NCCARF
National
Climate Change Adaptation
Research Facility
Adaptation Research Network
MARINE BIODIVERSITY AND RESOURCES

marine adaptation bulletin

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IN THIS ISSUE

At a glance

The Adaptation Research Network for Marine Biodiversity and Resources will foster an inclusive, collaborative and interdisciplinary research environment that generates outputs relevant for policy-makers and managers to develop appropriate climate change adaptation responses.

INVESTMENT
Australian Government Department of Climate Change through the National Climate Change Adaptation Research Facility (NCCARF) hosted by Griffith University

FRAMEWORK
Five interconnecting themes (integration, biodiversity & resources, communities, markets, policy)

HOST INSTITUTION
University of Tasmania

CONVENOR
Associate Professor Neil Holbrook

TIMEFRAME
2009-2012

Convenor's Spot

Welcome to the third issue of the Marine Adaptation Bulletin (MAB) for 2010.

The Marine Adaptation Network organisers recently facilitated a series of focused strategy meetings with high level marine sector stakeholders across all six states and the Northern Territory – a total of seven meetings conducted in the relevant capital cities. The key objectives were: to identify the research/adaptation needs of marine stakeholders (government, NGOs, industry and conservation groups) in the face of climate change; to provide relevant information to existing and future national research and action plans; to establish and consolidate Network links with key marine biodiversity, resource and tourism stakeholder groups; to inform marine stakeholders about NCCARF and the Network in helping to meet government/ industry/NGO management needs; and to structurally inform the next Marine Climate Change Impacts and Adaptation Report Card – currently proposed for 2011. The individual State and Territory meetings were informed by responses to a questionnaire that was completed, either as a phone interview or in writing, by the invited participants or their representatives ahead of the meeting.

The composition of the invited participants followed a careful and objective selection process. The marine stakeholder representatives included peak body, government and NGO leaders in conservation, commercial fishing, recreational fishing, aquaculture and tourism, i.e., the sectors also identified in the NCCARF National Climate Change Adaptation Research Plan for Marine Biodiversity and Resources, released in March 2010. Key representatives were also invited on behalf of natural resource management and the State/ Territory Government climate change office.

Following initial presentations about climate change particular to the marine environment for each State/ Territory by either the Network or the relevant Government climate change office, representatives at the 'roundtable' meetings contributed highly productive cross-sectoral discussions – while also providing important rationale to the priority issues and concerns that relate directly, or indirectly, to marine climate change impacts and adaptation for the various State/Territory jurisdictions. The contribution to each of the meetings by all participants was excellent, and we are grateful to everyone concerned. A briefing report will be written shortly that captures and reflects the identified State/Territory priorities.

Neil Holbrook.

Coral Reefs and Climate Change

Professor David Yellowlees, Assistant Director, ARC Centre of Excellence for Coral Reef Studies

The ARC Centre of Excellence for Coral Reef Studies is a global leader in climate change research publishing well over 500 papers on this broad inter-disciplinary topic since the Centre's inception in 2005. The ecological, social and economic consequences of climate change for coral reefs in Australia and throughout the tropics are critical issues that pervade all of the ARC Centre's eight research programs (<http://www.coralcoe.org.au/>). Researchers are engaged in addressing not only the impacts but also addressing solutions for dealing with climate change.

