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

Convenor's Spot

Welcome to the third issue of the Marine Adaptation Bulletin (MAB). Since the inaugural issue in March 2009, MAB has grown and we expect now to settle on this issue's format of an eight page quarterly Bulletin in future.

In the present issue, we focus our attention on: (1) scientific updates since the Fourth Assessment Report of the Intergovernmental Panel on Climate Change in 2007, (2) concerns regarding the Great Barrier Reef under climate change, (3) ocean observing into the future facilitated by Australia's Integrated Marine Observing System, and (4) encouraging data sharing by providing existing data (as metadata) through the Australian Ocean Data Network. We also take a look at how BLUElink, an Australia-wide ocean analysis and forecasting system, is being used to manage the southern bluefin tuna industry (p.3). Perhaps similar approaches may be used to take advantage of BLUElink ocean forecasts in other fisheries (or other marine) operations, now and in a changing climate!?

This MAB issue provides further information about the Network organisation and some of its ongoing and future activities. 'Markets' is the featured Network theme (p.2) - the theme leaders briefly describe how they are working to review the economics of climate adaptation in fisheries management. Applications are now open for Australia's First Marine (Climate Change) Adaptation Summer School to be held at the University of Tasmania on 4 December 2009 (see p.8 for details). The Marine Adaptation Network Website went live on 26 August 2009 (<http://www.nccarf.edu.au/marine/>), and we're delighted that many network members have now formally registered. If you haven't registered, please go to p.3 for details of how to do this. We aim to continue to build the members' page so that it better facilitates network members with the opportunity to identify, and build collaborations with, marine researchers and stakeholders with similar interests and complementary expertise.

Neil Holbrook

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

Featured Theme: Markets

Markets provide important signals and information across space and time that can help marine based sectors adapt to climate change. These signals in the form of prices, returns and investments can assist fishers and stakeholders to autonomously adjust to climate change.

The focus of the markets theme is to facilitate the development of economic tools and methods: (1) to evaluate socio-economic sensitivities and potential vulnerabilities associated with climate change, and (2) to evaluate responses in terms of their cost-effectiveness and ability to promote resilience as part of the policy development process in the marine sector. These adaptation options will promote management strategies to ensure economically resilient and sustainable fishing practices for traditional, commercial and recreational sectors.

Another key goal is to assist in the development of incentive-based approaches, where appropriate, that can be used to address conservation and resource impacts as part of planned climate change adaptation strategies in the marine sector.

Work is already underway to review the economics of climate change adaptation in fisheries management. This, and other work in the markets theme, will provide a solid basis to improve climate change adaptation policy and to help communities adjust to climate change.

To engage in the Markets theme please contact either Quentin Grafton at <quentin.grafton@anu.edu.au>, or the Project Officers at arnmbr@arnmbr.org

Photo courtesy of Tasmanian Seafood Industry Council

Scientific updates since AR4

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) released in 2007, provides an assessment of published peer reviewed scientific findings up to July 2006. Significant scientific developments have since been published, many of which are relevant to policy decisions that will be made prior to the next IPCC Assessment Report due for release in 2014. An overview of some of these recent findings is provided by the Pew Center on Global Climate Change[1].

The AR4 concluded that there is greater than 90% certainty that anthropogenic greenhouse gas emissions are responsible for most of the increase in global average temperature. More recent research, as reported in the Pew Science Brief, has found that human activities are most likely responsible for most of the observed increase in the sea surface temperature (SST). These increases in SST may be having an impact on the development of more intense hurricanes in the Atlantic and Pacific Oceans.

The Pew Science Brief also reports on the impact of ocean acidification on marine ecosystems. An increase in CO_2 emissions has resulted in an increase in the acidity of the oceans. This impacts the growth of corals and shell-forming organisms such as certain types of plankton. In October 2008, the InterAcademy Panel on International Issues, a panel of 155 scientists, found that "ocean acidification may render most regions chemically inhospitable to coral reefs" by 2050[2].

