MARINE ADAPTATION BULLETIN - VOLUME ONE, ISSUE FOUR: DECEMBER 2009

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

Convenor's Spot

Welcome to the fourth and final issue of the Marine Adaptation Bulletin (MAB) for 2009.

In this issue, we look at Australian estuaries from the perspective of the National Estuaries Network who report on a first pass national assessment of climate change risks to Australia's coasts (p.4). A separate report by the Sydney Institute of Marine Science (SIMS) on p.5 discusses SIMS (based on Sydney Harbour – Australia's most urbanised estuary) and also research programs proposed under the Eastern Seaboard Climate Change Initiative.

We welcome, for the first time, an international perspective into the MAB from one of the Marine Adaptation Network's international members, Doug Parsons. The co-authored article discusses Florida's coral reef ecosystem and the physical influences and climate change pressures that the reef is facing. We also feature the Network 'Policy' Theme. This Theme is currently working with scientists, policy makers and edible oyster industry groups to examine science-policy connections in relation to this aquaculture industry. Also included is a report by the South Eastern Australia Program on a coordinated program concerned with climate change adaptation for fisheries and aquaculture industries in south-eastern Australia. A report on the recent release of the 'Marine Climate Change in Australia Impacts and Adaptation Responses 2009 Report Card' is also provided. It is noteworthy that >50% of the authored assessment papers underpinning this Report Card were contributed by Marine Adaptation Network members. We acknowledge the recent launch of the Coastal Climate Change Range Extension Database and Mapping Project (REDMAP). The MAB concludes with a note on the United Nations Climate Change Conference in Copenhagen in December.

Neil Holbrook

Photograph of the leafy seadragon *(Phycodurus eques) at Rapid Bay* on the Fleurieu Peninsula, South Australia

Inside 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.

FUNDING

$1.6m direct funding
$1.9m cash and in-kind partner contributions

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

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Featured Theme: Policy

Peat Leith and Rosemary Sandford, University of Tasmania

Managing marine biodiversity and resources in an ecologically sustainable manner has always been a challenge for scientists, managers and policy makers. With climate change new challenges emerge, but there are also opportunities, particularly for strategic and collaborative planning.

Marine ecosystems are poorly understood compared to terrestrial ecosystems. Climate change is changing the stability of marine systems and therefore increasing the challenge of understanding and managing them. A key to improving our capacity to manage these systems is the development of appropriate formal and informal rules and relationships (institutions) institutions that can foster approaches to sustaining both livelihoods and the ecosystems themselves. Such institutions will rely on closer links between scientists, policy-makers, resources users, and other marine stakeholders. The Policy Theme of the Marine Adaptation Network is actively working to enhance such linkages and to improve social-ecological understanding within and across several key marine sectors.

Photo courtesy of Commonwealth of Australia (GBRMPA).

In Phase I, we are working with the edible oyster industry across New South Wales, South Australia and Tasmania. This work aims to: 1) build stronger science-policy-practice linkages; 2) synthesise our understanding of potential climate change hazards across the three states; 3) highlight barriers to adaptation, and; 4) identify practical and achievable forms of collective action for policy-makers, industry members and scientists. Though this is a relatively short-term project we want to ensure long-lasting legacy through the development of partnerships with these stakeholders. It is intended that this project design, and lessons learned , will inform similar collaborative projects with other marine sectors over coming years.

Although a collaborative approach is rarely straightforward where diverse interests, commitments and identities are at stake, there is wide acceptance that marine policy and management need to be underpinned by both inclusive dialogue, and rigorous science. There also appears to be a growing sense across diverse communities (of place and interest) that climatic and other stressors are beginning to have substantial impacts on fisheries and ecological systems. Even where some stakeholders are sceptical about the reality of human-induced climate change, they understand that there is little stability in the world and that any number of factors can affect the viability of a fishery or ecosystem. These factors can be as diverse as disease within target species, changes in global markets, or one-off events (such as oil spills, changes in oceanic currents or severe storms) which may push a biological system into an altered state that can threaten the fishery. Extending and building upon traditional decision-making networks broadens understanding of biological systems and the various reasons they are valued, and can form the basis of strategic management initiatives, and adaptive planning.