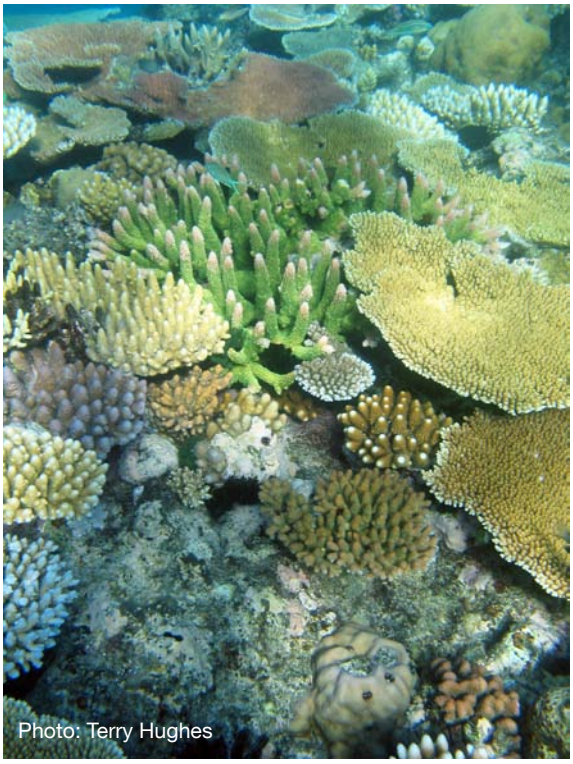
Photo: Terry Hughes

Global warming and ocean acidification are already changing the physiology, ecology and geology of coral reefs in ways that are still poorly understood. Centre researchers have combined resources to develop and apply novel geochemical methods, historical records and ecological studies to identify and understand changes in biodiversity and ecosystem function, over a range of timeframes. The initial findings of the long-term influence of ocean acidification on Arlington Reef, an oceanic coral reef system offshore from the Great Barrier Reef, indicate that the long-term pre-industrial variation of seawater pH in this region is partially related to the variability of atmospheric and oceanic anomalies in the Pacific. Importantly however, from the 1940s to the present-day, there is a general overall trend of increasing ocean acidification, with pH decreasing by about 0.2–0.3 pH units indicating that the increasing trend towards ocean acidification over the past 60 years in this region is clearly the result of enhanced dissolution of CO_2 derived mainly from fossil fuel burning.

Increasing ocean acidification has implications for fish. In a series of experiments, a team led by Philip Munday has shown that as ocean water acidifies the behaviour of baby fish changes dramatically in ways that decrease their chances of survival. The sense of smell and the behaviour of larval fish changes and instead of avoiding predators, they become attracted to them. They appear to lose their natural caution and start taking bigger risks, such as swimming out in the open, with lethal consequences. This change in fish behaviour could have implications for the sustainability of fish populations because fewer baby fish will survive to replenish adult populations. Critically, this impact is likely to happen independently of global warming, and is a direct consequence of human carbon emissions.

Global warming and ocean acidification will have major implications for coral reefs around the world and, in response to this, an international team including a number of scientists from the Centre has proposed a set of basic rules to help save the world's imperiled coral reefs. These include the reduction of immediate direct threats such as climate change, over-fishing and water pollution, and actions to protect or enhance the resilience of reef ecosystems in the face of existing and unavoidable future threats. The key to saving threatened coral ecosystems is to maintain the links (connectivity) between reefs, allowing larvae to flow between them and re-stock depleted areas.

Climate change, however, is global and its solution requires co-operation across boundaries. It was one of several examples of intertwined global challenges identified by international scientists and economists that is outpacing the capacity of existing institutions. Terry Hughes, Director of the Centre, was part of this group and whose work was published in Science in a landmark paper in 2009. They argue that coping with global changes requires new institutions and a global system of governance that is currently missing. They propose a much stronger focus on regional and worldwide cooperation, helped by better designed multi-national institutions. The threat of climate change to coral reefs, for example, has to be tackled at a global scale. Local and national efforts are already failing.

The ARC Centre also contributes its expertise, where appropriate, to a range of potential end-users. For instance, four of our scientists contributed to a briefing on emission reduction targets and the Great Barrier Reef, provided to Australian Members of Parliament and Senators, in Parliament House, Canberra in November last year, under the auspices of the Federation of Australian Scientific and Technological Societies. The Federal and Queensland environment ministers have also acknowledged the key research provider role of the ARC Centre in their formal response to the 2009 Great Barrier Reef Outlook Report. The inaugural


Photo: Simon Foale

2009 report provides a summary of many of the ARC Centre's research findings, and will inform policy and management decisions.

Many of these research outcomes were presented and discussed at the Centre's Annual symposium Coral Reefs in a Changing Environment in Canberra on 7th and 8th October 2010.

