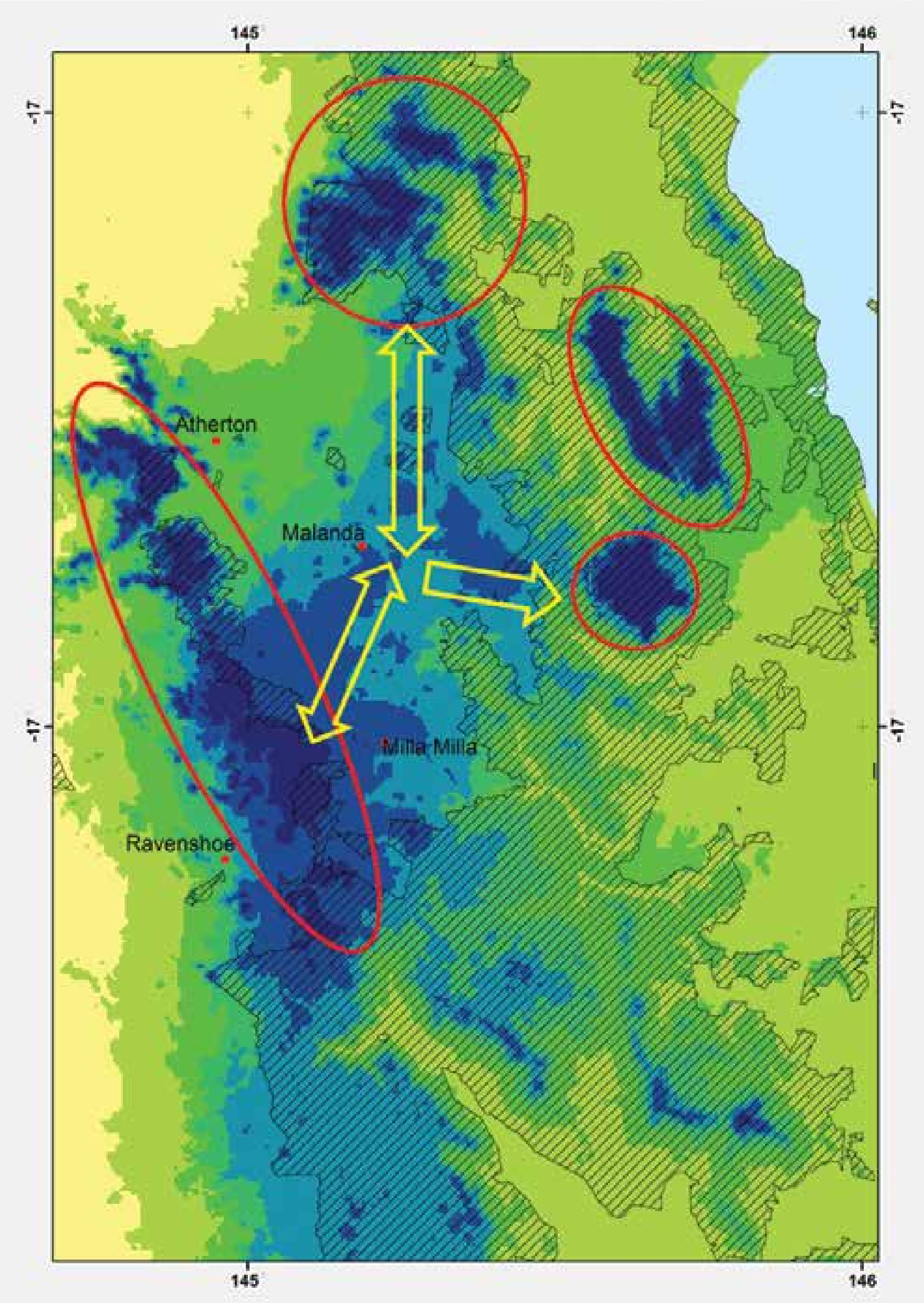
- some important future connectivity areas are not inside current protected areas
- the connectivity required to facilitate future movement between these areas is broken by the highly modified and fragmented forest on the Atherton Tableland and resilience would benefit from habitat restoration and revegetation 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.

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).

*RED-LEGGED PADEMELON*
WET TROPICS IMAGES/MIKE TRENERRY

## 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.



MILLAA MILLAA LOOKOUT
WET TROPICS IMAGES/PAUL CURTIS

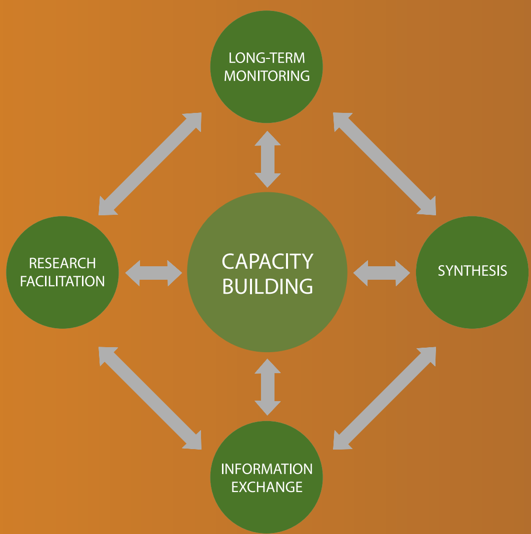




## From biodiversity science to new national parks for climate change

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

# References

1. Bertzky, B., et al., *Terrestrial Biodiversity and the World Heritage list: identifying borad gaps and potential candidate sites for inclussion in the natural World Heritage network.* 2013, IUCN, Gland and UNEP-WCMC: Cambridge, UK.
2. Winter, J.W., et al., *The distribution of rainforest in north-eastern Queensland, in The Rainforest Legacy*, P. Kershaw and G. Werren, Editors. 1987, AGPS: Canberra. p. 223-6.
3. Williams, S.E., *Vertebrates of the Wet Tropics Rainforest of Australia: Species Distributions and Biodiversity.* 2006, Cairns, Australia: Cooperative Research Centre for Tropical Rainforest Ecology and Management.
4. Welberger, J., S.E. Williams, and S. Goosem, *Gap analysis of environmental research needs in the Australian Wet Tropics.* 2011, Marine and Tropical Sciences Research Facility, Australian Government: Townsville - Queensland.
5. Media Release: *Queensland Site Sets Australian Rainfall Record.* 2001.
6. Williams, S.E., et al., *Towards an Understainding of Vertebrate Biodiveristy in the Australian Wet Tropics, in Living in a dynamic tropical forest landscape.* 2008, Blackwell Publishing, Ltd.: Cairns. p. 134-149.
7. Wilson, E.O., *The current state of biological diversity, in Biodiversity*, E.O. Wilson and F.M. Peter, Editors. 1998, National Academy Press: Washington DC. p. 3-20.
8. Myers, N., *Tropical Rainforests and their species: going, going...?*, in Biodiversity, E.O. Wilson and F.M. Peter, Editors. 1998, National Academy Press: Washington DC. p. 28-35.
9. Valentine, P. and H. Rosemary, *The Establishment of a World Heritage Area, in Living in a Dynamic Tropical Forest Landscape.* 2008, Wiley-Blackwell: Cairns. p. 81 - 93.
10. Stork, N.E. and S.M. Turton, *Living in a Dynamic Tropical Forest Landscape.* 2008, Blackwell Publishing: Carlton, Victoria.
11. Pusey, B., M. Kennard, and J. Bradley, *Species Richness and Geographical VAriation in Assemblage Structure of the Freswater Fish Fauna of the Wet Tropics Region of Northern Queensland.* 1996(556-573).
12. Goosem, S., G. Morgan, and J.E. Kemp, *In the Convervation Status of Queensland's Bioregional Ecosystems, in Living in a Dynamic Tropical Rainforest Landscape*, P.S. Sattler and R.D. Williams, Editors. 1999, Environmental Protection Agency: Brisbane, Australia. p. 1-73.
13. Welbergen, J., S.E. Williams, and S. Goosem, *Gap analysis of environmental research needs in the Australian Wet Tropics*. 2011, Marine and Tropical Sciences Research Facility, Australian Government: Townsville - Queensland.
14. Wet Tropics Management Authority, *State of the Tropics Management Authority 2013-2014 'Ancient, threatened and endemic plants of the Wet Tropics World Heritage Area'.* 2014, Wet Tropics Management Authority: Cairns, Australia.
15. Williams, S.E. and R.G. Pearson, *Historical Rainforest Contractions, Localized Extinctions and Patterns of Vertebrate Endemism in the Rainforest of Australia's Wet Tropics.* Proceedings of the Royal Society of London Series B-Biological Sciences, 1997(264): p. 709-716.
16. Williams, S.E., et al., *Ecological Specialization and Population Size in a Biodiversity Hotspot: How Rare Speices Avoid Extinction*. Proceedings of the National Academy of Sciences of the United States of America, 2009(106): p. 19737-19741.
17. Slatyer, C., D. Rosauer, and F. Lemckert, *An Assessment of Endemism and Species Richness Patterns in the Australia Anura.* Journal of Biogeography, 2007(34): p. 583-596.
18. Wiltshire, K., *Tropical Rainforest of North Queensland: Their Conservation Significance.* 1986, Canberra, Australia: Australian Government Publishing Service.
19. Nias, R., et al., *A Regional Action Plan for the Conservation for Threatened Species and Ecological Communities in the Wet Tropics of Queensland World Heritage Area.* 1993, WTMA-Scientific Reports: Cairns: Wet Tropics Management Authority.
20. Warren, G., *A Regional Action Plan for the Conservation of Rare and/or Threatened Wet Tropics Biota.* 1992, WTMA- Scientific Reports: Cairns - Wet Tropics Management Authority.
21. Williams, S.E., et al., *Distributional, Life History Characteristics, Ecological Specialization and Phylogeny of the Rainforest Vertebrates in the Australia Wet Tropics Bioregion.* Ecology, 2010. **VIII**(91): p. 2489.
22. Williams, S.E. and D. Hilbert, *Climate change threats to the biodiversity of tropical rainforests in Australia.*, in Emerging threats to tropical forests, W.F. Laurance and C. Peres, Editors. 2006, Chicago University Press, Chicage, USA.
23. Moritz, C., et al., *Identification and dynamics of a cryptic suture zone in tropical rainforest.* Proceedings of the Royal Society B-Biological Sciences, 2009. **276**(1660): p. 1235-1244.
24. Rosauer, D.F., et al., *Lineage range estimation method reveals fine-scale endemism linked to pleistocene stability in Australian rainforest herpetofauna.* PloS one, 2015. **10**(5): p. e0126274.

