House of Representatives Enquiry into the Impact of Climate Change on Australian Biodiversity

Submission by the Ecological Society of Australia

The Ecological Society of Australia (ESA) welcomes this opportunity to make a submission on the issue of how climate change will affect Australia's biodiversity.

The Ecological Society of Australia Incorporated is the peak group of ecologists in Australia, with over 1600 members from all states and territories.

We aim to create a community of knowledge and understanding amongst ecologists, and reach out to those working in related fields. Our principle objectives within this mission are:

- to promote the scientific study of all organisms in relation to their environment,
- encourage the application of ecological principles in the development, use and conservation of Australia's natural resources.
- promote the application of ecological principles to the development, utilisation and conservation of natural resources;
- advise governmental and other agencies in matters where the application of ecological principles may be relevant to their planning and decision making processes;
- foster the conservation and ecological management of native biota, their diversity, ecological function, and interaction with the environment;
- facilitate the dissemination and exchange of ideas and information about ecology both among ecologists, with other professional disciplines and the public; and
- encourage high professional and ethical standards among our members and other ecologists.

We would be happy to provide additional information and address any issues arising from our submission. Should you require any further detail please contact:

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Summary

- Australia's iconic and biologically diverse land and sea-scapes have significant social and economic value (e.g. Great Barrier Reef, Kakadu Wetlands, south-west Western Australia). In these and many other regions, climate change represents a threat to biodiversity and the regional communities and economies that depend upon it.

- Our unique biodiversity is shaped by the biogeographic history of the Australian continent: its soils, topography, and climate. These historical features, coupled with the human-changes to the environment, will greatly influence the magnitude of climate impacts in the future.

- Australian marine, terrestrial and freshwater biodiversity is already under stress from multiple threats, including habitat loss, coastal development, over-harvesting, reduced river flows, soils degradation, and invasive species.

- Biodiversity and ecological systems will be amongst the hardest hit by climate change, especially since adaptation measures in other sectors (e.g. water resources, energy) as well as mitigation strategies have a high potential for perverse ecological outcomes.

- The impacts of climate change on Australia's species and ecosystems are already being observed. These impacts are expected to accelerate sharply through this century and will include rising extinction rates, transformation of ecological communities, and reduction of the ecosystem services than sustain human well-being and the Australian economy.

- Increased investment is needed to better understand the impacts of climate change on Australia's biodiversity, and how to best protect it using a range of adaptation measures. These measures include the expansion of the national protected area estate, improved management of existing threats, landscape-scale focus on invasive species, water regimes and fire regimes, identification and protection of refugia, strategic improvements in connectivity, restoration of cleared and degraded landscapes, and multiple use planning for heavily exploited environments such as the ocean and inland floodplains.

- Adaptation and carbon sequestration are unlikely to be effective in reducing impacts in the absence of substantial emission reductions. Urgent and substantive abatement of greenhouse gas emissions, at both national and global levels, is critical if we are to avoid the dangerous impacts of global warming. Even a rise of 2^{o}C above pre-industrial levels will threaten many species and the integrity of ecosystems.

Uniqueness of the Australian biota

Australia's unique biodiversity has been shaped by a number of factors that will affect its vulnerability to climate change.

- *Isolation & endemicity:* The Australian continent has been isolated from other landmasses for over 45 million years. Today, Australia has 7-10% of all species on Earth and the majority of these species occur nowhere else, with many groups having 80% or higher levels of endemicity. Many endemic species are already threatened, and/or have small geographic and climatic ranges, making them highly vulnerable to rapid climate change.

- *High climate variability:* Australia's climate is characterised by a high degree of variability, with extremes in temperature and precipitation (droughts, floods and storms). These episodic climate events are extremely important in driving the structure and function of Australian terrestrial and freshwater ecosystems. If Australia's climate becomes drier, the pre-adaptation of some species to high aridity environments could bestow a degree of resilience but it is also likely that many species are operating close to their physiological extremes and therefore even small changes could have large impacts.

- *Poleward flowing currents: warm water.* Currents off the east and west coasts of Australia carry warm tropical waters to southern latitudes. Northern species may be able to move further south as waters warm, but in southern waters there is no shallow water habitat south of Australia for species that cannot cope with warming waters.

