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NCCARF
National Climate Change Adaptation Research Facility
Adaptation Research Network TERRESTRIAL BIODIVERSITY

Terrestrial Research E-bulletin

Convener's Update

Welcome to the two-year anniversary issue of the TRE-bulletin.

In the past two years, our Network has expanded considerably, provided a variety of services and resources for our members, and achieved a great deal in adaptation research.

The Terrestrial Biodiversity Network now comprises more than 1100 members, with 60 percent of membership coming from stake-holders, and 40 percent researchers.

We have funded 19 student projects, and 25 student travel grants, with further funding to be announced soon. Summaries of completed student projects can be found on our website.

We have also held four workshops on key climate change adaptation issues, and have two more workshops planned for 2011-2012.

Our information sheet series has been well received - we have published 4 information sheets, with another three planned for publication in the near future.

This issue of TRE-bulletin also highlights some of the achievements of our Network over the past two years. We have a special summary on extreme climatic events, and their observed and potential impact on terrestrial biodiversity by Dr Justin Welbergen, from JCU.

We also have an article on the potential for climate change to alter the distribution of koala's, by Christine Adams-Hosking, whose studies were partly funded by an NCCARF grant.

The resulting peer-reviewed published paper from Christine's work is showcased in our regular 'Must Read' section, along with recently published open access papers resulting from the NCCARF-TB Funded workshops on Genetic Translocation and Managed Relocation.

Finally, the Network has also recently finished it's highly successful Roadshow tour, and our co-ordinator, Dr. Yvette Williams, provides a sum-mary of the Roadshows on page 4.

We hope you enjoy this issue.

Steve Williams & Lesley Hughes

In this issue:

Meet the Steering Committee

Dr Nicola Mitchell

Nicki is an Assistant Professor in the School of Animal Biology at The University of Western Australia.

She has worked in Australia and New Zealand, and published widely on Australian frogs and temperature-dependent sex determination in reptiles.

Her current research melds ecophysiology with conservation biology – focussing on identifying how climate change will affect the life history of egg laying species, and on paths to adaptation.

She leads a collaborative project on managed relocation of the endangered western swamp tortoise, is a scientific advisor for the Climate-Watch initiative, and is incorporating Climate-Watch into first year biology teaching.

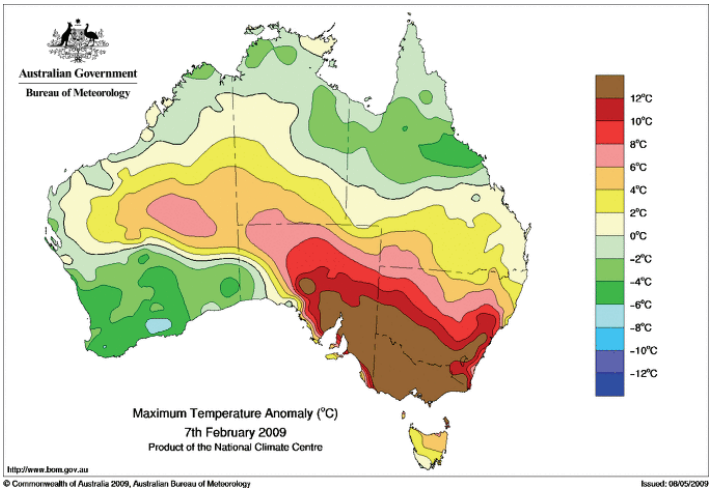
Extreme Weather Events: Special Summary

Many researchers believe that the predicted increase in extreme weather events, such as prolonged heat waves, flooding rains and cyclones, may pose the biggest threat to biodiversity from contemporary climate change. While many species may be able to adapt over time to more gradual changes, extreme events may cause mass mortalities for species which are unable to find immediate shelter or refuge. In this issue, **Dr Justin Welbergen**, from James Cook University, gives us an overview of extreme events from the perspective of his own research on flying foxes.

One of the greatest unknowns in climate change science is how changes in extreme climatic events, such as heatwaves, droughts, flooding rain and cyclones, will impact the natural world. Emerging evidence suggests that changes in the frequency, duration and intensity of such extremes will be even more important than gradual increases in climatic means in driving ecological responses to climatic change.

At present our understanding of the impacts of extreme events is limited at best, and the vulnerability of terrestrial biodiversity has not been quantitatively addressed. Accordingly, the recent NCCARF National Climate Change Adaptation Research Plan for Terrestrial Biodiversity highlighted climatic extremes as one of the highest priority areas of future climate change research in Australia, and particularly emphasised the need for quantitative, spatially-explicit investigations into the impacts of extreme events.

On a hot summer's day in January 2002, weather stations in northern NSW recorded maximum temperatures up to 16.5 C higher than normal, and we were directly confronted with the biological impacts of an extreme event. At that time, I was conducting field work in a large flying-fox colony as part of my PhD for the University of Cambridge, UK.



Predictions indicate that extreme events, such as prolonged heat waves, will become more common with climate change. The map show s the temperature anomaly recorded (by BOM) on Black Saturday in Victoria, New South Wales and South Australia, in 2009.

