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GOVERNMENT OF WESTERN AUSTRALIA

WESTERN AUSTRALIAN museum

29 July 2011

The Secretary
Standing Committee on Climate Change, Environment and the Arts
House of Representatives
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Dear Sir/Madam

Re: SUBMISSION FOR THE INQUIRY INTO AUSTRALIA'S BIODIVERSITY IN A CHANGING CLIMATE

The Western Australian Museum is responsible for researching, developing and maintaining Western Australia's biological, geological, anthropological, archaeological, and social and cultural history collections. More than four and a half million specimens/artefacts are the primary focus of research by the Museum, whose aim is to advance knowledge about the collections and associated research and communicate this to the public.

The WA Museum welcomes the opportunity to provide input into the Inquiry into Australia's biodiversity in a changing climate. We provide the following information in relation to the effects of climate change on Australia's biodiversity, with a particular focus on Western Australia and the need to adequately identify biodiversity values, for your consideration.

Ecosystems and the biodiversity contained within them are a fundamental component of Australia's environmental, social, cultural and economic future. Scientific evidence is indicating that species and ecosystems are likely to be dramatically affected by changing climate, and that management actions are required to minimise both the environmental and economic consequences of climate change effects. The impact that climate change will have on species, populations and ecosystems will be synergistic with the three other major processes acting on native biota, those of habitat alteration and fragmentation, impact of invasive species and the spread of disease and pollutants.

Terrestrial, marine and freshwater biodiversity in Australia and its territories

Australia has one of the largest jurisdictions globally, and an incredible diversity of species and ecosystems. It is one of 17 recognised megabiodiverse countries primarily, based on its highly, biodiverse and endemic terrestrial flora and fauna (Mittermeier *et al.*, 1999, UNEP-WCMC 2011). This trend is evidenced in both the Australian terrestrial and marine environments with internationally recognised World Heritage areas across the country, several of which occur in Western Australia, along with 15 nationally defined biodiversity 'hotspots' within Australia. However, the acknowledgement of areas as biodiversity 'hotspots' is predicated on the level of species richness, species endemism and degree of habitat loss or change, and is based entirely on vascular plants and vertebrate animals. It does not address the remaining 95% of the biota that are not encompassed in these groups.

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Our ability to predict what will happen to biodiversity as climate changes is confounded by a distinct lack of knowledge of the biodiversity of most groups of biota and their environments - and is exacerbated by our declining taxonomic expertise and resources. Museums are essential to the description, recording and housing of these biodiversity elements and they form an essential repository against which changes in species can be judged against time (How and Cowan 2006, MacFadden 2008, Wanderler *et al.* 2007). Recent systematic revisions of many groups, such as lizards, invertebrates and many marine benthic invertebrates, contain suites of cryptic species, so there is a serious underestimation of our known biodiversity (Oliver *et al.* 2009, Ponder *et al.* 2002, Harvey 2002, Harvey *et al.* 2011).

The effects of changing climate will have important consequences for biodiversity at three levels; extinction of species, extirpation of populations, and changes in species distributions (range-shifts).

Extinction risk is considered most likely for endemic species, and those that have narrow distributional ranges. For example, the Western Australian marine overlap zone between Ningaloo and the south west Capes region has a very high proportion of endemic species (i.e. they occur nowhere else). As the ocean warms, these species will increasingly be restricted to a smaller area and may become endangered and/or extinct, including many species of commercial and recreational importance. The commercially fished Western Rock Lobster, *Panulirus cygnus*, is endemic to this region, and studies have indicated that recruitment is strongly linked to the Leeuwin current, which itself is anticipated to modify in a changing climate. Examples such as this suggest a major challenge for Australia in the area of biodiversity conservation and management.

The increased frequency and severity of catastrophic events such as cyclones will damage marine coastal habitats impairing their function and impacting on biodiversity. One of the least well understood aspects of changing climate on species survival is the synergistic effects of environmental changes. Therefore, one of the challenges in managing biodiversity in a changing climate is that the effects on species will not occur in isolation, and any management or conservation measures will need to recognise ecological relationships, and will need to address community responses to change.

Changes in the distributions of species (range shifts) are also predicted to occur as a consequence of climate change. As physical factors are altered, species may migrate north or south into more favourable conditions, and there is evidence that pest species may increase. Such range shifts will alter species interactions and ecological processes with subsequent effects on biodiversity, including both changes in the relative abundance of species and local extinctions. While there will be winners and losers with climate change, our ability to predict how range changes will manifest, or the subsequent consequences for biodiversity, is hindered by a basic lack of understanding of the biology and ecology of the majority of our species.

