Submission 029
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Submission by the Centre for Tropical Biodiversity and Climate Change for the Inquiry into Australia's Biodiversity in a Changing Climate.

We thank you for the opportunity to make a submission to the Inquiry into Australia's Biodiversity in a changing climate in relation to "Nationally important ecosystems". This submission will emphasise the tropical rainforests of the Wet Tropics World Heritage Area as a nationally important ecosystem, discuss the current and predicted impacts of climate change on this region and highlight the research capacity within the Centre for Tropical Biodiversity and Climate Change (CTBCC) at James Cook University capable of addressing many of the research and knowledge gaps required in an inquiry on biodiversity and climate change.

This submission emphasises that as well as the Wet Tropics being a region and ecosystem of great national and global significance there is also a sufficent body of available knowledge and ongoing research to make it a useful case study in the context of this inquiry. We have attached here a report on knowledge gaps in the region, a report on climate change refugia and a list of pertinent peer-reviewed papers directly relevant to this region and topic. The knowledge gaps report is particulary relevant to this inquiry as it provides a summarised review and collation of knowledge on this important region and, importantly, combines this scientific knowledge with a detailed assessment of stakeholders needs and priorities in the region. It should be a valuable resource for the utilisation of this region as a case-study ecosystem.

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Summary of main points.

- Wet Tropics biogeographic region of North Queensland is internationally recognised for it's high biodiversity and unique fauna and flora values;
- Wet Tropics rainforest also critical for North Queensland livelihoods with ecotourism generating >$4 billion annually in the region;
- Wet Tropics biodiversity is highly threatened by climate change with a possible loss of 25-50% of the vertebrate fauna if we continue "business as usual" carbon emissions;
- Many of predicted species extinctions will be the very species that the region was made into a World Heritage Area to protect;
- The Centre for Tropical Biodiversity and Climate Change, at James Cook University in Townsville, has become a globally-leading hub for climate change and biodiversity research over recent years and with sufficent future resources, the CTBCC has the demonstrated experience and capacity to continue to make significant advances in our understanding of how to deal with climate change in order to protect our biodiversity;
- Our data clearly demonstrates that impacts have already been occurring with many species being pushed higher up the mountains and some species showing significant declines after heat waves;
- We can now produce a prioritised list of species vulnerability that takes into account comprehensive analyses of their sensitivity, exposure and adaptive capacity to climate change. These analyses are supported by strong evidence and can now be utilised to produce analytical tool-kits for use in other ecosystems across Australia and internationally;
- The attached gap analysis report provides a comprehensive review of current knowledge on biodiversity and climate change in the region combined with a detailed compilation of relevant stakeholder needs and priorities based on both individuals and management institutions;
- The biodiversity of the Wet Tropics World heritage Area is severely threatened by climate change and we need a significant global and national commitment to mitigation and adaptation if we are to prevent catastropic impacts on one of our most valuable natural ecosystems and the inevitable flow-on impacts to the regional and national economy.

Understanding the Impacts of Climate Change on the Wet Topics

The Wet Tropics rainforest of North Queensland has the highest biodiversity of any region in Australia. While world heritage listing of the area has prevented ongoing impacts from land clearing, our research clearly demonstrates global climate change as a severe threatening process in the region and suggests that we may be facing many species extinctions in similar systems around the world. This work resulted in the Australian Wet Tropics being internationally recognized by the IPCC as one of the worlds' most vulnerable ecosystems.

So how will climate change impact the Wet Tropics:

- Loss and or decline of important species - examples of species likely to be greatly impacted are: golden bower bird, lemuroid ringtail possum, many other species of high elevation vertebrates and insects.

- Increase in seasonality – longer dry seasons, wetter wet seasons resulting in population declines in marginal areas and greater stress due to decreased resources in the dry season.
- Increase in the threat of changing fire regimes on rainforest margins and in the sclerophyll habitats of the region
- Increase in sea level – inundation of lower elevation rainforest areas
- Changes in habitat structure, net primary productivity and soil decomposition processes

What can we do to minimise the effects of global climate change?