In sum, there is growing understanding that marine systems have closely intertwined social and ecological components, and the management of fisheries and marine biodiversity need to be considered in terms that include all manner of drivers of change. The Policy Theme is committed to facilitating dialogue and collaborations between scientists, policy-makers, industry groups, conservationists and communities to begin to understand the drivers of change and how we may collectively respond to them.

For more information contact Peat Leith at Peat.Leith@utas.edu.au

El-Nemo - South Eastern Australia

Ingrid Holliday, Program Manager of the South Eastern Australia Program gives an update on the activities of the program

Australia's south eastern states have agreed to join forces and coordinate efforts to prepare for climate change at sea.

"El-Nemo - South Eastern Australia" is a program now underway aimed at coordinating climate change related projects to prepare fisheries and aquaculture sectors and fisheries managers to adapt to change in South-Eastern Australia. It covers the marine region from approximately the South Australia/ Western Australia border to approximately the New South Wales/ Queensland border.

This Program was developed by State and Commonwealth fisheries agencies, research institutes and the Fisheries Research and Development Corporation. These organisations recognised the need for a coordinated, multi-jurisdictional, outcome focused program in South-Eastern Australia to facilitate adaptation of fisheries and aquaculture businesses and management to climate change.

The Program recognises that these marine waters are expected to experience the greatest climate driven changes in the southern hemisphere over the next century. It also recognises that the types of effects and opportunities experienced by Australian marine commercial, indigenous and recreational fisheries and aquaculture sectors will depend on how well prepared and adaptable the sectors and fisheries managers are to respond.

Information will be provided to help individuals and businesses manage risks and opportunities presented by climate change. Fisheries managers, fishers from all sectors (commercial recreational and indigenous) and aquac ulturalists will all benefit from the coordinated approach.

Photo courtesy of the Department of Primary Industries, Victoria.

The Program is governed by a multijurisdictional Program Management Committee and includes a Stakeholder Advisory Group to ensure that the program's activities are targeted to the needs of those that will use the information. It also recognises the common questions across borders and aims to coordinate investment on fisheries and aquaculture in this region to understand the risks and prepare for climate change.

The Program sets out projects for completion over four years that systematically answer questions such as 'what is going to happen to the currents and temperatures', 'what is going to happen to the fish', 'what opportunities do these changes present' and 'what are our options to respond?' The first projects of the program will use the latest modelling tools to predict future conditions.

This is the first coordinated regional program of its kind in Australia and is supported by the Victorian Department of Primary Industries, Primary Industries & Resources South Australia, New South Wales Department of Industry & Investment, Tasmanian Department of Primary Industries, Parks, Water & Environment, Australian Fisheries Management Authority, Fisheries Research and Development Corporation, CSIRO, South Australia Research and Development Institute and the Tasmanian Aquaculture & Fisheries Institute. It is also supported by the Department of Agriculture Fisheries and Forestry Australia's Farming Future - Climate Change Research Program.

This program forms one of three regional programs to be established across Australia as part of a National Framework to coordinate the implementation of a range of national plans and strategies including the National Climate Change Action Plan for Fisheries and Aquaculture, and the National Adaptation Research Plans (for Marine Biodiversity and Resources, and Primary Industries).

The National Climate Change Adaptation Research Facility (NCCARF) and the Marine Adaptation Network provide excellent mechanisms to ensure that the findings and outputs of the projects coordinated through the program are shared to enhance preparations for managing change.

For more information:

Visit <http://www.frdc.com.au/environment/climate-change> or

Contact Program Manager - Ingrid Holliday, Victorian Department of Primary Industries, 03 9658 4344, Ingrid.L.Holliday@dpi.vic.gov.au

New 'citizen science' website for marine climate change

redmap SPOT. LOG. MAP.