The Pew report goes on to highlight new estimates of average global sea level rise which are significantly higher than those predicted in the AR4. The AR4 reports a projected average sea level rise of 0.18 to 0.59 metres by the end of the 21st century. Due to the limited modelling capacity of how ice moves in large, land-based ice sheets, the AR4 report did not provide a best estimate or an upper limit for sea level rise. Previous estimates, such as provided in the AR4, were largely based on the thermal expansion of the oceans. More recent studies have attempted to capture the ice contribution to future sea level rise, projecting increases ranging from 0.5 to 2.0 metres by the end of the 21st century. Indeed, studies in Antarctica have indicated that the West Antarctic Ice Sheet continues to exhibit accelerated melting, with 10 major ice shelf collapses in the last decade.

Recent studies of the uniformity of sea level rise have concluded that the rise in sea level is not equal around the world and that there will be a greater rise in sea level on the Pacific and Atlantic coasts of the United States than considered to be the global average.

The Pew report elaborates on the long term impacts of climate change that may persist even after anthropogenic emissions stop completely. In the light of recent revisions of projected changes, the projections published by IPCC in 2007 now appear conservative. Observed climate change is proceeding at a more rapid pace than anticipated by previous estimates or model projections. Strong leadership and policies are required to reduce greenhouse gas emissions and potentially avert the worst consequences of climate change.

1. PEW Center on Global Climate Change (June 2009) *Key scientific developments since the IPCC Fourth Assessment Report. Science Brief 2, June 2009* available for download at <http://www.pewclimate.org/docUploads/Key-Scientific-Developments-Since-IPCC-4th-Assessment.pdf >.

2. Declaration can be found at: <http://ioc3.unesco.org/oanet/Symposium2008/MonacoDeclaration.pdf>

Website launch: the Networking begins

On 26 August 2009 we were pleased to be able to launch the Network website, which will be the hub of information describing all Network activities. It will be the place where you can find out about the Network, catch up on adaptation news, and link with other members to form collaborations.

The website has: information on climate change adaptation, links and updates on Network activities, back issues of the MAB, fact sheets, a list of adaptation relevant conferences, workshops and seminars. Importantly it also provides a members' area where you can connect with researchers, stakeholders and policy makers to potentially develop projects of mutual interest.

For those members who are yet to register, or anyone interested in participating in the Network, log on to <http://www.nccarf.edu.au/marine/content/index.php/member/register/> and enter your details. This system is secure and any information you provide will only be used for Network statistical purposes. Your personal information will not be circulated to other organisations.

Once registration is complete, and your account approved, the members' area can be easily accessed by logging in on the left hand side of the Network homepage (<http://www.nccarf.edu.au/marine/>) and then going to "Your Account" (same location). You can then search the "member list" inside the members area. You can search for people with similar or complementary climate change adaptation interests, and communicate with other members via the secure internal mail system.

Developments to the website over the next few months will include a discussion board for open discussion on marine climate change adaptation issues. We will also be developing a portal to the Metadata Entry and Search Tool (MEST) of the Australian Ocean Data Network (AODN). This will enable network members to provide metadata and will encourage data-sharing. For more information on the MEST see page 5.

For more information on how to use the website go to <http://www.nccarf.edu.au/marine/content/images/uploads/Network_website_launch.pdf>.

Ocean forecasting for tuna management

CSIRO scientists use BLUElink to manage tuna in a changing climate

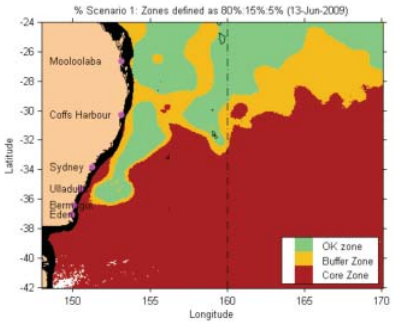
CSIRO's Wealth from Oceans Research Flagship, the Bureau of Meteorology and the Royal Australian Navy are collaborating on a $33 million, Australia-wide ocean analysis and forecasting system called BLUElink.

Every day, BLUElink produces an analysis of the present ocean conditions using satellite and other data. Twice weekly, the Bureau of Meteorology produces seven-day forecasts of coastal and ocean currents, and surface and subsurface ocean properties - such as temperature and salinity - important to marine industries, defence applications, safety at sea, and environmental management.

CSIRO scientists Alistair Hobday and Jason Hartog use data from the BLUElink oceanographic analysis called SynTS in a habitat model developed to reduce the unwanted capture of commercial southern bluefin tuna (SBT) off eastern Australia.