Potential Climate Change Impacts and Adaptation Pathways for the Australian Edible Oyster Industry

Dr Peat Leith, Research Fellow - Policy Theme, Marine Adaptation Network


Photo: Tony Troup

The Adaptation Research Network for Marine Biodiversity and Resources recently published the report Climate Change Adaptation in the Australian Edible Oyster Industry: an analysis of policy and practice. The report is the culmination of a network activity that engaged with policy-makers, industry and oyster growers in workshops across the three major oyster producing states of Australia – New South Wales (NSW), South Australia (SA) and Tasmania (TAS). The aim of the activity was to identify potential climate change impacts as well as factors that enable and constrain adaptive capacity in the sector across the three states. This work with oyster industry and government agencies provides a first pass assessment of risks, opportunities and collective actions to adapt to changing and uncertain climatic conditions.

Oysters occupy a unique position in Australian bays and estuaries and can therefore be affected by changes in both terrestrial and oceanic conditions. Although oysters are fairly tolerant of diverse conditions, as filter feeders they are dependent on a range of variables which can change with water conditions. Outbreaks of the diseases of oysters are often associated with particular environmental conditions, but appear to be dependent on complex and only partially understood relationships between organism, environment and pathogen. At a local and regional scale climate change impacts remain uncertain. Yet we are currently seeing changes in ocean currents, in rainfall patterns and in the frequency of extreme events. Some of these changes are expected to continue or intensify as greenhouse gas concentrations increase. In our bays and estuaries where oyster aquaculture takes place, the changes are likely to be substantial, affecting the timing and duration of phytoplankton productivity and potentially the distribution of harmful algal species and disease vectors. Such climate impacts also need to be considered in the context of changing population pressures on waterways and land use and the growing sea-change phenomenon that affects much of the eastern seaboard of Australia.

Adaptation will require diverse strategies and linkages across the public and private sectors. In the workshops across NSW, SA and TAS, oyster growers and other stakeholders identified a range of issues that are crucial to their adaptive capacity. These ranged from technological and research-based approaches to more social and economic measures to strengthen the resilience of the industry and individual growers.

Technological approaches include development of new infrastructure or breeding lines of oysters that are less susceptible to disease and emerging conditions, such as acidification. More scientific effort is required to understand environmental conditions which make oysters susceptible to diseases. Such understanding is likely to require development of cost-effective monitoring programs for estuaries and bays across oyster growing areas. Improving monitoring will require substantial partnerships among, for example, industry bodies, growers, regional NRM authorities, local councils, universities and state government agencies. They will also require support of major national initiatives to improve water management.

The effectiveness of research initiatives is as dependent on social networks and institutions as it is on equipment and funding. In workshops growers articulated the need for improved networks of communication, decision-making and knowledge-production. Much of the time, especially where oysters are grown in estuaries, the best way to minimise the effects of climate impacts is to reduce non-climate stressors, such as those caused by pollution, acid sulphate soils or altered environmental flows. These sorts of issues require good natural resource governance, strong relationships between the industry and the broader community, and effective policy instruments to protect water quality and ensure that oyster aquaculture is treated as a priority use. Together, such processes, structures and networks can help oyster aquaculture to develop a long-lasting 'social license to operate' that will lay the foundations for an adaptive industry which can continue to develop and flourish in a changing climate.

More information about this activity, including the final report, executive summary and information sheet are available at: <http://www.nccarf.edu.au/marine>.

Coastal Collaboration Cluster

Laura Stocker, Associate Professor, Sustainability, Curtin Sustainability Policy Institute

There is a wealth of research reporting the projected impacts of climate change on the Australian coastline, but decision-makers have been slow to take this information into strategies, plans and policies. This issue is relevant to both the CSIRO Wealth from Oceans Flagship and the Climate Adaptation Flagship. Therefore, for the first time a Cluster spanning these two Flagships was created. Formally titled the Enabling Science Uptake in Australia's Coastal Zone Cluster, but informally titled The Coastal Collaboration Cluster, this new research initiative will develop conceptual and adaptive approaches that will enable better science uptake by governance, and contributing to a more resilient and sustainable coastal zone. The Coastal Collaboration Cluster was launched in April and presented a workshop at the Coast to Coast Conference in Adelaide on September 22nd, 2010.

