Submission 067
Date received: 12/08/2011

Committee Secretary,
House of Representatives Standing Committee on Climate Change, Environment and the Arts
PO Box 6021
Parliament House
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I am here making a submission as an environmental consultant and science writer who has produced six reports on climate change for clients including the Federal Government, Queensland Government, and Murray-Darling Basin Authority.

My focus is on two conceptual biases that may be limiting thinking about climate change impacts and management in Australia. I spoke about these at the Greenhouse 2012 conference in Cairns in April, and I refer to them in a my recent report for the Queensland Government, *Climate Change and Queensland Biodiversity*, available at http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/climate-change-report.html and which I refer to in this submission.

These biases have created a distance in thinking between some climate change biologists and many in the Australian ecological community. Statements are made about the need for trees to migrate, but I have yet to meet a botanist who believes that eucalypts will march across the land in response to a changing climate. Climate modelling studies imply that reptiles with small distributions are very vulnerable to climate change, but the reptile experts I have interviewed reject this. Climate change biology has emerged so rapidly as a discipline that it unavoidably operates from assumptions that have not all been rigorously assessed. Scientific disciplines normally develop over decades, providing ample time for their early premises to be tested, but with the urgency surrounding climate change there has not yet been time for this. The issues I address here have been raised by scientists in Australia, as my submission shows, but they have not always been widely noted. They are important for their management implications, and I conclude my submission by listing several of these.

A list of my climate change work is appended at the end of my submission. I have written more than 200,000 words about climate change and biodiversity since 2006. I was an invited contributor to the leading report, *Australia's Biodiversity and Climate Change* (Steffen *et al.* 2009). I have served on the Federal Environment Minister's advisory committee (Biological Diversity Advisory Committee), and have written six books about nature and conservation. I was recently awarded a Churchill Fellowship to study climate change in Europe and the U.S.

Tim Low

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Submission about Climate Change and Biodiversity

By Tim Low

I contend that climate change biology in Australia is operating from two assumptions that need to be questioned, for the reasons outlined below. These assumptions are limiting thinking about how we should manage biodiversity in the face of climate change.

Assumption 1. Species Must Move

Because we need to act swiftly on climate change, we tend to think that nature must also act swiftly. The expectation is that animals and plants will move along any corridors we create. This thinking can be traced back to research from the northern hemisphere, where fossil pollen studies show that trees in glaciated regions rapidly changed their distributions in response to the advance and retreat of glaciers. But fossil pollen studies from Australia provide very little evidence of trees rapidly changing their distributions (see section 5.1.5 of my report). Eucalypts differ from most trees in not having any mechanism to move their seeds, so rapid dispersal could not be expected in response to past or future climate change. Studies conducted so far of the genetic structure of populations also suggest that most Australian plants and animals did not change their distributions dramatically in response to climate change (see section 5.1.4). The CSIRO report, *Australia's Biodiversity and Climate Change*, has a section by Margaret Byrne (on page 75 in the printed edition) about past species movement. Her contribution, titled 'Did Australian species stay or move when the climate changed in the past?', concludes that over the past 700 000 years of natural climate change 'most species have "stayed put"'. Margaret Byrne was recently awarded a $280 000 research grant by the Australian Department of Climate Change and Energy Efficiency.

If many species did not move much in the past they cannot be expected to do so in future. It is especially unrealistic to expect whole habitats to move along corridors. Even in the northern hemisphere, species did not move together (see page 59 of my report). Margaret Byrne concluded that some species had migrated, so corridors will serve a vital role for some proportion of biodiversity. Other species won't benefit, probably including many eucalypts. This is something I discuss at length in my Queensland report (section 5.3).

Many species will be better served by protection of refugia rather than by creation of corridors. Refugia are places in which species have consistently survived past climate

change. They can be identified by their high numbers of rare species. They are sometimes much smaller than the areas under consideration when corridors are the focus. Kroombit Tops is a refugial area near Gladstone in Queensland which is an example of an area that deserves enhanced protection because of the threats pose by climate change. Its rare species are concentrated in a very small elevated area, and cannot migrate to cooler or wetter locations because surrounding lands are lower and drier. Mt Elliot near Townsville is another example of a small refuge with unique species facing no migration prospects. My point is that a focus on corridors should not lead to a neglect of small isolated habitat remnants if these serve as refugia. In my report I discuss how Kroombit Tops can be better protected by increased investment in control of fire and feral pigs, both of which are exacerbating climate change impacts (see section 6.13). Kroombit Tops and Mt Elliot are both high points on mountain ranges that can serve as corridors for more common species that are not confined to high land, and a focus on these refugia would complement a focus on corridors, rather than conflict with it. In my report I note that most refugia in Queensland occur along corridors, so that corridor and refugia conservation can complement each other, although they are not the same thing. But southern-western Australia is a region where refugia and corridors often do not coincide, in which many rare species have poor prospects of migration.

