A National Approach to Addressing Marine Biodiversity Decline –

Report to the Natural Resource Management Ministerial Council

Marine Biodiversity Decline Working Group

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This document does not represent government policy. It was prepared by the Marine Biodiversity Decline Working Group under the Marine and Coastal Committee of the Natural Resource Management Ministerial Council. The views here do not necessarily reflect those for the governments represented on the Working Group.

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Executive summary

Over recent decades, all governments with responsibilities for Australia's marine jurisdiction have been working to limit the loss of marine biodiversity. Longstanding strategies and programs are in place across all jurisdictions that are concerned with conservation specifically or with the ecological sustainability of marine industry sectors.

Despite limitations in the knowledge of what exists, its current condition and pressures, observations of significant decline in some marine species in some areas lead to the conclusion that Australia's marine biodiversity and ecosystems are in a state of continuing decline. The effects of a number of threatening processes are resulting in declines in habitats, changes in ecosystems and loss of species.

The time is right to consider progress, policy directions and the effectiveness of program delivery. There is an opportunity now to review the effectiveness of, and seek improvements in, efforts to minimise future degradation.

At the request of Ministers, a Working Group was established to identify the threats and causes of marine biodiversity decline and to identify high-level gaps in information. The Working Group has also reviewed the current responses to the threats and challenges to the effective management of marine biodiversity. In considering a future national approach to managing biodiversity, key policy directions and priority actions for responses to threats have been proposed.

The Working Group has identified the five most significant, broad-scale threats to marine biodiversity, where existing responses should be enhanced and where national-scale attention is required for new actions. The five threats are: climate change, resource use, land-based impacts, marine biosecurity and marine pollution.

Response to these threats could be significantly enhanced with better coordination of responses across jurisdictions. Improving our understanding of the current condition of marine biodiversity and addressing knowledge gaps in a strategic manner would also enhance our capacity to respond to these threats.

As part of a national approach, eight key policy directions have been suggested to minimise threats to marine biodiversity, and to improve coordination and the capacity of governments to understand and respond to marine biodiversity decline. Implementing a national approach would result in better management of key threats to marine biodiversity, and through that reduce further losses, increase resilience, and allow damaged ecosystems an opportunity to recover. Suggested key directions are listed under broad themes below.

Theme 1 – Improving the Effectiveness of Delivery

Key Direction 1 – Foster collaborative relationships amongst jurisdictions to ensure complementary responses to the causes of marine biodiversity decline.

Key Direction 2 – Review and evaluate national coordination across jurisdictions of responses to marine biodiversity decline with respect to key threats.

Key Direction 3 – Promote cooperative and complementary, ecosystem-based planning and management approaches across jurisdictions.

Theme 2 – Measuring Success

Key Direction 4 – Work towards a nationally consistent marine and coastal biodiversity and fisheries monitoring and reporting framework with baseline/reference sites in and out of Marine Protected Areas.

Theme 3 – Improving Knowledge

Key Direction 5 – Develop a targeted strategy to address key gaps in knowledge of marine biodiversity and improve access and sharing of knowledge and data.

Theme 4 – Responses to key threats: protecting ecosystems, habitats and species and increasing resilience

Key Direction 6 – Improve the understanding of the vulnerability of marine biodiversity to climate change focusing on ecosystems and species that are at particular risk.

Key Direction 7 – Develop regional climate adaptation policies and plans based on predictive modelling and integrate them into marine bioregional planning processes.

Key Direction 8 – Progress the integrated management of the coastal zone including monitoring coastal marine biodiversity.

Priority actions have been identified in respect to climate change, resource use and land-based pollution. Agreed integrated strategies for action for marine biosecurity and marine pollution exist and are being implemented, and no additional actions are proposed. The report proposes both new actions and actions that require continuation and extension of the current work of governments.

Conservation of the marine environment is a complex matter involving multiple jurisdictions and stakeholders across a range of marine industries. Implementation of a national approach would require the cooperation and commitment of all relevant governments.

Acknowledgments

A National Approach to Addressing Marine Biodiversity Decline is the work of many people. The Working Group consisted of representatives from the Australian, state and Northern Territory governments, and the compilation of the report was coordinated by the Australian Government Department of the Environment, Water, Heritage and the Arts. The Working Group members were supported by many colleagues located within the environment and natural resource management agencies of the participating jurisdictions. The report was developed through the technical input, information and advice of the agencies and individuals listed below.

