

# EARTHWATCH INSTITUTE ANNUAL FIELD REPORT

**Date completed: Feb 2008**

**Completed by: Stephen Williams, Luke Shoo and Collin Storlie**

**Period covered by this report: June 2007 to Dec 2007**

Dear 2007 Earthwatch Volunteers,

First, allow us to extend our sincere thanks for your important contribution to research on the impacts of climate change in the Australian Wet Tropics. 2007 saw the formation of the Centre for Tropical Biodiversity and Climate Change Research (<http://www.jcu.edu.au/ctbcc/>). The Centre is comprised of an ever growing number of PhD students whose labour intensive projects benefited greatly from your help. You always seemed only too happy to assist, even when helping meant dawn bird surveys, spotlighting in the rain, collecting baited dung beetle traps, or measuring hundreds of leaf litter samples. These sorts of sampling techniques are absolutely essential to gather the information we need to understand the complex interactions between climate change and biodiversity. Our research would be greatly diminished without your help.

We had two great trips during 2007, both of which resulted in some fantastic memories. The June expedition served to remind all of us why it's called the **rain**forest. Tents, sleeping bags, and clothes (but not enthusiastic attitudes) quickly became damp. All of you handled the exceedingly soggy situation with great aplomb and forged on regardless. It was great to be able to connect with our eight young (one young at heart, Uncle Tay) Singaporean volunteers from a variety of different educational backgrounds. Unfortunately I couldn't attend the October expedition due to a series of meetings with policymakers in Australia and abroad. However, from what I've been told by Luke and Collin, it was certainly my loss. The October expedition was a much drier experience and some were even treated to good sightings of illusive rainforest inhabitants such as the cassowary. All volunteers seemed keen to join the sampling activities even when it meant forays into the lowlands which can be oppressively hot at that time of year. Jim's whole-hearted commitment to ant-collecting in particular won't be forgotten any time soon. Of course after sampling we always saved time for the finer things in life such as frisbee in the creek, the first annual Earthwatch beach-boules tournament, or lavish birthday parties in the hut at South Johnstone (Rolf, we all hope that it was a birthday that you will not quickly forget).

The impacts of the science from this research continue to increase. The research you all helped with is now internationally recognized and is being communicated all over the world. We hope you're all proud, we are, to be doing something that is making a difference and hopefully will continue to do so in the future. Come back again sometime ☺

Cheers,

Steve Williams, Collin Storlie and Luke Shoo

## Reporting on research objectives

**Objective 1:** Continue monitoring of established sites across altitudinal and latitudinal gradients in the region to obtain empirical measurements on distribution and abundance of selected vertebrate, invertebrate, and plant groups over the gradients most likely to be affected by climate change.

In 2007 field season with the help of Earthwatch volunteers the following monitoring was carried out:

- 20 days of data collection at 3 locations totalling 16 altitudinally stratified long-term monitoring sites with the help of 20 Earthwatch volunteers.
- In 47 standardised bird surveys totalling 23 hours, 2088 individual observations were made comprising 74 different species, 10 of which are endemic to the Wet Tropics World Heritage Area (WTWHA).
- In 68 standardised reptile surveys totalling 34 hours, 204 individual observations were made comprising 15 different species, 12 of which are endemic to the WTWHA.
- During 25 standardised night-time spotlight transects totalling 25 hours, 229 individual observations were recorded. These records comprised 36 different species, 22 of which are endemic to the WTWHA.
- 128 individual standardised microhylid frog point counts were undertaken. This resulted in 284 individual records comprising 5 different species all of which are endemic to the WTWHA.
- 390 cumulative days of Malaise insect trapping occurred across the altitudinal gradient. Schizophoran flies have been removed from samples and sorted to Family level.
- 21 standardized fruit and flower transects, totalling over 1 km, gathered information on the reproductive phenology of rainforest plants.
- 204 baited pitfall traps were placed across the altitudinal gradient to capture native dung beetles as part of a project examining their phonological patterns.