25. Isaac, N.J.B., et al., *Mammals on the EDGE: conservation priorities based on threat and phylogeny. .* PLoS One 2007. **2**(e29).

26. McJannet, D., J. Wallace, and P. Reddell, *Precipitation interception in Australian tropical rainforests: II. Altitudinal gradients of cloud interception, stemflow, throughfall and interception.* Hydrological Processes, 2007. **21**(13): p. 1703-1718.

27. McJannet, D., J. Wallace, and P. Reddell, *Precipitation interception in Australian tropical rainforests: I. Measurement of stemflow, throughfall and cloud interception.* Hydrological Processes, 2007. **21**(13): p. 1692-1702.

28. Williams, S.E. and J. Middleton, *Climatic seasonality, resource bottlenecks, and abundance of rainforest birds: implications for global climate change.* Diversity and Distributions, 2008. **14**: p. 69–77.

29. Williams, S.E., et al., *Distributional, life history characteristics, ecological specialization and phylogeny of the rainforest vertebrates in the Australia Wet Tropics bioregion.* Ecology (Data Paper), 2010.

30. Shoo, L.P., et al., *Potential for mountaintop boulder fields to buffer species against extreme heat stress under climate change.* International Journal of Biometeorology, 2010. **54**(4): p. 475-478.

31. Schneider, C. and S.E. Williams, *Effects of Quaternary Climate Change on Rainforest Diversity: Insights from Spatial Analyses of Species and Genes in Australia's Wet Tropics, in Tropical Rainforests: Past, Present and Future*, E. Bermingham, C.W. Dick, and C. Moritz, Editors. 2005, Chicago University Press: Chicago.

32. Ricklefs, R.E., *Community diversity: relative roles of local and regional processes.* Science, 1987. **235**(4785): p. 167-71.

33. Ricklefs, R.E. and D. Schluter, *Species Diversity in ecological communities: historical and geographical perspectives.* 1993, Chicago, USA: U. of Chicago Press.

34. Bermingham, E., C.W. Dick, and C. Moritz, *Tropical rainforests: past, present, and future.* 2005: University of Chicago Press.

35. Archer, M., S.J. Hand, and H. Godthelp, *Australia's lost world: prehistoric animals of Riversleigh.* 1991: Indiana University Press.

36. Hocknull, S.A., et al., *Responses of Quaternary rainforest vertebrates to climate change in Australia.* Earth and Planetary Science Letters, 2007. **264**(1): p. 317-331.

37. Skinner, A., A.F. Hugall, and M.N. Hutchinson, *Lygosomine phylogeny and the origins of Australian scincid lizards.* Journal of Biogeography, 2011. **38**(6): p. 1044-1058.

38. Rowe, K.C., et al., *Recent and rapid speciation with limited morphological disparity in the genus Rattus.* Systematic Biology, 2011. **60**(2): p. 188-203.

39. Mitchell, K.J., et al., *Ancient DNA reveals elephant birds and kiwi are sister taxa and clarifies ratite bird evolution.* Science, 2014. **344**(6186): p. 898-900.

40. Hoskin, C.J., *The advertisement call of the Cape Melville Treefrog Litoria andiirrmalin (Anura: Hylidae).* Zootaxa, 2014. **3786**(4): p. 499-500.

41. Mahony, M., et al., *Species boundaries among barred river frogs, Mixophyes (Anura : Myobatrachidae) in north-eastern Australia, with descriptions of two new species.* Zootaxa, 2006(1228): p. 35-60.

42. Oza, A.U., et al., *Recent speciation and limited phylogeographic structure in Mixophyes frogs from the Australian Wet Tropics.* Molecular phylogenetics and evolution, 2012. **62**(1): p. 407-413.

43. Hoskin, C.J., *Australian microhylid frogs (Cophixalus and Austrochaperina): phylogeny, taxonomy, calls, distributions and breeding biology.* Australian Journal of Zoology, 2004. **52**(3): p. 237-269.

44. Hoskin, C.J., *Two new frog species (Microhylidae: Cophixalus) from the Australian Wet Tropics region, and redescription of Cophixalus ornatus.* Zootaxa, 2012. **3271**: p. 1-16.

45. Moritz, C., et al., *Historical biogeography, diversity and conservation of Australia's tropical rainforest herpetofauna, in Phylogeny and Conservation*, A. Purvis, J.L. Gittleman, and T. Brooks, Editors. 2005. p. 243-264.

46. Hoskin, C.J., et al., *Reinforcement drives rapid allopatric speciation.* Nature, 2005. **437**(7063): p. 1353-1356.

47. Hoskin, C.J. and H. McCallum, *Phylogeography of the parasitic fly Batrachomyia in the Wet Tropics of north-east Australia, and susceptibility of host frog lineages in a mosaic contact zone.* Biological Journal of the Linnean Society, 2007. **92**(3): p. 593-603.

48. Graham, C.H., C. Moritz, and S.E. Williams, *Habitat history improves prediction of biodiversity in rainforest fauna. Proceedings of the National Academy of Sciences of the United States of America*, 2006. **103**(3): p. 632-636.

49. Graham, C.H., et al., *Dynamic refugia and species persistence: tracking spatial shifts in habitat through time. Ecography*, 2010. **33**(6): p. 1062-1069.

50. Williams, S.E. and R.G. Pearson, *Historical rainforest contractions, localized extinctions and patterns of vertebrate endemism in the rainforests of Australia's wet tropics.* Proceedings of the Royal Society of

London Series B-Biological Sciences, 1997. **264**(1382): p. 709-716.

51. Williams, S.E., et al., *Distributions, life history specialisation and phylogeny of the rainforest vertebrates in the Australian Wet Tropics.* Ecology (Data Paper), 2010. **91**(8): p. 2493.
52. Williams, S.E. and J.-M. Hero, *Rainforest frogs of the Australian Wet Tropics: guild classification and the ecological similarity of declining species.* Proceedings of the Royal Society of London B: Biological Sciences, 1998. **265**(1396): p. 597-602.
53. Staunton, K.M., et al., *Projected Distributions and Diversity of Flightless Ground Beetles within the Australian Wet Tropics and Their Environmental Correlates.* PLoS ONE, 2014. **9**(2).
54. Zamora-Vilchis, I., S.E. Williams, and C.N. Johnson, *Environmental Temperature Affects Prevalence of Blood Parasites of Birds on an Elevation Gradient: Implications for Disease in a Warming Climate.* PLoS ONE, 2012. **7**(6).
55. Hugall, A., et al., *Reconciling paleodistribution models and comparative phylogeography in the Wet Tropics rainforest land snail Gnarosophia bellendenkerensis (Brazier 1875).* Proceedings of the National Academy of Sciences of the United States of America, 2002. **99**(9): p. 6112-6117.
56. Bell, R.C., et al., *Patterns of persistence and isolation indicate resilience to climate change in montane rainforest lizards.* Molecular Ecology, 2010. **19**(12): p. 2531-2544.
57. Moussalli, A., et al., *Variable responses of skinks to a common history of rainforest fluctuation: concordance between phylogeography and palaeo-distribution models.* Molecular Ecology, 2009. **18**(3): p. 483-499.
58. Singhal, S. and C. Moritz, *Strong selection against hybrids maintains a narrow contact zone between morphologically cryptic lineages in a rainforest lizard.* Evolution, 2012. **66**(5): p. 1474-1489.
59. VanDerWal, J., L.P. Shoo, and S.E. Williams, *New approaches to understanding late Quaternary climate fluctuations and refugial dynamics in Australian wet tropical rainforests.* Journal of Biogeography, 2009. **36**(2): p. 291-301.
60. Kershaw, A.P., et al., *Patterns and causes of vegetation change in the Australian Wet Tropics region over the last 10 million years.* Tropical rainforests: past, present and future, 2005: p. 374-400.
61. Carnaval, A.C., et al., *Stability predicts genetic diversity in the Brazilian Atlantic forest hotspot.* Science, 2009. **323**(5915): p. 785-789.
62. Knowles, L.L., *Statistical phylogeography. Annual Review of Ecology, Evolution, and Systematics*, 2009. **40**: p. 593-612.
63. Werneck, F.P., et al., *Revisiting the historical distribution of Seasonally Dry Tropical Forests: new insights based on palaeodistribution modelling and palynological evidence.* Global Ecology and Biogeography, 2011. 20(2): p. 272-288.
64. Sandel, B., et al., *The Influence of Late Quaternary Climate-Change Velocity on Species Endemism. Science*, 2011. **334**(6056): p. 660-664.
65. Graham, C.H., et al., *The origin and maintenance of montane diversity: integrating evolutionary and ecological processes.* Ecography, 2014. **37**(8): p. 711-719.
66. Isaac, J.L., et al., *Resistance and resilience: quantifying relative extinction risk in a diverse assemblage of Australian tropical rainforest vertebrates.* Diversity and Distributions, 2009. **15**(2): p. 280-288.
67. Moritz, C., et al., *Diversification of rainforest faunas: An integrated molecular approach.* Annual Review of Ecology and Systematics, 2000. **31**: p. 533-563.
68. Hoskin, C.J., et al., *Persistence in peripheral refugia promotes phenotypic divergence and speciation in a rainforest frog.* The American Naturalist, 2011. **178**(5): p. 561-578.
69. Araújo, M.B., et al., *Quaternary climate changes explain diversity among reptiles and amphibians.* Ecography, 2008. **31**(1): p. 1600-0587.
70. Nix, H.A. and M.A. Switzer, *Rainforest Animals: Atlas of Vertebrates Endemic to the Wet Tropics.* 1991, Australian National Parks and Wildlife Service: Canberra, Australia.
71. Schneider, C. and S.E. Williams, *Quaternary climate change and rainforest diversity: insights from spatial analyses of species and genes in Australia's wet tropics, in Tropical Rainforests: Past, Present and Future.* 2005, Chicagao University Press, Chicago, USA.
72. Mora, C., et al., *The projected timing of climate departure from recent variability.* Nature, 2013. **502**(7470): p. 183-187.
73. Beaumont, L.J., et al., *Impacts of climate change on the world's most exceptional ecoregions.* Proceedings of the National Academy of Sciences, 2011. **108**(6): p. 2306-2311.
74. Williams, S.E., et al., T*owards an Integrated Framework for Assessing the Vulnerability of Species to Climate Change.* Plos Biology, 2008. **6**(12): p. 2621-2626.
75. Wet Tropics Managemetnt Authority (2012) Annual Report and State of Wet Tropics Report, Wet Tropics Management Authority, Cairns.
76. Girringun Aboriginal Corporation, 2005. No Wabu No Wuju No Gunduy, No Rainforest, No Food, No Cassowary. DVD, Girringun Aboriginal Corporation, Carwell,QLD.

