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Associate Professor Neil Holbrook
Convenor
Adaptation Research Network for Marine
Biodiversity & Resources

Julia Morris
Committee Secretary
Standing Committee on Climate Change, Environment and the Arts
PO Box 6021
Parliament House, Canberra ACT 2600

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Dear Ms Morris,

SUBMISSION BASED ON REPORTS PUBLISHED AS PART OF THE ADAPTATION RESEARCH NETWORK FOR MARINE BIODIVERSITY AND RESOURCES

[This represents a submission by A/Prof Neil Holbrook, Dr Julie Davidson and Laura Purcell]

Up-front note
This response document provides a very brief outline of some key messages extracted from a number of information sheets, reports and activities that we consider may be relevant to the Parliamentary Inquiry on Australia's Biodiversity in a Changing Climate – specifically here, particular to *marine biodiversity* under climate change. The documents informing this submission were primarily from syntheses of peer-reviewed literature by partners and members of the Adaptation Research Network for Marine Biodiversity and Resources. It is important to point out that this letter of response neither represents a whole-of-Network submission, nor an exhaustive submission of national issues confronting Australia's marine biodiversity. The Network members (>700 members now nationally) were notified about this inquiry and may choose individually or as small groups to make separate submissions. Rather, this submission represents the response from a few of the central organisers of the Network, based on various reports compiled as part of its Network activities and understanding of issues confronting marine biodiversity.

Summary of information contained

1. Adaptation Research Network for Marine Biodiversity and Resources

    Mission: to enhance adaptive capacity and reduce vulnerability of Australia's marine biodiversity and living marine resources under climate change.

2. Observed changes in marine species and climate change connections

    Environmental changes associated with climate change are leading species to move to different locations to match their habitat requirements. Climate change is modifying the temperature and chemistry of our oceans, with direct and indirect consequences on the oceanography and functioning of marine ecosystems.

3. Community and stakeholder engagement

    The network has undertaken projects to enhance community engagement where climate change is an immediate challenge confronting marine environments and species.

The key message from focused strategy meetings was the high importance placed on science-stakeholder communication and consultation.

4. Marine biodiversity governance under climate change

There are concerns about the adequacy of marine conservation governance arrangements which are likely to be deficient in essential capacities for supporting and enabling management of change.

5. Difficulties of conducting research in the marine environment

There are limited observations and knowledge, and difficulties with conducting scientific experiments at appropriate scales.

1. Adaptation Research Network for Marine Biodiversity and Resources

The (National Climate Change) Adaptation Research Network for Marine Biodiversity and Resources (a.k.a. the Marine Adaptation Network) was established for the four-year period from 2009-2012, and is funded by the Australian Government Department of Climate Change and Energy Efficiency (DCCEE) through the National Climate Change Adaptation Research Facility (NCCARF). The Marine Adaptation Network works closely with NCCARF to deliver on its vision aiming to build adaptive capacity and adaptive response strategies for the effective management of marine biodiversity and living marine resources under climate change.

The Network's mission is to implement a strong interdisciplinary organisational framework to engage researchers, governments and industry in a way that will enhance adaptive capacity and reduce vulnerability of Australia's marine biodiversity and living marine resources to climate change risks.

The Marine Adaptation Network is nationally hosted at the University of Tasmania and led by Associate Professor Neil Holbrook (convenor). It comprises a holistic framework of five connecting marine themes (integration; biodiversity and resources; communities; markets; and policy) that cross-cuts climate change risk, marine biodiversity and resources, socio-economics, policy and governance, and includes ecosystems and species from the tropics to Australian Antarctic waters.

2. Observed changes in marine species and climate change connections

Marine organisms typically live within, for example, limited ranges of temperature and pH corresponding to the range where cellular exchanges and whole-organism processes are optimised for the species. Acidification and/or increases in ocean temperature can push some species towards their physiological limits (i.e. the edges of their thermal or pH range), resulting in negative effects on the organisms' growth, reproduction, foraging, immunity, behaviour and competitiveness (Pörtner & Farrell 2008). Marine species have particular habitat preferences which reflect their most suitable environments for thriving and defining their distributions. Suitable habitats can be characterised by specific water temperature and salinity, depth range and substrate, as well as the presence of adequate food supplies and shelter. Environmental changes associated with climate change are leading species to move to different locations to match their habitat requirements. Climate change is modifying the temperature and chemistry of our oceans, with direct and indirect consequences on the oceanography and functioning of marine ecosystems.
[see <http://arnmbr.org/content/images/uploads/Fact_sheet_1.pdf> for more details]

