Implementation Plan for

Climate Change Adaptation Research: Marine Biodiversity and Resources

April 2012

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1. Purpose of Implementation Plan

This Implementation Plan for Marine Biodiversity and Resources (2012) outlines implementation directions for the updated *National Climate Change Adaptation Research Plan for Marine Biodiversity and Resources (2012)* (Marine NARP). It takes account of changes to critical implementation factors for the research priorities identified for NCCARF's marine biodiversity and resources theme: (a) research funding availability and (b) research capacity for climate change adaptation for marine biodiversity and resources.

Since the first Implementation Plan for the original Marine NARP, a joint NCCARF(ARGP)/FRDC research program has commissioned 17 research projects, using about $3,500,000 of Adaptation Research Grants Program (ARGP) funding. The 17 research projects supported by this funding have a total research value of more than $17,000,000 (cash and in-kind). These projects are managed by FRDC and will be reported as they are completed.

Climate change poses significant threats to Australia. The National Climate Change Adaptation Research Facility (NCCARF) has developed nine *National Climate Change Adaptation Research Plans (NARPs)* to identify critical gaps in the information needed to address issues arising from the

impacts of climate change on key theme areas. NARPS outline priorities for research for a 5-7 year period.

The purpose of an Implementation Plan is to define the most effective way to build national investments to address the research priorities identified by a NARP.

The focus is on:

1. delivering research, and the adoption of research outputs, to address the objectives of the research plan,
2. facilitating collaborative arrangements,
3. maximising resources for priority research, and
4. optimising the timing of research investments.

Implementation Plans consider opportunities for implementing research at a specific time, and so are not static documents. NCCARF updates Implementation Plans periodically to ensure that new opportunities are continually identified, developed and harnessed over time.

The focus of an Implementation Plan is on (1) delivering research and the adoption of research outputs to address the objectives of the NARP, (2) facilitating collaborative arrangements, (3) maximising resources for priority research, and (4) optimising the timing of research investments.

Additional opportunities for research investment may arise in this area over the next few years and in a next Phase of NCCARF. This Implementation Plan will be updated periodically to reflect the development of new opportunities.

2. Background

2.1 Australia's Climate and Marine Biodiversity and Resources

Climate change affects marine systems physically, chemically, and biologically. Climate and atmospheric change can affect marine biodiversity and resources directly, as through changes to water temperatures or altered pH. Indirect impacts also occur, such changed water flows from land to estuaries or inshore marine waters caused by changed rainfall pattern over land. These changed biophysical conditions can result in changes to the composition of marine ecosystems, the incursion of weed or invasive species, or the regional loss or reduction of ecologically or economically important species, with far reaching consequences for marine biodiversity, resource management, and the users of the resource.

2.2 The Marine NARP

The Marine NARP (Mapstone et al. 2010) was prepared for NCCARF in 2009 by a team with high expertise in climate change adaptation research and response for marine biodiversity and resources. In 2012 NCCARF revisited the Marine NARP to take account of developments after the original NARP was completed, including:

- research published,
- changes to stakeholder information needs, and
- research commissioned after the NARP was completed.

The revisit process resulted in the preparation of an Update Report (Holbrook et al. 2012) that sets out amendments to the list of priority research questions identified in 2009. The new list of high priority research questions is provided in Appendix 1.

2.3 Preparation of the Implementation Plan

NCCARF has updated the Marine Implementation Plan in 2012 to take account of changes in:

- the capacity of Australian researchers to undertake climate change adaptation research for marine biodiversity and resources and
- the capacity of key potential research funding organisations to invest in research to address the updated research priorities in the marine biodiversity and resources research theme.

Australia has a long history of high-quality research that addresses marine biodiversity and resources, funded by both the public and private sectors. This research provided a good platform for the national focus on climate change adaptation research that resulted from the identification of research priorities in the Marine NARP and research calls under a joint FRDC and DCCEE arrangement (see section 3.1.1).

3. Potential Sources of Research Funding

This section deals with potential sources of research funding to address climate change adaptation for marine biodiversity and resources, including current investment activities and opportunities for collaboration.

3.1 Key changes since 2010

- Seventeen research projects have been commissioned using the Adaptation Research Grants Program (ARGP) funding available for the Marine Biodiversity and Resources theme; this has fully allocated the ARGP funding available for this theme (see Section 3.2).
- All other ARGP funding has also been allocated (see Section 3.3.1).
- Griffith University, NCCARF and DCCEE are investigating options for further research funding for this theme and for an extension of NCCARF (see Section 3.3.1).
- The FRDC is currently considering the extent to which its investment in research about climate change adaptation may increase over the next few years (see Section 3.3.2).
- GBRMPA has identified adaptation to climate change as a primary research need, especially for establishing management responses to bio-physical and socio-economic issues (see Section 3.3.5).

3.2 Current Joint NCCARF (ARGP) / FRDC Research Program

In 2009, the Department of Climate Change and Energy Efficiency (DCCEE) provided $3,500,000 from the Adaptation Research Grants Program (ARGP) funds to support climate change adaptation research that addressed the priority research questions identified in the original Marine NARP, with FRDC managing the research program and communicating it to stakeholders. FRDC augmented the DCCEE (ARGP) funding. From 2011, NCCARF took over DCCEE's involvement in oversighting the management and delivery of this research program; for this reason the program is termed the 'NCCARF(ARGP)/FRDC' research program in this Implementation Plan.

Seventeen research projects have been commissioned under the joint NCCARF(ARGP)/FRDC funding that address the research priorities in the original Marine NARP. Including ARGP, FRDC

and other funding and in-kind from researchers and other parties the total value of this research portfolio is about $17,130,000. The projects are listed in Appendix 2.

All ARGP funds directed to FRDC for this research program have been allocated.

3.3 Australian Government

3.3.1 Department of Climate Change and Energy Efficiency (DCCEE)

As noted in Section 3.2, DCCEE allocated $3,500,000 of ARGP funds for research focussed on the priorities research questions in the original Marine NARP, and all of this funding has been allocated. Nevertheless DCCEE retains an interest in promoting further research into the Marine and other NARP theme areas. All other ARGP funding has been allocated.

Griffith University, NCCARF, the NCCARF Board and DCCEE are looking at options for an extension of NCCARF. No funding for further marine biodiversity research will be available from an extension of the ARGP until decisions are made about the future of NCCARF.