77. Williams, S.E., E.E. Bolitho, and S. Fox, *Climate change in Australian tropical rainforests: an impending environmental catastrophe*. Proceedings of the Royal Society of London Series B-Biological Sciences, 2003. **270**(1527): p. 1887-1892.
78. Urban, M., *Accelerating extinction risk from climate change*. Science, 2015. **348**(6234): p. 571-573.
79. Pounds, A.J., et al., Widespread amphibian extinctions from epidemic disease driven by global warming. Nature, 2006. 439(7073): p. 161-167.
80. La Sorte, F. and W. Jetz, *Projected range contractions of montane biodiversity under global warming*. Proceedings of Royal Society B, 2010. **277**(1699).
81. Thomas, C.D., et al., *Biodiversity conservation: Uncertainty in predictions of extinction risk/Effects of changes in climate and land use/Climate change and extinction risk (reply)*. Nature, 2004. **430**(6995).
82. Urban, M.C., *Accelerating extinction risk from climate change*. Science, 2015. **348**(6234): p. 571-573.
83. Williams, S.E., et al., *Elevational gradients in assemblage structure and productivity of rainforest birds in the Australian Wet Tropics bioregion*. Austral Ecology, 2010. **35**: p. 650-664.
84. Williams, S.E., E.E. Bolitho, and S. Fox, *Climate change in Australian tropical rainforests: an impending environmental catastrophe*. Proceedings of the Royal Society of London Series B-Biological Sciences, 2003. **270**(1527): p. 1887-1892.
85. Shoo, L., et al., *Making decisions to conserve species under climate change.* Climatic Change, 2013. **119**(2): p. 239–246.
86. Reside, A.E., et al., *Climate change refugia for terrestrial biodiversity*. 2013, National Climate Change Adaptation Research Facility.
87. Scheffers, B.R., et al., *Thermal buffering of microhabitats is a critical factor mediating warming vulnerability of frogs in the Philippine biodiversity hotspot*. Biotropica, 2013. **45**(5): p. 628-635.
88. Hoffmann, A.A. and C.M. Sgro, *Climate change and evolutionary adaptation*. Nature, 2011. **470**(7335): p. 479-485.
89. Moritz, C., et al., *Integrating phylogeography and physiology reveals divergence of thermal traits between central and peripheral lineages of tropical rainforest lizards*. Philosophical Transactions of the Royal Society B: Biological Sciences, 2012. **367**(1596): p. 1680-1687.
90. Llewelyn, J., et al., *Intraspecific variation in climate-relevant traits in a tropical rainforest lizard*. Diversity and Distributions, 2016.
91. IUCN. *IUCN Red List of Threatened Species*. Version 2010.4. 2010 09 March 2011; Available from: www.iucnredlist.org.
92. Winter, J.W., et al., *Rainforest clearfelling in northeastern Australia*. Proceedings of the Royal Society of Queensland, 1987. **98** p. 41-57.
93. Laurance, W.F., M. Goosem, and S.G.W. Laurance, *Impacts of roads and linear clearings on tropical forests*. Trends in Ecology & Evolution, 2009. **24**(12): p. 659-669.
94. Goosem, M., *Effects of tropical rainforest roads on small mammals: edge changes in community composition*. Wildlife Research, 2000. **27**(2): p. 151-163.
95. Laurance, W.F., S.G. Laurance, and D.W. Hilbert, *Long-term dynamics of a fragmented rainforest mammal assemblage*. Conservation Biology, 2008. **22**(5): p. 1154-1164.
96. Sumner, J., C. Moritz, and R. Shine, *Shrinking forest shrinks skink: morphological change in response to rainforest fragmentation in the prickly forest skink (Gnypetoscincus queenslandiae)*. Biological Conservation, 1999. **91**(2): p. 159-167.
97. Sumner, J., *Decreased relatedness between male prickly forest skinks (Gnypetoscincus queenslandiae) in habitat fragments.* Conservation Genetics, 2005. **6**(3): p. 333-340.
98. Vitousek, P.M., et al., *Biological Invasions as Global Environmental Change.* American Scientist 1996. **84**: p. 468–478.
99. Hughes, L., et al., *National Climate Change Adaptation Research Plan: Terrestrial Biodiversity*. 2010, Brisbane: NCCARF.
100. Poon, E., et al., *Assessment of Research Needs for the Management of Invasive Species in the Terrestrial and Aquatic Ecosystems of the Wet Tropics.* 2007, Reef and Rainforest Centre Limited: Cairns: Marine and Tropical Sciences Research Facility.
101. *Wet Tropics Conservation Strategy*. 2004, Wet Tropics Management Authority, Cairns.
102. Berger, L., et al., *Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America.* Proceedings of the National Academy of Sciences, 1998. **95**(15): p. 9031-9036.
103. Lips, K.R., et al., *Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community*. Proceedings of the national academy of sciences of the United States of America, 2006. **103**(9): p. 3165-3170.

104. Collins, J.P. and M.L. Crump, *Global amphibian extinctions: the mysterious environmental die-off*. 2009, USA, Oxford University Press.

105. Puschendorf, R., et al., *Environmental Refuge from Disease-Driven Amphibian Extinction*. Conservation Biology, 2011. 25(5): p. 956-964.

106. Stuart, S.N., et al., *Status and Trends of Amphibian Declines and Extinctions Worldwide*. Science, 2004. 306: p. 1783-1786.

107. McDonald, K. and R.A. Alford, *A review of declining frogs in northern Queensland*. Declines and disappearances of Australian frogs, 1999: p. 14-22.

108. Hoskin, C.J. and J.-M. Hero, *Rainforest frogs of the Wet Tropics, north-east Australia*. Griffith University, 2008.

109. Richards, S., K. McDonald, and R. Alford, *Declines in Populations of Australia's Endemic Tropical Rainforest Frogs, in WTMA - Scientific Reports*. 1993, Wet Tropics Management Authority: Cairns.

110. McDonald, K.R., *Distribution patterns and conservation status of north Queensland rainforest frogs, in Conservation*. Technical Report No. 1. 1992, Queensland Department of Environment and Heritage (now Queensland Environmental Protection Agency): Brisbane.

111. Wet Tropics Management Authority, 2009. *Annual Report and State of the Wet Tropics Report 2008–2009* Wet Tropics Management Authority: Cairns.

112. Harrison, D.A., Congdon, and B. C., *Wet Tropics Vertebrate Pest Risk Assessment Scheme*. 2006, Cooperative Research Centre for Tropical Rainforest Ecology and Management: Cairns.

113. Congdon, B.C. and D.A. Harrison, *Vertebrate Pests of the Wet Tropics Bioregion: Current and Future Status, in Living in a Dynamic Tropical Forest Landscape*, N. Stork and T. S., Editors. 2008, Blackwell Publishing.: Carlton, Victoria. p. 322-333.

114. Lach, L. and Hoskin, C. Yellow Crazy Ants in the Wet Tropics, Wildlife Australia.org. 2015 p 39-41,

115. Gross, C.L. and D. Mackay, *Honeybees Reduce Fitness in the Pioneer Shrub Melastoma Affine (Melastomataceae)* Biological Conservation, 1998. 86: p. 169-178.

116. Bowman, D.M.J.S., *Australian Rainforests: Island of Green in a Land of Fire*. 2001, Cambridge: Cambridge University Press.

117. Williams, A.J., D.J. Karoly, and T. N., *The Sensitivity of Australian Fire Danger to Climate Change*. Climatic Change, 2001. **49**(1): p. 171-191.

118. Poon, E., et al., *Assessment of Research Needs for the Management of Invasive Species in the Terrestrial and Aquatic Ecosystems of the Wet Tropics*. 2007, Reef and Rainforest Centre Limited: Cairns: Marine and Tropical Sciences Research Facility.

119. Climate Change 2007: *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. 2007, Cambridge U.K: Cambridge University Press.

120. Hughes, L., *Biological Consequences of Global Warming: Is the Signal Already Apparent?*. Trends in Ecology & Evolution, 2000(15): p. 56-61.

121. IPCC, *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. 2014, Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. 1132.

122. Suppiah, R., I. Macadam, and P.H. Whetton, *Climate Change Projections for the Tropical Rainforest Region of North Queensland*. 2007, Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited.: Cairns, Australia.

123. Easterling, D.R., et al., *Climate Extremes: Observations, Modeling, and Impacts*. Science, 2000(289): p. 2068-2074.

124 Johnson, A.K.L. and A.E. Murray, *Modelling the Spatial and Temporal Distribution of Rainfall: A Case Study in the Wet and Dry Tropics of North East Australia*. Australian Geographer 2004(35): p. 39-57.

125. Pounds, A.J., M.P.L. Fogden, and J.H. Campbell, *Biological Response to Climate Change on a Tropical Mountain*. Nature, 1999(398): p. 611-615.

126. Dunlop, M. and P.R. Brown, *Implications of Climate Change for Australia's National Reserve System: A Preliminary Assessment*. Report to the Department of Climate Change, February 2008. 2008, Department of Climate Change: Canberra, Australia.

127. IPCC, Climate Change 2014: I*mpacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change 2014*, Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. 1132

128. Rosauer, D.F., et al., *Lineage range estimation method reveals fine-scale endemism linked to pleistocene stability in Australian rainforest herpetofauna*. PloS one, 2015. **10**(5): p. e0126274.

129. Isaac, N.J.B., et al., *Mammals on the EDGE: conservation priorities based on threat and phylogeny*. PLoS One 2007. 2(e29).

130. Warren, R., et al., Quantifying the benefit of early climate change mitigation in avoiding biodiversity loss. Nature Climate Change, 2013. 3(7): p. 678-682.

131. Welbergen, J., S. Williams, and S. Goosem, *Gap analysis of environmental research needs in the Australian Wet Tropics*. Australian Government, 2011.

132. Queensland Government 2015, Reef 2050 Plan- implementation Strategy available at www.environment.gov.au/system/files/resources/32cb8925-03ee-40e7-9b27-4b3848d3b5f5/files/reef-2050-plan-implementation-strategy_0.pdf)

133. Turton, S. 2016. Ecocheck: Australia's Wet Tropics are worth billions, if we can keep out the invading ants. The Conversation, published on line 31 March, 2016. Available from: https://theconversation.com/ecocheck-australias-wet-tropics-are-worth-billions-if-we-can-keep-out-the-invading-ants-56815

134. Isaac, N.J.B., et al., *Mammals on the EDGE: conservation priorities based on threat and phylogeny*. PLoS One 2007. 2(e29).