The effects of changing climate on species biodiversity will not be uniform across ecosystems and so it is important not to generalise about the likely impacts of climate change. For example, recent analysis of marine communities occurring on the continental atolls of north Western Australia found that fishes and corals, the taxa normally examined in tropical coral reef studies to detect change, are not appropriate surrogates for marine assemblages in all tropical habitats, in particular in intertidal areas where they are not the dominant species (Sampey & Fromont 2011). In these instances, monitoring of species should include additional fauna or floral groups to capture changes that will not be detected by examining only fishes and corals.

Connectivity between ecosystems and across landscapes that may contribute to biodiversity conservation

Maintenance of connections among populations, habitats and ecosystems is recognised as an integral part of maintaining healthy ecosystems that can provide essential goods and services for Australia. In the context of changing climate, maintaining connections across populations and regions will be critical to facilitate range shifts for species that are displaced from their usual habitats. Similarly, because extinction risk is highest in those species and populations that are both isolated and have low genetic diversity, ensuring migration and gene flow can continue will contribute to the mitigation of the impacts of climate change and the resilience of communities. There are many population studies of vertebrate animals and plants, modelled in the literature, that indicate how, under changed climatic conditions, many species will be confined to peripheral areas of their current range or disappear from the landscape altogether. An essential underpinning of all of these models is a detailed understanding of the species identity, distribution in time and space, and an appreciation of the basic biological parameters of the species; knowledge that is acquired and maintained in museum collections and databases. Recent research on corals on north western shelf edge atolls found genetic isolation of broadcast species between Mermaid Reef and Scott Reef (a distance of 500 km), while brooding species had genetic differences at much smaller distances (<1 km, Underwood *et al.*, 2009). Previously, corals were thought to be able to recruit over large distances, and this may still be the case where reef systems occur that can act as stepping stones. However, many other invertebrates that occur on tropical reefs have larval phases with short or no pelagic phase. Evidence is mounting that sessile marine invertebrates, such as sponges, are cryptically diverse and potential short range endemics (Lazoski *et al.* 2001, Hooper and Kennedy 2002, Nichols and Barnes 2005, Fromont and Vanderklift 2009, Xavier *et al.* 2010). These large habitat-forming invertebrates host numerous other invertebrates including molluscs, crustaceans, polychaetes and fish. These species have specialist habitat requirements and are likely to show high levels of cryptic diversity, low potential dispersal ability and consequent vulnerability to changing climate.

Genetic tools are becoming increasingly important to understand population connectivity and currently it is difficult to predict the effects of a changing climate on species distributions. However, there is consensus across the scientific community that recruitment processes will be affected by climate change.

Connectivity through migration and range-shifts is thought to provide a means by which species can seek refugia, as their existing habitats become uninhabitable due to changing environmental conditions. However, this assumes that migration to new habitats is possible - which may not always be so. Marine communities have traditionally been viewed as 'open' with a large degree of connectivity between populations but increasingly studies are suggesting that there may be high levels of self recruitment in some populations (Sponaugle *et al.* 2002). In particular some studies have shown that atoll lagoons, such as those in the north west of Western Australia, may have higher levels of self-recruitment than some other habitats such as the reef front. Sampey & Fromont (2011) found the lagoon community assemblages on the northern Western Australian atolls had a higher number of unique species than the reef front habitats, in particular in Mermaid Reef lagoon. Therefore, enclosed lagoon habitats at these atolls may pose more of a barrier to dispersal than the reef front environments and preclude dispersal of species with short-lived or non pelagic larvae. These isolated communities become vulnerable to extinction with increasing disturbance, with high self recruitment within atolls (Underwood *et al.* 2007) and high levels of unique species occurring there.

How climate change impacts on biodiversity may flow on to affect human communities and the economy

Australians rely on their environment for a range of essential goods and services including food, livelihoods, and recreational activities. Any changes associated with the environment are likely to have downstream effects on human communities and the economy as they impact on ecosystems services provided by the natural communities of plants, fungi and animals. It is now well documented in the conservation literature that such ecosystem services as water filtration, groundwater recharging, storm water control, air purification, nutrient recycling, crop pollination, soil enrichment, carbon sequestration, waste decomposition, as well as many others, are best provided by retaining natural biodiversity elements. Natural biodiversity also provides unparalleled opportunities for learning and research and are clearly beneficial to improved health and well being in human populations (NHS 2007)

Many species of commercial and recreational importance will undergo range shifts; some of these will be range reductions and some will become extinct. The scale of population connectivity will decrease, which will have a strong impact on viability of populations and on management of living resources (including fisheries and agriculture).

Repeated bleaching events on reefs will lead to death of corals and associated invertebrates (Stella *et al.* 2011), leading to increased rates of bioerosion and loss of reef substrate. This will reduce the ability of fringing reefs to protect low lying coastal communities. Loss of reefs and associated fauna will reduce the value of those reefs, both in terms of loss of fisheries and tourism.