The modelling work, funded by the Australian Fisheries Management Authority, combines the BLUElink estimates of water temperature at depth with SBT temperature and depth preferences derived from pop-up satellite tags deployed on the fish.

The model provides fortnightly near real-time habitat predictions used to identify three habitat types in the fishing region – a core zone, a buffer zone and an "okay" zone – based on probability of SBT occurring in that area. This spatial zoning is used to regulate fisher access to these zones based on the amount of SBT quota they hold.



"The pop-up tags provide information about surface and sub-surface temperatures encountered by tagged SBT," Mr Hartog says.

"SBT sub-surface temperature preferences to a depth of 200 m are used in combination with up-to-date estimates of sub-surface temperature to calculate the probability of SBT being present in various regions of the fishery."

The project has been running since 2003, but has evolved over time to the present model. Initially, the team used only surface temperature information, but as BLUElink gained momentum, subsurface temperature estimates were added. SBT spend 95% of their time in the top 200 m, so there is little need to look deeper than that.

Management complexity has increased at the same time. As the BLUElink product is updated every day, the team provides intermediate reports when requested as ocean conditions can change quite rapidly in the region off northern New South Wales and southern Queensland.

The work is a successful example of dynamic spatial zoning, a fishery management approach that may become increasingly important as marine ecosystems are affected by climate change.

Daily ocean analysis – <http://www.marine.csiro.au/remotesensing/oceancurrents/>

AFMA habitat zones - <http://www.afma.gov.au/fisheries/tuna/etbf/mgt/zones.htm>

Image courtesy of Australian Fisheries Management Association

The Australian Integrated Marine Observing System

Tim Moltmann, Marian McGowen

The Australian Integrated Marine Observing System (IMOS) is a national facility for observing the oceans surrounding Australia using state of the art equipment and data services. Access to all IMOS data streams is free and open. IMOS was established in 2006 as a collaborative program led by the University of Tasmania and operated by 10 Australian agencies, supported by a number of co-investors. IMOS is a research infrastructure program, with the data produced from sustained ocean observing becoming the 'infrastructure' created and developed under the program. Five Science Nodes - in the blue-water and in Australia's coastal regions - are responsible for identifying the scientific rationale for sustained observing in their regions, and promoting the uptake of the data by users in the marine and climate science community.

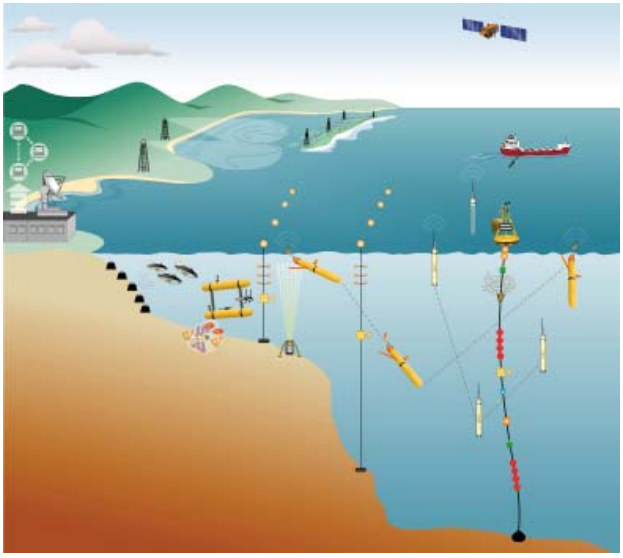


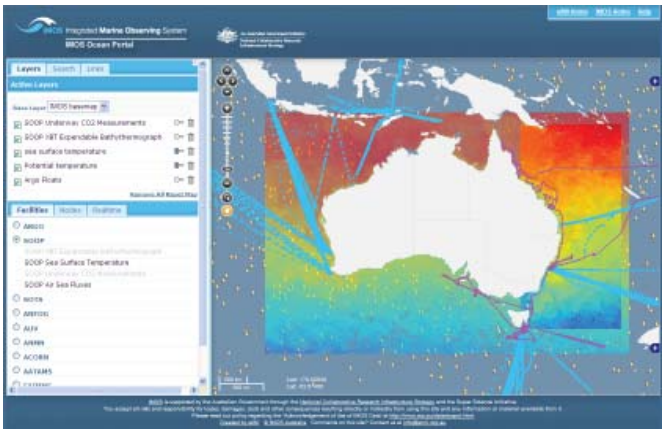
Diagram illustrating how the national IMOS program works. IMOS integrates several independent technologies and instruments, ranging from moored sensors and deep sea autonomous floats, to acoustic tracking devices, radar imagery and remote satellites, among others, into research infrastructure covering a vast swath of Australia's large coastal and deep water marine territory. IMOS will generate critical data needed to support a diverse range of marine research projects.