The Coastal Climate Change Range Extension Database and Mapping Project (REDMAP) was created by the Tasmanian Aquaculture and Fisheries Institute (TAFI) and designed to engage and inform the Tasmanian community about the impacts of climate change on the marine environment. This innovative and interactive website lets the public report sightings of marine species which might be changing their distributions due to warming waters along the Tasmanian coast. Recent research and anecdotal evidence has indicated at least several dozen marine species are shifting their ranges further south, thought to be largely in response to warming waters. REDMAP will capture these changes by using the extensive knowledge and experience of local fishers and divers to create a network of observers across the state.

The website, www.redmap.org.au was officially launched by th Hon. David Llewellyn, Tasmanian Minister for Primary Industries and Water, on 9 December 2009.

TAFI is a joint venture between the University of Tasmania and the Tasmanian Government Department of Primary Industries and Water. REDMAP was funded by a Tasmanian Community Fund grant. For more information please contact Redmap on 03 6227 7277 or email enquiries@redmap.org.au.

A quick look at Australian estuaries

A report entitled The Management of Natural Coastal Carbon Sinks[1] *(released on 17 November 2009) examines the contribution of coastal communities to carbon sequestration. The Report by the International Union for Conservation of Nature (IUCN) aims to draw the attention of policy makers to include coastal ecosystems when considering potential carbon sinks (and the preservation thereof) in their strategies for the mitigation of climate change impacts. Two other recent Australian Government reports,* Managing our coastal zone in a changing climate[2] *(released October 2009) and* Climate change risks to Australia's Coast[3] *(released 14 November 2009) also focus on coastal communities and their response to climate change. Richard Mount from the National Estuaries Network reports on the state of Australian estuaries and these recently released reports.* (1. <http://cmsdata.iucn.org/downloads/carbon_managment_report_final_printed_version_1.pdf>, 2. <http://www.aph.gov.au/house/committee/ccwea/coastalzone/report/Final%20Report.pdf>, 3. <http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx>)

Following the recent release of "Climate Change Risks to Australia's Coast: A First Pass National Assessment Report" (Department of Climate Change 2009) and the House of Representatives Standing Committee on Climate Change report "Managing our coastal zone in a changing climate", there has been increasing interest in the management of Australia's coast.


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Both reports present information and ideas about how our coast works, what we think is going to happen at the coast as a result of our changing climate, and how we might respond to those changes. It is becoming clearer that Australia's estuaries , besides having very large natural value, provide humans with exceptionally high levels of ecosystem services (recent valuations of ecosystem services provided by habitats in a New South Wales (NSW) estuary ranged up to $40,000/Ha). They are also the places where population centres are found, and they are the transition zone through which our catchments empty into the sea. The climate change hazards acting on estuaries are surprisingly aggressive especially coastal erosion and flooding. The projected impacts of sea level rise will be insidious and persistent. As an example, Tasmanian beaches within large fetch dominated estuarine systems, such as Pitt Water and Macquarie Harbour, are already experiencing significant erosion. Sea level rise and changes in environmental flows to estuaries and their associated tidal wetlands areas, including groundwater inputs, are contributing to a host of emerging consequences including "sinking centres" in mangroves, shifts in habitat boundaries ("squeezing saltmarshes") and increased subsidence rates in saltmarshes due to a drying climate.

The First Pass National Assessment focused on open coasts. Further work is needed in sensitivity assessment such as by combining Smartline (see <http://www.ozcoasts.org.au/>) with wave climate modelling. There is also pressing need to evaluate the sensitivity of estuarine shores and assess their degree of exposure to the fetch wave environment hazard. This is a relatively straightforward task with well known spatial science methods. Light Detection and Ranging (LiDAR) data are proving valuable in assessing potential flood levels and tidal wetland migration pathways.

More broadly, the National Estuaries Network (see <http://www.ozcoasts.org.au/nen.jsp>) has been discussing the need for national level work including improved understanding of land surface levels for estuaries and catchments utilising LiDAR - specifically, the identification of estuarine tidal wetland retreat pathways and estuarine hydrodynamic modelling and flow rates.