135. Williams, S.E. and J.-M. Hero, *Rainforest frogs of the Australian Wet Tropics: guild classification and the ecological similarity of declining species*. Proceedings of the Royal Society of London B: Biological Sciences, 1998. **265**(1396): p. 597-602.

136. Carroll, C., J.R. Dunk, and A. Moilanen, *Optimizing resiliency of reserve networks to climate change: multispecies conservation planning in the Pacific Northwest, USA*. Global Change Biology, 2010. **16**(3): p. 891-904.

137. Shoo, L.P., et al., *Targeted protection and restoration to conserve tropical biodiversity in a warming world*. Global Change Biology, 2011. 17(1): p. 186-193.

138. Williams, S.E. and L. Falconi, *Climate change could empty wildlife from Australia's rainforests, in The Conversation*. 2015

139. Vanderwal, J., et al., *Science can influence policy and benefit the public – here's how, in The Conversation*. 2015.

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

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

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

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

| Family | Species | Common Name | WT End. | Con Stat. | VIS | Elev. Range | Temp. Range | Precip. Range |
|---|---|---|---|---|---|---|---|---|
| Burhinidae | *Burhinus grallarius* | bush stone-curlew | | | | | | |
| Burhinidae | *Esacus magnirostris* | beach stone-curlew | | VU | 1 | | | |
| Haematopodidae | *Haematopus fuliginosus* | sooty oystercatcher | | | | | | |
| Recurvirostridae | *Himantopus leucocephalus* | black-winged stilt | | | | | | |
| Charadriidae | *Vanellus miles* | masked lapwing | | | | | | |
| Charadriidae | *Vanellus tricolor* | banded lapwing | | | | | | |
| Charadriidae | *Erythrogonys cinctus* | red-kneed dotterel | | | | | | |
| Charadriidae | *Charadrius ruficapillus* | red-capped plover | | | | | | |
| Charadriidae | *Charadrius veredus* | oriental plover | | | | | | |
| Charadriidae | *Elseyornis melanops* | black-fronted dotterel | | | | | | |
| Glareolidae | *Stiltia isabella* | Australian pratincole | | | | | | |
| Laridae | *Hydroprogne caspia* | caspian tern | | | | | | |
| Laridae | *Chlidonias hybrida* | whiskered tern | | | | | | |
| Columbidae | *Geophaps scripta* | squatter pigeon | | | | | | |
| Columbidae | *Phaps chalcoptera* | common bronzewing | | | | | | |
| Columbidae | *Geopelia placida* | peaceful dove | | | | | | |
| Columbidae | *Chalcophaps indica* | grey-capped emerald dove | | | 1 | 2 - 1294 | 17.4 - 24.6 | 1059 - 4157 |
| Columbidae | *Phaps histrionica* | flock bronzewing | | | | | | |
| Columbidae | *Ducula bicolor* | pied imperial-pigeon | | | | 0 - 1110 | 18.1 - 24.6 | 1005 - 4149 |
| Columbidae | *Ptilinopus magnificus* | wet tropics wompoo fruit-dove | 3 | | 1 | 9 - 1246 | 17.6 - 24.6 | 1137 - 4141 |
| Columbidae | *Lopholaimus antarcticus* | topknot pigeon | | | 1 | 3 - 1540 | 15.7 - 24.6 | 1170 - 7408 |
| Columbidae | *Columba leucomela* | white-headed pigeon | | | | 18 - 1350 | 16.7 - 24.5 | 1241 - 5825 |
| Columbidae | *Streptopelia chinensis* | spotted turtle-dove | | | | | | |
| Columbidae | *Ocyphaps lophotes* | crested pigeon | | | | | | |
| Columbidae | *Ptilinopus superbus* | superb fruit-dove | | | | 8 - 1540 | 15.7 - 24.5 | 1131 - 7413 |
| Columbidae | *Ptilinopus regina* | rose-crowned fruit-dove | | | | 0 - 1090 | 18.2 - 24.7 | 1028 - 3675 |
| Columbidae | *Geopelia humeralis* | bar-shouldered dove | | | | | | |
| Columbidae | *Geopelia cuneata* | diamond dove | | | | | | |
| Columbidae | *Macropygia amboinensis* | brown cuckoo-dove | | | | 9 - 1372 | 16.6 - 24.5 | 1052 - 5493 |
| Cacatuidae | *Cacatua sanguinea* | little corella | | | | | | |
| Cacatuidae | *Nymphicus hollandicus* | cockatiel | | | | | | |
| Cacatuidae | *Eolophus roseicapillus* | galah | | | | | | |
| Cacatuidae | *Calyptorhynchus banksii* | red-tailed black cockatoo | | | | | | |
| Cacatuidae | *Cacatua galerita* | sulphur-crested cockatoo | | | | 0 - 1437 | 16.2 - 24.8 | 814 - 6505 |
| Cacatuidae | *Calyptorhynchus lathami* | glossy black cockatoo | | | 1 | | | |
| Psittaculidae | *Cyclopsitta diophthalma* | Coxen's fig-parrot | 3 | VU | 1 | 0 - 1210 | 17.7 - 24.6 | 1230 - 4157 |
| Psittaculidae | *Trichoglossus chlorolepidotus* | scaly-breasted lorikeet | | | | 0 - 1300 | 17.3 - 24.6 | 893 - 4047 |
| Psittaculidae | *Parvipsitta pusilla* | little lorikeet | | | | | | |
| Psittaculidae | *Aprosmictus erythropterus* | red-winged parrot | | | | | | |
| Psittaculidae | *Trichoglossus haematodus* | rainbow lorikeet | | | | 0 - 1294 | 17.2 - 24.9 | 812 - 5252 |
| Psittaculidae | *Melopsittacus undulatus* | budgerigar | | | | | | |
| Psittaculidae | *Platycercus elegans* | crimson rosella | | | | 360 - 1437 | 16.2 - 22.5 | 1321 - 6505 |
| Psittaculidae | *Alisterus scapularis* | Australian king-parrot | 3 | | 1 | 20 - 1540 | 15.7 - 23.9 | 1202 - 7408 |
| Psittaculidae | *Platycercus adscitus* | pale-headed rosella | | | | | | |
| Cuculidae | *Cacomantis castaneiventris* | chestnut-breasted cuckoo | | | | 20 - 612 | 20.7 - 24.3 | 2036 - 2397 |
| Cuculidae | *Eudynamys orientalis* | eastern koel | | | 1 | 0 - 1110 | 18.1 - 24.6 | 938 - 3915 |
| Cuculidae | *Chalcites minutillus* | Gould's bronze-cuckoo | | | 1 | 0 - 979 | 18.9 - 24.7 | 1061 - 4149 |
| Cuculidae | *Chalcites minutillus* | little bronze-cuckoo | | | 1 | 0 - 1260 | 17.5 - 24.8 | 1039 - 3915 |
| Cuculidae | *Scythrops novaehollandiae* | channel-billed cuckoo | | | 1 | 0 - 1110 | 18.1 - 24.6 | 812 - 4074 |
| Cuculidae | *Chalcites osculans* | black-eared cuckoo | | | | | | |
| Cuculidae | *Cuculus optatus* | oriental cuckoo | | | | 7 - 902 | 19.3 - 24.5 | 989 - 3091 |
| Cuculidae | *Chalcites basalis* | Horsfield's bronze-cuckoo | | | | | | |
| Cuculidae | *Cacomantis pallidus* | pallid cuckoo | | | | | | |
| Cuculidae | *Chalcites lucidus* | 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 | *Cacomantis variolosus* | brush cuckoo | | | 1 | 1 - 1181 | 18 - 24.6 | 886 - 3915 |
| Cuculidae | *Cacomantis flabelliformis* | fan-tailed cuckoo | | | | 0 - 1507 | 15.9 - 24.3 | 828 - 7109 |
| Cuculidae | *Centropus phasianinus* | pheasant coucal | | | | | | |
| Strigidae | *Ninox boobook* | wet tropics boobook | 3 | | 1 | 4 - 1443 | 16.2 - 23.9 | 828 - 6556 |
| Strigidae | *Ninox rufa* | rufous owl | | | 1 | 5 - 1140 | 18.2 - 24.4 | 1057 - 2784 |
| Strigidae | *Ninox connivens* | barking owl | | | | | | |
| Tytonidae | *Tyto delicatula* | eastern barn owl | | | | | | |
| Tytonidae | *Tyto multipunctata* | lesser sooty owl | 2 | | 1 | 23 - 1215 | 17.7 - 24.3 | 1202 - 4677 |
| Tytonidae | *Tyto longimembris* | eastern grass owl | | | | | | |
| Tytonidae | *Tyto novaehollandiae* | masked owl | | | | | | |
| Podargidae | *Podargus strigoides* | tawny frogmouth | | | 1 | | | |
| Podargidae | *Podargus papuensis* | Papuan frogmouth | | | 1 | 4 - 1198 | 17.8 - 24.6 | 1356 - 3908 |
| Caprimulgidae | *Eurostopodus argus* | spotted nightjar | | | | | | |
| Caprimulgidae | *Eurostopodus mystacalis* | white-throated nightjar | | | | | | |
| Caprimulgidae | *Caprimulgus macrurus* | large-tailed bightjar | | | | | | |
| Aegothelidae | *Aegotheles cristatus* | Australian owlet-nightjar | | | | | | |
| Apodidae | *Aerodramus vanikorensis* | uniform swiftlet | | | | | | |
| Apodidae | *Apus pacificus* | fork-tailed swift | | | | | | |
| Apodidae | *Hirundapus caudacutus* | white-throated needletail | | | 1 | 3 - 1414 | 16.4 - 24.4 | 950 - 5805 |
| Apodidae | *Collocalia esculenta* | glossy swiftlet | | | | | | |
| Apodidae | *Aerodramus terraereginae* | Australian swiftlet | | | | 0 - 1317 | 17.1 - 24.7 | 924 - 4157 |