We believe we have a good start on the information, the anaytical techniques and the main infrastructure elements required to tackle this complex problem and produce a "no-regrets" strategy that allows for the high uncertainty in future predictions. Many of the tasks described below are well advanced in the CTBCC research in the region but it is necessary to continue to build on this important knowledge-base in order to make it more robust and enable its application more widely in Australia and globally, including:

- increase our ability to make robust assessments of the relative vulnerability of species and ecosystems in order to inform prioritisation processes;
- assess the location, efficacy and relative importance of potential biodiversity refugia and their capacity to buffer biodiversity from extreme climatic events such as heat waves and increasingly severe dry seasons;
- identify important new reserves and evaluate the potential and tradeoffs involved in other forms of off-reserve management;
- manage the threats to ecosystem resilience due to existing stressors such as drought, invasives and extreme climate events;
- enhance our understanding of the relative value of different landscape structures and restoration options, for example the relative cost-benefits of habitat corridors and environmental gradients;
- ensure that the necessary resources for long-term monitoring, evaluation and data infrastructure are in place, co-ordinated and have guaranteed longevity to provide reliable and comprehensive access to the information necessary for effective and timely decision making;
- develop low risk strategies that could assist in developing resilience such as increased control of invasives and genetic translocation;
- conduct the necessary research now that will increase the chances of success in the future of the riskier adaptation options like translocation so that they are possible if required.
- Improved decision support frameworks for managers to make decisions about where and when to apply the most-effective adpatation measures.

Submission 029
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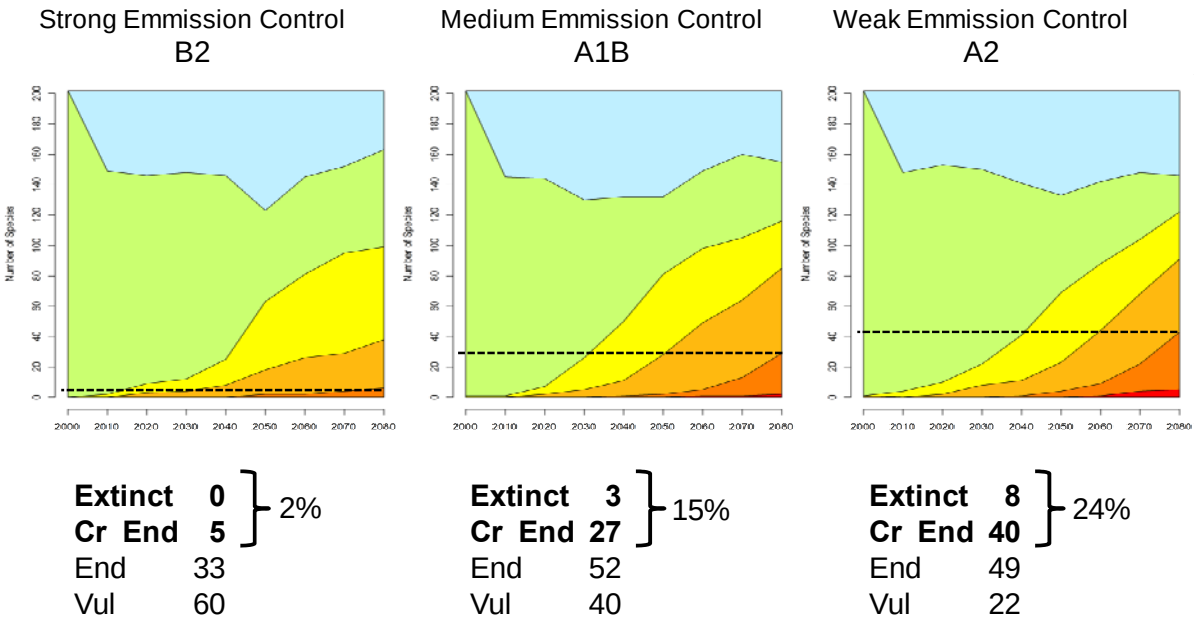
Centre for Tropical Biodiversity and Climate Change

The CTBCC was established in 2006 as a multidisciplinary research centre aimed at understanding the patterns and processes underlying tropical biodiversity and the impacts that global climate change will have on the natural environment. The CTBCC is an initiative supported by James Cook University, QLD Government Innovation Funds, National Climate Change Adaptation Research Facility, Tropical Ecosystems Hub – National Environmental Research Program, Australian Research Council and Earthwatch Institute. The CTBCC is currently examining a diverse range of research topics on climate change and biodiversity (vertebrates, invertebrates, plants and ecosystem processes) including biodiversity patterns and processes, population genetics, thermal physiology, paleo-modelling of habitats and species distributions, extinction proneness, phenology, nutrient cycling, climatic seasonality, trophic interactions, net primary productivity, vegetation structure, resilience and estimating the relative vulnerability of species and habitats.

Mitigation remains the most important factor in reducing the impacts on biodiversity. Within the Wet Tropics the difference between “buiness-as-usual” and strong global emmission control could be the prevention of **25% of all species going extinct** compared to no extinction under strong mitigation scenarios (Figure 1). No matter what mitigation measures (or emission scenarios –Fig 1) are put in place, lag effects will still result in impacts of climate change on biodiversity over the remaining century. Therefore, directing and prioritising research and management resources, through science knowledge transfer, will be a necessary part of adaptation and resilience management.