Australia has one of the largest marine jurisdictions on earth, with more than 70% of our territory in the marine realm. The major ocean currents on our eastern, western, northern and southern boundaries — the best known of these being the East Australia Current and the Leeuwin Current – affect regional climatic conditions and help to sustain marine ecosystems. Recent research has identified long term changes in both of these currents, and there is evidence that coastal marine ecosystems are changing in response. Sustained observations are needed to answer questions regarding the use, management and conservation of our marine biodiversity particularly under future change.

IMOS was initially funded under the National Collaborative Research Infrastructure Strategy (NCRIS) with $50 million over 4 years (2007-11). This Commonwealth investment attracted nearly equal in kind and partner contributions from research agencies, universities and State Governments. The five science Nodes established at the beginning of IMOS consist of a Bluewater and Climate Node, and four regional nodes in the Great Barrier Reef, New South Wales, Southern Australia and Western Australia. IMOS infrastructure is funded and operated through 11 Facilities; the Facilities provide the sustained observations needed to address the big science questions posed via the Nodes. The IMOS Facilities can be divided into four categories:

- Bluewater and Climate (Argo Australia, Enhanced measurements from Ships of Opportunity, Southern Ocean Time Series)
- Coastal Currents and Water Properties (Australian Coastal Ocean Radar Network, Australian National Facility for Ocean Gliders, Australian National Mooring Network)
- Coastal Ecosystems (Australian Acoustic Tagging and Monitoring System, Autonomous Underwater Vehicle, Facility for Automated Intelligent Monitoring of Marine Systems)
- Data (e-Marine Information Infrastructure, Satellite Remote Sensing).

Access to IMOS data is through the recently launched Ocean Portal, which allows the marine science community to discover and explore the data streams coming from the facilities - <http://www.imos.org.au>. Although there is still more equipment to deploy and data to serve, IMOS is well underway and it is time for the Australian marine and climate science community to start making good use of the data streams now available.



The IMOS Ocean Portal. IMOS data from all around Australia is delivered direct to your computer through this interactive map based interface. See <http://www.imos.org.au>

In the Federal Budget of May 2009 IMOS was provided with an additional $52 million. This funding is through the Super Science Marine and Climate Initiative and will enhance IMOS' operation for the second half of the initial funding period (to June 2011), and extend it to June 2013. This decision provides strong confirmation of the initial IMOS plan and gives further directions in terms of

requirements for enhanced monitoring capability in the Southern Ocean and extended coverage in northern Australian waters. The process for developing the new IMOS plan will be nationally facilitated, and guided by the Nodes. Funds will be invested through the Facilities, with core funds from the Commonwealth and co-investment from partners.

IMOS is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative. The IMOS Facilities are operated through the following agencies and universities: Australian Institute of Marine Science, Bureau of Meteorology, Commonwealth Scientific and Industrial Research Organisation, Curtin University of Technology, Geoscience Australia, James Cook University, South Australian Research and Development Institute, Sydney Institute of Marine Science, University of Tasmania, and University of Western Australia.

For more information see <http://www.imos.org.au>.

A philosophy of data sharing

An important philosophy of the Network is to encourage collaboration amongst researchers, stakeholders and policy makers and to encourage data sharing.

Australian marine researchers collectively have large amounts of marine ecological and socio-economic data. These data have already been used to generate vast amounts of published research, but much value is yet to be tapped. The Network wants to encourage the further use of these data. In what format the data are stored, who and how they are accessed and how they are used are key considerations in maximising research opportunities that the data provide and minimising the time it takes to act on those research findings and provide adaptation solutions.