| Apodidae | *Apus affinis* | house swift | | | | | | |
| Alcedinidae | *Todiramphus sordidus* | Torresian kingfisher | | | | | | |
| Alcedinidae | *Todiramphus sanctus* | sacred kingfisher | | | | | | |
| Alcedinidae | *Todiramphus pyrrhopygius* | red-backed kingfisher | | | | | | |
| Alcedinidae | *Ceyx azureus* | azure kingfisher | | | 1 | 2 - 1080 | 18.2 - 24.7 | 817 - 4157 |
| Alcedinidae | *Dacelo leachii* | blue-winged kookaburra | | | | | | |
| Alcedinidae | *Dacelo novaeguineae* | laughing kookaburra | | | | | | |
| Alcedinidae | *Ceyx pusilla* | little kingfisher | | | 1 | 1 - 880 | 19.4 - 24.7 | 817 - 3727 |
| Alcedinidae | *Todiramphus macleayii* | forest kingfisher | | | | | | |
| Alcedinidae | *Tanysiptera sylvia* | buff-breasted paradise-kingfisher | | | 1 | 0 - 934 | 19 - 24.7 | 1087 - 3915 |
| Meropidae | *Merops ornatus* | rainbow bee-eater | | | | 0 - 1280 | 17.4 - 24.8 | 814 - 4157 |
| Coraciidae | *Eurystomus orientalis* | dollarbird | | | | | | |
| Pittidae | *Pitta versicolor* | noisy pitta | | | | 2 - 1160 | 18 - 24.6 | 1044 - 3915 |
| Climacteridae | *Climacteris picumnus* | Cape York brown treecreeper | | | | | | |
| Climacteridae | *Cormobates leucophaea* | white-throated treecreeper | | | 1 | 20 - 1537 | 15.7 - 24.3 | 1202 - 7392 |
| Climacteridae | *Climacteris picumnus* | north-eastern brown treecreeper | | | | | | |
| Maluridae | *Malurus melanocephalus* | red-backed fairy-wren | | | | | | |
| Maluridae | *Malurus amabilis* | lovely rairy-wren | | | | | | |
| Pardalotidae | *Pardalotus striatus* | striated pardalote | | | | | | |
| Pardalotidae | *Pardalotus punctatus* | spotted pardalote | | | | | | |
| Pardalotidae | *Pardalotus rubricatus* | red-browed pardalote | | | | | | |
| Acanthizidae | *Gerygone palpebrosa* | Cape York fairy gerygone | | | | 0 - 950 | 19 - 24.8 | 812 - 3915 |
| Acanthizidae | *Gerygone magnirostris* | large-billed gerygone | | | | 1 - 840 | 19.4 - 24.6 | 1031 - 4149 |
| Acanthizidae | *Gerygone palpebrosa* | southern fairy gerygone | | | | | | |
| Acanthizidae | *Acanthiza nana* | yellow thornbill | | | | | | |
| Acanthizidae | *Oreoscopus gutturalis* | fernwren | 2 | | 1 | 115 - 1540 | 15.7 - 23.9 | 1288 - 7408 |
| Acanthizidae | *Gerygone olivacea* | white-throated gerygone | | | | | | |
| Acanthizidae | *Sericornis magnirostra* | large-billed scrubwren | 3 | | 1 | 2 - 1540 | 15.7 - 24.6 | 1170 - 7413 |
| Acanthizidae | *Sericornis keri* | Atherton scrubwren | 2 | | 1 | 133 - 1480 | 16 - 23.8 | 1282 - 6879 |
| Acanthizidae | *Sericornis citreogularis* | yellow-throated scrubwren | 3 | | 1 | 115 - 1537 | 15.7 - 23.9 | 1170 - 7392 |
| Acanthizidae | *Acanthiza reguloides* | buff-rumped thornbill | | | | | | |
| Acanthizidae | *Gerygone mouki* | brown gerygone | 3 | | 1 | 18 - 1239 | 17.6 - 24.4 | 814 - 4157 |
| Acanthizidae | *Acanthiza katherina* | 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 | *Smicrornis brevirostris* | weebill | | | | | | |
| Acanthizidae | *Gerygone levigaster* | mangrove gerygone | | | | | | |
| Acanthizidae | *Sericornis frontalis* | white-browed scrubwren | | | | 60 - 1168 | 17.6 - 23.6 | 1170 - 2635 |
| Meliphagidae | *Acanthorhynchus tenuirostris* | eastern spinebill | | | 1 | 200 - 1540 | 15.7 - 23 | 1237 - 7408 |
| Meliphagidae | *Myzomela obscura* | dusky honeyeater | | | | 0 - 1110 | 18.1 - 24.8 | 812 - 4149 |
| Meliphagidae | *Philemon buceroides* | helmeted friarbird | | | | 0 - 1054 | 18.5 - 24.8 | 893 - 4149 |
| Meliphagidae | *Manorina flavigula* | yellow-throated miner | | | | | | |
| Meliphagidae | *Meliphaga notata* | yellow-spotted honeyeater | 3 | | 1 | 0 - 1147 | 18 - 24.8 | 893 - 4157 |
| Meliphagidae | *Caligavis chrysops* | yellow-faced honeyeater | 3 | | 1 | | | |
| Meliphagidae | *Ptilotula flavescens* | yellow-tinted honeyeater | | | | | | |
| Meliphagidae | *Meliphaga gracilis* | wet tropics graceful honeyeater | 3 | | 1 | 0 - 950 | 19 - 24.7 | 1173 - 4149 |
| Meliphagidae | *Meliphaga lewinii* | Lewin's honeyeater | | | | 9 - 1300 | 17.2 - 24.8 | 989 - 5252 |
| Meliphagidae | *Ptilotula fusca* | fuscous honeyeater | | | | | | |
| Meliphagidae | *Philemon citreogularis* | little friarbird | | | | | | |
| Meliphagidae | *Lichmera indistincta* | brown honeyeater | | | | | | |
| Meliphagidae | *Bolemoreus frenatus* | bridled honeyeater | 2 | | 1 | 20 - 1537 | 15.7 - 24.5 | 1170 - 7392 |
| Meliphagidae | *Ramsayornis fasciatus* | bar-breasted honeyeater | | | | | | |
| Meliphagidae | *Cissomela pectoralis* | banded honeyeater | | | | | | |
| Meliphagidae | *Stomiopera flava* | yellow honeyeater | | | | | | |
| Meliphagidae | *Gavicalis versicolor* | varied honeyeater | | | | | | |
| Meliphagidae | *Trichodere cockerelli* | white-streaked honeyeater | | | | | | |
| Meliphagidae | *Philemon corniculatus* | noisy Friarbird | | | | | | |
| Meliphagidae | *Melithreptus albogularis* | white-throated honeyeater | | | | | | |
| Meliphagidae | *Stomiopera unicolor* | white-gaped honeyeater | | | | | | |
| Meliphagidae | *Conopophila rufogularis* | rufous-throated honeyeater | | | | | | |
| Meliphagidae | *Myzomela sanguinolenta* | scarlet honeyeater | | | 1 | 7 - 1140 | 18.1 - 24.3 | 817 - 3395 |
| Meliphagidae | *Melithreptus lunatus* | white-naped honeyeater | | | | | | |
| Meliphagidae | *Acanthagenys rufogularis* | spiny-cheeked honeyeater | | | | | | |
| Meliphagidae | *Ramsayornis modestus* | brown-backed honeyeater | | | | | | |
| Meliphagidae | *Phylidonyris niger* | white-cheeked honeyeater | | | | | | |
| Meliphagidae | *Gavicalis fasciogularis* | mangrove honeyeater | | | | | | |
| Meliphagidae | *Xanthotis macleayanus* | Macleay's honeyeater | 2 | | 1 | 2 - 1198 | 17.5 - 24.7 | 1202 - 4901 |
| Meliphagidae | *Plectorhyncha lanceolata* | striped honeyeater | | | | | | |
| Meliphagidae | *Melithreptus gularis* | black-chinned honeyeater | | | | | | |
| Meliphagidae | *Entomyzon cyanotis* | blue-faced honeyeater | | | | | | |
| Meliphagidae | *Manorina melanocephala* | noisy miner | | | | | | |
| Meliphagidae | *Philemon argenticeps* | silver-crowned friarbird | | | | | | |
| Petroicidae | *Tregellasia capito* | pale-yellow robin | 3 | | 1 | 9 - 1294 | 17.4 - 24.4 | 920 - 4047 |
| Petroicidae | *Peneonanthe pulverulenta* | mangrove robin | | | | | | |
| Petroicidae | *Eopsaltria australis* | north-eastern yellow robin | | | | | | |
| Petroicidae | *Heteromyias cinereifrons* | grey-headed robin | 3 | | 1 | 20 - 1540 | 15.7 - 24.5 | 1170 - 7408 |
| Petroicidae | *Microeca flavigaster* | lemon-bellied flycatcher | | | | | | |
| Petroicidae | *Microeca fascinans* | jacky winter | | | | | | |
| Petroicidae | *Poecilodryas superciliosa* | white-browed robin | | | | 0 - 691 | 20.2 - 24 | 1005 - 1718 |
| Orthonychidae | *Orthonyx spaldingii* | chowchilla | 2 | | 1 | 20 - 1430 | 16.3 - 24.5 | 1227 - 5900 |
| Pomatostomidae | *Pomatostomus temporalis* | grey-crowned babbler | | | | | | |
| Psophodidae | *Psophodes olivaceus* | wet tropics eastern whipbird | 3 | | 1 | 20 - 1540 | 15.7 - 24.4 | 1202 - 7413 |
| Neosittidae | *Daphoenositta chrysoptera* | varied sittella | | | | | | |
| Falcunculidae | *Falcunculus frontatus* | crested shrike-tit | | | | | | |
| Pachycephalidae | *Pachycephala rufiventris* | rufous whistler | | | | | | |
| Pachycephalidae | *Colluricincla megarhyncha* | little shrike-thrush | | | 1 | 0 - 1180 | 17.9 - 24.6 | 1005 - 4157 |
| Pachycephalidae | *Pachycephala simplex* | grey whistler | | | | 2 - 1215 | 17.6 - 24.6 | 1230 - 4074 |
| Pachycephalidae | *Pachycephala pectoralis* | golden whistler | | | | 2 - 1527 | 15.8 - 24.5 | 1170 - 7292 |
| Pachycephalidae | *Colluricincla harmonica* | grey shrike-thrush | | | | | | |