Figure 1: Projected impacts on biodiversity in the Australian Wet Tropics for three levels of emmission control based on changes in total population size for 202 species of vertebrates projected using 8 global climate models and multiple model realisations using 300 000+ vertebrate records. With business as usual (A2), weak emission control, we are facing a quarter of all vertebrates in the region either being extinct or critically endangered. With reasonable, strong emission control (B2) this is reduced to only 2% of species, with potentially no extinctions. (Williams & VanDerWal, unpublished data). Population size changes: Blue –increase; green – no change; yellow – IUCN Vulnerable (50% population loss); light Orange – IUCN Endangered (>70% loss); dark orange – IUCN Endangered (>90%); red – extinct (100% population loss).



Regional gap analysis (see more information below and in attached document)

We would like to bring a recent report to the attention of the inquiry. The CTBCC in association with the Wet Tropics Management Authority and the MTSRF recently produced a review of biodviersity research in the region including a detailed assessment of climate change impacts. The report combined this science review with stakeholder consultation and feedback to produce a summary of previous research and a prioritised identification of knowledge gaps and their relative importance as identified by the biodivesity stakeholders in the region. We have attached this report.

Relevant Publications:

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

Shoo L.P., C. Storlie, Y.M. Williams & S.E. Williams. 2010. Potential for mountaintop boulder fields to buffer species against extreme heat stress under climate change. *International Journal of Biometeorology* 54: 475-478

Li, J., D.W. Hilbert, T. Parker & S.E. Williams. 2009. How do species respond to climate change along an elevation gradient? A case study of the Grey-headed Robin (*Heteromyias albispecularis*). *Global Change Biology* 15: 255-267 (IF: 5.88 ERA: A*)

Williams S.E., Shoo L.P., Isaac J., Hoffmann A.A. & Langham G. 2008. Toward an Integrated Framework for Assessing the Vulnerability of Species to Climate Change. *PLOS Biology* 6: 2621- 2626

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

Williams, S.E., Isaac, J.L., Shoo, L.P. 2008. The impact of climate change on the biodiversity and ecosystem functions of the Wet Tropics. Pp282-294 *In* Living in a dynamic tropical forest landscape, N. Stork & S. Turton (eds.), Blackwell Publishing.

Williams S.E. & Isaac J. 2008. Tropical rainforests. Pp 67-72 *in*: "Ten Commitments: reshaping the lucky country's environment", eds. D. Lindenmayer, S. Dovers, M. Harriss Olson and S. Morton, CSIRO Publishing, Melbourne.

Isaac, J. & Williams, S.E. 2007. Climate change and extinctions. Cambridge Encyclopaedia of Biodiversity, S. Levin (ed.) Published online: doi:10.1016/B978-012226865-6/00579-1

Wilson R.D., Trueman J.W.H., Williams S.E., Yeates D.K. 2007. Altitudinally restricted communities of Schizophoran flies in Queensland's Wet Tropics: vulnerability to climate change. *Biodiversity & Conservation* 16: 3163-3177

Shoo, L., Williams S.E. & J-M Hero. 2006. Predicting and detecting impacts of climate change on montane rainforest birds in the Australian wet tropics, p.205. *In* Global change in mountain regions, M.F. Price (ed.), Sapiens Publishing, UK, ISBN 0-9552282-2-0

Shoo L.P., Williams S.E. & Hero J-M. 2006. Detecting climate change induced range shifts: where and how should we be looking? *Austral Ecology* 31:22-29.

Shoo L.P., Williams S.E. & Hero J-M. 2005. Potential decoupling of trends in distribution area and population size of species' with climate change. *Global Change Biology* 11: 1469-1476.

Shoo L.P., Williams S.E & Hero J-M. 2005. Climate warming and the rainforest birds of the Australian Wet Tropics: using abundance data as a sensitive predictor of the change in total population size. *Biological Conservation* 125: 335-343.

Thomas C.D., A. Cameron, R.E. Green, M. Bakkenes, L.J. Beaumont, Y.C. Collingham, B.F. N. Erasmus, M. Ferriera de Siqueira, L. Hannah, L. Hughes, B. Huntley, A.S. van Jaarsveld, G.F. Midgley, L. Miles, M.A. Ortega-Huerta, A.T. Peterson, S.E. Williams. 2004. Extinction risk from climate change. *Nature* 427: 145-148.