Botanists have made the point that eucalypts have mobile pollen rather than mobile seeds (see Reid and Potts 1998). Eucalypts invest very heavily in pollination, often producing masses of flowers that attract a wide range of insects and birds, and sometimes mammals as well. Australia is unique as the only continent on which the dominant trees are often bird and mammal pollinated. I am writing a book about birds in which I explore this in great detail, noting that Australia has much larger and more numerous pollinating birds than other continents because nectar is so plentiful. Our lorikeets, wattlebirds and friarbirds are much larger than the hummingbirds and sunbirds found overseas. In Europe and North America all the dominant trees are pollinated by wind instead. Australia has very infertile soil and highly structured soil (Morton et al. 2011), and plants achieve local dominance by being well adapted to a specific substrate. When the climate changes (naturally or otherwise) they cannot simply migrate because the soil often changes over short distances. But by investing heavily in pollination instead, they can produce a wide range of offspring, some of which may be suited to the new climate. Eucalypts hybridise freely, so that genes that confer survival under more arid conditions can circulate widely. McKinnon et al. (2004) suggested that various species 'have merged and been resurrected to varying degrees following the climatic perturbations of the Quaternary glacial cycles', implying that hybridisation promoted by pollination could be important to their future.

The fact that eucalypts invest more in pollen dispersal than seed dispersal suggests that conservation of long range pollinators may matter more to the future of many eucalypts than provision of corridors. But the conservation of pollinators has not received any emphasis in climate change reports to date, except in my report for the Queensland

Government, where I discuss this issue on pages 41-42 and 165-167. Here are some quotes:

> 'If long-range pollinators are protected, eucalypt genes that confer adaptation to aridity could circulate widely.'
>
> 'Climate change is likely to increase the already complex movements of birds and flying foxes as changing weather patterns disrupt regular flowering events, increasing the prospects of eucalypt cross-pollination and hybridisation when it is most needed. Hybrid combinations that fail today because they are poorly adapted to the current climate may become the success stories of the future.'
>
> 'Some vertebrate pollinators are declining. In southeastern Australia, two of the longest-range pollinators – the regent honeyeater (*Xanthomyza phrygia)* and swift parrot (*Lathamus discolor*) – have declined so dramatically they are now endangered. The grey-headed flying fox (*Pteropus poliocephalus*) and spectacled flying fox (*P. conspicillatus*) are federally listed as vulnerable. Scaly-breasted lorikeets (*Trichoglossus chlorolepidotus*) have declined in Southeast Queensland, although they still remain plentiful.'
>
> 'Little red flying foxes (*Pteropus scapulatus*) are potentially the most important of all pollinators under climate change because they travel very large distances in very large numbers and seldom feed on anything other than nectar. They have been described as 'at the forefront in the genetic preservation of many bioregional ecosystems' (Van Dyck and Strahan 2008). But they elicit the most complaints, visiting urban camps in immense numbers, damaging trees and increasing noise levels.'

I am not suggesting that corridors are not important. What I am suggesting is that a focus on connectivity will not be useful for many species. Your committee is seeking advice about strategies to enhance climate change adaptation, including promoting resilience in ecosystems. I contend that the protection of long range pollinators is one important way to increase resilience in forest ecosystems.

The Tasmanian Government has recently allowed logging of blue gums in Wielangta Forest where endangered swift parrots breed. This is an example of a failure to recognise the importance of pollination to climate change. The blue gum (*Eucalyptus globulus*) is a major economic resource in Tasmania (and globally), and the migratory swift parrot is the only pollinator capable of bringing blue gum pollen from the mainland - where the trees are adapted to a hotter climate - to Tasmania. Swift parrots migrate each year between Tasmania and the mainland during the period when blue flowers are flowering.

Pollinator conservation will also help eucalypts adapt to the exotic pathogen, myrtle rust (which is probably the same organism as eucalyptus rust). This rust is expected to

reduce eucalypt growth rates, and thus carbon sequestration. Rust susceptibility is highly variable within plant populations, and high levels of cross pollination will best ensure that genes that confer resistance circulate widely among eucalypts, paperbarks and other susceptible trees.

Assumption 2. Climate Sets Distribution Limits

A scientific study has more credibility if it is based upon on statistical analysis of data. But in climate change biology the only statistical approach that is easy to apply is what is variously called species distribution modelling, or niche (or climate-envelope) modelling, in which the climatic space a species occupies is projected into the future under different climatic scenarios. Thomas et al. (2004) is the best known example. When applied to species with small distributions, the conclusion is often that extinction is likely unless the species move (or are moved) to cooler and/or wetter locations.