| Family | Species | Common Name | WT End. | Con Stat. | VIS | Elev. Range | Temp. Range | Precip. Range |
|---|---|---|---|---|---|---|---|---|
| Pachycephalidae | *Colluricincla boweri* | Bower's shrike-thrush | 2 | | 1 | 55 - 1480 | 16 - 24 | 1237 - 6879 |
| Pachycephalidae | *Pachycephala melanura* | mangrove golden whistler | | | | | | |
| Dicruridae | *Dicrurus bracteatus* | north-eastern spangled drongo | | | | 0 - 1211 | 17.8 - 24.8 | 814 - 4157 |
| Monarchidae | *Myiagra cyanoleuca* | satin flycatcher | | | | | | |
| Monarchidae | *Grallina cyanoleuca* | magpie lark | | | | | | |
| Monarchidae | *Arses kaupi* | pied monarch | 2 | | 1 | 0 - 1183 | 17.9 - 25 | 1202 - 3869 |
| Monarchidae | *Myiagra rubecula* | leaden flycatcher | | | | | | |
| Monarchidae | *Myiagra inquieta* | restless flycatcher | | | | | | |
| Monarchidae | *Monarcha frater* | black-winged monarch | | | | | | |
| Monarchidae | *Carternornis leucotis* | white-eared monarch | | | 1 | 0 - 940 | 19 - 24.5 | 1226 - 3915 |
| Monarchidae | *Myiagra ruficollis* | broad-billed flycatcher | | | | | | |
| Monarchidae | *Symposiarchus trivirgatus* | wet tropics spectacled monarch | 3 | | 1 | 0 - 1300 | 17.3 - 24.8 | 933 - 4157 |
| Monarchidae | *Monarcha melanopsis* | black-faced monarch | | | | 1 - 1527 | 15.8 - 24.5 | 1091 - 7292 |
| Monarchidae | *Myiagra alecto* | shining flycatcher | | | | | | |
| Machaerirhynchidae | *Machaerirhynchus flaviventer* | yellow-breasted boatbill | 3 | | 1 | 5 - 1280 | 17.4 - 24.6 | 1202 - 4020 |
| Rhipiduridae | *Rhipidura rufifrons* | rufous fantail | | | | 0 - 1437 | 16.2 - 24.5 | 973 - 6505 |
| Rhipiduridae | *Rhipidura albiscapa* | grey fantail | 3 | | 1 | 0 - 1346 | 16.7 - 24.8 | 715 - 5372 |
| Rhipiduridae | *Rhipidura rufiventris* | northern fantail | | | | | | |
| Rhipiduridae | *Rhipidura leucophrys* | willie wagtail | | | | | | |
| Campephagidae | *Coracina papuensis* | white-bellied cuckoo-shrike | | | | | | |
| Campephagidae | *Lalage leucomela* | varied triller | | | | 0 - 1110 | 18.1 - 24.8 | 1005 - 4149 |
| Campephagidae | *Coracina lineata* | barred cuckoo-shrike | | | | 18 - 1260 | 17.5 - 24.5 | 1017 - 3915 |
| Campephagidae | *Coracina maxima* | ground cuckoo-shrike | | | | | | |
| Campephagidae | *Coracina tenuirostris* | cicadabird | | | | | | |
| Campephagidae | *Lalage tricolor* | white-winged triller | | | | | | |
| Campephagidae | *Coracina novaehollandiae* | black-faced cuckoo-shrike | | | | | | |
| Oriolidae | *Oriolus sagittatus* | olive-backed oriole | | | | 3 - 960 | 19 - 24.5 | 886 - 4020 |
| Oriolidae | *Sphecotheres vieilloti* | Australasian figbird | | | | 0 - 1110 | 18.1 - 24.8 | 886 - 4157 |
| Oriolidae | *Oriolus flavocinctus* | yellow oriole | 3 | | 1 | 0 - 900 | 19.3 - 25 | 1147 - 4149 |
| Artamidae | *Cracticus quoyi* | black butcherbird | | | | 0 - 1200 | 17.8 - 24.7 | 1090 - 4157 |
| Artamidae | *Artamus minor* | little woodswallow | | | | | | |
| Artamidae | *Strepera graculina* | wet tropics pied currawong | 3 | | 1 | 4 - 1540 | 15.7 - 24.5 | 828 - 7413 |
| Artamidae | *Artamus leucorynchus* | white-breasted woodswallow | | | 1 | 0 - 1211 | 17.8 - 24.6 | 763 - 4032 |
| Artamidae | *Cracticus tibicen* | Australian magpie | | | | | | |
| Artamidae | *Cracticus torquatus* | grey butcherbird | | | | | | |
| Artamidae | *Cracticus nigrogularis* | pied butcherbird | | | | | | |
| Artamidae | *Artamus cyanopterus* | dusky woodswallow | | | | | | |
| Artamidae | *Artamus cinereus* | black-faced woodswallow | | | | | | |
| Artamidae | *Artamus personatus* | masked woodswallow | | | | | | |
| Artamidae | *Artamus superciliosus* | white-browed woodswallow | | | | | | |
| Paradisaeidae | *Ptiloris victoriae* | Victoria's riflebird | 2 | | 1 | 20 - 1280 | 17.2 - 24.5 | 1170 - 4032 |
| Corvidae | *Corvus coronoides* | Australian raven | | | | | | |
| Corvidae | *Corvus orru* | Torresian crow | | | | | | |
| Corcoracidae | *Corcorax melanorhamphos* | white-winged chough | | | | | | |
| Ptilonorhynchidae | *Amblyornis newtonianus* | golden bowerbird | 2 | | 1 | 464 - 1540 | 15.7 - 21.4 | 1253 - 7408 |
| Ptilonorhynchidae | *Ailuroedus melanotis* | spotted catbird | 3 | | 1 | 10 - 1527 | 15.8 - 24.5 | 1186 - 7292 |
| Ptilonorhynchidae | *Ptilonorhynchus violaceus* | wet tropics satin bowerbird | 3 | | 1 | 267 - 1490 | 16 - 22.7 | 1356 - 6950 |
| Ptilonorhynchidae | *Scenopoeetes dentirostris* | tooth-billed bowerbird | 2 | | 1 | 70 - 1362 | 16.6 - 23.7 | 1170 - 5447 |
| Ptilonorhynchidae | *Ptilonorhynchus nuchalis* | Horsefield's great bowerbird | | | | | | |
| Alaudidae | *Mirafra javanica* | wet tropics horsefield bushlark | 3 | | 1 | | | |
| Motacillidae | *Anthus novaeseelandiae* | Australasian pipit | | | | | | |
| Passeridae | *Passer domesticus* | house sparrow | | | | | | |
| Nectariniidae | *Nectarinia jugularis* | olive-backed sunbird | | | | | | |
| Dicaeidae | *Dicaeum hirundinaceum* | 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 | *Petrochelidon ariel* | fairy martin | | | | | | |
| Hirundinidae | *Cecropis daurica* | red-rumped swallow | | | | | | |
| Hirundinidae | *Hirundo neoxena* | welcome swallow | | | | | | |
| Hirundinidae | *Petrochelidon nigricans* | tree martin | | | | | | |
| Hirundinidae | *Hirundo rustica* | barn swallow | | | | | | |
| Acrocephalidae | *Acrocephalus australis* | Australian reed-warbler | | | | | | |
| Acrocephalidae | *Acrocephalus orientalis* | oriental reed-warbler | | | | | | |
| Locustellidae | *Megalurus timoriensis* | tawny grassbird | | | | | | |
| Locustellidae | *Cinclorhamphus cruralis* | brown songlark | | | | | | |
| Locustellidae | *Megalurus gramineus* | little grassbird | | | | | | |
| Locustellidae | *Cinclorhamphus mathewsi* | rufous songlark | | | | | | |
| Cisticolidae | *Cisticola exilis* | golden-headed cisticola | | | | | | |
| Zosteropidae | *Zosterops lateralis* | silvereye | | | | 0 - 1500 | 15.9 - 24.6 | 1044 - 7067 |
| Turdidae | *Zoothera lunulata* | wet tropics bassian thrush | 3 | | 1 | 600 - 1480 | 16 - 20.8 | 1270 - 6879 |
| Turdidae | *Zoothera heinei* | russet-tailed thrush | | | 1 | | | |
| Sturnidae | *Acridotheres tristis* | common myna | | | | | | |
| Sturnidae | *Aplonis metallica* | metallic starling | | | | 0 - 1208 | 17.7 - 24.6 | 1239 - 4157 |
| Estrildidae | *Taeniopygia bichenovii* | double-barred finch | | | | | | |
| Estrildidae | *Neochmia phaeton* | crimson finch | | | | | | |
| Estrildidae | *Neochmia modesta* | plum-headed finch | | | | | | |
| Estrildidae | *Neochmia ruficauda* | star finch | | EN | 1 | | | |
| Estrildidae | *Poephila personata* | masked finch | | | | | | |
| Estrildidae | *Poephila cincta* | black-throated finch | | EN | 1 | | | |
| Estrildidae | *Lonchura punctulata* | nutmeg mannikin | | | | | | |
| Estrildidae | *Taeniopygia guttata* | zebra finch | | | | | | |
| Estrildidae | *Neochmia temporalis* | red-browed finch | | | | | | |
| Estrildidae | *Lonchura castaneothorax* | chestnut-breasted mannikin | | | | | | |
| Estrildidae | *Erythrura trichroa* | blue-faced parrot-finch | | NT | 1 | 20 - 1140 | 18.1 - 24.4 | 1371 - 3151 |
| | | | | | | | | |
| **REPTILES** | | | | | | | | |
| Crocodylidae | *Crocodylus johnstoni* | Australian freshwater crocodile | | | | | | |
| Crocodylidae | *Crocodylus porosus* | estuarine crocodile | | VU | 1 | | | |
| Chelidae | *Elseya irwini* | Johnston River snapping turtle | | | | | | |
| Chelidae | *Emydura macquarii* | Krefft's river turtle | | | | | | |
| Chelidae | *Chelodina oblonga* | northern snake-necked turtle | | | | | | |
| Chelidae | *Wollumbinia latisternum* | saw-shelled turtle | | | | | | |
| Gekkonidae | *Nactus cheverti* | Chevert gecko | | | 1 | 7 - 668 | 20.5 - 25 | 1281 - 3423 |
| Gekkonidae | *Phyllurus gulbaru* | Gulbaru gecko | 1 | CR | 1 | 366 - 538 | 21.3 - 22.1 | 1137 - 1176 |
| Gekkonidae | *Heteronotia binoei* | Bynoe's gecko | | | | | | |
| Gekkonidae | *Nephrurus asper* | spiny knob-tailed gecko | | | | | | |
| Gekkonidae | *Hemidactylus frenatus* | house gecko | | | | | | |
| Gekkonidae | *Strophurus williamsi* | replace with soft-spined gecko | | | | | | |
| Gekkonidae | *Gehyra dubia* | dubious dtella | | | | | | |
| Gekkonidae | *Gehyra nana* | northern spotted rock dtella | | | | | | |
| Gekkonidae | *Gehyra versicolor* | tree dtella | | | | | | |
| Gekkonidae | *Oedura coggeri* | northern spotted velvet gecko | | | | | | |
| Gekkonidae | *Nactus galgajuga* | black mountain gecko | 1 | VU | 1 | | | |
| Gekkonidae | *Lepidodactylus lugubris* | mourning gecko | | | | | | |
| Gekkonidae | *Carphodactylus laevis* | chameleon gecko | 2 | | 1 | 115 - 1079 | 18.4 - 23.9 | 1453 - 4083 |
| Gekkonidae | *Cyrtodactylus tuberculatus* | tuberculated ring-tailed gecko | | | | | | |
| Gekkonidae | *Oedura castelnaui* | northern velvet gecko | | | | | | |
| Gekkonidae | *Saltuarius cornutus* | northern leaf-tailed gecko | 2 | | 1 | 19 - 1512 | 15.9 - 24.5 | 1205 - 6380 |
| Gekkonidae | *Phyllurus amnicola* | Mt. Elliot leaf-tail gecko | 1 | | 1 | 157 - 644 | 20.4 - 23.1 | 982 - 1315 |
| Gekkonidae | *Lucasium steindachneri* | Steindachner's gecko | | | | | | |