In addition, the National Estuaries Network is recommending a valuation of estuarine ecosystem services to assist with understanding the intrinsic and natural value of estuaries - a retrospective evaluation of estuary time series to assist people visualise and understand how these systems have altered and changed both naturally and through human adaptation, as well as providing a guide to climate change adaptation in estuaries.

It is vital that we become better coordinated and organised with our coastal zone data. The Integrated Marine Observing System (IMOS) and Terrestrial Ecosystem Research Network (TERN) provide useful models on which to build coastal data and information systems that will be beneficial into the future.

SIMS, Sydney Harbour and Climate Change

Peter Steinberg, Director of the Sydney Institute of Marine Science

The Sydney Institute of Marine Science (SIMS) is one of the newest institutions on the Australian marine science scene. Based at Chowder Bay on Sydney Harbour, SIMS was established in 2005 as a consortium of four Sydney universities, and in subsequent years additional university and state and federal government partners have come on board.


© Charlie Shuetrim

SIMS' vision is to be a multidisciplinary focal point for marine science along the New South Wales coast and a key node in a network of marine institutes Australia wide. Embedded within this vision is the goal of using the full diversity of research at SIMS to provide expertise to relevant government departments and policy makers for the sustainable management of our coastal and oceanic environments.

Much of the research done at SIMS derives from its geography. SIMS is located at the intersection of Sydney Harbour, Australia's most urbanised estuary, and the East Australian Current (EAC). The four million people that surround Sydney Harbour and the adjacent coast have an enormous influence on the marine and estuarine environment. The EAC, made famous in the movie *Finding Nemo*, is the dominant oceanographic feature off eastern Australia and is responsible for our waters warming faster than almost anywhere else on earth. SIMS is thus perfectly positioned to investigate questions relating to the interaction between climate change and urban impacts.

These ideas were addressed at a SIMS workshop earlier this year, under the SIMS led Eastern Seaboard Climate Change Initiative, or ESCCI. ESCCI brought together physical and biological scientists working in both government and academia to try and understand how oceanic and atmospheric drivers would change in the future under climate change scenarios, and how those changes would affect both human and natural coastal communities. Three broad research programs arose from the workshop:

East Coast Lows (ECLs) are severe storms that arise through particular combinations of ocean and land temperature gradients and tropospheric (lower atmosphere) conditions. Their impact can be seen from the five ECL storms of June 2007, which resulted in 10 deaths and $1 billion in damage in the Sydney and Newcastle region, and the grounding of the tanker *Pasha Bulker*. ECLs are a primary example of the importance of ocean/ atmosphere interactions as climate drivers, and this research program will focus in part on the effects of EAC variability on the intensity and frequency of ECLs. These storms are one of the main factors responsible for beach erosion and sediment transport along the NSW coast, so understanding and hopefully predicting ECLs is fundamental to managing coastal development and beach conservation.

The biological consequences of changes in the physical oceanography of our coasts are reflected in the *Vanishing kelp* project and the impact of *Ocean acidification* on marine biota. The large brown seaweeds known as kelp are the "trees" of temperate rocky shores, creating the biological habitat in which many other marine organisms flourish. In the same way that the loss of coral reefs due to climate change would have dramatic, system-wide effects in tropical waters, the loss of kelp from temperate shores would be devastating to these colder water systems.

Key species of kelp appear to have shifted southward in the last few decades, consistent with climate change scenarios, and kelp have also disappeared from urban areas around Sydney and Adelaide, suggesting that these seaweeds are being challenged by human impacts from cities as well as global warming. A coordinated research program to further investigate these changes, initiated at the ESCCI workshop, will bring together scientists from academic institutions and government departments from Queensland to Tasmania, and link in scientists from Western Australia.

Ocean acidification has achieved prominence due to its potential impact on the Great Barrier Reef. However, changes in oceanic CO_2 concentrations could have devastating effects throughout the world's oceans via changes in both ocean acidity and in fluxes of crucial elements in the sea such as calcium (Ca). This is because many of the dominant organisms in the ocean rely on calcium to build their shells or skeletons.