The Network is not encouraging the reckless posting of streams of numbers on the internet; we encourage the provision of metadata, opening the doors for collaborative and interdisciplinary research. The management, storage and control of the original data remains with the researcher(s) who collected them. Production of metadata is rapidly becoming a common part of research culture. Metadata identifies how data were collected, the rationale for their collection, who to contact about them, the sensor(s) used, sensor calibration information, the list continues... Metadata describes data. Dr Roger Proctor, Director of IMOS' eMarine Information Infrastructure (eMII), describes the relationship between data and metadata with an analogy to a can of soup:

> *"A can of soup has a label on it, the label contains information about the manufacturer, the use-by-date, contact details and the nutritional breakdown. If the label was missing, the can of soup becomes less valuable; as you wouldn't know if it was safe to eat or even what it is!"*

For data sharing to be valuable, effective and controlled, we want to encourage the input of metadata into the Australian Ocean Data Network (AODN): a data storage and discovery network involving leading Australian marine research facilities.

The AODN will provide the expertise, management and curation skills and infrastructure to host Marine Adaptation Network members' meta-data. The AODN now hosts the historical BlueNET data archive of marine ecological data. The AODN will enhance access to, and re-use of, Australian marine science data and data products by ensuring standards-of-practice (ISO 19115/19139 standard) across the marine science data and management community. It also provides a one-stop-shop for marine science meta-data access using the foundation architecture and services of the IMOS Ocean Portal and Metadata Entry and Search Tool (MEST).

By maintaining a standard approach to metadata entry across a range of marine science disciplines ensures that online resources (metadata) are consistently catalogued and structured. This allows metadata records to be organised, stored and retrieved for multiple purposes. The advantage of using a common standard (such as that being developed by AODN) is that records are compatible with other metadata storage systems that adhere to the same standard.

The Marine Adaptation Network is currently working on providing a portal to the AODN MEST, and Network members will be notified when this is complete.

To improve our capacity to adapt to climate change, we first need to know what knowledge already exists. The provision of metadata will help facilitate this.

More updates since AR4

Will Steffen's report, "Climate Change 2009 Faster Change & More Serious Risks", provides a synthesis of scientific papers published since the IPCC's AR4. It emphasises the rapidity of change in both science and policy, focussing strongly on issues of importance to Australia. Steffen discusses in detail what he refers to as the most important new developments and significant new insights which have been gained since AR4. These include the fact that the climate system is changing faster than thought likely. Also, uncertainty still surrounds the rates and magnitudes of change in the major processes that drive serious impacts for human societies and the natural world. Steffen also points out that climate change is not linear and long-term feedbacks in the climate system may be starting to develop now. He also points out that we need to focus on adaptation and recognise possible limits to adaptation. The full report can be downloaded from <www.climatechange.gov.au/science/publications/faster-change-more-risks.html>

Issues for the Great Barrier Reef

While the absorption of anthropogenic carbon dioxide emissions into the ocean has been beneficial in reducing the impact of global warming, it is causing the oceans to become more acidic. When carbon dioxide dissolves in water it forms carbonic acid. The resultant changes in chemical equilibria in the ocean reduce the ability of calcifying organisms to produce their calcium carbonate skeletons. Hence, ocean acidification is expected to adversely impact a number of marine species including corals, calcifying algae, molluscs and echinoderms.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Ocean acidification is predicted to affect food webs and ecosystems, as well as the communities that rely on these ecosystems. For more details see the accompanying article "*Coral Reefs in Crisis*" by Charlie Veron.

The current rate of ocean acidification is a hundred times faster than any change that has occurred naturally in at least the past several million years[1]. However, recovery from ocean acidification is slow, where it is predicted that coral reefs could take up to millions of years to recover after an extinction event. Ocean acidification is already detectable and can only be controlled by minimising atmospheric carbon dioxide emissions. This is an area where it is likely that communities that are reliant on ecosystems affected by ocean acidification will need to adapt.

The Great Barrier Reef Outlook Report 2009 was released on 2 September 2009. The report states that the condition of the Reef is declining, and that changes to the reef system will not only result in a loss of biodiversity, but will also have social and economic implications. To view the report see <http://www.gbrmpa.gov.au/corp_site/about_us/great_barrier_reef_outlook_report>. Below are articles written by network members about the issues surrounding the GBR.