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

| Family | Species | Common Name | WT End. | Con Stat. | VIS | Elev. Range | Temp. Range | Precip. Range |
|---|---|---|---|---|---|---|---|---|
| Scincidae | *Glaphyromorphus punctulatus* | fine-spotted mulch-skink | | | | | | |
| Scincidae | *Gnypetoscincus queenslandiae* | prickly forest skink | 2 | | 1 | 20 - 1443 | 16.2 - 24.5 | 1265 - 6556 |
| Scincidae | *Egernia hosmeri* | Hosmer's skink | | | | | | |
| Scincidae | *Lygisaurus aeratus* | large-disced litter-skink | | | | | | |
| Scincidae | *Lampropholis delicata* | dark flecked garden sunskink | | | | | | |
| Scincidae | *Lygisaurus laevis* | rainforest edge litter-skink | 2 | | 1 | | | |
| Scincidae | *Lygisaurus tanneri* | Endeavour River litter-skink | | VU | 1 | | | |
| Scincidae | *Pygmaeascincus timlowi* | dwarf litter-skink | | | | | | |
| Scincidae | *Glaphyromorphus fuscicaudis* | brown-tailed bar-lipped skink | 2 | | 1 | 20 - 1300 | 17.3 - 24.5 | 1256 - 4032 |
| Scincidae | *Lampropholis coggeri* | rainforest sunskink | 2 | | 1 | 20 - 1300 | 17.3 - 24.5 | 975 - 4141 |
| Scincidae | *Lygisaurus zuma* | sun-loving litter-skink | | | | | | |
| Scincidae | *Lerista zonulata* | girdled slider | | | | | | |
| Scincidae | *Morethia taeniopleura* | eastern fire-tailed skink | | | | | | |
| Scincidae | *Menetia greyii* | common dwarf skink | | | | | | |
| Scincidae | *Pygmaeascincus koshlandae* | fine-browed dwarf skink | | | | | | |
| Scincidae | *Pygmaeascincus sadlieri* | Magnetic Island dwarf skink | 1 | VU | 1 | | | |
| Scincidae | *Proablepharus tenuis* | northern soil-crevice skink | | | | | | |
| Scincidae | *Saproscincus basiliscus* | basilisk shadeskink | 2 | | 1 | 20 - 1215 | 17.7 - 24.6 | 1137 - 4157 |
| Scincidae | *Saproscincus czechurai* | wedge-snouted shadeskink | 2 | | 1 | 606 - 1540 | 15.7 - 21 | 1445 - 7408 |
| Scincidae | *Saproscincus lewisi* | Cooktown shadeskink | 2 | | 1 | 14 - 700 | 20.4 - 24.5 | 2056 - 3534 |
| Scincidae | *Saproscincus tetradactylus* | four-fingured shadeskink | 2 | | 1 | 40 - 1181 | 17.9 - 24.1 | 1227 - 4157 |
| Scincidae | *Techmarscincus jigurru* | Bartle Frere cool-skink | 1 | VU | 1 | 1452 - 1600 | 15.4 - 16.2 | 6003 - 6717 |
| Scincidae | *Tiliqua scincoides* | eastern blue-tongue lizard | | | | | | |
| Scincidae | *Cryptoblepharus pannosus* | ragged snake-eyed skink | | | | | | |
| Scincidae | *Egernia rugosa* | yakka skink | | VU | 1 | | | |
| Scincidae | *Glaphyromorphus cracens* | slender mulch-skink | | | | | | |
| Scincidae | *Glaphyromorphus clandestinus* | Mt Elliot skink | 1 | | 1 | 495 - 500 | 21.2 - 21.2 | 1193 - 1196 |
| Scincidae | *Eulamprus quoyii* | eastern water skink | | | | 27 - 1110 | 18.1 - 24.3 | 1056 - 4020 |
| Scincidae | *Concinnia frerei* | Bartle Frere bar-sided skink | 1 | | 1 | 1437 - 1600 | 15.4 - 16.2 | 6169 - 6717 |
| Scincidae | *Anomalopus gowi* | speckled worm-skink | | | | | | |
| Scincidae | *Lygisaurus foliorum* | tree-base litter-skink | | | | | | |
| Scincidae | *Concinnia tigrina* | yellow-blotched forest-skink | 2 | | 1 | 11 - 1317 | 17.1 - 24.6 | 1482 - 4157 |
| Scincidae | *Concinnia sokosoma* | stout bar-sided skink | | | | | | |
| Scincidae | *Concinnia brachysoma* | Cape York bar-side skink | | | | 82 - 1073 | 18.5 - 23.5 | 982 - 3359 |
| Scincidae | *Egernia striolata* | tree skink | | | | | | |
| Scincidae | *Glaphyromorphus crassicaudus* | Cape York mulch-skink | | | | | | |
| Typhlopidae | *Anilios torresianus* | north-eastern blind snake | | | 1 | 94 - 660 | 20.5 - 23.4 | 1494 - 4020 |
| Typhlopidae | *Anilios unguirostris* | claw-snouted blind snake | | | | | | |
| Typhlopidae | *Anilios robertsi* | Roberts' blind snake | 2 | | 1 | | | |
| Typhlopidae | *Anilios proximus* | proximus blind snake | | | | | | |
| Typhlopidae | *Anilios affinis* | small-headed blind snake | | | | | | |
| Typhlopidae | *Anilios broomi* | faint-striped blind snake | | | | | | |
| Typhlopidae | *Anilios ligatus* | robust blind snake | | | | | | |
| Pythonidae | *Liasis mackloti* | water python | | | | | | |
| Pythonidae | *Morelia amethistina* | amethystine python | | | | 4 - 1110 | 18.3 - 24.9 | 1094 - 4032 |
| Pythonidae | *Antaresia maculosa* | spotted python | | | | | | |
| Pythonidae | *Antaresia stimsoni* | Stimson's python | | | | | | |
| Pythonidae | *Aspidites melanocephalus* | black-headed python | | | | | | |
| Pythonidae | *Morelia spilota* | jungle carpet python | 3 | | 1 | 9 - 1190 | 17.5 - 24.6 | 1005 - 4194 |
| Pythonidae | *Morelia spilota* | coastal carpet python | | | | | | |
| Acrochordidae | *Acrochordus granulatus* | little file snake | | | | | | |
| Colubridae | *Dendrelaphis calligastra* | northern tree snake | | | | 11 - 1073 | 18.5 - 24.9 | 1033 - 3534 |
| Colubridae | *Dendrelaphis punctulatus* | green tree snake | | | | 2 - 950 | 19 - 24.4 | 999 - 3377 |
| Colubridae | *Stegonotus cucullatus* | 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 | *Boiga irregularis* | brown tree snake | | | | 15 - 1110 | 18.1 - 24.5 | 1003 - 4177 |
| Colubridae | *Tropidonophis mairii* | freshwater snake | | | | 2 - 817 | 19.7 - 24 | 1023 - 2861 |
| Homalopsidae | *Pseudoferania polylepis* | MacLeay's water snake | | | | | | |
| Elapidae | *Cryptophis nigrostriatus* | black-striped snake | | | | | | |
| Elapidae | *Cryptophis nigrescens* | eastern small-eyed snake | | | | 16 - 1214 | 17.6 - 24.4 | 934 - 3872 |
| Elapidae | *Cryptophis boschmai* | Carpentaria whip snake | | | | | | |
| Elapidae | *Antaioserpens albiceps* | north-eastern plain-nosed burrowing snake | | | | | | |
| Elapidae | *Suta suta* | myall snake | | | | | | |
| Elapidae | *Tropidechis carinatus* | rough-scaled snake | | | | 20 - 1238 | 17.5 - 23.7 | 1342 - 3374 |
| Elapidae | *Vermicella annulata* | bandy-bandy | | | | 530 - 1000 | 18.7 - 21.3 | 1272 - 1513 |
| Elapidae | *Cacophis squamulosus* | golden crowned snake | | | | | | |
| Elapidae | *Cacophis churchilli* | northern dwarf crowned snake | 2 | | 1 | 71 - 1214 | 17.6 - 23.6 | 1372 - 2933 |
| Elapidae | *Hemiaspis signata* | black-bellied swamp snake | | | 1 | 10 - 1225 | 17.6 - 24.3 | 934 - 3339 |
| Elapidae | *Hoplocephalus bitorquatus* | pale-headed snake | | | | | | |
| Elapidae | *Acanthophis praelongus* | northern death adder | | | | | | |
| Elapidae | *Acanthophis antarcticus* | common death adder | | VU | 1 | | | |
| Elapidae | *Demansia papuensis* | greater black whipsnake | | | | | | |
| Elapidae | *Demansia psammophis* | yellow-faced whipsnake | | | | 58 - 961 | 18.9 - 24.3 | 1102 - 3243 |
| Elapidae | *Furina barnardi* | yellow-naped snake | | | | | | |
| Elapidae | *Demansia vestigiata* | lesser black whipsnake | | | | | | |
| Elapidae | *Pseudonaja textilis* | eastern brown snake | | | | | | |
| Elapidae | *Furina tristis* | brown-headed snake | | | | 12 - 157 | 23.6 - 24.9 | 1723 - 3339 |
| Elapidae | *Furina ornata* | orange-naped snake | | | | 56 - 600 | 20.8 - 23.6 | 934 - 2064 |
| Elapidae | *Furina diadema* | red-naped snake | | | | | | |
| Elapidae | *Oxyuranus scutellatus* | coastal taipan | | | | | | |
| Elapidae | *Pseudechis australis* | king brown snake / mulga snake | | | | | | |
| Elapidae | *Pseudechis porphyriacus* | red-bellied black snake | | | | 80 - 1280 | 17.4 - 23.9 | 934 - 4157 |
| Elapidae | *Demansia torquata* | collared whipsnake | | DD | | | | |
| **FROGS** | | | | | | | | |
| Hylidae | *Litoria nigrofrenata* | tawny rocketfrog | | | | | | |
| Hylidae | *Litoria nasuta* | striped rocketfrog | | | | | | |
| Hylidae | *Litoria caerulea* | common green treefrog | | | | | | |
| Hylidae | *Litoria serrata* | tapping green-eyed treefrog | 2 | VU | 1 | 11 - 1443 | 16.2 - 24.6 | 1111 - 6556 |
| Hylidae | *Litoria nannotis* | waterfall frog | 2 | EN | 1 | 60 - 1214 | 17.7 - 24.2 | 1079 - 4157 |
| Hylidae | *Litoria inermis* | bumpy rocketfrog | | | | | | |
| Hylidae | *Litoria infrafrenata* | white-lipped treefrog | | | | 4 - 1013 | 18.8 - 24.9 | 1057 - 4157 |
| Hylidae | *Litoria jungguy* | northern stony-creek frog | 2 | | 1 | 14 - 1431 | 16.3 - 24.7 | 981 - 5879 |
| Hylidae | *Litoria latopalmata* | broad-palmed rocketfrog | | | | | | |
| Hylidae | *Litoria lorica* | little waterfall frog | 1 | EN | 1 | 240 - 1302 | 17.2 - 23 | 2584 - 3008 |
| Hylidae | *Litoria bicolor* | northern sedgefrog | | | | | | |
| Hylidae | *Litoria myola* | Kuranda treefrog | 1 | EN | 1 | | | |
| Hylidae | *Litoria fallax* | eastern sedgefrog | | | | 0 - 1065 | 18.3 - 24.5 | 838 - 3726 |
| Hylidae | *Litoria nyakalensis* | mountain mistfrog | 2 | CR | 1 | 10 - 1015 | 18.6 - 23.9 | 1211 - 3846 |
| Hylidae | *Litoria pallida* | pallid rocketfrog | | | | | | |
| Hylidae | *Litoria revelata* | whirring treefrog | 3 | | 1 | 768 - 1194 | 17.6 - 19.8 | 1323 - 2850 |
| Hylidae | *Litoria rheocola* | common mistfrog | 2 | EN | 1 | 15 - 1122 | 18.2 - 24.6 | 953 - 4168 |
| Hylidae | *Litoria rothii* | northern laughing treefrog | | | | | | |
| Hylidae | *Litoria rubella* | ruddy treefrog | | | | | | |
| Hylidae | *Litoria wilcoxii* | eastern stony-creek frog | | | | | | |
| Hylidae | *Litoria xanthomera* | orange thighed treefrog | 2 | | 1 | 36 - 1300 | 17.3 - 24.4 | 953 - 3519 |
| Hylidae | *Litoria dayi* | Australian lacelid | 2 | EN | 1 | 18 - 1214 | 17.7 - 24.5 | 953 - 4168 |
| Hylidae | *Litoria microbelos* | javelin frog | | | | | | |
| Hylidae | *Litoria gracilenta* | graceful treefrog | | | | | | |