Some examples of change
The rate of ocean warming off south eastern Australia over recent decades is around 3-4 times the global average (Holbrook and Bindoff 1997; Ridgway 2007), making this the fastest warming region in the southern hemisphere – and a global 'hotspot'. Recent studies have shown that the multi-decadal warming in this region is consistent with a 'spin up' of the South Pacific gyre in response to climate change from greenhouse warming and ozone depletion (Cai et al. 2005; Cai 2006).

A key example of concern in southeast Australian waters is associated with changes in the distribution of the spiny sea urchin, *Centrostephanus rodgersii. C. rodgersii* is native to New South Wales (NSW), but has extended its distribution poleward into Victorian and Tasmanian waters in response to the warming waters (Ling et al, 2009). A voracious grazer of kelp, *C. rodgersii*'s presence has resulted in the decline of kelp forest and an increase in urchin 'barrens'. The increase in distribution and abundance of this species is expected to continue to negatively impact these kelp environments. Experiments have also shown, for example, that increased densities of *C. rodgersii*, as the superior grazing competitor, can cause an increase in abalone mortality rates (Strain & Johnson 2009).
[see
<http://arnmbr.org/content/images/uploads/Information_Sheet_3_Climate_change_impacts_on_Tasmanias_marine_life.pdf>]

Another example of a marine species impact associated with a changing climate (i.e., from increased freshwater inflows into estuarine waters a s a result of changes in rainfall intensity) is that on black bream recruitment. Many organisms inhabiting estuaries are capable of tolerating a wide range of physical and chemical conditions than can occur in highly-variable environments. However, an analysis of more than 25 years of data on black bream age structure and pre-recruit surveys has demonstrated that year-class strength is heavily related to the amount of salinity stratification in Gippsland Lakes and freshwater flow into the Lakes (Jenkins et al. 2010). Salinity stratification tends to increase with increasing freshwater flows but may decline at very high flows. Black bream recruitment showed a linear relationship with stratification and a dome shaped relationship with freshwater flow (i.e. recruitment was highest at intermediate flows) (Jenkins et al. 2010). It was suggested that introducing intermediate flows more strategically may reduce black bream vulnerability to climate change and help adaptation. The relationship between successful recruitment of black bream and freshwater flow in other Victorian estuaries is currently unknown.
[see
<http://arnmbr.org/content/images/uploads/Climate_Change_and_the_Marine_Environment_Victoria.pdf>]

3. Community and stakeholder engagement

Community engagement
The following are examples of projects developed by Network partners and members to enhance community engagement where climate change is an immediate challenge confronting our marine environments and species, and decision makers.

a) The *Coastal Climate Change Range Extension Database and Mapping Project* (REDMAP) was created by the Tasmanian Aquaculture and Fisheries Institute (TAFI – which has since been renamed as part of a new centre of the Institute for Marine and Antarctic Studies at the University of Tasmania) and designed to engage and inform the Tasmanian community about the impacts of climate change on the marine environment. With very few monitoring programs that provide information of changes in distribution within the marine environment, this 'citizen science' project is an interactive website inviting the public, consisting of scuba divers, commercial and

recreational fishers, marine naturalists and beachcombers, to report sightings of marine species which might be changing their distributions due to warming waters along the Tasmanian coast.

Although not traditionally scientific, the data collection undertaken by the public is enhancing already existing research programs and capturing important information within much shorter time frames and with less expense than any traditional scientific program can realistically expect.
[see <http://www.redmap.org.au>]

b) *Community-based participatory research* (CBPR) is research that is conducted as an equal partnership between traditionally trained "experts" and members of a community. CBPR projects start with the community which include general categories of geographic community, community of individuals with a common problem or issue, or a community of individuals with a common interest or goal. Members are encouraged to fully participate in all aspects of the research process.

Australia's Sunshine Coast has a subtropical climate and its coastal regions and waterways represent complex ecosystems with unique biodiversity and high conservation value. The Sunshine Coast is also home to a number of turtle species, predominately the Loggerhead turtle (Caretta caretta) and less frequently, the Green turtle (Chelonia mydas). These turtles nest on Sunshine Coast beaches, often producing on average 100-130 eggs per individual nest. One of the threats to turtles is climate change, which may impact on the natural sex ratios of hatchlings.