Species distribution models operate from the assumption that the distribution of a species indicates its climatic tolerances. But it is well established that the distribution of a species is often limited instead by competition from other species, by a requirement for particular substrate (a certain soil type or rock outcrops), by a geographic barrier, or by a failure to spread widely from a refuge that was occupied during a cold dry glacial period. In these circumstances models will produce predictions that are too pessimistic.

The assumptions behind these models have been very widely criticised by biologists around the world, including by CSIRO scientists such as Austin and Dunlop (Araujo and Luoto 2007; Austin and Van Niel 2011; Chambers et al. 2005; Davis et al. 1998; Elith and Leathwick 2009; Hampe and Petit 2005; Heikkinen et al. 2006; Ibanez et al. 2006; Jackson et al. 2009; Lavergne et al. 2010; Lewis 2006; Pearman et al. 2008; Sutherst et al. 2007) (see section 5 of my report). The assumptions have been questioned in the two major reports about climate change and biodiversity produced in Australia to date.

Steffen et al. (2009, page 89) commented on the modelling study of Hughes et al (1996) (1996), in which it was suggested that large numbers of eucalypts with very small distributions may face extinction from a 2–3 °C rise in temperature:

> 'many of Australia's endemic species have adapted to a highly variable climate, especially in arid and semi-arid regions, and thus may have greater resistance to climate variability than their narrow ranges might otherwise suggest. In addition, their narrow ranges may be due to species-species interactions rather to their fundamental environmental niche.'

Steffen et al. (2009, page 79) also noted that we are particularly ignorant about what currently limits distributions of Australian species.

Dunlop and Brown (2008, page 60), in their major report about Australia's reserve system, warn that 'predictions from these models are based on many contested assumptions and it is unclear to what extent they reveal how likely potentially important distribution changes might be'.

Of the many critical overseas papers, here are quotes from one of the most recent, by Dawson et al. (2011), which appeared recently in the leading journal *Science*:

> 'To date, assessments of climate-change impacts on biodiversity have largely been based on empirical niche (or climate-envelope) models. For most species, these models indicate large geographic displacements and widespread extinctions. However, niche models are best suited to identifying exposure to climate change, which is only one aspect of vulnerability...'
>
> 'The heavy reliance of conservation management and policy on a single scientific approach creates risks of policy or management failures, particularly given that the underlying assumptions of that approach are under debate. Critiques center on the correlative nature of the niche models, scale dependency, the difficulty of reliable extrapolation outside observed climate space, and failure to represent key ecological and evolutionary processes that could allow species to persist in a heterogeneous landscape. Niche models impart ease of use and power in explaining modern distributions, but their efficacy in assessing extinction risk, delineating suitable future habitats, and predicting ecological outcomes is unproven.'

The assumption that the distribution of a species reflects its climatic limits is especially likely to be untrue in Australia, where many plants appear to be adapted for particular soil types, and many reptiles are adapted for specific substrates. It is unlikely to be true for many eucalypts, as explained in my report. I note (section 5) that large numbers of species have distributions that are climatically incoherent – their boundaries do not match any climatic boundaries – and it is especially obvious that such distributions do not indicate climatic limits on those boundaries at least.

If the assumption behind these models was accepted, vast numbers of species with small distributions face major threats from climate change, and corridors and translocation would be the only management options. The number of species with very small distributions is well beyond the current capacity of environmental agencies to save them in these ways. They occur throughout Australia, often far from national parks or existing corridors.

But if the assumption behind these models is questioned, the management prospects are very different. The threat faced from climate change (in terrestrial ecosystems) may be less urgent, and it may come indirectly from altered competition or predation. For example, it is widely assumed by alpine botanists that alpine vegetation is threatened more by invading trees than by direct climate change. This conclusion has been reached

because alpine plants can often be found below their usual limits in forest clearings. If climate change poses a direct threat then nothing can be done for plants confined to high mountains. But if invading trees are the problem then their removal could become a viable management action. Many high mountains in eastern Australia have rare plants growing near their summits that appear to be at high risk from invading trees.

In my Queensland report I suggest that many inland plants with small distributions face a larger threat from increased goat browsing than from direct climate change (see section 7.3.4.) (Goats represent an indirect climate change threat because climate change will probably lead to more goat farming because of their high temperature tolerances). Limiting goat browsing is a more viable management action for these plants than creating corridors or translocation, which has a low success rate.