1. Raven *et al.* 2005. *Ocean acidification due to increasing carbon dioxide*. Royal Society Special Report, London.

Implications of Ocean Acidification

Dr Will Howard, Antarctic Climate and Ecosystems Cooperative Research Centre

Ocean acidification differs from global warming in that its impact derives from the chemistry of carbon dioxide (CO_2) in seawater, rather than from its physical (radiative) action as a greenhouse gas in the atmosphere. This means that increasing atmospheric CO_2 will inevitably increase ocean acidity, largely independent of the rate of global warming and its impacts, and independent of climate-model projections. Ocean acidification will need to be considered in the context of setting stabilisation targets for atmospheric CO_2 and the timelines on which the targets need to be reached. There are natural time lags involved in the marine carbon cycle, both in the uptake of CO_2 by the ocean as well as in the centuries needed to reverse the acidification already under way. These lags place a penalty on delaying limits on carbon emissions and a premium on early action. A further policy challenge arises because the only mitigation option available is a reduction in carbon dioxide emissions. The thresholds for atmospheric CO_2 levels at which acidification impacts begin may differ from those which trigger warming impacts (e.g. McNeil and Matear, 2008), so mitigating acidification may require different emissions-limitation targets than global warming. Similarly, because acidification caused by gas-chemical changes arises only from the atmosphere-ocean influx of CO_2, limiting other greenhouse gases (such as nitrous oxide) will not mitigate ocean acidification.


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Atmospheric CO_2 is absorbed by the ocean faster than natural processes can neutralise the increased acidity it causes. The Southern Ocean is particularly vulnerable to the phenomenon, partly due to the higher solubility of CO_2 in cold water.

Evidence is already emerging of changes in the growth and structure of marine organisms in response to ocean acidification. Recent studies by the Antarctic Climate and Ecosystems Cooperative Research Centre have shown that the shells of some microscopic marine organisms in the Southern Ocean are getting thinner (Moy *et al*., 2009). The evidence is a warning that ocean acidification will have potentially serious impacts within the 21st century for the sustainability and management of many marine ecosystems and the human communities that depend on them.


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McNeil, B. I., and R. J. Matear (2008), Southern Ocean acidification: A tipping point at 450-ppm atmospheric CO2, Proceedings of the National Academy of Sciences, 105(48), 18860–18864 doi:10.1073/pnas.0806318105.

Moy, A. D., W. R. Howard, S. G. Bray, and T. W. Trull (2009), Reduced calcification in modern Southern Ocean planktonic foraminifera, Nature Geoscience, 2, 276-280, doi:10.1038/ngeo460.

Action from Network PhD student on GBR

Emily Shaw, Network PhD student at UNSW, writes about the reefs and her planned PhD

Future predictions of the effects of ocean acidification are dependent on having an understanding of the baseline ocean carbonate chemistry and the natural variability in the carbonate system. However, despite the importance of the Great Barrier Reef, these measurements are currently lacking. The aim of Emily Shaw's research is to characterise the diurnal and seasonal variability of ocean carbon chemistry at Lady Elliot Island on the southern Great Barrier Reef. This will allow us to determine the baseline variability in the carbonate system that the ecosystem responds to and will allow for improved understanding of future ocean acidification dynamics. The measurements taken during this study will also allow us to calculate a calcification budget for Lady Elliot Island reef and determine whether the reef is a source or sink of atmospheric carbon dioxide.

Sampling at Lady Elliot Island will commence at the end of 2009 and will be conducted for two weeks every season for a year. The sampling procedure involves collecting water samples that are later analysed for dissolved inorganic carbon, total alkalinity and nutrient concentrations at the CSIRO Marine Laboratories in Hobart. The salinity and temperature of the water will also be recorded at the time of sampling. From these measurements, other carbonate system parameters, such as pH, the partial pressure of CO_2 and aragonite saturation state, can be calculated. A modelling analysis will then be used to determine the importance of different physical, chemical and biological processes in determining the seasonal and diurnal variations in the carbonate system.

Coral Reefs in Crisis

Dr J.E.N. Veron, coral reef scientist, comments on the impacts of temperature and acidification on coral reefs.