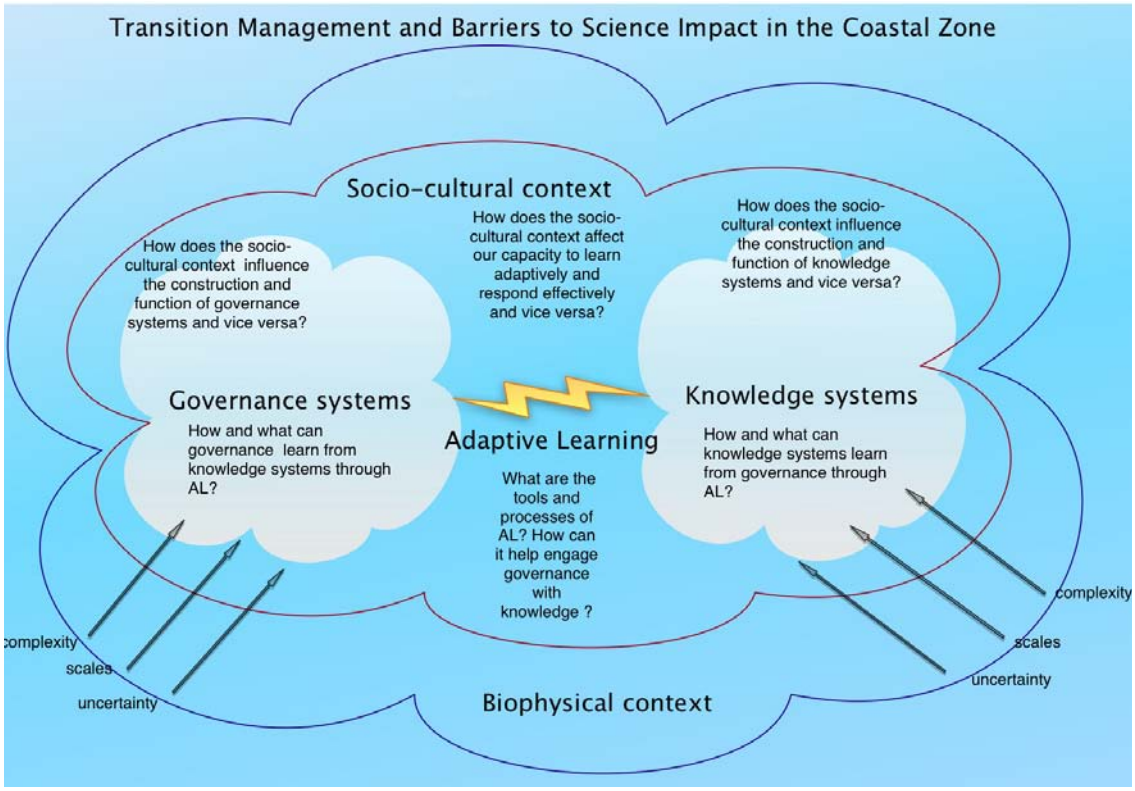

Figure 1. The conceptual map of the Coastal Cluster Themes.

The Cluster is composed of five Themes studied across seven universities. The seven universities are: Curtin, Adelaide, Deakin, Flinders, Sunshine Coast, Tasmania and Wollongong. The Themes are: governance, socio-cultural context, knowledge systems, and adaptive learning (Fig 1); plus the keystone Theme of integration, analysis and synthesis.

The socio-cultural context of the coastal zone strongly influences its adaptive management. Specifically, the socio-cultural context influences: the politics and practice of knowledge generation, dissemination and use; the process of governance; and actors' ability to learn and respond adaptively. The **Socio-cultural Context Theme** thus provides an envelope in which the other Cluster Themes are located conceptually (Fig 1). The Socio-cultural Context Theme of the Cluster specifically investigates the informal and formal relations among community, industry, universities and government that surround knowledge formation and its use or non-use in decision-making.