3.3.2 Fisheries Research and Development Corporation (FRDC)

The FRDC was formed as a statutory corporation in 1991 under the provisions of the Primary Industries and Energy Research and Development Act (1989), and is responsible to the Minister of Agriculture, Fisheries and Forestry. The FRDC is a co-funded partnership between the Australian Government and the Australian fisheries and aquaculture industry. It takes an environmental, economic and social approach to management of Australia's marine resources, investing in research, development, and extension.

The FRDC facilitates government and industry investment, and establishes and addresses RD&E priorities by collaborating with stakeholders and key partners. It also invests in the adoption of research outputs and evaluates the benefit of investments.

A National Climate Change Implementation Framework for Fisheries and Aquaculture has been developed in conjunction with the Australian Fisheries Management Forum (comprising the Australian, state, and territory governments), the fisheries and aquaculture sectors, Australian Government Department of Climate Change and Energy Efficiency, NCCARF and the NCCARF Marine Biodiversity and Resources Adaptation Research Network. This framework brings these groups together to understand, prepare, and respond to the challenges and opportunities resulting from climate change, including in relation to research, development, and extension. The framework recognises the *National Climate Change Adaptation Research Plan: Marine Biodiversity and Resources*, and the *National Climate Change Action Plan for Fisheries and Aquaculture* as principal documents to identify and guide priorities.

The Committee meets regularly and guides the direction of research issues associated with research projects, and also identifies possible research funds.

The Committee meets regularly and guides the direction of research, addresses issues associated with research projects, and also identifies possible further research funds.

The FRDC is currently considering the extent to which its investment in this area may increase over the next few years.

3.3.3 Department of Agriculture, Fisheries and Forestry (DAFF)

DAFF is the Australian Government Department with primary carriage of all policy and regulatory matters relating to the Australian fishing industry. The *National Climate Change Action Plan for*

Fisheries and Aquaculture drafted by DAFF on behalf of the Australian Fisheries Management Forum (comprising state, territory and Commonwealth governments) doesn't include funding options past 2012.

3.3.4 Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC)

SEWPaC is the Australian Government Department with prime responsibility for developing and implementing national policy, programs, and legislation to protect and conserve Australia's environment and heritage.

National Environment Research Programs (NERPs)

The National Environmental Research Program (NERP) will provide around $20 million each year for environmental research to improve our capacity to understand, manage and conserve Australia's unique biodiversity and ecosystems through the generation of world-class research, and its delivery to Australian environmental decision-makers and other stakeholders.

On 6 December 2010 the Minister for Sustainability, Environment, Water, Population and Communities announced that five research hubs will be funded by this department under the NERP. Up to $68.5 million in funding over 4 years will be made available to provide first-class science that is essential for sustainably managing Australia's environment.

- NERP Tropical Ecosystems Hub — Science Leader: Dr Peter Doherty, Australian Institute of Marine Science,
- NERP Environmental Decisions Hub — Director: Prof Hugh Possingham, University of Queensland,
- NERP Northern Australia Hub — Director: Prof Michael Douglas, Charles Darwin University,
- NERP Landscapes and Policy Hub — Director: Prof Ted Lefroy, University of Tasmania,
- NERP Marine Biodiversity Hub — Director: Prof Nic Bax, University of Tasmania.

The National Environmental Research Program provides for applied public good research that addresses the programs overall objective to: improve our capacity to understand, manage and conserve Australia's unique biodiversity and ecosystems through the generation of world-class research and its delivery to Australian environmental decision makers and other stakeholders.

It builds on the lessons learned from the Commonwealth Environment Research Facilities (CERF) program, replacing that program and focusing more specifically on biodiversity and improving research delivery to the Australian Government, other end-users and stakeholders.

NERP funding will be allocated for biodiversity research and will deliver information that the Australian Government needs to better inform environmental management, policy and decision making, both in the short-term and into the future. This includes understanding how ecosystems function, monitoring their health, maintaining and building their resilience, using them sustainably, and exploring how to better use markets to protect biodiversity.

The NERP seeks to achieve its objectives by providing around $20 million each year to support applied research that:

- has a strong public-good focus and public-good outcome,
- is end-user focused and addresses the needs of the Australian Government and other stakeholders in developing evidence-based policy and improving management of the Australian environment,

- is highly innovative and aims to achieve world-class research and an international standing in the chosen field of research,
- enhances Australia's environmental research capacity,
- is collaborative and builds critical mass by drawing on multiple disciplines from multiple research institutions to address challenging research questions,
- provides results accessible to government, industry and the community, and
- includes focussing on synthesis and analysis of existing knowledge.

The NERPs do not fund adaptation research specifically, but much of their information and research outcomes will be relevant to climate change adaptation research.

3.3.5 Great Barrier Reef Marine Park Authority (GBRMPA)

The primary focus of GBRMPA is policy and implementation of the management of the reef's resources. It also provides some financial support for research that informs policy and planning. Research is undertaken in collaboration with a range of industry bodies (e.g. tourism and fisheries organisations) and research institutes (e.g. James Cook University). Opportunities exist for GBRMPA to play a strong role in the emerging collaborative research agenda with partners in tropical Australia and overseas.

GBRMPA is currently delivering a 5-year $9 million *Climate Change Action Plan* that has been funded through the Council of Australian Governments (COAG). Funds from the plan have already been committed and research to date is already making a significant contribution to knowledge on the impacts of climate change on coral reef systems. Adaptation to climate change has been identified as a primary research need, especially for establishing management responses to bio-physical and socio-economic issues.

GBRMPA recently released a *Tourism and Climate Change Action Strategy 2009*-2012 that includes monitoring, reporting, and research objectives. It identifies climate change as a major threat to tourism in and around the Great Barrier Reef.

3.3.6 **Caring for our Country**

Caring for our Country is an ongoing Australian Government initiative that seeks to achieve an environment that is healthier, better protected, well managed, resilient and provides essential ecosystem services in a changing climate. Funding in some areas is relevant to the priorities of the Marine NARP. All Caring for Country funds have been allocated in 2012-2013, but further funds are likely to be made available after that time.

3.3.7 Australian Research Council (ARC)

The Australian Research Council (ARC) is a statutory authority within the Australian Government's Industry, Innovation, Science, Research and Tertiary Education (IISRTE) portfolio. The ARC's mission is *to deliver policy and programs that advance Australian research and innovation globally and benefit the community***.**

In seeking to achieve its mission, the ARC supports the highest-quality fundamental and applied research and research training through national competition across all disciplines, with the exception of clinical medicine and dentistry. In addition, the ARC brokers partnerships between researchers and industry, government, community organisations and the international community.

ARC funding programs come under the umbrella of the National Competitive Grants Program. The ARC *Discovery* programs fund individual researchers and projects.