Marine Biodiversity Decline Working Group

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Context and scope

Australia's ocean territory covers 14.7 million square kilometres and includes some 36,000 kilometres of coastline extending from the tropical north to the cool temperate south. The biodiversity of Australia's vast marine jurisdiction has been recognised as being globally significant.

Australia's marine biodiversity is under pressure from many uses of the marine environment, such as fisheries, shipping, petroleum and mineral extraction, tourism and recreation. Pressures from changing land use, including agricultural and urban run-off and coastal development, also continue. Biodiversity loss caused by climate change is an increasing concern globally.

Large gaps exist in our knowledge of Australia's marine environment and its interactions with terrestrial and inland habitat and activities. Although knowledge is limited, Australia's marine biodiversity appears to be in a better condition than that of many other countries. There are significant concerns with decline in some key species, localised impacts on habitats and conditions and emerging threats despite the combined efforts of Australia's governments and stakeholders.

The need to sustainably manage the use of our coastal and marine environments and maintain our biological diversity is accepted by Australian Governments. The Australian, state and Northern Territory governments already have a broad range of programs in place to manage and regulate uses of the marine environment, to protect marine biodiversity, and to increase our understanding and improve management of the marine environment.

Australians are increasingly valuing the environmental, economic and social impacts of marine biodiversity and the ecosystem services that a healthy marine environment provides. In response to this change in public values, it is appropriate to review the status, policy directions and delivery mechanisms of marine biodiversity conservation and management programs.

In December 2004, Australia's governments, through the NRM Ministerial Council, agreed to work towards a collaborative approach to oceans management as set out in a Draft Framework for a National Approach to Integrated Oceans Management. The Draft Framework includes principles that will guide Australian governments in the coordination of planning and management activities and policy development to deliver ecologically sustainable development of the ocean and its resources.[1]

In April 2006, the NRM Ministerial Council agreed to establish a Working Group to develop a report that identifies the threats and causes of marine biodiversity decline, and high-level gaps in information. The Working Group has prepared this report which identifies significant, broad-scale threats to marine biodiversity as well as several related knowledge gaps. It proposes an approach to responding to those threats, including improving the effectiveness of responses.

[1] NRMMC 2004a, Draft Framework for a National Approach to Integrated Oceans Management (endorsed on 3 December 2004) Natural Resource Management Ministerial Council, Australian Government, Department of the Environment and Heritage, Canberra.

Section 1: Marine biodiversity decline in Australia

1.1 What is biodiversity?

Marine biodiversity is more than a count of species in the sea, and biodiversity decline is more than a record of extinctions.

Biodiversity is the variation of life at all levels of biological organisation. It refers to plants, animals and micro-organisms, the genes they contain, and ecosystems and ecosystem processes they form. It is typically considered at three levels: genetic diversity, species diversity and ecosystem diversity.

Marine biodiversity decline is characterised not only by extinctions, but by invasions and hybridisations, populations of species reduced in number, habitats that have been diminished or removed, and ecosystem processes (e.g. cycling of water, nutrients and energy) that have been disrupted.

When considering human impacts on marine biodiversity it should be kept in mind that we often are looking at marine biodiversity that is already altered. The 'shifting baseline syndrome' is a common obstacle to useful biodiversity assessment and monitoring.

1.2 Trends in Australia's marine biodiversity

The past 200 years of human activity have had substantial impacts on marine environments, not just near population centres, but in the most remote areas. In many cases it is only by looking back to historical records that it is apparent how much biodiversity loss has already occurred. Over long time spans incremental impacts have led to major shifts in biodiversity composition. An analysis of marine biodiversity decline over a couple of decades will miss the major changes that occur incrementally over long periods.

Current trends in the status of Australia's marine biodiversity are difficult to determine for several reasons, including lack of information and lack of a nationally coordinated approach to assessing and monitoring marine biodiversity. Despite this lack of comprehensive information on marine biodiversity, expert opinion based on observations of significant decline in some marine species in some areas suggests that there is a continuing decline occurring in Australia's marine biodiversity and ecosystems.