Williams S.E., Bolitho, E. E. & Fox, S. 2003. Climate change in Australian tropical rainforests: an impending environmental catastrophe. *Proceedings of the Royal Society Lond. B.* 270:1887-1892.

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*** see full report - attached (Welbergen, Williams and Goosem, 2011).

Gap analysis of environmental research needs in the Australian Wet Tropics

Dr Justin A. Welbergen, Prof Stephen E. Williams, Dr Steve Goosem

EXECUTIVE SUMMARY

Environmental research involves "understanding how environmental systems function and interact, and the impact that humans are having on the environment". Strengthened linkages between terrestrial biodiversity researchers and end-users are desirable to reduce duplicative effort and achieve maximum return on public investment in applied research. To assist this process, our analysis provides a significant review and consultation process with the aim of identifying end-user needs, research gaps and possible synergies, delivering a valuable resource for terrestrially focussed research providers and end-user groups.

This report provides a resource for research providers by helping to locate relevant research information more efficiently, and by ensuring that proposed research is strategic and targeted at the needs of the end-users. It provides a resource for end-users by delivering a repository of biodiversity research that is digested and easily accessible, and by identifying the areas of research where stakeholder interests overlap. Finally, the report can also be used by funding bodies to help guide the prioritisation of resources into future biodiversity research in the Wet Tropics bioregion.

The tangible outputs are:

1) **Broad systematic review of biodiversity research in the Wet Tropics**. This report makes accessible 824 references from the peer-reviewed and grey literature. It categorises the literature according to three main categories of biodiversity research ('status and trends', 'risks and threats', 'mitigation and adaptation') and a range of logical sub-categories. In doing so it provides a relative indication of the effort allocated to the various areas of biodiversity research in the Wet Tropics.

2) **List of research gaps** – The report provides a list of 195 research gaps as identified during a workshop by 15 expert end-users and research providers in the region, and categorised according to the same categories as the broad systematic review.

3) **Identification of possible synergies** - Each research gap has also been rated by representatives from 13 end user and research provider organisations, enabling the identification of shared stakeholder interest.

4) **Major reference database** – The report incorporates a major electronic reference list (N > 2500 references) of the peer-reviewed and the grey literature on biodiversity research in the Wet Tropics.

We envision that these outputs are updated on a 5-year cycle, so that our approach can continue to provide a valuable resource for terrestrially focussed end-user groups.

List of the 20 highest-value biodiversity research gaps, identified by research experts and rated by organisations with a stake in biodiversity research in the Wet Tropics. During our workshop a total of 195 research gaps (Appendix 8.1.) was identified by 15 people with expert knowledge in biodiversity research in the Wet Tropics. Subsequently, representatives from 13 regional stakeholders were asked by email to rank each gap in terms of its 'relative value' to the stakeholder's organisation (1 = 'low value; 5 = 'high value') (for methodological details, see sections 4.4.2 & 4.4.3).

●	**Key research gaps**	**Average value**
1	Long-term monitoring data, essential for decision making	4.28
2	Understanding how to create a resilient landscape in the face of climate change - What criteria? Where? Why?	4.19
3	Maps of habitats of all endangered and vulnerable species	4.18
4	Establishing monitoring and conservation strategies for key species vulnerable to climate change	4.11
5	Information on the distribution and abundance of weeds and invasives	4.08
6	Understanding which ecosystems and species are most vulnerable to climate change (including shifts in averages and extreme events)	4.02
7	Understanding of the key indicators of ecosystem health that can be regularly measured at a landscape scale, with a focus on rare regional ecosystems that are threatened by antropogenic (climate) change	4.02
8	Research into thresholds or tipping points that lead to catastrophic irreversible ecological changes	4.00
9	Quantification of the value of restoration and regrowth in maintaining and improving ecosystem function	3.97
10	Identification of species-specific mitigation strategies for keystone / flagship species	3.97
11	Understanding the threat of climate change to ecosystem processes, e.g. primary production, dispersal, water relations, etc.	3.96
12	Understanding how to increase regional resilience - identification of options to extend conserved areas and the connectivity between them?	3.95
13	Greater emphasis on adaptive management between researchers and management	3.95
14	A baseline health status assessment of key threatened and endemic species	3.93
15	Understanding the interactions of climate change with other threats, e.g. invasive species	3.93
16	The assessment of the abundance and population structure of threatened and endemic species	3.92
17	Understanding the role of refugia under climate change; at what scales do they exists, where they, and what is their value?	3.92
18	A characterisation and mapping of the key climate refugia as a basis for management intervention	3.92
19	Knowing the risk of loss of tall open forest in the Wet Tropics	3.90
20	Biodiversity Planning Assessment for the Wet Tropics	3.89