At the workshop we heard that while the ocean in general is becoming more acidic, there is little relevant data from the east coast of Australia. The effects of acidification will also be complex, because "acidification" is in fact short-hand for a range of geochemical changes resulting from increasing CO_2 levels in seawater. Encouragingly, there is genetic variation in the responses of marine organisms to acidification, meaning that genes for resistance to this aspect of climate change exist within natural populations. We may be able to exploit this variation to "climate-protect" commercially important marine organisms.


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International Perspective: Florida

Robert A. Glazer and Doug Parsons, from the Florida Fish and Wildlife Conservation Commission consider Florida's coral reef ecosystem in a changing climate

The State of Florida (USA) is a low-lying peninsula comprised of over 1,900 km of coastline. The State supports numerous terrestrial, freshwater, and marine ecosystems and hosts a wide diversity of species, many of which are threatened or endangered. Off the southern tip of the peninsula, Florida's coral reef ecosystem extends approximately 200 km from Miami through the Florida Keys to the Dry Tortugas and provides habitat for over 4,000 marine species. Florida's reef tract also protects south Florida's shorelines from tropical cyclones, and sustains south Florida's recreational and commercial fisheries, renowned beaches, tourism and recreation. It is estimated that Florida's reefs provide US$5.5 billion dollars annually to local economies and supports approximately 71,000 jobs (Johns *et al*. 2001).

Florida's coral reefs are juxtaposed closely to a number of diverse influences. To the north, the reef is influenced by The Everglades, a vast freshwater estuary, and by the Gulf of Mexico with numerous urban centres located along its shoreline. To the south, the Florida Current or Gulf Stream bathes south Florida on its way from the Caribbean to the North Atlantic. Most of the coral reefs are within the boundaries of the Florida Keys National Marine Sanctuary or Biscayne and Dry Tortugas National Parks. Nevertheless, zoning plans allow for no-take zones as well as large-scale commercial fishing operations.

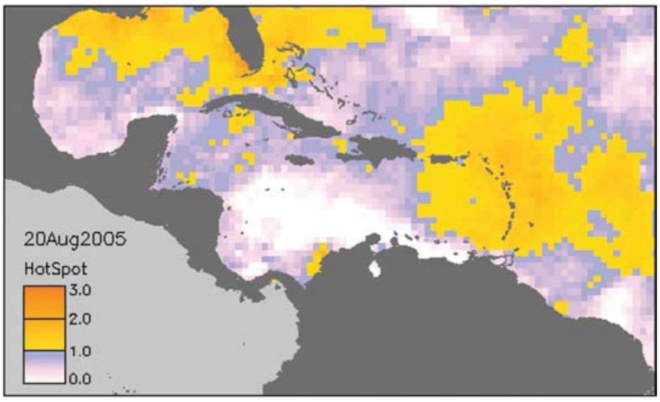

Figure 1. Sea surface temperatures associated with the 2005 region-wide bleaching events. Figure courtesy the U.S. National Oceanographic and Atmospheric Administration

Yet, Florida's coral reefs are in trouble. A number of anthropogenic threats had already been identified before the pernicious effects of climate change were first documented. These threats included sewage, agricultural, shipping, and industrial discharges; pesticide application for mosquito control; shoreline development; over-fishing; dredging; vessel groundings and anchoring; and aquatic invasive species. The likely result is that these stressors have contributed to a reduction in resilience of the coral ecosystem (sensu Nyström *et al.* 2000).