The *Australia State of the Environment 2006* report (*SoE 2006*) recognises that the lack of baseline information on the current state and trends makes it difficult to make definite statements. However, *SoE 2006* concludes:

> *…we can not, at this stage, even in the rare cases where we know changes are happening, be sure whether changes in either extent of the selected habitats, or in populations of particular species, are indicative of healthy or unhealthy changes for their supporting and supported ecosystems. A precautionary approach would suggest that if, on balance, in the context of a range of anthropogenic pressures, more species and habitats seem to be declining than expanding, it probably does not bode well for the condition of ecosystems more broadly.*

> *On the basis of the very limited data found for this very narrow range of species, groups of species and habitats, in a narrow range of locations, the conclusion must be that, on balance, more things seem to be declining than remaining stable.*

Some examples of ecosystems, habitats and species that are declining are documented in Appendix 2.

1.3 Gaps in knowledge

We still know very little about Australia's marine biodiversity. This is especially the case for species and ecosystems in more remote, deeper oceanic areas. This lack of knowledge represents a significant challenge to achieving the environmental, social and economic objectives of existing and future policies and management initiatives that seek to halt and reverse marine biodiversity decline.

The two major knowledge gaps that hinder management identified in *SoE 2006* are:

- sparse biodiversity baseline information for management areas; and
- the lack of a systematic national-scale approach to monitoring biodiversity trends (i.e. by comparing subsequent studies to the baseline information) in Australia.

Specific examples of uncertainties in knowledge identified in *SoE 2006* include the following:

- A lack of understanding of natural fluctuations in populations of waterbirds, coastal shorebirds, island birds and seabirds, particularly between species utilising the same habitat.
- Very little systematic monitoring of fish populations has occurred, except in the commercial fisheries, and many fisheries have no biomass reference points, little reliable data and no fully independent assessment of stocks.
- The data on coral and seagrass are primarily available from the Great Barrier Reef and therefore do not provide a comprehensive continental picture. Despite knowing more about the Great Barrier Reef than most other areas, a lack of data and uncertainties regarding natural fluctuations in populations and distributions of some species inhibit the meaningful assessment of the condition of some species and the sustainability of various uses.
- Seagrass condition and distribution may change dramatically over time, with seagrasses declining in response to disturbance events such as floods and cyclones, and followed by a period of recovery. Up-to-date information is required to understand responses to chronic and widespread pressures from human activities such as declining water quality and coastal development.
- Mangroves are declining in some places and expanding in others – but it is not clear whether they are expanding at the expense of saltmarsh, freshwater wetlands, rainforests or other habitats.
- Data on kelp forests are limited to the giant kelp (*Macrocystis*) in eastern Tasmania. Giant kelp data indicate a greater than 50% decline both in overall area and in number of beds, during the second half of the 20th century and observed declines continued into the 1990s in some places, with only very slight recovery in others. Data for Victoria and South Australia are not available. More recent data for Tasmania and other kelp species and other habitat-forming macroalgae are not available.

There is a lack of systematic broad-scale sampling of, and taxonomic information on, species and their distribution within the marine environment. Australia is facing a critical shortage of expertise in taxonomic identification. This problem, also known as the 'taxonomic impediment', has been highlighted by both the Australian Marine Sciences Association and Oceans Policy Science Advisory Group.[2] (See Case Study – Successional Planning for Marine Taxonomists.)

Even in the better-known types of marine animals such as finfish, new species are regularly discovered, leading to changes in our understanding of biodiversity patterns around Australia and appropriate management for commercially fished species complexes. The continental slopes of north-east and north-west Australia have been identified by marine invertebrate and fish taxonomists as areas that are little-known.

Many large areas of Australia's continental slope (200–1000 m) have never been sampled. When areas are surveyed, many of the species discovered are new to science or new to Australian waters. For example, of the 529 decapod species (including crabs, prawns and lobsters) collected on the 2005 Commonwealth Scientific and Industrial Research Organisation (CSIRO)/Museum of Victoria's Voyage of Discovery of the continental slope off Western Australia, at least 167 species (30%) were new to science and a further 95 (18%) were new records of Australian fauna.