Governance refers to "the institutional arrangements, laws, regulations, negotiations, elections, public consultations, protests, and other decision-making processes" that emerge from the interactions of diverse actors. In order for knowledge to be incorporated into governance systems, knowledge needs to be accessible and the governance process receptive to such knowledge. The **Governance Theme** of this Cluster addresses what kinds of governance processes are most likely to enable uptake of knowledge about coastal adaptation and generate on-ground solutions. The Governance Theme draws on the ideas of transition management such as visualisation exercises, transdisciplinary research, deliberative workshops and trials in governance.

CSIRO's own knowledge systems have generated a substantial body of scientific data and models about likely climate change impacts on the coast from which decision-makers and stakeholders should be able to act to improve governance of the coast. Lay and traditional knowledge systems also report evidence of climate change.

The **Knowledge Systems Theme** of this Cluster analyses this process of knowledge diffusion as it presently affects coastal zone management. New processes are needed to engage the decision-makers and stakeholders in scientific data and models that relate to building resilient communities and sustainably managing the coastal zone. Features of these 'post-normal' processes are likely to include:

- units of analysis which are strongly coupled, jointly determined, nonlinear, complex socio-ecological systems
- integrated research which is

transdisciplinary and interdisciplinary

- a focus on integration as well as analysis in seeking 'truth'
- inclusion of qualitative values, rigorously treated
- explicit treatment of uncertainty with reflexive, iterative and adaptive approaches
- incorporation of non-scientific knowledges
- inter-paradigmatic dialogues and adaptive learning
- stakeholder involvement
- dealing with multiple scales.

Adaptive learning drives the adaptive management process by facilitating connections between knowledge and governance processes – and thereby maximises pathways to knowledge uptake. Adaptive management is an important paradigm for responding to these characteristics such as complexity, uncertainty and high decision-stakes within coastal systems. Adaptive learning supports reflexive governance and deliberative approaches in handling pervasive uncertainty and conflict resolution among competing interests. It also supports knowledge makers to learn from and respond to the requirements of governance. The **Adaptive**

Learning Theme analyses how a more communicative relationship between knowledge-makers and decision-makers could be enabled for the coastal zone.

The **Integration, Analysis and Synthesis Theme** of the Cluster plays an active role in bringing the other themes together, but it generates insights and analyses that are greater than the sum of individual Themes. Integrating, distilling and testing common lessons, and understanding why significant divergences may occur, are key outcomes of this Theme.

<http://www.csiro.au/partnerships/Coastal-Cluster.html>

Research Support Grant Student Profile: Claire O'Neill

Research Support Grants offered by the Marine Adaptation Network facilitate research conducted by Honours and Masters students whose projects focus on adaptation to marine climate change. The results of this research will inform managers and policy makers with recommendations for adaptive management of marine and coastal regions. Claire O'Neill from the University of New South Wales is a first round recipient of one of these grants and she outlines below her project, "An integrated approach to the development of climate change policy and management strategies for marine resources in Torres Strait, Queensland".

This project aims to better understand and address the barriers and opportunities to adapting to climate change among Torres Strait Islanders. Developed using an innovative approach to the integration of Indigenous Knowledge (IK) and scientific adaptation strategies, this study will provide policy-relevant advice for the future development of culturally appropriate adaptation strategies for the marine environment in the Torres Strait.

In recent years there has been a growing recognition of the role of IK in maintaining high levels of resilience in the face of environmental change. The use of IK in climate change adaptation strategies is still under-developed, but there is a substantial amount of evidence showing that IK is crucial in both the development of culturally appropriate adaptation strategies for Indigenous communities, and in adding specific local contextual insight to mainstream adaptation science.

Sea country is central to both Islanders' identity and their way of life, serving as a determinant for subsistence practices and ceremonial life. Islanders have been managing both their land and sea country in the face of environmental change for thousands of years, so it is important that adaptation plans in the region take this into account. However, without culturally appropriate adaptation strategies for the marine environment in the Torres Strait, climate change and environmental degradation pose serious threats to both Islanders' culture and their livelihoods. This project aims to work directly with Island Councillors, Traditional Owners, and other relevant members of the community to develop recommendations for future policy that are informed by both IK and mainstream adaptation science.