**Objective 2:** Continue long-term micro-climate monitoring sites in key areas where global climate change is predicted to have initial impacts.

From climate monitoring sites the following data was collected:

- 26 previously placed weather stations were downloaded for both field trips in June and October, establishing microclimate data on cloud stripping, temperature, humidity, and soil moisture at 15 minute intervals

**Objective 3:** Obtain measures of Net Primary Productivity, (i.e. rate at which organic matter is incorporated into plant bodies so as to produce growth), and soil processes, such as nutrient and carbon cycling, across the altitudinal and latitudinal range of the Wet Tropics region

The following information was collected for Monitoring NPP and soil processes:

- 1480 litter standing crop samples were taken to help quantify net primary productivity and nutrient cycling across the altitudinal gradient.
- 255 trees fixed with dendrometer bands had their growth measured as part of an ongoing project examining net primary productivity; 340 previously established leaf litter traps were also cleared as part of this project.

## Non-technical summary of results

**Give an account of the data collected and results (inputs and data) for the period covered by this report, mentioning any emerging trends.**

Results from Steve Williams and Jeff Middleton (Williams and Middleton 2008, see details below) have found that while the number of bird species that are recorded across the Wet Tropics region varies little from Mt Spec (Paluma) to Mt Lewis (Carbine Uplands), the abundance of each species varies greatly. That is the number of individuals for each species is lower in areas where there is more within-year climatic variability, particularly areas where there is more rainfall seasonality such as Mt Spec and Mt Lewis compared to Atherton tablelands. Williams and Middleton suggest that the reason for this pattern is resource bottleneck (insects, nectar and fruit) during the dry season that limits the population sizes of many species.

Rohan Wilson & Steve Williams et al. (2007) looked at the abundance and distribution of Diptera sub-order Schizophora (true Flies) along an altitudinal gradient at Mt Lewis (Carbine Uplands). The season of peak abundance of Schizophora changed with altitude, with highlands peaking in October and lowlands peaking in abundance in April. There was a high level of species turnover with altitude; there was also some evidence of distinct low-, mid-, and high- elevation assemblages, with the high-elevation assemblages containing the most restricted species.

McGuire & Williams (honours project abstract summary) looked at fruiting phenology of rainforest plants throughout the Australian Wet Tropics for seven months by surveying transects on a monthly basis and collecting fruits and flowers from the forest floor. Rainforest plant communities showed seasonal and altitudinal trends in the phenology of flowering and fruiting, although patterns were highly variable across species and sites. Fruits were most abundant at higher altitudes (1000-1200 m a.s.l.). Fruiting peaks occurred earlier and over a longer period in the uplands (October through to March) than in the lowlands (February to March), indicating that fruit production may be less seasonal at higher altitudes. Flowering was concentrated in the drier months, with flowering peaks between September and December. Maximum fruit abundance was limited by net primary productivity (NPP). These relationships suggest that phenological events are closely associated with climatic variables such as temperature and rainfall, and are therefore sensitive to climatic changes.

However, the abundance of flowers at mid-altitude sites was similar to that at other altitudes, and the flowering peak at mid-altitudes was not followed by a fruiting peak of relative magnitude as it was at other sites. Comparison of fruit abundance data with bird abundance data collected from the same sites suggests that frugivorous birds removed large proportions of the fruit produced and that this was a significant bias in the estimates of fruit abundance at mid-altitude sites where frugivorous bird abundance is highest.

Fruit abundance may actually follow a similar pattern to NPP across altitude, which was masked in this study by a greater rate of removal of fruit by frugivores at mid-altitude sites. The seemingly large quantity of fruit consumed by frugivorous birds highlights the important role that frugivores play in the tropical rainforest, and the extent of the influence of frugivory on plant community dynamics and structure in tropical rainforest.