The ARC *Linkage* programs help to broker partnerships between researchers and industry, government and community organisations as well as the international community. The ARC Centres programs build research scale and focus and strengthen major research partnerships and networks.

The ARC Super Science Fellowships have been established to attract and retain outstanding early-career researchers in three key areas: space and astronomy; marine and climate; and future industries. These could have a substantial flow-on effect to national programs and research capacity.

The ERA initiative will assess research quality within Australia's higher education institutions and will give government, industry, business and the wider community assurance of the excellence of research conducted. It will also provide a national stocktake, by research discipline areas, of research strength against international benchmarks.

Opportunities for funding marine and climate research also exist at ARC within the *Centres of Excellence* scheme. Several CoEs are relevant to climate change adaptation and marine biodiversity and resources.

- ARC Centre for Coral Reef Studies (JCU);
    - This CoE is focussed on leading-edge research on the sustainable use and management of coral reefs. While there is alignment with some of the goals of the centre and priorities in the adaptation research plan, the centre is approaching its last year of funding (2012-2013), making it impractical to establish new collaborative links at present.
- ARC Centre for Excellence for Climate System Science (UNSW);
    - The objective of this CoE is to resolve uncertainties in regional climate science to support for impacts and adaptation research, and thereby to deliver economic, social and environmental benefits by improving advice to all levels of Government and the broader community on the scale, speed and timing of regional climate change.
- ARC Centre of Excellence for Environmental Decisions (UQ)
    - The objective of this CoE is to generate the fundamental knowledge and tools needed to make the best use of available resources for conservation and provide new techniques for assessing what resources are required and innovative ways for learning from investment decisions.

3.3.8 Department of Defence

The Department of Defence manages naval port bases and training facilities, and operates fleet units all around the Australian coastline as well as in the exclusive economic zone. Environmental stewardship is an integral part of land and maritime naval operational activity that takes place in areas of ecological sensitivity such as Cockburn Sound and Ningaloo Reef in the Northwest Cape (WA), Sydney Harbour, Jervis Bay and Twofold Bay (NSW), and the Great Barrier Reef and Shoalwater Bay (Qld). No opportunities are evident at present for collaborative research with the Department of Defence to address climate change adaptation and marine system ecology. The NCCARF will continue to explore options.

3.3.9 Other Australian Government Departments

Some other Australian Government Departments, or Divisions within Departments, appear to have either a direct or indirect interest in climate change adaptation for marine biodiversity and resources. The main ones are the Department of Education, Employment and Workplace Relations, Department of Innovation, Industry, Science, Research and Tertiary Education, Department of Resources Energy and Tourism, Australian Maritime Safety Authority, and the Environmental Research Institute of the Supervising Scientist. Opportunities for collaborative funding with these bodies will be explored further by NCCARF in the context of future partnerships in research investment.

3.4 State and Territory Government Organisations

All state governments and the Northern Territory government have departmental administrative arrangements and research capacity in the area of marine biodiversity and resources, covering marine conservation and fisheries resources management.

NCCARF has held discussions with representatives of some state and territory government agencies to explore collaborative arrangements. These discussions have not yet identified opportunities for partnerships at the program level to lever funding towards a national investment portfolio for research in climate change and marine biodiversity and resources. NCCARF will continue to explore possible opportunities with state, territory, and local governments. State-based research organisations are able to respond to research calls with the possibility of attracting some state-based support on a project-by-project basis.

3.5 Private Sector

Great Barrier Reef Foundation

The Great Barrier Reef Foundation funds research that protects and preserves the Great Barrier Reef, particularly in the face of climate change.

The Foundation plays a critical role in strategically engaging the private sector in supporting research that protects and preserves the Reef. The private sector in Australia has an important part to play, adding its resources and voice to the quest to protect and preserve the Great Barrier Reef.

Through its growing project portfolio, the Great Barrier Reef Foundation provides ‘a way in’ for business and philanthropy to invest in the Reef’s future. Working in partnership with business, government and philanthropy, the Great Barrier Reef Foundation promotes a strategic, collaborative and coordinated approach to Reef research and increases the pool of funding available to investigate and address the threats to the Great Barrier Reef.

With its business-focused Board, the Foundation is uniquely positioned to understand the drivers for business engagement in scientific research on the Reef.

Recognising that no one group alone could solve the climate change challenges facing coral reefs, and that such a challenge required leadership and a strong drive for innovation, the Foundation convened experts from its network to develop a Portfolio of research addressing a vision of “resilient coral reefs, successfully adapting to climate change”.

This research Portfolio comprises three priority groupings: Attributes, Solutions and Adaptation and Integration.

The Portfolio begins with the attributes of a resilient Reef successfully adapting to climate change.

Understanding what constitutes a reef resilient to climate change and how it can be measured and communicated will provide the baseline and metrics for managers, policy makers and users confronting an ecosystem put directly at risk by climate change. Attributes projects extend across two streams, core coral reef systems and socio-economic systems.

In parallel, the Portfolio develops a suite of solutions and adaptation options which, once researched, could allow more of the Reef to adapt and survive, buying time until mitigation measures take effect. Solutions & adaptation projects address two streams of work:

- Ecological and physical solutions & adaptation strategies which seek to minimise the effects of increasing water temperature and ocean acidification, and assist ecological communities to adapt.
- Enabling strategies which address industry, community and management capacity to adapt to climate change and to adopt solutions.

Integration projects bring together the learnings and outcomes from the other research streams, minimising risk of divergence and unintended consequences. Integration activities focus on the development of integration tools and technologies to provide the critical decision support framework for management and policy makers as the effects of climate change are felt more deeply.

A wide range of peak bodies for industry sectors, non-government organisations and advisory bodies are increasingly becoming more aware of the implications of the need to adapt to extreme weather and changing climatic conditions.

Peak bodies represent the interests of producers of both specific fisheries resources such as finfish, shellfish and salmonid aquaculture, and broader sectoral interests. These bodies include the Commonwealth Fisheries Association, Recfish Australia, and the National Aquaculture Council. They also cover the interests of maritime operators (e.g. the Australian Association of Port and Marine Authorities) and offshore oil and gas producers (e.g. Australian Petroleum Production and Exploration Association).

Conservation interests are represented by bodies such as OceanWatch Australia and World Wildlife Fund. Advisory bodies in the field include Oceans Policy Science Advisory Group, and the Fisheries Research Advisory Bodies.

Collectively, these and similar bodies demonstrate that there is a diverse range of potential players who could influence the emerging research agenda and point out pathways for innovative funding arrangements. The NCCARF will continue to explore these for future funding opportunities.