Photo: Claire O'Neill

International Perspective: Egypt

Dr Nadine Marshall (CSIRO) and Dr Paul Marshall (Great Barrier Reef Marine Park Authority)

Coral reefs support a significant proportion of commercial fishing activities globally. Perhaps even more importantly, coral reefs support artisanal and subsistence fishing activities that provide the basic needs for some 500 million people. Demands on fish and other marine resources provided by coral reefs continue to increase with human population and affluence, yet the ability of reefs to sustain provision of goods and services is declining. The imperative to constrain extractive uses of fisheries resources will strengthen as resources degrade through over-use or exposure to climate changes.

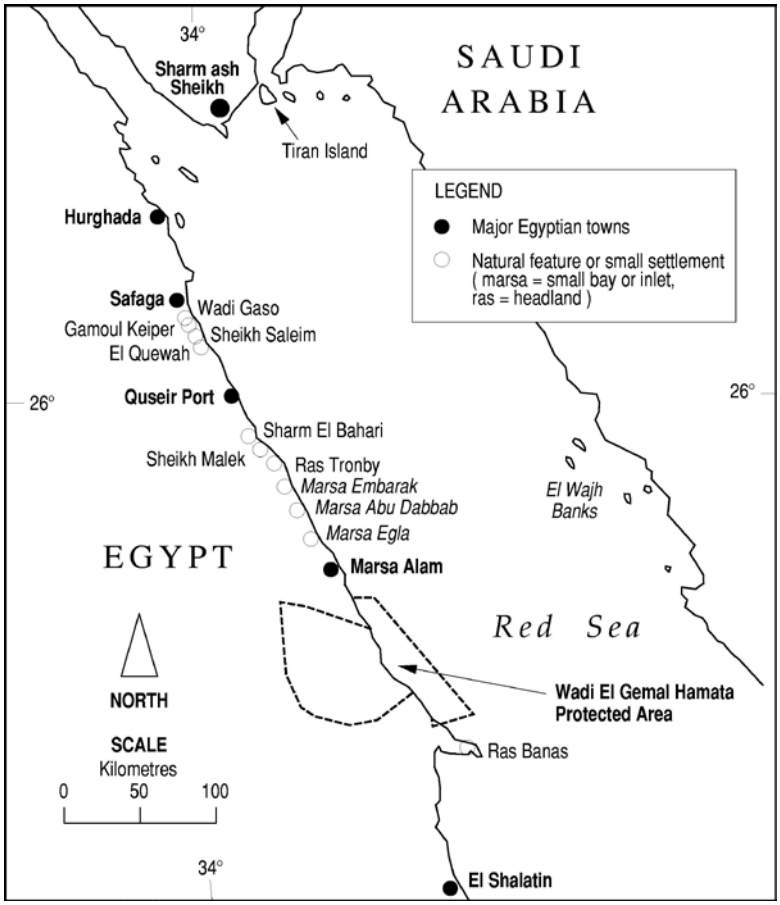

Diagram courtesy of Nadine Marshall

In a recent project in Egypt, we explored an approach to increase the support for marine conservation among coral reef fishers within the context of marine protected areas (MPAs). MPAs are a central strategy of management approaches that aim to protect biodiversity, as well as support the social and economic wellbeing of human societies. Increasing the proportion of marine areas under management or protection, and maximising their effectiveness through informed design and implementation are priorities for international conservation efforts and organisations such as the Convention of Biological Diversity and the IUCN - the World Conservation Union.

We explored the proposition that resource dependency in the Egyptian Red Sea can act as a barrier to marine conservation. Resource dependency is a concept describing the nature and strength of the relationship that people have with the environment that they depend upon. Where dependency on marine resources is very strong, incentives to continue extractive activities (such as subsistence or poverty) can readily outweigh disincentives (such as fines or jail). Strong resource dependency - the norm in many coral reef areas around the world – may be acting as a 'barrier' to accepting and complying with regulatory change. Improved understanding of resource dependency, and knowing how to manage or reduce it, might be a much more cost-effective and sustainable approach to improving conservation effectiveness.