**How do these data contribute to achieving conservation impacts? (e.g. actions based on results, management plans, site protection)**

The Wet Tropics rainforest of North Queensland has the highest biodiversity of any region in Australia. The vertebrate fauna alone has 87 species which are endemic to this region. While world heritage listing of the area in 1980s, based on this regions' biodiversity values, has prevented ongoing impacts from land clearing, our research suggests that the region is highly vulnerable to global climate change. Up to 46% of the unique rainforest fauna could be lost with an increase in temperature of 3.5<sup>o</sup>c. This is significant as the IPCC fourth assessment report and regional climate models suggest that we will see between 1.1 – 4.8°C of warming by the year 2070: potentially a catastrophic impact on the world heritage values of the region.

Regional Climate change predictions suggest that annual rainfall will not change markedly but that seasonality (climate variation from wet to dry for each month) will increase. We predict that increases in seasonality due to global climate change could cause significant declines in bird density in the rainforests of the Wet Tropics. It is therefore important that good populations and habitat be maintained in refuge areas such as the Atherton Tablelands and Kirrima region.

Similar to the vertebrates of the Wet Tropics, high elevation Schizophoran flies assemblages are at risk of local extinction with 2 - 3<sup>o</sup> of warming, and the mid-elevation assemblages to be at risk with 4-5<sup>o</sup> warming. This study suggests that the highland species –*Helosciomyza ferruginea* would be a good indicator species for monitoring the effects of climate change. Wilson is currently extending this study across the Wet Tropics region (Paluma to Mt Windsor).

The study of fruiting phenology and frugivory, provides the first empirical measurements of fruit and bird abundance across altitudinal gradients in the Australian tropical rainforest. These findings suggest that reduced bird populations and shifts in the distribution of frugivorous bird species associated with climate change have the potential to reduce seed-dispersal rates thereby negatively affecting recruitment and dispersal of many plant species. Likewise, changes in the timing, spatial distribution and success of fruiting events could limit frugivore populations and alter community structure and function.

### **What is/ are the significance/ benefits of your research?**

The rainforests in the region are of immense scientific, economic and social value. Climate change poses a severe threat to these values with a recent study showing that tourism alone in the rainforest of the Wet Tropics generates over \$426 million in revenue to our local community, conserving this region is essential for the sustainability of many peoples livelihood. Therefore, by providing the information necessary to help protect the natural ecosystems of the region, this research will directly benefit many groups of people and organizations including scientists, natural resource managers (e.g., Wet Tropics Management Authority; Environmental Protection Agency), the local community and indeed the global community (as recognized by the World Heritage listing of the area). Most conservation management is aimed at the preservation and protection of selected conservation areas; however, this is a static strategy which does not allow for a changing world. In the Wet Tropics World Heritage Area (WTWHA) there is a very well protected conservation area that is severely threatened by a changing global climate. In order to protect this unique area the project must be able to predict the future impacts of these changes and design management policies that will attempt to minimize these impacts in a changing climate. The type of information that will be collected within this project has been lacking within Australia, therefore the formation of appropriate public policy dealing with climate change impacts has been severely limited. The data and

analyses produced within this project will enable more efficient and informed decisions on the allocation of scarce management resources across the region.

The research carried out by this research group and Earthwatch volunteers has directly been taken up by end-users (Environmental Protection Agency and Wet Tropics Management Authority) and policy-makers in the following ways:

### **Engagement with Research End-users:**

#### **International**

- Global Environmental Change & Biodiversity, UNEP (2005), Paris – Organised by UN and DIVERSITAS to discuss how climate change would impact global biodiversity.
- Expert reviewer for the 2007 IPCC report: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of working Group II to the fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- Workshop IUCN (2007), London – “Developing criteria to assess vulnerability to climate change” in order to guide future IUCN listing of threatened species.