| Family | Species | Common Name | WT End. | Con Stat. | VIS | Elev. Range | Temp. Range | Precip. Range |
|---|---|---|---|---|---|---|---|---|
| Hylidae | *Cyclorana alboguttata* | greenstripe frog | | | | | | |
| Hylidae | *Cyclorana brevipes* | superb collared-frog | | | | | | |
| Hylidae | *Cyclorana novaehollandiae* | eastern snapping-frog | | | | | | |
| Myobatrachidae | *Mixophyes schevilli* | northern barred frog | 2 | | 1 | 26 - 1437 | 16.2 - 23.5 | 889 - 6505 |
| Myobatrachidae | *Notaden melanoscaphus* | brown shovelfoot | | | | | | |
| Myobatrachidae | *Crinia deserticola* | chirping froglet | | | | | | |
| Myobatrachidae | *Crinia remota* | northern froglet | | | | | | |
| Myobatrachidae | *Mixophyes carbinensis* | Carbine barred frog | 2 | | 1 | | | |
| Myobatrachidae | *Mixophyes coggeri* | mottled barred frog | 2 | | 1 | 26 - 1437 | 16.2 - 23.5 | 889 - 6505 |
| Myobatrachidae | *Pseudophryne covacevichae* | magnificent broodfog | 2 | VU | 1 | | | |
| Myobatrachidae | *Limnodynastes convexiusculus* | marbled frog | | | | | | |
| Myobatrachidae | *Uperoleia mimula* | mimicking gungan | | | | | | |
| Myobatrachidae | *Uperoleia littlejohni* | Einasleigh gungan | | | | | | |
| Myobatrachidae | *Uperoleia lithomoda* | stonemason gungan | | | | | | |
| Myobatrachidae | *Taudactylus rheophilus* | northern tinkerfrog | 2 | EN | 1 | 704 - 1527 | 15.8 - 20.5 | 1429 - 7292 |
| Myobatrachidae | *Taudactylus acutirostris* | sharp-snouted dayfrog | 2 | EX | 1 | 33 - 1302 | 17.2 - 23.8 | 1174 - 4405 |
| Myobatrachidae | *Platyplectrum ornatum* | ornate burrowing frog | | | | | | |
| Myobatrachidae | *Limnodynastes peronii* | striped marsh frog | | | 1 | 15 - 1194 | 17.6 - 23.9 | 866 - 4081 |
| Myobatrachidae | *Limnodynastes tasmaniensis* | spotted marsh frog | | | | | | |
| Myobatrachidae | *Limnodynastes terraereginae* | scarlet-sided pobblebonk | | | | | | |
| Myobatrachidae | *Uperoleia altissima* | Tableland gungan | | | | | | |
| Microhylidae | *Cophixalus infacetus* | creaking nurseryfrog | 2 | | 1 | 20 - 1037 | 18.4 - 24.3 | 1583 - 4157 |
| Microhylidae | *Cophixalus bombiens* | buzzing nurseryfrog | 2 | | 1 | 42 - 1280 | 17.4 - 24.4 | 1851 - 3320 |
| Microhylidae | *Cophixalus ornatus* | northern ornate nurseryfrog | 2 | | 1 | 15 - 1512 | 15.9 - 24.3 | 1219 - 7036 |
| Microhylidae | *Cophixalus concinnus* | beautiful nurseryfrog | 1 | CR | 1 | 913 - 1279 | 17.3 - 19.2 | 2756 - 3456 |
| Microhylidae | *Cophixalus exiguus* | dainty nurseryfrog | 1 | VU | 1 | 320 - 700 | 20.4 - 22.5 | 2226 - 2939 |
| Microhylidae | *Cophixalus hosmeri* | rattling nurseryfrog | 1 | NT | 1 | 704 - 1302 | 17.2 - 20.5 | 1429 - 3008 |
| Microhylidae | *Cophixalus australis* | southern ornate nurseryfrog | 2 | | 1 | | | |
| Microhylidae | *Austrochaperina pluvialis* | white-browed whistlefrog | 2 | | 1 | 10 - 1293 | 17.4 - 24.6 | 1289 - 4157 |
| Microhylidae | *Austrochaperina robusta* | robust whistled frog | 2 | | 1 | 26 - 1517 | 15.8 - 23.7 | 1242 - 7212 |
| Microhylidae | *Cophixalus monticola* | mountain nurseryfrog | 1 | EN | 1 | 1134 - 1240 | 17.6 - 18.1 | 2469 - 2758 |
| Microhylidae | *Cophixalus aenigma* | tapping nurseryfrog | 2 | VU | 1 | 372 - 1317 | 17.1 - 22 | 1477 - 3550 |
| Microhylidae | *Cophixalus mcdonaldi* | Mount Elliot nurseryfrog | 1 | EN | 1 | 465 - 780 | 19.7 - 21.4 | 1170 - 1459 |
| Microhylidae | *Cophixalus hinchinbrookensis* | Hinchinbrook Island nurseryfrog | 1 | | 1 | | | |
| Microhylidae | *Cophixalus neglectus* | Bellenden Ker nurseryfrog | 1 | EN | 1 | 765 - 1585 | 15.5 - 19.7 | 3437 - 7417 |
| Microhylidae | *Austrochaperina fryi* | peeping whistlefrog | 2 | | 1 | 0 - 1302 | 17.2 - 24.6 | 1362 - 3555 |
| Microhylidae | *Cophixalus saxatilis* | Black Mountain boulderfrog | 1 | VU | 1 | | | |
| Ranidae | *Papurana daemeli* | Australian woodfrog | | | | 10 - 618 | 20.9 - 24.7 | 917 - 3987 |
| Bufonidae | *Rhinella marina* | 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 ENDEMICS | 12 | 12 | 21 | 21 | 66 |
| ENDEMIC SPECIES | RESTRICTED REGIONAL ENDEMICS | 0 | 3 | 11 | 10 | 24 |
| ENDEMIC SPECIES | TOTAL ENDEMIC | 12 | 15 | 32 | 31 | 90 |
| ENDEMIC SPECIES | ENDEMIC SUBSPECIES | 23 | 7 | 1 | 1 | 32 |
| RAINFOREST SPECIES | RAINFOREST SPECIES [3-6] | 104 | 43 | 73 | 34 | 254 |
| RAINFOREST SPECIES | RAINFOREST SPECIALIST SPECIES [5,6] | 46 | 21 | 23 | 29 | 119 |
| CONSERVATION STATUS | NT | 2 | 6 | 0 | 1 | 9 |
| CONSERVATION STATUS | CR | 0 | 1 | 1 | 2 | 4 |
| CONSERVATION STATUS | E | 5 | 5 | 1 | 9 | 20 |
| CONSERVATION STATUS | V | 4 | 12 | 11 | 5 | 32 |
| CONSERVATION STATUS | EX | 0 | 0 | 0 | 1 | 1 |
| CONSERVATION STATUS | THREATENED SPECIES | 11 | 24 | 13 | 18 | 66 |
| ANCIENT LINEAGES | ANCIENT 5% | 10 | 2 | 0 | 4 | 16 |
| ANCIENT LINEAGES | ANCIENT 10% | 22 | 5 | 2 | 4 | 33 |
| RARITY | ECOL. RARE | 26 | 12 | 25 | 17 | 80 |
| | VIS | 46 | 39 | 38 | 32 | 155 |