We administered face-to-face surveys to 49% of the fishing industry to: (i) identify the level of compliance to the local marine protected area (MPA), (ii) assess the level of dependency on marine resources in the region, and (iii) examine the relationship between resource dependency and conservation attitudes. We found that only 11.4% of fishers were aware of the MPA. Fishers were mostly limited in their social flexibility and livelihood options. Results suggested that resource dependency is highly and negatively correlated with conservation attitudes suggesting that management efforts need to seriously focus on reducing dependency if conservation goals are to be met. We then explored the significance of our findings for the planning and management of MPAs more generally and considered the implications for the resilience of social-ecological systems to climate change. We suggested that building knowledge of local dependency on marine resources into MPA planning and management could substantially improve the prospects for MPA success. Knowledge of resource dependency can also underpin efforts to minimise negative impacts of protected areas on resource users through strategies that reduce their dependency and increase their resilience to changes in resource access policy.

For more information, see:

Marshall, N.A., P.A. Marshall, A. Abdulla, and A.B. Rouphael. 2010. Toward improved MPA compliance among fishers: understanding links between resource dependency and attitude to conservation in the Red Sea. AMBIO 39(4):305.

Marshall, N. A., P. A. Marshall, A. Abdulla, A. B. Rouphael, and A. Ali. (in press). Preparing for climate change: recognizing its early impacts through the perceptions of dive tourists and dive operators in the Egyptian Red Sea. Current Issues in Tourism.

Global Marine Hotspots Network

By Dr Gretta Pecl, A/Prof Stewart Frusher, Dr Warwick Sauer and Dr Alistair Hobday

Ocean 'hotspots', areas typified by above average ocean temperature increases, are the planet's early warning system for understanding the impacts associated with global warming.

To highlight where global marine 'hotspots' occur throughout our oceans, summarize the information currently emerging on biological climate change impacts, and to discuss the potential for developing a global network of scientists, policy makers and managers working in marine hotspots, the authors convened an international workshop associated with the ICES/PICES 'Effects of climate change on fish and fisheries' symposium. The workshop attracted considerable interest, was attended by approximately 50 delegates including invitees from identified hotspot regions, and provided a platform to explore the idea of a global network covering these fast-changing areas. The workshop was introduced by Dr Pecl who described our approach to defining hotspots, their location, and the rationale for the use of sea surface temperature (SST) to determine potential hotspots to include in a global network. Temperature, the most commonly used variable in marine species distribution studies, and the variable most often used as a metric of marine climate change, is considered the major driver of distribution, abundance, phenology and life history. After extensive discussion, the general consensus was that SST is a key factor affecting biological processes, and the most accessible global data for defining rapidly changing regions. Based on historical (last 50 years) and projected (next 50 years) rates of ocean warming, 24 regional hotspots were identified as warming faster than 90% of the oceans. These hotspot regions covered tropical, temperate, sub-temperate and polar regions, developed and developing countries with a range of adaptive capacities, a variety of ecosystem types, and regions with varying degrees of anthropogenic pressures and disturbances.

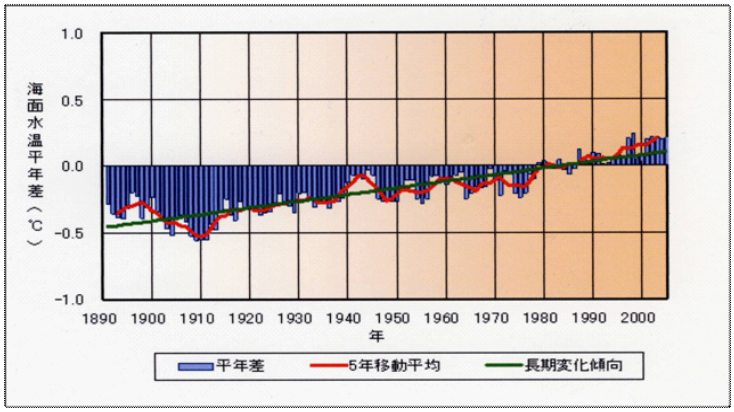

Figure 1: Increment of sea water temperature change in the North East Pacific (source: Japan Meteorological Agency). Taken from Satoshi Nojima's workshop presentation.