Case Study – Successional Planning for Marine Taxonomists

The need to accurately identify and catalogue the huge diversity of Australian marine species is essential for undertaking meaningful attempts to understand the extent and rate of marine biodiversity decline. While identifying many of the large iconic species like marine mammals, seabirds and finfishes is reasonably simple, identifying the vast majority of species in Commonwealth waters (i.e. invertebrates and marine plants) is quite difficult, as many species are new to science and most are still not yet even formally described. In south-eastern Australia, only about 40% of the marine invertebrate fauna is thought to have been described and some groups are almost completely unknown.

Marine invertebrate and plant taxonomy (requiring both parataxonomists[1] and alphataxonomists[2]) is the domain of an increasingly small number of specialists, who generally work in Australian museums or scientific institutions. Many of these people are approaching retirement age but there is no recognised successional planning to replace them.

It is therefore critical to provide additional formal tertiary courses in marine taxonomy for training the next wave of marine taxonomists, as presently only the University of New England offers an undergraduate course in biosystematics, run in partnership with the Australian Museum and the Royal Botanic Gardens in Sydney. It is also essential to provide competitive employment opportunities for these people once they complete their courses, as many marine taxonomists have had to move overseas to continue working in their chosen field. Unless long-term employment opportunities exist for these highly specialised people, it will become increasingly difficult for natural resource managers to make informed decisions about the extent and potential causes of marine biodiversity decline, and how best to invest time and resources to reverse this apparent decline in Commonwealth waters.

[1] Have the skills to identify species using the resources available today e.g. keys and books.
[2] Can describe and identify new species in addition to identifying species using the available resources.

[2] Australian Marine Sciences Association, *Marine Taxonomy in the New Millennium*, Discussion Paper for the Oceans Policy Science Advisory Group, May 2005.

Section 2: The rationale for a national approach

2.1 Overview

Successful management of threats to complex ecological systems that cut across multiple habitats, ecosystems, management areas and jurisdictions, and impact on a wide array of stakeholders requires a suitably resourced, nationally coordinated approach. The rationale for a national approach is based on both experience with successful frameworks in similar areas of management and recognised gaps where such frameworks could provide better outcomes.

Over recent decades all Australian governments with marine jurisdictions have recognised the importance of arresting marine biodiversity decline, and are making large investments of time and resources in coastal and marine management, and in understanding the dynamics of ecosystems and our impacts on them. There are clear environmental, economic and social benefits to doing so.

A national approach to addressing marine biodiversity decline should include a range of cost-effective national actions to reduce the impact of broad-scale threats that are the underlying causes of decline. Objectives should include reducing further losses, increasing resilience to prepare for increasing climate change impacts, allowing damaged ecosystems an opportunity to recover and improving the effectiveness of program delivery. It is possible to substantially improve outcomes for marine biodiversity.

Underlying principles of a national approach

Precautionary principle
A national approach should reinforce the precautionary principle. If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Ecosystem resilience
Resilience refers to an ecosystem's capacity to bounce back from disturbance. The healthier an ecosystem is, the greater its resilience. Managing pressures to bolster resilience will help ecosystems adapt to the effects of climate change.

Ecosystem-based management
Ecosystem-based management is a management approach that recognises that maintaining the structure and function of ecosystems is vital and that human uses and ecosystem health are interdependent.

Adaptive management
Adaptive management involves learning from management actions, and using those lessons to improve future management. It requires the development of an adequate monitoring framework that yields results that can be fed back into the management process. Adaptive management is an approach that allows us to 'embrace' uncertainty in ecological systems. Understanding uncertainty as information, rather than avoiding or ignoring it, will help us respond to threats associated with climate change.

2.2 Current programs to address marine biodiversity decline

Australia has several longstanding strategies and programs across Commonwealth and state and territory jurisdictions that address marine conservation from a variety of perspectives and seek to halt and reverse marine biodiversity decline.