#### **National**

- Intergovernmental Panel on Climate Change (IPCC) authors meeting, Canberra, 2005.
- National Climate Change and Biodiversity Action Plan (2004-2007) - Contributor and reviewer.
- DIVERSITAS National Committee Australia - Invited scientific advisor. DIVERSITAS is an international collaborative project with the goal of providing accurate scientific information and predictive models of the status of biodiversity.
- Australian Greenhouse Office workshop (2007) – “A strategic assessment of the vulnerability of Australian Biodiversity to climate change”. Aims to formulate research priority for research and biodiversity at national scale.
- Earthwatch Australia, Scientific Advisory Committee – Invited scientific advisor of research priorities within Australian region.

#### **Regional**

- Williams (2006) book generated due to demand by Environmental Protection Agency and Wet Tropics Management Agencies need for information on species distributions and regional biodiversity maps.
- Invited member of Wet Tropics Management Authority (WTMA) Scientific Advisory Committee to provide advice on the conservation of biodiversity in this region.
- North Queensland Climate Alliance – part of the formation of the community and communication based group to inform North Queenslanders on resilience and adaptation to climate change
- Great Barrier Marine Park Authority – scientific research priority advisor for this region.

### **Policy Uptake**

#### **International**

- Papers (Thomas et al. –including Williams (2004) and Williams and Hilbert (2006)) have been used in the “Climate Change and Biodiversity Information Network by the IUCN CBSG Climate change working Group which aim was to “establish the most significant climate change related biodiversity impact research, publications and specialists’ network”. The information was used as “key to enhancing the conservation community’s ability to incorporate climate change dynamics into

species risk assessment processes and modelling tools, conservation programs and awareness raising capability”.

- Research used by Birdlife International- State of the World's birds (2004) which uses research information to describe the state of global bird biodiversity, the pressures upon it and the solutions that are being, or should be, put in place. Page 49 – references Williams et al. (2003) to show the bird species which will be threatened with extinction due to climate change in Australian Wet Tropics.

### **National / Regional**

- Paper in “Climate change impacts on biodiversity in Australia” which was the outcome of a workshop sponsored by the Biological Diversity Advisory Committee (2003) used to advise the Minister for the Environment and Heritage on matters relating to conservation and ecological sustainable use of biodiversity.
- Work described and directly referenced in National Biodiversity and Climate Change Action Plan (2004-2007). The action plan is used to help coordinate national, state and territory government’s climate change impacts and adaptation programs.
- Australian Greenhouse Office, Department of Environment and Heritage Report “Climate Change Risk and Vulnerability: promoting an efficient adoption response in Australia “ (2005) Page 69 specifically describes work on climate change impacts on Wet Topics rainforest vertebrates carried out by Williams et al. under the ‘Biodiversity: Prospects under climate change’ section. This report was the first step in identifying priorities for the National Climate Change Adaptation Programme which was an initiative of the Australian Government to commence preparing Australian governments and vulnerable industries and communities for the unavoidable impacts of climate change.
- State of the Australian birds report (2006) directly reports on work by Williams on impacts of Climate change on Wet Tropics birds.
- Climate Change in Australia technical report 2007 by CSIRO, Australian Bureau of Meteorology and Australian Greenhouse Office- directly references Williams et al. (2003) on impacts of Climate change on Wet Tropics Fauna.

### **Local** (to the area of the research site)

- Queensland Premier’s Department supported the production of Environmental Crisis: Climate Change and Terrestrial Biodiversity in Queensland special report (2004). Page 4 references directly Williams et al. (2003), Thomas et al. (2004) and Williams & Hilbert (2006) work on climate change impacts on Wet Tropics Biodiversity.
- Williams et al. (2003) and Williams & Hilbert (2006) cited in Annual Report and State of the Wet Tropics Report 2006/2007 by Wet Tropics Management Authority in listing climate change as the leading underlying threat to the Wet Tropics World Heritage Area and which vertebrate species are most threatened.
- Regional distribution maps of vertebrate fauna used by Environmental Protection Agency and Wet Tropics Management Agency for management decisions in Wet Tropics when looking at biodiversity values in an area, e.g. Mt Elith Rd and Mt Lewis.
- Williams’ contributions have helped to highlight areas of conservation priority for maintaining biodiversity values within the Wet Tropic Region, e.g. Carbine Uplands – Mt Lewis, Mt Windsor.