3.6 International

There are a range of international organisations that could interface with research in Australia to address the research priorities in the adaptation research plan. While no immediate opportunities for program-to-program collaboration have been identified with these organisations, opportunities remain for scientific exchange and collaboration on a project-to-project basis. Some examples are listed below:

- World Bank - previously funded coral research and is now moving into climate change,
- Nippon Foundation - looking to develop initiatives on climate change with a focus on the Pacific Islands,
- United Nation Environment Program (UNEP) - revamping its marine program,
- Asia Development Bank - Australia has membership,

- National Ocean and Atmosphere Administration (NOAA) - has a new coral policy and is looking at climate change,
- AustralianAid - focuses on in-country climate change adaptation research capacity building,
- International Climate Change Adaptation Initiative for the Pacific and SE Asia,
- Australian Centre for International Agricultural Research, and
- Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security - multi-national initiative.

In September 2009, the US Administration released the Interim Report of the Interagency Ocean Policy Task Force, describing a comprehensive and ecosystem based approach to the management of marine resources. This includes strengthening the abilities of coastal communities and marine environments to adapt to climate change. The report calls for substantial funding investment and describes the need for research to inform decision making. The NCCARF will explore collaborative opportunities through existing and possibly new climate change initiatives between Australia and the US, as the US program develops.

4. Potential Sources of Research Delivery

4.1 Key changes since 2010

- AIMS is a major player in the marine biodiversity and resources area and is keen to explore additional collaborative work with partners to address the research priorities in the Marine NARP (see Section 4.4).
- The ACE CRC was extended to 2014 (see Section 4.9.1), with a research plan that covers four key areas, including:
    - Changes in the southern ocean's temperature and currents, and
    - Impacts of changes on southern ocean ecosystems.
- The membership of the Adaptation Research Network for Marine Biodiversity and Resources has increased from about 300 members to about 750 members and now comprises almost equal membership of research providers and research users (see Section 4.10).

4.2 Background

Australia has a long history of research into marine ecology, biodiversity, natural resource management, fisheries, and aquaculture. More recently, there is a growing body of research and understanding of the effect of climate change on Australia's marine environment. Research includes a focus on selected geographic locations (especially the Great Barrier Reef, the North West Shelf and Tasmanian East Coast). Research has included relatively focussed and impact-related questions such as coral reef bleaching, fisheries recruitment, effects of ocean acidification and impacts of flooding on near-shore environments. Agencies with an existing focus on marine research provide a strong research platform to address the priorities in the adaptation research plan within a collaborative approach to ecosystem based management.

This section describes some of the main research organisations that have been and may continue to be involved in implementing the adaptation research plan. In many cases, these research organisations have access to resources that might be used to assist with funding the research.

4.3 Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Two key initiatives in CSIRO are directly relevant to delivery of the research priorities in the adaptation research plan - the *Climate Adaptation Flagship* and the *Wealth from Oceans Flagship*. These flagships support research within CSIRO that are applicable to the research plan, delivering both targeted information and underpinning knowledge that contribute to a better understanding of marine biodiversity and resources.

CSIRO considers partnerships in research investment on a case-by-case basis depending on the mutual alignment of interests. Examples include long-term partnerships in Cooperative Research Centres (CRCs) and other research ventures where the prospects of end-user engagement and research effectiveness are likely to be increased by partnering. CSIRO is not a funding agency *per se* but does co-invest from time to time when there are distinct opportunities to align its research interests with those of partner organisations.

CSIRO led the development of a National *Marine Climate Change in Australia: Impacts and Adaptation Responses 2009 Report Card* (Report Card of Marine Climate Change for Australia (2009) Eds. E.S. Poloczanska, A.J. Hobday and A.J. Richardson, NCCARF Publication 05/09), that included recommendations for enhancing climate change adaptation – we note here that a Second Marine Report Card will be released in 2012. It followed an earlier report on *Climate Change Impacts for Australian Marine Life.* Collectively, these efforts showed the need for more applied research on marine biodiversity and fisheries resources.

4.4 Centre for Australian Weather and Climate Research (CAWCR)

The Centre for Australian Weather and Climate Research is a partnership between Australia's leading atmospheric and oceanographic research agencies - the Bureau of Meteorology and CSIRO. The centre was established in 2007 to ensure that Australia remains a world leader in climate, weather and oceans research so that it can meet the severe weather and climatic challenges that continue to confront the nation. The centre has five research programs:

- Atmosphere-Land Observation and Assessment;
- Climate Variability and Change;
- Earth System Modelling;
- Ocean Observation Assessment and Prediction; and
- Weather and Environmental Prediction.

These research activities will improve observational databases, improve understanding of observed climate variability, and deliver climate predictions (seasonal to decadal) for use in risk assessments. Improved accuracy and resolution of the prediction of future climate are particularly relevant to management of marine biodiversity and resources.

CAWCR could provide contextual climate change information to underpin research projects that address priorities in the adaptation research plan, in particular outputs from the physical models used to make future climate projections.

4.5 Geoscience Australia

Geoscience Australia (GA) is a prescribed agency within the Australian Government Department of Resources, Energy and Tourism. Geoscience Australia's Marine and Coastal Environment Group provides the Australian Government with geoscientific advice and products to help it meet its objectives for implementation of Australia's Oceans Policy within Australia’s Exclusive Economic Zone., including development of fundamental data and information products that are needed for climate change adaptation and the assessment of community safety issues such as natural hazard risk.

The Marine and Coastal Environment Group (MCEG) provides the Australian Government with geoscientific advice and products to inform management and regulation of Australia's marine jurisdiction.

A major focus of the MCEG is to generate scientifically rigorous geoscience products which have application to the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*, the *Seas and Submerged Lands Act 1973*, the *Environmental Protection and Biodiversity Conservation Act 1999*, and the Antarctic Treaty System. In addition, MCEG research supports the National Co-operative Approach to Integrated Coastal Zone Management – Framework and Implementation Plan.

The MCEG has the following functions within Government:

- Support environmental regulation of Australia's offshore oil and gas industry
- Support management of Australia's National Representative System of Marine Protected Areas
- Maintain the regulatory spatial framework for Australia's marine jurisdiction
- Support Australia's Antarctic interests
- Take stewardship of Australia's marine and coastal geoscience-related data and information
- Provide logistical and technical support for Geoscience Australia science programmes.