Australia is exceptionally well positioned to participate and prosper in the field of marine biodiscovery because it combines a world-class scientific base with immense raw materials within its biodiversity. Climate change has the potential to impact on the development of new industries such as biodiscovery.

Given the evidence that climate change is likely to be responsible for shifts in many species' biogeographic ranges, more research is needed to understand the full extent of range shifts and the role that climate change plays in these shifts.

Strategies to enhance climate change adaptation, including promoting resilience in ecosystems and human communities

Adaptation to the effects of predicted warming will be a complex, difficult and multi-dimensional undertaking, but one that is necessary for lessening the impacts of climate change in a warming world. Considering the ecological, socioeconomic and management implications of climate changes before they occur is essential to mitigating their negative effects and developing effective adaptive response strategies. This necessitates a detailed knowledge of a species identity, morphological, physiological and molecular variation so that appropriate management and conservation methods can be employed to mitigate against the major impact of changed climatic regimes and altered habitats.

Resilience of ecosystems can be promoted by reducing other impacts, such as pollution, habitat destruction and over-exploitation, recognising that the effects of environmental change will be synergistic and potentially greater in populations that are already stressed. For example, corals at Scott Reef are exposed to a range of natural disturbances, some of which are being amplified by climate change. These include elevated water temperatures resulting in coral bleaching and severe storms and cyclones. Coral communities at the reef have been slow to recover from the severe 1998 bleaching and this is thought to be in part a result of cyclones that have impacted the reef since the bleaching (Scott Reef Status Report 2010).

Mechanisms to promote the sustainable use of natural resources and ecosystem services in a changing climate

Australia has had very limited investment in large-scale and long-term monitoring of its biological resources, and as such our baseline knowledge of the distribution of many species is poor or unknown. Sustainable use of biodiversity with a changing climate will depend upon improving this level of knowledge by developing and maintaining appropriate large-scale and long-term monitoring programs, along with continued investment in fundamental research in biodiversity, connectivity and the biological effects (incorporating life-history and ecology) of change. Improved knowledge will enable us to better understand the way populations of animals, fungi and plants function and, therefore, to manage them more effectively for sustainability and climate change impact.

Marine protected areas (including extensive no-take zones) are a major means by which resilience and sustainability can be enhanced. However, Marine Protected Areas (MPAs) are only part of the solution. We also need to change the way non MPAs are managed, for example areas used for food capture such as fishing, aquaculture and ecotourism.

Are current governance arrangements well placed to deal with the challenges of conserving biodiversity in a changing climate

There will be many challenges to meet in conserving Australia's biodiversity under a changing climate. Adequate resources need to be provided to those institutions that can document biodiversity (remembering that many species are still to be described). State Museums are increasingly being subjected to funding and staffing cuts. Furthermore, because our knowledge of many ecosystems and the species that inhabit them is rudimentary, conservation measures will need to be adaptive as new information becomes available.

In both the marine and terrestrial environments it is critical to record changes in the lower levels of the food chain, such as the invertebrates, and not just concentrate on the "charismatic megafauna". Conserving biodiversity involves more than just protecting mammals, birds and flowering plants. We need to conserve all functioning levels if we are to have functioning and resilient ecosystems.

Mechanisms to enhance community engagement

Limited information about biodiversity over most of Australia's territory has been a significant barrier to developing a strategic approach to the sustainable management of our environments. Another, and equally challenging, issue is effectively communicating these issues, especially climate change impacts to users and stakeholders. Evidence suggests the majority of Australians are yet to understand the impacts of climate change and the significant life style changes that may need to occur to reduce our footprint. Museums will be pivotal in providing Australians with a deeper appreciation of climate change issues by developing virtual and physical exhibitions, informing schools, societies and families and providing the essential nomenclature (i.e. taxonomy) to facilitate informed discussions and research on which species are most likely to be impacted by altered climatic regimes.

Nationally important ecosystems

While all ecosystems are important and rarely exist in isolation, some areas are considered especially vulnerable to the effects of climate change and in this context warrant greater attention. Terrestrial examples of such ecosystems in Western Australia are the monsoonal vineforests of the wet-dry Kimberley and some of the mesic adapted heaths and forests of the southwest of the State. In 2011 during a strong Leeuwin current event, significant coral bleaching was detected as far south as Rottnest Island off Perth. Western Australia also has a drying climate resulting in increasing use of underground aquifers and significant salinity issues. In both terrestrial and marine Western Australian habitats there is increased mining and mining exploration in areas where the biodiversity is still largely unknown.

Yours sincerely

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Executive Director
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