## **Communication of results**

**Printed:** peer reviewed scientific publications; books / book sections; reports, management plans or policies; fact sheets, brochures, leaflets, pamphlets, posters, academic

dissertations, annual reports, proceedings of conferences or workshops; letters; newsletters.

## **PUBLICATIONS:**

### **In Review:**

**Williams S.E.**, Shoo L.P., Isaac J., Hoffmann A.A. & Langham G. (invited review, submitted 27 Nov., MS#: TREE-D-07-00253). Assessing the vulnerability of biodiversity to climate change.

***Trends in Ecology & Evolution* (Impact Factor = 14.125)**

**Williams S.E.**, Shoo L., Henriod R. & Pearson R.G. Macroecology of rainforest birds in the Australian Wet Tropics bioregion: elevation, diversity, abundance, productivity and the impacts of climate change. ***Journal of Animal Ecology*** (submitted 30 Oct 2007: MS#: JAE-2007-00611) **(Impact Factor = 3.390)**

VanDerWal, J., Shoo, L.P. & **Williams S.E.** Late Quaternary climate fluctuations and refugial dynamics in Australian wet tropical rain forests: vegetation stability and bottlenecks in area. ***Journal of Biogeography*** (submitted 17 Dec 2007, MS#: JBI-07-0478)

Yek, S.H., **Williams, S.E.**, Burwell, C., Robson, S.K.A. & Crozier, R.H. Leaf Litter Ants as Surrogates for Establishing Conservation Priorities in the Australian Wet Tropics ***Biodiversity & Conservation***.

Goodman, B. & Williams, S.E. Sexual size dimorphism in the tropical skink *Carlia rostralis*. ***Memoirs of the Queensland Museum***.

Isaac, J.L., VanDerwal, J., Johnson, C.N. & Williams, S.E. Using life history and ecology to predict IUCN categories in Non-evaluated reptiles. ***Herpetological Conservation and Biology***.

### **In Press:**

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

**Williams, S.E.**, Isaac, J.L., Graham, C., Moritz, C.M. Towards an understanding of vertebrate biodiversity in the Australian Wet Tropics. *In* Living in a dynamic tropical forest landscape, N. Stork & S. Turton (eds.), Blackwell Publishing.

Graham *et al.* (including **Williams**). The influence of spatial errors in species occurrence data on distribution models. ***J. of Applied Ecology***

Steiner, F.M., Schlick-Steiner, B.C., VanDerWal, J.J., Reuther, D., Keefe D., Christian, E., Stauffer, C., Suarez, A.V., **Williams, S.E.** & Crozier R.H. Combined modelling of distribution and niche in invasion biology: a case study of two invasive *Tetramorium* ant species. ***Diversity & Distributions***. Accepted 13/12/07

### **Published:**

**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**

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**

Guisan, A. *et al.* (including **Williams**). 2007. Sensitivity of predictive species distribution models to change in grain size. ***Diversity and Distributions* 13: 332-340.**

Marsh H., Dennis A., Hines H., Kutt A., McDonald K., Weber E., **Williams S.E.** & Winter J. 2007. Optimising the allocation of management resources to species of wildlife. ***Conservation Biology* 21: 387-399**

**Digital:** database; internet - websites, email group/ blog/forum; CD Rom, e-newsletter

A new website has now been established for the Centre for Tropical Biodiversity and Climate Change which shows the work and information on all of the research lead by A/Prof Stephen Williams' group and students. The website is <http://www.jcu.edu.au/ctbcc/>.

**Mass media:** broadcast production; film; TV, radio, print (newspaper/ magazine coverage); Press releases; press conference; interview, article creation; press trip

Adam Burke joined the Earthwatch trip in June and is a radio presented for the show "The DNA files"; this can be listened to on the website [www.dnfiles.org/programs/heat](http://www.dnfiles.org/programs/heat) .