The group provides advice to the Australian Government and industry in the form of maps and associated reports and research publications that document indicative regional spatial patterns of seafloor physical characteristics and associated biodiversity. The MCEG also maintains and co-ordinates delivery of coastal and marine data and information through two online web portals: the Australian Marine Spatial Information System and OzCoasts, and Australia's marine samples database – MARS.

The group also represents Australia in the United Nations Global Reporting and Assessment of the State of the Marine Environment and has membership to the United Nations Commission on the Limits of the Continental Shelf.

Within Geoscience Australia the group supports many other activities through the provision of technical advice and completion of shared science programmes on topics such as offshore petroleum prospectivity, climate change and groundwater

GA's Risk & Impact Analysis Group develops risk assessment models, tools and databases to assess the risk to a range of natural and human-caused hazards. Climate-related hazards of interest include tropical cyclone, storm surge, flood, landslide and coastal erosion. An example of climate change adaptation research is the assessment of physical and socio-economic vulnerability of coastal systems and communities to the consequences of sea-level rise and potential changes in storm frequencies and magnitudes.

GA's research and policy advice is done in large part through the agency's appropriated budget, and through collaborative or co-funded projects with the Australian, state and local governments, CRCs, universities, and industry partnerships. GA seeks partnerships to develop, maintain, and value-add to geoscience information to inform government policy and the public in the national interest. GA is not a funding agency, but does co-invest in areas of interest to the Resources, Energy and Tourism portfolio, including marine resources where geoscience information is required.

4.6 Australian Institute of Marine Science (AIMS)

AIMS is Australia's major tropical research institute based in Townsville with research facilities also in Darwin and Perth.

The institute maintains and operates fixed ocean and air-sea interface monitoring equipment and research craft – deployed to monitor the marine ecosystems of the Great Barrier Reef (for more than 20 years) and the North West Shelf of WA (>15 years). Climate change is now a major research focus with projects addressing the impacts of climate change on reef micro-biology, coral reef bleaching and ocean acidification. The institute is establishing an Australian Tropical Oceans Simulator (ATOS) that will allow controlled experiments to reflect climate change impacts and ecosystem perturbations under range of short and long term environmental conditions.

The Australian Coral Core Archive is also maintained by AIMS as a record of environmental change that can be re-interpreted as knowledge expands and new theories arise. As a major player in the marine biodiversity and resources area, AIMS is keen to explore additional collaborative work with partners to address the research priorities in the adaptation research plan.

4.7 Australian Ocean Data Centre Joint Facility

The Australian Ocean Data Centre Joint Facility (AODCJF) provides a whole-of-government approach to ocean data management. It aims to develop a national multi-agency data management system to manage the ocean data resources of partner agencies through a distributed network. It is a joint venture between six Australian Government marine data agencies - Australian Institute of Marine Science (AIMS), Australian Antarctic Division (AAD), Bureau of Meteorology (BOM), CSIRO Marine and Atmospheric Research (CMAR), Geoscience Australia (GA) and Department of Defence (RAN Directorate of Oceanography and Meteorology).

The Facility provides an accessible source of information for any new research initiative addressing the priorities in the adaptation research plan. Information stemming from new research will be able to be placed within the Facility. It is unlikely that the Facility, itself, would undertake new research addressing the priorities.

4.8 Integrated Marine Observing System (IMOS)

Australia's Integrated Marine Observing System (IMOS) was established in 2007 under the National Collaborative Research Infrastructure Strategy (NCRIS. It has successfully deployed a range of observing equipment in the oceans around Australia, and is making all of the data freely and openly available through the IMOS Ocean Portal for the benefit of Australian marine and climate science as a whole.

With the injection of additional funds from the Education Investment Fund (EIF) in 2009, and with further co-investment, IMOS will be extended out to mid-2013 and enhance its monitoring in the Southern Ocean and northern Australian waters.

IMOS is designed to be a fully-integrated, national system, observing at ocean-basin and regional scales, and covering physical, chemical and biological variables.

IMOS provides a valuable resource to underpin the building of the research effort across Australia to address the priorities in the adaptation research plan.

4.9 Cooperative Research Centres (CRCs)

Cooperative Research Centres (CRCs) bring together researchers from universities, CSIRO, other Australian and state government research organisations, private industry, and/or public sector agencies in long-term collaborative research arrangements. CRCs are funded to support research, development, and education activities to achieve real outcomes of national economic and social importance.

4.9.1 CRC for Antarctic Climate and Ecosystems (ACE CRC)

ACE CRC leads Australia's effort to understand the roles of Antarctica and the southern ocean in the global climate system and climate change. It is a joint venture between Australian Antarctic Division, CSIRO Marine and Atmospheric Research, the Commonwealth Bureau of Meteorology, and the University of Tasmania as its core partners. There is an extensive range of contributing support partners from Australia and overseas.

The ACE CRC was extended to 2014, with a research plan that covers four key areas:

- Antarctica's ice sheets and the surrounding sea ice
- Changes in the southern ocean's temperature and currents
- Role of the southern ocean in storing carbon
- Impacts of changes on southern ocean ecosystems.

The ACE CRC is well positioned to play a strong role in building and delivering the national research agenda addressing the priorities in the adaptation research plan.

4.9.2 Australian Seafood CRC

The Australian Seafood CRC's research centres on the seafood value chain from wild harvest or from aquaculture production, including genetic and wild harvest management strategies.

4.10 Universities

Universities employ researchers with wide ranging capabilities for research across disciplines relevant to marine biodiversity and resources - from highly theoretical approaches which challenge the ways we frame problems through to practical problem solving.

There is also the opportunity for large groups of researchers across universities to tackle complex multi-faceted problems. Universities generally welcome partnership arrangements such as those with CRCs, other research groups (including those overseas) and agencies, but need to consider carefully costs and benefits on a case-by-case basis.

4.11 The NCCARF Adaptation Research Network for Marine Biodiversity and Resources

The NCCARF Adaptation Research Network for Marine Biodiversity and Resources, hosted by the University of Tasmania, has more than 750 members from universities, government, other research institutions, NRM agencies, conservation groups, and industry. Collectively, the Network membership have access to a wide range of field and laboratory research facilities, and have knowledge of the pathways to public and private sector research investment funds. Direct cash investment is unlikely to be secured through these sources, but in-kind research time may be possible.

4.12 Regional or Strategic Partnerships

Currently there are a number of regional partnerships between universities, state, and national agencies with research interests in the climate change dimensions of marine biodiversity, conservation management (parks, reserves, and species), fisheries and aquaculture.