There are reasons to think that the threats posed by climate change to biodiversity will often be indirect, arising when species that benefit from climate change (subalpine trees, goats, pigs, weeds) go on to harm to other species by displacing or eating them. A particular concern I have (one shared by leading fire experts, see section 2.5) is the potential for introduced pasture grasses, including buffel grass (*Pennisetum ciliare*) and gamba grass (*Andropogon gayanus*), to increase fire risk (see section 3.5). Hot fires in grass kill seedling trees, and because these grasses are larger than native grasses and thus burn hotter, they can prevent the establishment of tree seedlings, and even kill adult trees, resulting in sparser woodland that it poorer (and hotter) habitat with less stored carbon. Their spread into woodlands should be limited as a very high priority. The modelling studies divert attention away from such issues by implying that the threat posed by climate change is direct, rather than mediated by other species.

Conclusions

Here are some of the conclusions I draw:

1. We should not assume that most species can or will move along corridors in response to climate change. Many species did not relocate in response to past climate change and cannot be expected to do so in future. Many species will benefit more from protection of refugia than from increases in connectivity.

2. The focus on connectivity should not become a reason to devalue isolated habitat remnants where these serve as refugia. The refugia that species depend on are sometimes small.

3. A very small distribution does not necessarily imply that a species faces an immediate direct threat from climate change. Other threats may be more significant.

4. Protection of long range pollinators should become a major goal of climate change adaptation.

5. The threats posed by climate change will often be indirect, in the form of species that benefit from climate change displacing or preying on other species. Adaptation should often be about the management of increasing species (including invasive species such as flammable grasses).

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Tim Low Climate CV

Only climate change projects and publications are listed

Consultancies

2011 **Climate Change and Queensland Biodiversity**. A 120,000 word report commissioned by the Queensland Department of Environment and Water Resources, that reviews the species and habitats at most risk in each of Queensland's 14 bioregions. At : http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/climate-change-report.html

2010 **Low Carbon Diet in Ipswich**. Text for a brochure and a talk to rural landholders about how to manage habitat remnants to minimise climate change impacts on biodiversity. Funded by the DERM Low Carbon Diet Community Funding Program. At : http://www.ipswich.qld.gov.au/documents/environment/helping_nature_survive_climate_change.pdf

2009 **Climate Change, Weeds & Pests in the Murray Darling Basin.** A 38,000 word report for the Murray-Darling Basin Authority.

2009 **Climate Change & Brisbane's Threatened Species and Communities.** A 30,000 word report for Brisbane City Council that assesses the vulnerabilities to climate change of Brisbane's habitats and species. It assesses the expected impacts or rising temperatures, reduced rainfall, sea level rise and carbon dioxide fertilisation.

2009 **Climate Change Impacts on Natural Areas: Report prepared for Ipswich City Council.** An assessment of the vulnerabilities to climate change of Ipswich's natural areas, a map of climate change refuges, and an action plan. Produced in association with BAAM.

2007 **Climate Change and Invasive Species**. A major report for the federal Department of Environment and Water Resources. This followed from a workshop run in Canberra by Tim, at which he also spoke. At: http://www.environment.gov.au/biodiversity/publications/pubs/interactions-cc-invasive.pdf

2007 **Climate Change & Brisbane Biodiversity.** A report for Brisbane City Council with many adaptation recommendations. At: http://www.brisbane.qld.gov.au/documents/environment/tim_low%27s_report_on_biodiversity.pdf

Publications

In addition to the above.

2011 **Rising CO2 plants and biodiversity** *Ecos magazine* 161. Co-authored with Carol Booth. At: www.ecosmagazine.com/?paper=EC10105

2011 **Weedy biofuels: what can be done?** *Current Opinion in Environmental Sustainability* 3:1–5. Co-authored with Carol Booth and Andy Sheppard. At: ftp://ftp.inach.cl/rjana/ingrid/EnvSust/Low_2011_Weedy-biofuels-what-can-be-done.pdf

2010 Section on invasive species in the CSIRO book **Australia's Biodiversity and Climate Change,** edited by Wil Steffen et al. This was converted into a factsheet at: http://www.climatechange.gov.au/publications/biodiversity/~/media/publications/biodiversity/biodiversity-vulnerability-invasive-species.ashx

2007 **Biodiversity Conservation Research in a Changing Climate**. Workshop Report: Research Needs and Information Gaps for the Implementation of the Key Objectives of the National Biodiversity and Climate Change Action Plan. Tim was one of the conveners of a workshop held in Canberra in 2005 and a co-author of the subsequent report:

2007 Two sections, **Invasive Pests and Birds**, and **Fewer Insects for Birds**, commissioned for a State of Environment report on climate change by Birds Australia. In a report partly funded by the Department of Environment and Water Resources. The second article reviews the impact of elevated carbon dioxide levels on leaf nutrients and herbivorous insect abundance.

2006 **When Cyclones Strike**. A feature article in Australian Geographic magazine about the impact of cyclones on biodiversity. The article assesses the outcomes for biodiversity of more intense cyclones.