**Meetings and conferences:** presentations/ lectures; conferences; workshops; training sessions; discussions; local community meetings and events.

**Invited Participation / Presentations ( • indicates funded participation by inviting organization):**

- Niche breadth & sensitivity to climate change, National Academy of Sciences (USA), Arthur M. Sackler Colloquium, Irvine Cal., Dec 2008.
- Climate change impacts presentation to US Congressional committee for Science & Technology, Jan 2008.
- Southern Hemisphere Ornithological Congress (Plenary presentation), Perth 2007.
- IUCN Workshop on assessing vulnerability of species to climate change, London Oct 2007.
- Strategic National Assessment of the Vulnerability of Australia's Biodiversity to Climate Change, Canberra Oct 2007
- Aust Greenhouse Office, Climate change modelling workshop, Sept 2007
- QLD Museum Public forum on climate change impacts, Brisbane Sept 2007.

**Policy Involvement:**

- Strategic National Assessment of the Vulnerability of Australia's Biodiversity to Climate Change, AGO 2007/2008.
- Invited expert reviewer: IPCC 4<sup>th</sup> Assessment Report on the impacts of climate change, 2007.
- Invited member of the GBRMPA climate change vulnerability advisory committee, 2007.
- Wet Tropics Management Authority, Scientific Advisory Committee, 2007-2010.

**Conferences:**

Ecological Society of Australia – Nov 2007, Perth  
Australasian Ornithological Society meeting – Nov 2007, Perth  
Herpetological Society of Australia – Nov 2007, Perth

## Educational Opportunities

**Does your project directly or indirectly involve the following groups in your research topic?**

Students and early career scientists are directly involved in the research through collaborative projects coming out of the CTBCC. Two PhD students have commenced within the last 12 months: Andres Merino-Viteri will be looking at the physiological tolerances of Microhylid frogs and Kyran Staunton will look at the abundance and distribution of predatory beetles. We also had an Honours student Anna McGuire who investigated the fruiting and flowering phenology of rainforest trees and has now

completed this degree with 1<sup>st</sup> class honours (the highest level). For the 2007 field season, we had some Post-graduate students join the Earthwatch trips to be trained in bird sampling techniques and call recognition. We often also use Earthwatch trips to introduce 2<sup>nd</sup> and 3<sup>rd</sup> year biology students who are interested in pursuing post-graduate research to the requirement, logistics and responsibilities involved in the collection of field data.

### **How does your research help these groups better understand and act towards the conservation of a sustainable environment?**

The research carried out by A/Prof Stephen Williams and his research group has direct relevance to the conservation of a sustainable environment at many levels:

- Local communities (including Aborigines and/or Torres Strait Islanders)  
Invited talks presented to community groups (including at the Indigenous Conference 2007) help to make local communities aware of the potential impacts climate change may have in their local area and how this will impact on their lives. These talks also suggest ways in which measures can be made to try and reduce these impacts. Steve Williams is also part of the North Queensland Climate Change Alliance, whose primary aim is to inform the local community of measures which can be taken to decrease climate change impacts in our local region.
- Students  
Steve Williams regularly presents talks to undergraduate University students on tropical biodiversity and climate change as well as local school groups.
- Early career scientists  
Steve Williams currently has 14 early career scientists working with him on this project and they are all directly involved in carrying out research which will help with the conservation of our environment.
- Other groups  
See above in 4.3.

### **Has your project contributed to the completion of Masters' or PhD theses or degrees, or other educational research findings?**

Rohan Wilson, who is well known to many volunteers, has just completed his sampling for his PhD thesis and has returned to Canberra to complete the sorting of these samples and the write up of his thesis (which is due in mid to late 2009). Anna McGuire completed her Honours degree with 1<sup>st</sup> class honours and has now moved back to Melbourne.

## **Acknowledgements**

Thanks again to the volunteers for all of their hard work and making our field trips over the year a whole lot more interesting.