These are illustrated by the Sydney Institute of Marine Science, the Victorian Marine Science Consortium, the ARC Centre of Excellence for Coral Reef Studies (based at James Cook University)., the Western Australian Marine Science Institute, the Arafura Timor Research Facility, the Australian Maritime Hydrodynamics Research Centre, and Institute for Marine and Antarctic Studies (based at the University of Tasmania).

The geographic spread of these partner groups provides a rich resource to address national-scale research questions in marine biodiversity and resources. Many already have cross-institutional arrangements, and many of the researchers in these partner groups are active members of the NCCARF Climate Change Adaptation Research Network for Marine Biodiversity and Resources.

These partnerships are also highly successful at leveraging research investment – working across state and local governments, and stakeholder communities. A number of these partnerships have expressed keen desire to connect into the national research agenda and work with NCCARF in the delivery of the adaptation research plan.

5. Strategy for National Coordination

There is a broad recognition that adaptation to climate change will become an increasingly important factor in government, industry, business and community planning and decision-making. A significant amount of research has been commissioned since the original Marine NARP was completed and is now being undertaken. Much of the research into areas identified as high priority in the Marine NARP has been funded through the partnership between DCCEE (ARGP) and FRDC (see Section 3.1 and Appendix 2). Research is also being funded and / or conducted by a variety of other providers (e.g., ARC), research organisations (e.g., AIMS), and Commonwealth and State Agencies.

5.1 Immediate Investment (2012-2013)

NCCARF has undertaken a range of activities to formulate this Implementation Plan, including interviews with prospective research partners and meetings with key players.

The Australian Government's *Climate Change Adaptation Research Grants Program (ARGP)* funding is now fully allocated. No further funding for climate change adaptation research is currently available from this source during the present Phase of NCCARF. Further program level research funding into marine climate change adaptation will need to be sourced elsewhere.

Some Australian Government Departments have an interest in climate change adaptation research for marine biodiversity and resources. However, no Departments appear to be in a position to invest now at the program level in research to address the priorities in the Marine NARP. Nevertheless, NCCARF will continue to discuss potential immediate investment opportunities with a range of Australian Government Departments.

The ARC has regular calls for research, including research relating to climate change adaptation. There is every reason to presume that sound research proposals are likely to be successful.

AIMS, CSIRO and CRCs undertake research relevant to the Marine NARP research priorities; collaboration may be possible with these organisations. NCCARF will continue to investigate with these and other research investors options for developing coordinated research programs that will advance Australia's climate change adaptation knowledge base for the marine biodiversity and resources theme.

NCCARF is also developing an on-line hyperlinked source-page of potential climate change adaptation funding sources available to Australian researchers. When this page is live it will be announced at www.nccarf.edu.au and all Adaptation Research Network members will be advised.

The NCCARF Climate Change Adaptation Research Network for Marine Biodiversity and Resources (hosted by the University of Tasmania) is well placed to work with NCCARF to build research consortia and investigate the availability of additional resources for new research programs.

5.2 Building future programs

A next Phase of NCCARF is being proposed to commence from 2013. NCCARF is seeking to establish a new round of core funding for further climate change adaptation research, with additional funds available for the marine biodiversity and resources theme.

NCCARF will continue to investigate with all potential research investors how further coordinated research programs could be developed to advance Australia's capacity to respond effectively to climate change adaptation challenges and opportunities.

The NCCARF Adaptation Research Network for Marine Biodiversity and Resources will continue to monitor the interests of stakeholders with a view to developing and enhancing opportunities for research investment and collaboration. It is also enhancing international links of individual members of the network through its International Visiting Professor Program.

6. Impediments and Risks

6.1 Impediments

The capacity of Australia's relatively small research community has grown during the 2009 – 2012 period and is now more focussed on and experienced with climate change adaptation research than it was when the original Marine NARP was completed in 2009. Nevertheless, the challenges of building and delivering a national research program to address the priorities in the Marine NARP will require several research phases.

Implementing the research agenda will therefore take time. A key focus will need to be on increasing the size of the research funding directed to this research agenda – across a wide variety of organisations and stakeholder groups - while at the same time utilizing the resources available immediately for carefully targeted and effective research. The Adaptation Research Network for Marine Biodiversity and Resources will play a prime role in building the research agenda and reducing risks in program implementation.

6.2 Risks

Total research value of the NCCARF (ARGP) / FRDC research projects relevant to the research priorities in the Marine NARP comprises $3,500,000 of ARGP funds, and a total research value of about $17,130,000 (cash and in-kind). NCCARF must collaborate closely with the FRDC and other relevant organisations to ensure that the outcomes from the research are managed and communicated so that decisions about climate change adaptation concerning marine biodiversity and resource are able to effectively use the information generated by this research program**.**

7. Monitoring

NCCARF will work with the Adaptation Research Network for Marine Biodiversity and Resources to track research being conducted across Australia that implements the adaptation research plan. NCCARF together with the National Coordinating Committee, will monitor the progress of research commissioned through the research call in order to identify emerging gaps and research needs. It will also maintain continuing dialogue with key stakeholders and the research community.

The Marine NARP and Implementation Plan will be updated periodically to take account of changes in the information base available, current research being undertaken and changes in stakeholder information needs. NCCARF, through a dedicated research program, also synthesises research outcomes as these evolve.

NCCARF undertakes a yearly survey of stakeholders which obtains feedback about a variety of issues including stakeholder engagement in projects and the delivery of useful information to end users.

8. References

Holbrook NJ, Creighton C, Robertson J, Vu H and McKellar R (2012), National Climate Change Adaptation Research Plan: Marine Biodiversity and Resources - Update 2012, *National Climate Change Adaptation Research Facility*, Gold Coast.

Mapstone B, Appleford P, Broderick K, Connolly R, Higgins J, Hobday A, Hughes T, Marshall P, MacDonald J, Wascha M (2010) National Climate Climate Change Adaptation Research Plan for Marine Biodiversity and Resources, *National Climate Change Adaptation Research Facility*, Gold Coast.