Twelve invited presentations followed from hotspot regions including Southeast Australia, Southern Africa/Benguela region, Bering Sea, British Columbia, Galapagos Islands, Mozambique Channel, North Sea, Sea of Japan, Taiwan and Vietnam. Published and unpublished in situ temperature records demonstrated significant recent increases in temperatures, 'validating' the selection of regions as hotspots. Figure 1 was taken from Satoshi Nojima's talk on waters around southern Japan and delivered in his absence by Graham Edgar. However, in many cases temperature either was, or was suspected to be, a proxy for current and/or wind regime changes. Common themes emerged including high rates of temperature increase, areas of significant deoxygenation, increased frequency of harmful algal blooms, shifts in species diversity of phyto/zooplankton communities, and increased diversity and species richness of fish. Evidence was given of large-scale range shifts of a wide variety of species, with movements to deeper waters in some cases. In several regions, large changes in the distribution and abundance of range-shifting species resulted in these acting as 'invasives' creating negative ecosystem impacts, e.g. pipefishes in the North Sea and long-spined sea urchins in Tasmania. Interestingly, regions with naturally high climate variability were not less sensitive to climate change factors. They appeared to be at least equally vulnerable to change, not necessarily 'pre-adapted'. In several hotspots, redistribution of fisheries effort and associated changes in fleet structure and operations has led to current or impending management implications for harvesting of "shifting biomass", especially across jurisdictional boundaries.

A series of discussion topics followed. The first of these identified practical functions that a global hotspot network could achieve, including communication between scientists, managers and policy makers translating outcomes into policy and practical adaptive management. Networking would also promote consistency in data collection and reporting, resulting in greater certainty in projection models. Comparisons between regions would provide shared learning and better understanding of impacts for stakeholders. The meeting agreed that a global network of researchers, managers and policy makers working in marine hotspot locations was an appropriate action for providing the 'science to policy' framework that would guide climate change adaptation globally.

Actions to be taken were identified, including a Consensus Statement of participants with in principal support from their respective institutions, a Summary Paper of physical changes documented in the last few decades in each region, a Website for network communication, and Applications for Funds to run targeted workshops and specific projects. Identification of key monitoring sites for global comparisons, monitored methodologies and inter-disciplinary approaches will facilitate the linkage of science to practical adaptive management.

The workshop was sponsored by NCCARF's Adaptation Research Network for Marine Biodiversity and Resources.

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MARINE BIODIVERSITY AND RESOURCES

An FRDC update: Marine NARP proposals approved

Colin Creighton, Chair, Climate Change Adaptation – Marine Biodiversity, Resources and Fisheries
Chair, Science Review Panel and National Coordinating Committee

Thirteen projects have been approved as part of the $6+ million for research to help managers and users of the marine environment prepare for and adapt to the impacts of climate change. These are now proceeding to contract through the Fisheries Research and Development Corporation (FRDC) as part of the partnership with the Australian Government Department of Climate Change and Energy Efficiency (DCCEE). Additional investment is already starting to build around the Portfolio, including additional funds from FRDC core budget and from the Department of Agriculture, Fisheries and Forestry (DAFF).

The projects span the Marine Conservation and Resources National Adaptation Research Plan's priority areas of Marine Biodiversity, Commercial Fisheries and Aquaculture, Recreation and Tourism, and Cross Cutting issues. Funds have also been allocated to extension and knowledge interchange with coastal communities so that the findings of all of the research are communicated widely.

Several of the projects are Australia-wide in scope. The majority focus on one of the three broad regions of Australia and their marine biodiversity and fisheries management adaptation needs. The three regions are tropical, western and south east, as outlined in the National Climate Change Action Plan.

Full detail of projects to be funded will be included in the Climate Change insert to the next edition of FRDC's newsletter, FISH (Volume 18 number 4, available at <http://www.frdc.com.au> when published).

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Marine Adaptation Network Partners:

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