The day began as normal with females nursing their young and males squabbling over territories. As the temperature rose, large bats first fanned themselves with their wings; but soon the mood changed as the animals began jostling for cooler spots, started panting frantically, and finally resorted to licking their wrists in a last-ditch effort to stay cool. When the soaring temperatures hit 42.9 degrees C it began raining dead flying-foxes from the trees. It was gruesome. On that single day in the colony about 1,500 bats succumbed to the heat, representing approximately five percent of those that were present, and several thousands more died in other colonies along a 250-kilometre stretch of NSW coastline. (see: Welbergen et al. (2008), Proc. R. Soc. Lond. B, 275, 419-425)

This was not an isolated event. Since the early 1990s, tens of thousands of flying-foxes have died in at least 20 extreme heat events, with the most severe die-off taking place in 2009 on Victoria's Black Saturday. These events arguably feature among the most dramatic natural die-offs recorded in nature but warn us of the potential impacts of extreme events under climate change.

Dead flying foxes gather on the floor following an extreme temperature event (© J. Cheetham).

Extreme temperature events are of special concern to biodiversity conservation, not only because of their direct impacts on organismal health, but also because of their effects on water demand and evaporative losses and on the frequency and intensity of droughts and wildfires. Heat-related die-offs have now also been recorded in other Australian fauna, including birds and marsupials; and extreme droughts and wildfires can result in widespread mortality in Australian flora.

What determines the vulnerability of natural systems to extreme climatic events? The answer to this question is crucial for predicting potential impacts under different climate scenarios, and ultimately for developing better and more sustainable management strategies for our biodiversity and natural resources. Currently, there are few examples of adaptation strategies that minimise impacts of climatic extremes. These include experimental trials of shading parts of coral reefs to prevent thermal bleaching; shading of turtle nesting areas to reduce offspring sex-ratio deviations; and misting of flying-fox colonies to mitigate mass die-off events. Knowledge of the sensitivities of species and the probability of exposure is critical for the successful development and targeting of proactive conservation strategies that minimise vulnerability.

Here at Centre for Tropical Biodiversity and Climate Change, at James Cook University, we have been awarded an ARC Discovery Grant to study the effects of extreme climatic events on terrestrial biodiversity. We will focus on a model taxonomic group (Australian flying-foxes), known to be vulnerable to extreme events, and on a model ecosystem (Australian Wet Tropics), known to be under threat from climate change. We chose this approach because a comprehensive mechanistic understanding of the impacts of extreme events requires integration of information on the drivers of vulnerability across different levels of biological organisation, and across a whole range of spatial scales. We hope that by quantifying and making spatially explicit the risks of extreme events for biodiversity, our research program will, for the first time, enable the development of informed management strategies that preserve our unique biota in the face of future changes in the regimes of climatic extremes.

Conservation Under Climate Change: A Koala Case Study

By Christine Adams-Hosking, University of Queensland

The processes of habitat loss, fragmentation and degradation threaten numerous species globally and these threats are now being amplified by rapid climate change. Conservation planning for biodiversity under climate change requires the identification of priority areas for conservation to make the best use of resources available. For native marsupials such as koalas (*Phascolarctos cinereus*), that depend on a limited variety of primarily, *Eucalyptus* trees for their food and habitat, understanding the potential effects of a changing climate on their natural geographic range can help with planning for their future adaptation under climate change.

My PhD research has been investigating the potential shifts in these ranges under various climate scenarios. Firstly, I looked to the past. How did koalas, who we know from the fossil records have existed in Australia since the Oligocene (approximately 25 million years ago), manage to survive the climatic events of the past?

Possibly Australia's most iconic terrestrial species, the koala could become significantly more restricted in terms of it's distribution under climate change (© B.Balch)

To answer this question, I used bioclimatic modelling, based on climatic conditions at the Last Glacial Maximum (approximately 18, 000 years ago). I found that koalas may have experienced significant contractions in their ranges and utilised 'climate refugia' in restricted areas of southeast Queensland and northern New South Wales.

To investigate the effects of a future climate on the range of koalas, I then developed species distribution models based on mean maximum summer temperatures and mean annual rainfall using CSIRO climate change projections of current, 2030, 2050 and 2070 climates. These models showed that as climate change progresses, the distribution of koalas will be significantly altered. Their range in eastern Australia will contract eastwards and southwards towards rapidly developing coastal areas. By 2050, they will not persist in their current western range. These findings highlight the potential impact that a warming climate can have on one of Australia's most iconic animals. It also highlights the need for proactive koala conservation planning investment, to facilitate their adaptation and therefore survival, under climate change. This planning needs to be underpinned by effective communication and cooperation between various stakeholders, researchers and policy makers.

More: Adams-Hosking *et al.* Wildlife Research 38, 122-130.