Appendix 1

Priorities for research in the *National Climate Change Adaptation Research Plan: Marine Biodiversity and Resources - Update (2012).*

High priority research questions (2012)
1. Aquaculture
1.3 What are the likely policy changes driven by climate change that will affect aquaculture businesses either directly through changes in access to suitable locations, and natural resources such as freshwater or marine-based feeds or indirectly because of changes in harvest marine policies, affecting feed supplies or non-marine climate adaptation and mitigation policies?
1.5 What options are there for businesses to adapt to climate change effects either by minimising adverse impacts or taking advantage of opportunities? What are the facilitators and barriers to implementing such changes and how might they be managed for effective adaptation outcomes?
2. Commercial and recreational fishing
2.5 What options or opportunities are there for commercial fishers in identified vulnerable fisheries to adapt to climate change effects through changing target species, capture methods and management regime, or industry diversification, relocation or divestment? What are the enablers and barriers to fishers implementing adaptation options?
2.6 What options or opportunities exist or might become available for recreational fishers in identified vulnerable fisheries to adapt to climate change effects through changing target species or preferred fishing method or travelling to pursue their preferred target species or method? What are the enablers and barriers to fishers implementing adaptation options?
2.7How have enablers to adaptation been used and barriers to adaptation been overcome? What significant changes in fisheries have occurred before because of extrinsic factors and what can be learned from those changes that will inform adaptation to climate change?
3. Conservation management
3.1 Which ecosystems and species of conservation priority most require adaptation management and supporting research, based on their status, value, vulnerability to climate change and the feasibility of adaptive responses? What adaptation management frameworks and tools will identify vulnerable species and habitats within ecosystems, and how can these approaches build adaptive capacity and/ or resilience?
3.4 How should conservation managers and planners adapt their practices to alleviate climate change risks and enhance adaptation options? What intervention strategies will increase system resilience and increase the time within which biological systems are given the opportunity to adjust to a future climate?
4. Tourism and recreational uses
4.4 What is the adaptive capacity of the marine tourism industry and how can it be enhanced to cope with climate change impacts?
5. Cross-cutting issues
5.1 What are the key interactions across sectors, cumulative impacts and cross-jurisdictional issues that will affect the development of adaptation strategies in each sector and how can these cross- and multi-sectoral issues best be addressed?
5.2 What are the most appropriate techniques for preserving estuarine systems in the face of climate change?
5.3 How can land-based climate change adaptation decisions be developed and implemented to also support adaptation for marine water quality and marine resources and biodiversity, including aquaculture, fisheries, conservation and tourism, taking account of multiple stressors, the cumulative pressures of co-occurring factors and flow-on effects for industries and ecosystem health?

APPENDIX 2
Current NCCARF (ARGP) / FRDC Research for Marine Biodiversity and Resources

Project Title	Lead Organisation	Lead Investigator
Management implications of climate change impacts on fisheries resources of tropical Australia	**James Cook University**	**David Welch**
The aims of this project are to: Describe the projected climate-driven changes that are relevant to northern Australian marine fisheries; Assess the potential impacts of climate change on key fisheries and species in northern Australia; and Assess current management to identify approaches that are adaptive to potential climate change scenarios.		
Pre-adapting a Tasmanian coastal ecosystem to ongoing climate change through reintroduction of a locally extinct species	**University of Tasmania**	**Nicholas Bax**
The aims of this project are to: Develop and promote a national framework to evaluate potential translocations of native marine species; Determine the feasibility of reintroducing blue groper as a test case; Design a monitoring and evaluation program to determine the effects of a trial re-introduction; and Reach the critical decision point on whether to re-establish blue groper in Tasmania, or to take an alternative approach indicated by the research. Develop a proposal to support this outcome.		
Effects of climate change on reproduction, larval development and population growth of coral trout	**James Cook University**	**Morgan Pratchett**
The aims of this project are to: assess sensitivities of coral trout to climate-related changes in temperature and seawater chemistry, during fertilisation and early larval development; test the effects of increasing temperature and ocean acidification on growth, condition, behaviour and survivorship of early post-settlement coral trout; test for spatial variation in sensitivities to increasing temperatures for coral trout in three distinct sectors along the Great Barrier Reef; and measure coral-dependence at different ontogenetic stages, to test whether coral trout will be adversely affected by climate-induced bleaching and coral loss.		
Beach and surf tourism and recreation in Australia: vulnerability and adaptation	**Bond University**	**Mike Raybould**
The aims of this project are to: an LGA/site scale identification and assessment of the vulnerability to climate change of assets that are key drivers of marine and coastal tourism and recreation; the valuation of existing income streams due to beach-related tourism and recreation in case study locations; an application of valuation tool (developed in previous stage) in identified seachange localities to test transferability of results; to identify social and behavioural responses to climate change impacts on vulnerable tourism and recreation assets; and to report on the net vulnerability of regional locations to climate change.		

Project Title	Lead Organisation	Lead Investigator
A climate change adaptation blueprint for coastal regional communities.	**University of Tasmania & CSIRO**	**Stewart Frusher & Nadine Marshall**
The aims of this project is to develop the tools that provide the relevant information to reduce risks and increase capacity to cope with, and benefit from change is urgently needed for coastal regional communities.		
Adaptive management of temperate reefs to minimise effects of climate change: developing effective approaches for ecological monitoring and predictive modelling	**University of Tasmania**	**Neville Barrett**
The aims of this project are to: Collate and analyse the long-term ecological records for SE Australian reefs and develop quantitative relationships between species distributions and abundances and key physical processes; Identify optimal locations and species for monitoring programs to best inform adaptive management via delivery of up-to-date relevant information on change; Assess the costs and benefits of existing temperate MPAs for biodiversity conservation management in response to climate change; and Develop models that quantify and predict the impacts of climate change on inshore reef fishes, invertebrates and macroalgae so potential management responses can be identified, considered and developed appropriately.		
Management implications of climate change effects on fisheries in Western Australia	**WA Fisheries and Marine Research Laboratories**	**Nick Caputi**
The aims of this project are to: Assess future climate change effects on Western Australia marine environments using a suite of IPCC model projections, downscaled to the key shelf regions and the spatial and temporal scales relevant for key fisheries; Examine the modeled shelf climate change scenarios on fisheries and implications of historic and future climate change effects; and Review management arrangements to examine their robustness to possible effects of climate change.		
Ensuring that the Australian oyster industry adapts to a changing climate: a natural resource and industry spatial information portal for knowledge action and informed adaptation frameworks.	**University of Woollongong**	**Andrew Davis**
The aims of this project are to: To source and review spatially referenced data for relevance to the oyster industry and its response to natural resource management and climate change, and align primary and meta-data standards; To engage the oyster industry in developing the content style and delivery of natural resource and industry information in an online portal, including industry sourced data from Quality Assurance Programs and Environmental Management Strategies; To deliver a pilot, online, spatially-referenced, natural resource and industry information portal, making use of extensive primary data sources, meta-data standards and national spatial data delivery initiatives; and Identify pathways for the spatial information portal to inform governance and statutory authorities (e.g. NRM, State and LGA), monitoring programs, strategies (e.g. oyster industry and NRM strategies), planning policies (e.g. development application processes).		