However, massive, wide-scale coral die-offs didn't occur until elevated seawater temperatures were recorded. From 1996 to 1999, coral cover along the Florida reef tract declined 38% (Porter *et al.* 2002). Since then, stony corals (*Montastraea* spp.), the backbone of the reef, declined an additional 16% as measured by live tissue area (Gischler 2006) and a shift occurred Caribbean-wide from reef framework building coral species (e.g. *Acropora* and *Montastraea*) to non-reef building species (e.g. *Porites*, *Agaricea* and sponges). In 2005, reefs throughout the region suffered unprecedented additional losses due to two climate-related events - coral bleaching and hurricane damage. The most extreme reports came from the U.S. Virgin Islands where corals bleached due to elevated seawater temperatures and subsequently succumbed to disease; 51.5% of the remaining coral cover died in a matter of months (Waddell and Clark 2008). Florida's coral reefs were also influenced by this event, but bleaching was likely not as severe.

Other more subtle impacts may be manifested as sea surface temperatures rise. In south Florida, mesoscale gyres develop during the summer and these features facilitate the retention and deposition of larvae within the system (Lee *et al*. 1992). At least one species, the queen conch, spawns during the period within which those features are most prominent thereby maximizing the potential for recruitment. However, scientists have observed that the spawning season is now prolonged with reproduction occurring outside of the genesis of the gyres. The effects of a prolonged spawning season on recruitment is not known, but it is not unreasonable to assume that the Florida metapopulation may be at risk due to production of propagules at times that don't favour retention.

The effects of climate change on Florida's reef ecosystem are not limited to elevated seawater temperature. Ocean acidification may have implications for corals as well as crustaceans, two of which (shrimp and spiny lobster) comprise the most economically important commercial fisheries in Florida. Molluscs, the forage source for many important reef fish species, will also be affected. Sea-level rise will likely impact sea turtle nesting.

Not all is gloom, however. The Nature Conservancy's Florida Reef Resilience program (<http://www.nature.org/wherewework/northamerica/states/florida/preserves/art17499.html>) is examining ways to increase resilience in the coral reef ecosystem. Coral restoration programs are beginning to show signs of success. Perhaps most promising, managers are beginning to create mechanisms that will build resilience into the ecosystems by reducing the stressors that are easily controlled. One method that is gaining traction is the implementation of marine reserves as mechanisms not only to restore depleted fisheries, but as ways to restore trophic structure and function to impacted ecosystems (sensu Keller *et al*. 2009).

The Florida Fish and Wildlife Conservation Commission (FWC) is the state agency responsible for managing biodiversity in the state. FWC hosted a Climate Change summit in October 2008, working with over 250 stakeholders to generate ideas to address adaptation for these key topics: marine, inland aquatic, terrestrial, invasive species and natural resource management. FWC now has five teams focusing on climate change, developing strategies and research priorities to address the current and future impacts of climate change. We have much to learn from what Australia is doing and we look forward to any future collaborations that might arise.

The Florida Fish and Wildlife Conservation Commission wants to thank the Australian Adaptation Research Network for Marine Biodiversity and Resources for this opportunity to share information regarding climate change and marine resources.

Florida Fish and Wildlife Climate Change Summit Report, October 2008 (<http://www.myfwc.com/CONSERVATION/ClimateChange_index.htm>).

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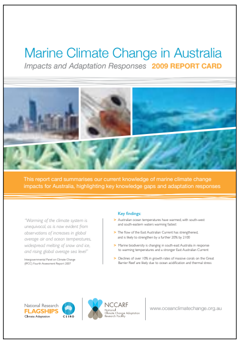
First National Marine Report Card