The project entitled "Protection and monitoring of turtle nesting activity: the case of Sunshine Coast Turtlecare volunteers**"** (accessible via <http://arnmbr.org/content/index.php/site/cbpr/>), was assisted by a number of important strategies that brought together the community's motivation to protect and conserve the local turtle population, and by building volunteer capacity to respond and take action through empowerment, equality, and leadership.

Focused meetings with key marine stakeholders

In October and November 2010, the Marine Adaptation Network organisers held a series of focused strategy ('roundtable') meetings with key marine stakeholders across Australia to assess the concerns and needs of industry, government, and non-government organisations (NGOs) in attempting to reduce and manage the risks associated with climate change impacts on the marine environment and specifically focusing on five marine sectors – marine aquaculture, commercial fishing, recreational fishing, marine conservation and marine tourism. The overall aim of the focused strategy meetings was to scope marine stakeholder needs to respond to, prepare for, and manage the risks associated with climate change impacts on these sectors.

Based on the workshop facilitators' own observations and listening to all of the discussions across the seven meetings, the most significant message arising from the focused strategy meetings was interpreted to be the high importance placed on science-stakeholder communication and consultation that comprised of targeted, clear and accessible information exchange.

In particular, the commonly identified 'flexible or adaptive management' priority tended to typify the considered and combined needs of fisheries/aquaculture and marine conservation.

Summary of issues raised by stakeholders in the area of marine conservation:

Government
Marine conservation was represented in each of the six States and Northern Territory from Government organisations. In order, the priorty issues identified were: (1) communication and education; (1) risk and impact assessments; (3) resilience; (3) biosecurity and disease; (5) planning – conservation; (5) flexible or adaptive management; (5) monitoring and benchmarking.

NGO
Marine conservation was represented by all State/NT NGOs except for South Australia and Western Australia. In order, the priority issues identified were: (1) communication and education; (2) resilience; (2) flexible or adaptive management; (2) carbon pricing; (2) climate modelling.

NRM
Marine conservation was further represented by State/NT NRM agencies except for South Australia and Western Australia. In order, the priority issues identified were: (1) consultation and collaboration; (1) communication and education; (1) resourcing; (4) resilience; (4) risk and impact assessments.

4. Marine biodiversity governance under climate change

Given projections by the Intergovernmental Panel on Climate Change (IPCC) that global warming will affect the planet over at least the next couple of centuries, it is clear that new paradigms, policies, and governance systems will be essential for Australia in order to sustain the capacity of its marine ecosystems and for securing future economic and societal development.

In the context of climate change, there are concerns about the adequacy of marine conservation governance arrangements. As current arrangements have been designed for more stable climatic conditions, they are likely to be deficient in essential capacities for supporting and enabling management of change. For example, while marine reserves have their value, many have failed to prevent overfishing, many are vulnerable to degradation from external influences, and many are far too small and too far apart to be self-sustaining (Hughes et al. 2010). Arrangements for the protection of marine biodiversity will need to accommodate both present and future species and ecosystem distributions (Hickling et al. 2006, Jentoft et al. 2007); and fixed-boundary protected areas will need to be supplemented with flexible options such as fuzzy boundaries, strategically located reserves, broad-scale connectivity, and sympathetic management of buffer zones (Sutherland and Nichols 2006).

More broadly, improved linkages between dynamic ecological and social systems will be critical to supporting the resilience of marine ecosystems and their biota (Hughes et al. 2005). Maintaining the natural resilience of ecosystems should be a key principle of conservation governance and management to allow sufficient time for an evolutionary response and in order to prevent ecosystems crossing thresholds and shifting into alternative less desirable and/or less productive states.

5. Difficulties of conducting research in the marine environment

Compared to biological changes in terrestrial systems, observations of marine biological changes are much fewer (Richardson and Poloczanska 2008). Marine systems cannot readily be probed by means of experiments at relevant scales (Scheffer 2009). Instead we have to rely on natural experiments or mechanistic models that are tuned until they reproduce the observed dynamics. Given that some very large changes are expected in the

oceans, currently there is limited knowledge about the implications of those changes for marine biodiversity.

Neil J Holbrook
Associate Professor of Climatology and Climate Change
Convenor, Marine Adaptation Network

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