Project Title	Lead Organisation	Lead Investigator
Human adaptation options to increase resilience of conservation-dependent seabirds and marine mammals impacted by climate change	**CSIRO**	**Alistair Hobday**
The aims of this project are to: Connect researchers, managers and policy makers, to focus on climate-ready monitoring and adaptation options for conservation-dependent seabirds and marine mammals; Link ongoing monitoring programs around Australia for seabirds and marine mammals with relevant wildlife and conservation management agencies; Extract climate signals for selected time series around Australia using cutting-edge statistical approaches; Develop protocols for monitoring impacts of environmental variation on indicator species and develop an indicator suite of spatial and temporal metrics for climate change impacts; Combine the indicator metrics to develop multi-species productivity indicators for Australian regions; and Provide practical adaptation guidelines for science and management, including on-ground monitoring protocols.		
Changing currents in marine biodiversity governance and management responding to climate change	**University of Tasmania**	**Michael Lockwood**
The aims of this project are to: identify the requirements for adaptive marine biodiversity conservation governance and management in the context of climate change; assess how well current regimes, with a particular focus on marine protected areas, meet these requirements, and determine any necessary changes; identify alternatives to current regimes that are likely to enhance adaptivity and assess their governance and management effectiveness; and offer advice to governance and management authorities on how regime reform might be achieved.		
Identification of climate-driven species shifts and adaptation options for recreational fishers: learning general lessons from a data rich case	**CSIRO**	**Daniel Gledhill**
The aims of this project are to: Determine changes in distributions of rocky reef fish in eastern Australia over the past four decades, and establish correlation of these changes to climate induced environmental change (e.g. temperature); Determine perceptions of the test group regarding climate-induced changes to fish distributions and abundance and identify adaptation options; and Develop and test a “process model” for engagement and development of climate change adaptation options suitable for deployment to other fishing sectors and user groups, including commercial fishers.		

Project Title	Lead Organisation	Lead Investigator
Vulnerability of an iconic Australian finfish (Barramundi, *Lates calcarifer*) and related industries to altered climate across tropical Australia	**James Cook University**	**Dean Jerry**
The aims of this project are to: Define current thermal tolerances and associated physiological/energetic consequences of thermal adaptation in genetically divergent barramundi stocks across tropical Australia; Develop predictive models incorporating new physiological and genetic data with available population genetic, environmental and fisheries data to identify vulnerable wild stocks and associated stakeholders under realistic climate change predictions. Opportunities for expansion of fisheries and aquaculture will be determined; Establish genetic basis of thermal tolerance differences through identification of candidate thermal tolerance related genes within functionally/genetically divergent stocks. These candidate genes can be used as biomarkers for the aquaculture industry in the identification of fish with genetic tolerance to thermal stress; and Quantify parasite impacts on sea-cage barramundi under different temperature, pH and salinity and develop adaptive management strategies to minimize impacts under altered climate change scenarios.		
Adapting to the effects of climate change on Australia's deep marine reserves	**CSIRO**	**Ron Thresher**
The aims of this project are to: develop practical options for DEWHA to manage the impacts of climate change on the South-east Commonwealth Marine Reserve; and develop a generic model that can be applied to forecasting the impacts of climate change on other deep sea biota		
Climate change adaptation - building community and industry knowledge	**WA Marine Science Institution**	**Jenny Shaw**
Foster climate change understanding and knowledge development in 3 coastal regions, in both community and marine-related industries. [Project builds on and helps disseminate all relevant research projects to these coastal regions and supports the Community Blueprint Project (2010/542).		
Preparing fisheries for climate change: identifying adaptation options for four key fisheries in South Eastern Australia	**University of Tasmania**	**Gretta Pecl**
This project will provide the scientific information on the likely effects of climate change on rock lobster, abalone, blue grenadier and snapper that is needed (see National Climate Change Action Plan) to ensure that: 1) stock assessment procedures and harvest strategies can be established that perform effectively under predicted scenarios; 2) management arrangements can be refined to allow the profitability of commercial fisheries and participation in recreational fisheries to be maximised and 3) monitoring systems can be established that are suitable for measuring the likely impacts of climate change and other drivers on these key species.		

Project Title	Lead Organisation	Lead Investigator
Estuarine and nearshore ecosystems – assessing alternative adaptive management strategies for the management of estuarine and coastal ecosystems	**James Cook University**	**Marcus Sheaves**
The project focuses on developing and assessing adaptation strategies for estuaries and other coastal ecosystems to optimise ecosystem functions, fisheries outcomes and biodiversity values in a changing world. The aim is to develop strategies and tools to facilitate management that are sensitive to (a) regional and typological differences, (b) the inherently complex nature of estuary ecology the features a complexly interacting mosaic of interacting habitats where biological connectivity is a key attribute, (c) the far reaching implications of estuary adaptation strategies for the full spectrum of services and values connectivity to other stuff and (d) the competing needs, scales of influence, impacts, outcomes, consequences and costs across the spectrum of sectors affected by Climate Change and adaptation responses (policy, management, environment, social, urban, financial, industry etc.). The project will take knowledge feeds from complimentary NARP projects and all other relevant sources and value add by integrating available inputs and knowledge to develop meaningful adaptation strategies, decision frameworks, policy options and decision tools. It will also exchange information and ideas with other projects to maximise joint outcomes for climate change adaptation. The project recognises the key role of connectivity in estuary ecology, support for fisheries stocks, transmitting impacts to other biological and anthropogenic systems and values. Understanding and recognising the connectivities in systems is intrinsic to managing them. Consequently, a key focus is on how adaptation can be optimised in estuarine/coastal ecosystems that feature complex mosaics of interconnected habitats, and in which maintaining connectivities is often as important as protecting individual habitat units, and how adaptation strategies interact with the other components connected system. The project also recognises the complex spatial and conceptual framework in which estuary adaptation is set, and the need to evaluate issues of scale. These issues include region differences in impact nature and intensity; typological differences among estuaries; the extent of the match or mismatch between process, planning, management, impact and outcome; the differing needs of the various stakeholders; and the profitability of management of individual estuaries in a space-based context (the traditional approach) versus a systems-based approach focused on optimising outcomes for particular estuary types, assemblages and functions.		
Growth opportunities & critical elements in the value chain for wild fisheries & aquaculture in a changing climate	**CSIRO**	**Alistair Hobday**
Development of realistic adaptation management and policy options to enhance cost-effectiveness along the supply chain. Generate targeted recommendations in relation to efficiencies and reduction of the carbon footprint.		