- *Infertile soils*: Australian soils are some of the oldest and most nutrient-poor in the world. Nutrient limitations may constrain the responses of many Australian vegetation types to the fertiliser effect of rising atmospheric CO_2 levels. In addition, significant soil changes over small distances and highly specific soil and nutrient requirements could limit establishment opportunities for many species dispersing to more climatically-suitable areas.

- *Flat topography*: Australia has limited topographic relief with less than 5% of the land more than 600 m above sea level. Lack of topographic variability will limit the opportunity for many species to migrate to higher elevations as temperatures increase.

- *Role of fire*: The combination of periodically low humidity, high winds and temperatures and flammable vegetation means that fire plays an important role in ecosystem structure and function in all but the wettest areas. Climate-associated changes in fire regimes may be one of the most significant drivers of ecosystem change in many regions.

- *Ocean acidification:* Marine species have evolved at a time when ocean chemistry has been relatively constant – pH over the past 300 million years has been similar to pre-industrial levels. Thus, a range of marine species and habitats may be threatened by projected changes over the next century.

Existing stresses on Australian biodiversity

Climate change is a new stressor that adds to, and interacts with, a range of existing stressors that have already significantly changed and diminished Australia's biodiversity. The most important proximate drivers that will interact with climate change include loss and fragmentation of habitat associated with land clearing, coastal and port development, diversion of water resources and changes to flow and flood regimes, eutrophication of soil and water, changes in fire regimes, mining, spread of invasive species and dryland salinity. Several other drivers that act mainly through socio-economic forces and institutional arrangements at a national and a global level and which have indirect impacts on organisms include human population growth, global markets and globalization, primary industries, and perverse incentives including subsidies for fisheries, forestry, land clearing, agriculture, and grazing.

Climate change as a threatening process

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) identified natural ecosystems as being the most vulnerable sector in Australia to the negative impacts of climate change. The incidence and severity of extreme events is expected to increase even more rapidly than mean climatic conditions. The current and expected rate of change is almost certainly too rapid for many (perhaps most) species to adapt via genetic change, particularly for long-lived species that reproduce slowly, such as rainforest trees, including the Wollemi Pine. The Millennium Ecosystem Assessment (2005) warned that climate change is likely to become the dominant direct driver of biodiversity loss by the end of the century. Fresh water availability and quality will be one of the main pressures on both human communities and the environment under climate change.

The threats to biodiversity from climate change arise from changes in the basic physical and chemical environment underpinning all life. All organisms are able to cope with some degree of variability in their environment, however, beyond some physiological threshold, responses change quite dramatically and death may result. These processes are evident in the restricted distribution of most species.

Species challenged by climate change in their current location may adapt locally, move elsewhere, or go extinct. Changes in the response of individual species to climate change will disrupt both the structure and function of ecosystems, potentially undermining the economic sustainability of regional communities. Differential rates of species dispersal as climate zones shift, for example, mean that ecological communities will not "move" together across a landscape. Off the east coast of Australia, a sea urchin has moved south ahead of the rest of its community, resulting in habitat changes and reduced fishery catches. Flow-on effects to ecosystem services on which humans depend are potentially significant. Such ecosystem services include production of food, fibre, and water; pollination of crops; pest control; purification of water; and biogeochemical (nutrient) cycling. Many of the changes are expected to be non-linear and may accelerate suddenly when certain thresholds are exceeded. This behaviour inherently increases uncertainty in impact predictions.

While all species and ecological communities will be affected by climate change, several regions can be identified as being of most immediate concern. These include:

- **Alpine regions** are home to many rare and threatened species that are close to their climatic limits of tolerance and already experiencing temperature rise and substantial declines in snowfall.
- **Coral reefs,** including the Great Barrier Reef and Ningaloo Reef, have experienced increased frequency and intensity of bleaching events since the 1980s. Coral reefs are also highly vulnerable to the impacts of increasing ocean acidity, rising sea levels, and increased intensity of tropical cyclones.
- **North QLD Wet Tropics**, including the World Heritage Area. This region supports a large percentage of Australia's endemic species and is vulnerable to rising temperatures, drying, increased cyclone intensity, and changes in fire regimes.
- **Southwest Western Australia:** supports large numbers of threatened endemic species and has been subject to substantial drying trends since the 1970s. Many of the unique plant species that characterise this region depend on winter rainfall for regeneration and are exposed to increasing risk of extinction as this continues to decline.
- **Freshwater and estuarine wetlands** are vulnerable in coastal regions to intrusion from saltwater as sea levels continue to rise (e.g. Kakadu National park). Wetlands in areas such as the Coorong in the Murray Darling Basin are also threatened by reduced environmental flows and increasing salinity. Coastal development on populated coasts prevents landward movement of habitats as sea level rises.
- **Riparian ecosystems of inland Australia**, including iconic river red gum forests and Coolabah woodlands, are in decline due to downward trends in water tables and flood frequencies that are essential for survival and regeneration.
- **South-east Australia marine hotspot**. Waters off the south-east coast of Australia are warming at approximately four times the global average. Movement of species to the south is changing community composition and fisheries (e.g. rock lobster), are declining in some regions.
- **Swamps and peatlands** of the Great Divide and associated uplands, which have proved to be highly sensitive to variations in climatic moisture in recent history and which play key roles in sustained high quality flows in metropolitan and rural water supply catchments.

Impacts of climate change already observed

The impacts of climate change are already discernible at the genetic, species, community and ecosystem levels across the continent and in our marine environment. The availability of long-term biological datasets in the Northern Hemisphere has enabled extensive documentation of recent climate and biological trends. There are fewer datasets from Australia, but they show that similar impacts are underway. The clearest evidence for such changes comes from observations of phenology (mostly advances in life cycle events) and geographic range shifts (mostly polewards and to higher elevations). For example, some forty-five coastal fish species have exhibited major distributional shifts in south-east Australia. There is

also evidence that some organisms are responding genetically to the strong selective pressures imposed by climatic changes.

While long term monitoring data is limited in Australia, we have confidence that many observed changes in species' life cycles and distribution can be attributed to climate change, at least in part. Many of these changes may also involve significant interactions and synergisms with non-climatic threats, and the precise roles of different factors are very difficult to quantify in most cases. Observed changes likely to be driven, at least in part, by climate change include:

- Genetic changes in wild populations of fruit flies and genetically-associated changes in body size in birds (e.g. Grey-crowned Babbler, Yellow-rumped Thornbill)
- Feral horses and native macropods moving to higher elevations in alpine and sub-alpine areas
- Range shifts and expansions of bird species to higher elevations or to the south, and of coastal and pelagic marine species to more southerly waters
- Shifts in the composition of ecological communities with cool-adapted species declining relative to warm-adapted species.
- Earlier arrival and later departure times of migratory birds in Australian breeding and feeding grounds (e.g. Black-faced Monarch, Channel-billed Cuckoo)
- Contraction of wetlands and dieback of inland riparian forests and woodlands
- Dramatic reductions in waterbird numbers over the last 25 years (Eastern Aerial bird survey)
- Expansion of rainforest at the expense of eucalypt savanna woodland and grassland in Northern Territory and Queensland
- Significant mortality of birds and flying foxes during heatwaves
- Southward shifts in the distributions of some coastal fish species
- Increased frequency of coral bleaching and reduced calcification rates on the Great Barrier Reef

What is most noteworthy about these observations both in Australia and elsewhere is that in many cases, significant impacts are apparently occurring with *extremely modest increases* in temperature compared with those expected over coming decades.

Investment and strategies needed

The ESA welcomes the announcement of increased resources for protecting Australian biodiversity in the face of climate change under the new Biodiversity Fund. This announcement is an explicit recognition on the part of Government that an absolute increase in resources is needed, as well as fundamental changes in the way in which we approach conservation.

A strategic assessment of the vulnerability of Australia's biodiversity to climate change included the following key message:

"A business-as-usual approach to biodiversity conservation will fall short of meeting the climate change challenge. A transformation is required in the way Australians

think about biodiversity, its importance in the contemporary world, the threat presented by climate change, the strategies and tools needed to implement biodiversity conservation, the institutional arrangements that support these efforts, and the level of investment required to secure the biotic heritage of the continent" (Steffen et al. 2009).