Elvira Poloczanska, CSIRO Marine and Atmospheric Research

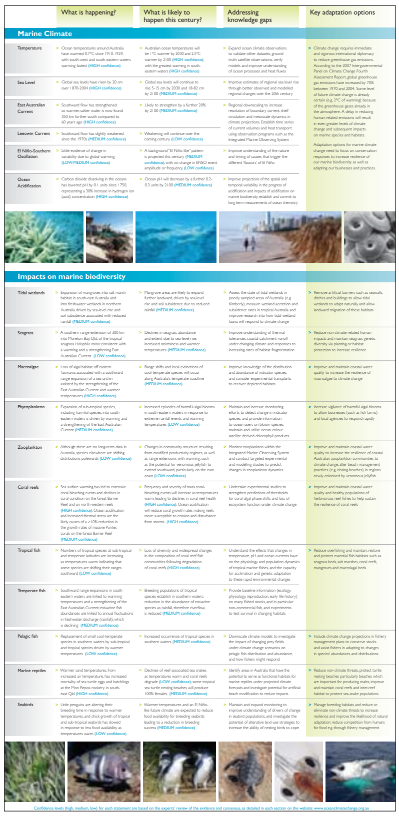


The Report Card of Marine Climate Change for Australia 2009, and the accompanying website <www.oceanclimatechange.org.au>, is Australia's first guide for scientists, government and the community on the observed and projected impacts of climate change on the ocean, its chemistry and biology, and on potential adaptation options to protect our marine systems. Funded by the Australian Climate Change Science Program, The National Climate Change Adaptation Research Facility (NCCARF) and CSIRO's Climate Adaptation National Research Flagship, the project is an early outcome of a broader national response to climate change being conducted through NCCARF. The Report Card will help inform policy by identifying regions, habitats and species most at risk, as well as highlight knowledge gaps and adaptation options.

More than 70 authors from 35 universities and organisations were involved in production of the Report Card led by the project team from the CSIRO Climate Adaptation Flagship comprising Elvira Poloczanska, Alistair Hobday and Anthony Richardson. Authors included scientists from CSIRO, Australian and overseas universities, State and Territory environmental agencies, the Australian Institute of Marine Science and the Bureau of Meteorology. The Marine Adaptation Network partners and members authored more than half of the published contributions.

The Report Card highlights observations over the past decade, projects forward to 2030 and 2100 with assessments of likely status and confidence ratings, and offers adaptation responses that can inform policy makers. It will be updated every two years, so this version and future Report Cards will document changes in our marine ecosystems as climate changes, and chart developments in our knowledge and adaptation responses.

Key concerns raised in the Report Card include waters around Australia becoming warmer and more acidic, combined with changes in the strength of Australia's major boundary currents. Observations highlight that marine biodiversity in south-east Australia is already changing in response to warmer temperatures and a strengthening East Australian Current, while in tropical waters growth declines in massive corals are likely due to thermal stress and ocean acidification.



COP 15

Friday 18th December was the concluding day of the 15th United Nations Climate Change Conference (COP15) taking place at the Bella Centre in Copenhagen. The Conference brought together 160 world leaders to try to plan the way forward from 2012, when the Kyoto protocol will expire. The Kyoto agreement (See <http://unfccc.int/resource/docs/convkp/kpeng.pdf>) was first adopted on 11 December 1997 and came into force on 16 February 2005. Within this agreement industrialised nations agreed to reduce their collective greenhouse gas emissions by at least 5% from the 1990 emissions level by 2010.

Australian leaders joined those from European Union countries and others in supporting the Copenhagen Accord (See <http://en.cop15.dk/files/pdf/copenhagen_accord.pdf>). The accord commits to limiting global warming to below 2 degrees Celsius (2°C) and will be reviewed in 2015 to consider the need to move to a target of keeping warming below 1.5°C, which is generally agreed as the target necessary to avoid the worst impacts of climate change.

No resolution was made regarding cutting greenhouse gas emissions. However, Australia retained its commitment to an emissions reduction of 5–25% by 2020 against those in 2000.

Australia agreed to support the Copenhagen Accord's goals for short term finance of $30 billion between 2010 and 2012, and $100 billion per year by 2020, to help developing countries reduce emissions and adapt to the impacts of climate change. They also agreed to continue negotiations throughout 2010 up to the next UN Climate Change Conference in Mexico in Nov/Dec 2010.

Australia pushed for a legally binding instrument (a treaty) integrated with an extension of the Kyoto Protocol to be concluded by December 2010 or before.

How to contribute

If you would like to contribute an article to the Marine Adaptation Bulletin, or have a photograph featured on the front cover, please write to arnmbr@arnmbr.org or call 03 6226 2134.

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MAB Editors: Neil Holbrook and Clare Brooker

Marine Adaptation Network Partners:

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