Temperature-induced mass coral bleaching causing mortality on a wide geographic scale started when atmospheric CO_2 levels exceeded 320ppm. When CO_2 levels reached 345ppm, sporadic but highly destructive mass bleaching occurred in most reefs world-wide in response to El Niño cycles. Recovery was dependent on the vulnerability of individual reef areas and on the reef's previous history and resilience. At today's level of ~387ppm, with a lag-time of 10 years factored in, most reefs world-wide are committed to an irreversible decline. Mass bleaching may in future become annual, departing from the 4-7 year return-time of El Niño cycles. Bleaching will be exacerbated by the effects of degraded water-quality and increased severe weather events.

In addition, the progressive onset of ocean acidification will cause reduction of coral growth and retardation of the growth of high magnesium calcite-secreting coralline algae. If CO_2 levels are allowed to reach 450ppm (projected by 2030-2040 at current rates), reefs will be in rapid and terminal decline world-wide from multiple synergies arising from mass bleaching, ocean acidification, and other environmental impacts. Damage to shallow reef communities will become extensive with consequent reduction of biodiversity followed by extinctions. Reefs would cease to be large-scale nursery grounds for fish and cease to have most of their current value to humanity. There would be flow-on effects to ecosystems associated with reefs, and then to other pelagic and benthic ecosystems. Should CO_2 levels reach 600ppm (by the 2050s in worst case scenarios) reefs would be eroding geological structures with populations of surviving biota restricted to refuges. Domino effects would follow, affecting most marine ecosystems. This is likely to have been the path of great mass extinctions of the past, raising the possibility that anthropogenic CO_2 emissions could trigger the Earth's sixth mass extinction.

For more information see < http://www.zsl.org/climatechange>.

Australian Scientists Participate in US think-tank

Anthony Richardson and Elvira Poloczanska from CSIRO's Climate Adaptation Flagship have brought together 16 scientists from around the world for a US-based think tank to understand the marine biological impacts of climate change.

They were successful in an application for $177,000 funding from the National Center for Ecological Analysis and Synthesis at Santa Barbara, funding that will bring the working group together four times in Santa Barbara over the next two years. The group has expertise in marine ecosystems and statistical analysis and will present a globally coherent picture of the vulnerability of marine systems to climate change. Australians on the working group include UQ's Chris Brown and John Pandolfi, Pippa Moore from Edith Cowan University, Anthony and Elvira, with remaining team members from the US, UK, Denmark, Spain and South Africa. The group's first meeting starts on 15 September.

One outcome will be a marine climate impacts database, and they hope the work will be the basis for contributions to the 5th Intergovernmental Panel on Climate Change Assessment, due for release in 2014. Elvira is presently leading development of the Marine Climate Impacts and Adaptation Report Card and web-based inventory providing a form guide to climate change impacts on the marine environment in the Australian region. The Report Card is due for release in late October.

More information: <http://www.nceas.ucsb.edu/featured/Richardson>

Marine Adaptation Summer School

Applications are now open for Australia's first Marine Climate Change Adaptation Summer School. The Summer School will be a one day event open to no more than 30 honours students, postgraduate students and early career researchers. It will be held on **4 December 2009** at the University of Tasmania

Participants in the Summer School will hear about building resilience of the marine social-ecological system from a variety of social, economic, policy and biophysical perspectives with the aid of case studies.

The Marine Adaptation Network is offering funding for successful applicants to attend the Summer School. To apply to participate in the Summer School, and for a travel bursary, send the following documentation to arnmbr@arnmbr.org :

- Your research interest (half page)
- Your academic transcript/record
- Costing for your budget economy airfares and transfers

Applications for participation/funding close on 9 October 2009.

Industry Grants

The Australian Government is providing grants for Industry organisations (including Fisheries) to increase their industries' self reliance and preparedness to adapt to climate change and climate variability.

FarmReady Industry Grants of up to $80 000 per financial year are available to eligible groups to undertake projects that deliver tangible outcomes and develop strategies to help their members adapt to climate change.

Applications for this round of FarmReady grants close on **30 September 2009.**

For more information on the FarmReady grants program go to <http://www.farmready.gov.au/>.

Rock Lobster Report Release

A new report on the vulnerability and adaptive capacity of Tasmania's east coast rock lobster fishery system to climate change has been released. See <http://www.climatechange.gov.au/publications/index.html#impacts>.

Marine Adaptation Network Partners:

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THEMES

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MAB Editors: Neil Holbrook and Clare Brooker

Featured Theme: Markets article was written by Professor Quentin Grafton.