Scientists acknowledge that some future uncertainty is unavoidable but that these uncertainties pertain principally to the magnitude of impacts, not to their likely eventuality or cause. No-regrets adaptation decisions that are robust to a range of possible futures are urgently required. This adaptation planning needs to be flexible with clear 'signposts' - monitoring to assess the effectiveness of the actions relative to these signposts is critical. When trade-offs are required, stakeholder involvement is crucial to select strategies that will determine the future of Australia's marine, freshwater and terrestrial ecosystems.

Strategies to improve protection of Australia's biodiversity into the future include:

- *Enhancement of the existing national protected areas system.* This system needs to be expanded as well as being integrated with more effective off-reserve conservation. An expanded system will help support increased population sizes of species currently under-represented in protected areas and reduce some of the existing threats such as over-exploitation of marine resources.
- *Increased focus on identifying and protecting landscapes with the greatest environmental heterogeneity to maximise their capacity to support functional ecosystems.* A species-based focus needs to be increasingly expanded to address landscape-level conservation, to maximise the capacity for biodiversity to adapt.
- *Acceleration of actions to control and reduce existing stressors to increase resilience to the growing stress of climate change.* Increased resources are needed to better manage invasive species, soil and water degradation, reverse over-harvesting trends, manage risks of adverse fire regimes and ensure that no further clearing of remnant vegetation occurs. Such strategies are likely to be 'win-win' or low or no-regrets given their substantial benefits for ecosystem services.
- *Monitoring of biodiversity trends*, effectively integrated with flexible and adaptive management. There is an urgent need for integrated, long-term ecological monitoring.
- *Integrated regional biodiversity response strategies*, tailored for regional differences in environments, climate change impacts and socio-economic trends need to be developed.
- *Community/stakeholder engagement* throughout the adaptation process will be vital to the successful uptake, implementation and future of adaptation strategies. As a corollary of this, adaptation measures for the protection of biodiversity range in scale from those implemented at an individual level to that of federal policy and greater recognition and policy that supports individual adaptation is likely to be critical.
- *Improved valuation of the services that ecosystems contribute to human health and well-being, essential resources including clean water and economic viability of major Australian industries including agriculture, tourism and fisheries.* This will involve design of innovative market instruments, regulatory and taxation reform to

promote stewardship of environmental assets that sustain these services and create incentives to reduce carbon emissions. Unless ecosystem services are more effectively integrated into the Australian economy, the costs of climate change will be increasingly borne by Australian communities through inflated costs of public health, food, water, energy and loss of local employment opportunities.

- *Design strategies to mitigate greenhouse gas emissions, and/or to adapt to the impacts of climate change in other sectors to minimise unintended negative consequences for biodiversity.* Shifts in patterns of agriculture and biofuel production, increased "hard-engineering" options for increasing water security and protection against sea level increase, and incentives to sequester carbon by promoting monoculture plantations of fast-growing exotic species, all have the capacity to threaten biodiversity. Research into how land-based mitigation strategies and human sector adaptation can be achieved with win-win biodiversity benefits is critical.
- *Increased recognition that healthy ecosystems are vital for adaptation of human society, well-being, and our economy to the threat of climate change.* Adaptation strategies that take a landscape-level focus will maximize the protection of ecosystem services and also contribute to adaptation in other sectors ("ecosystem-based adaptation"). For example, in the face of sea level rise and the projected increase in extreme events such as storm surges, healthy coastal wetlands can provide protection for human infrastructure. Incorporating ecosystem management into broader cross-sectoral adaptation policies as a complement to technological and structural measures, is likely to result in more sustainable adaptation in many sectors.

The need for mitigation

There is a limit above which biodiversity will become increasingly vulnerable to climate change even with the most effective adaptation measures possible. Global average temperature increases of 1.5 or 2.0°C above pre-industrial levels – and we are already committed to an increase of around 1.2 or 1.3°C – will likely lead to a massive loss of biodiversity worldwide. Thus, the mitigation issue is central to biodiversity conservation under climate change. To avoid an inevitable wave of extinctions in the second half of the century, deep cuts in global greenhouse gas emissions are required by 2020 at the latest. By demonstrating its willingness to contribute to emission reduction, Australia will exert greater influence to promote similar actions in other countries. The more effectively the rate of climate change can be slowed and the sooner climate can be stabilised, the better are the prospects that biodiversity loss will be reduced.

Main sources used for this submission

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