Must Read

Hot off the press— papers and reports on climate change adaptation

Modelling climate-change induced shifts in the distribution of the koala (2011) Adams-Hosking *et al*. *Wildlife Research*, 38, 122 -130. This study, partially funded by NCCARF ARN- TB, investigates the potential impact on the distribution of the koala under different climate change scenarios. The authors find that koala may become more restricted to habitat refugia in the east and south of it's current range. The study concludes that management measures need to focus on conserving eucalypt forests in these regions in order to ensure the future of the koala. http://dx.doi.org/10.1071/WR10156

♦ **Assessing the benefits and risks of translocations in changing environments: a genetic perspective.** (2011) Weeks *et al*. *Evolutionary Applications* (open access). This review paper is a result of an NCCARF - TB funded workshop on Genetic Translocations. The authors provide a classification of translocations based on genetic goals and provide a framework for assessing the genetic benefits and risks associated with translocations. http://onlinelibrary.wiley.com/doi/10.1111/j.1752-4571.2011.00192.x/full

♦ **Optimal timing for managed relocation of species faced with climate change**. McDonald-Madden et al. (2011) *Nature Climate Change*, 1, 261-265. This paper is also a result of an NCCARF-TB funded workshop, on managed relocation of species. Here, the authors construct a framework to inform decision-makers on moving species threatened by climate change, under a number of scenarios. doi:10.1038/nclimate1170

♦ **Refugia: Identifying and understanding safe havens for biodiversity under climate change**. (2011) Keppel *et al*. *Global Ecology and Biogeography* (online early). This paper, co-authored by one of NCCARF-TB's Steering Committee members, provides a review of habitat refugia in the scientific literature, and develops a framework to identify and describe refugia in any environment. The authors conclude that this framework will allow the identification, and subsequent protection, of habitat refugia that can protect species under climate change. DOI: 10.1111/j.1466-8238.2011.00686.x

Roadshow Summary by Yvette Williams, NCCARF-TB co-ordinator

Over the past 9 months, the Terrestrial Biodiversity Network has held it's Roadshow presentations and workshops in every State and Territory. More than 395 participants attended, from all sectors, including researchers, policy-makers, managers and local government.

A number of key achievements came out of the Roadshows, including a nationwide comparison of how adaptation challenges, concerns and priorities differ across Australia.

Queensland, Victoria, the ACT, and New South Wales cited habitat fragmentation and connectivity issues as their most important challenges. However, the Tasmanians were most concerned about extreme events, while South Australians are worried about interactions with a variety of other stressors.

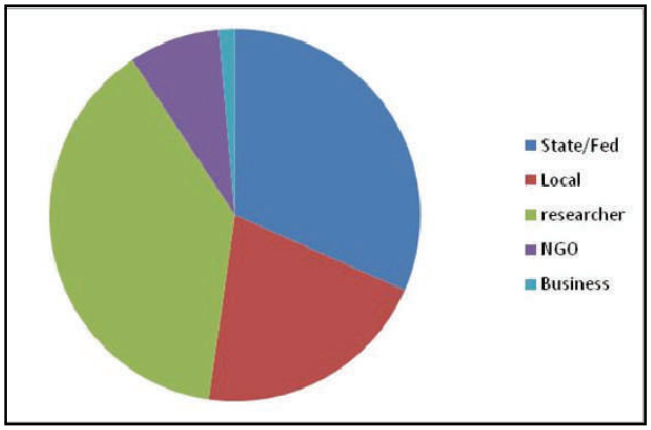


Chart showing participants by sector at the 8 Terrestrial Biodiversity Roadshows In 2010 and 2011.

Unsurprisingly, Western Australia's greatest challenge is changes in rainfall, and Northern Territory participants were most concerned about changes in fire regime.

More than 60 presentations were given from a variety of speakers, and a summary of each roadshow is available on our website, here. More comprehensive outputs from the Roadshows will be available in the near future, including a compilation of information gathered for each State or Territory.

Although priorities differed somewhat between States and Territories, some key issues and concerns for climate change, adaptation and terrestrial biodiversity were identified across regions. These included interactions with climate change and other threats to biodiversity such as habitat loss and invasive species, the impact of extreme weather events and potential changes in ecosystem services.

By gathering researchers and decision-makers together under one roof, the Roadshows were fundamental in facilitating the exchange of ideas, concerns and information on climate change science and adaptation measures for terrestrial biodiversity.

Conference Update

International Conference on Energy, Environment and Sustainable Development.Shanghai, China, 21 - 23 October 2011. http://www.iceesd.org/

World Congress for man and Nature: Global Climate Change & Biodiversity Conservation. Haridwar, India, 11-13 November 2011. http://wcmanu.com/

EcoForum: Conference and Exhibition. Sydney, Australia, 7-9 March 2012. **Abstract Submission TBA.** http://www.ecoforum.net.au/2012/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About the Adaptation Research Network for Terrestrial Biodiversity

The Adaptation Research Network for Terrestrial Biodiversity is one of eight Research Networks administered by the National Climate Change Adaptation Research Facility - www.nccarf.edu.au.

It is hosted by James Cook University in Townsville.

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