Key strategies and programs that address marine biodiversity decline are:

- an ecosystem-based approach to marine management through the development of Marine Bioregional Plans in Commonwealth waters and complementary state and territory marine planning processes;
- extending and managing the National Representative System of Marine Protected Areas and networks of Marine Protected Areas (MPAs) in Commonwealth, state and territory waters;
- sustainable, ecosystem-based fisheries management;
- regulation working with the full range of marine industries and some land-based activities to reduce threats;
- developing the capacity to assess the performance of marine plans and management measures and to monitor and report on marine biodiversity condition including the development of a national suite of estuarine, coastal and marine indicators;
- protecting threatened marine species through recovery planning and threat abatement planning in all jurisdictions, including working internationally to protect migratory marine species;
- an almost complete national system to reduce the spread of invasive species around Australia by vectors ranging from ballast water to the aquarium trade;
- research and monitoring to better understand and manage ecosystems;
- maintaining and building capacity in marine science; and
- education and outreach that mobilises industry and communities better as custodians of coastal and marine environments.

These strategies and programs are put in place by the Commonwealth, states and territories individually or are cross-jurisdictional. The input, cooperation and goodwill from industry and the public also significantly contribute to responses.

For each of the main marine industry sectors, jurisdictional management arrangements involve strategies and programs that aim to minimise impacts on marine biodiversity either as a direct objective or as a secondary benefit.

For example, strategies and programs that contribute to the management of wild capture fisheries on a sustainable basis are contributing to marine biodiversity conservation, as the fisheries themselves are an important component of biodiversity. In that respect, fisheries management regimes are contributing to ‘off-reserve’ conservation measures. The key fisheries management programs are:

- Commonwealth Fisheries Harvest Strategy Policy (see Case Study – Harvest Strategy Policy) – ensuring that fisheries are being managed for long-term biological sustainability and economic profitability;
- Fisheries Ecologically Sustainable Development Program;
- Securing our Fishing Future – funding initiative involving funds for structural industry adjustment to reduce pressures on available resources;
- National Plan of Action to Prevent, Deter and Eliminate IUU [Illegal, Unreported and Unregulated] Fishing;

- bycatch devices in use under Bycatch Action Plans and required under other fisheries management regimes;
- Ecological Risk Assessment of the Effects of Fishing;
- Recovery Plans for various threatened species involve actions by fisheries sector;
- ecosystem-based fishery management – the development of fisheries management regimes in all jurisdictions addressing sustainable management of target species, bycatch, by-product and ecosystem impacts;
- National Recreational Fishing Policy (to be reviewed in 2008);
- Indigenous fisheries policy;
- National Plan of Action for the Conservation and Management of Sharks; and
- National Bycatch Policy.

For each main marine industry sector and for other types of activity that impact on the marine environment (e.g. urban and coastal development) there are strategies and programs in place to minimise impacts on marine biodiversity. For example, regulation of offshore petroleum exploration and development both in Commonwealth and state and territory waters serves to protect marine biodiversity by controlling and preventing the escape of wastes and petroleum.

With the shipping sector a national plan is in place to combat pollution from oil and noxious and hazardous substances. The plan provides a nationally integrated government and industry organisational framework to respond to marine pollution incidents. Programs are also in place to address risks of introducing marine species through ballast water, biofouling and marine debris from ships.

Strategies and programs exist to minimise threats to marine biodiversity from climate change, land-based impacts, introduced marine species and marine pollution. Responses to these threats are described in Section 3.

The strategies and programs to address marine biodiversity decline sit under the overarching national biodiversity conservation strategies, in particular the National Strategy for Ecologically Sustainable Development and the National Strategy for the Conservation of Australia's Biological Diversity. These strategies and programs contribute to meeting Australia’s commitments under international conventions and agreements, which also work to halt and reverse marine biodiversity decline. These international commitments include:

- a responsibility under the United Nations Convention on the Law of the Sea (UNCLOS), to protect the marine environment from land-based activities;
- an agreement to recover fish stocks by 2015 (Convention on Biological Diversity, CBD);
- the commitment undertaken at the 2002 World Summit on Sustainable Development to develop a national network of MPAs by 2012;
- the Convention for the Conservation of Migratory Species (CMS);
- Convention on International Trade in Endangered Species(CITES);
- GloBallast, the Global Environment Facility/United Nations Development Programme/International Maritime Organization Global Ballast Water Management Programme; and
- the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities.

As outlined in Section 1, significant declines in some species and some general downward trends continue despite investments in programs to limit marine

biodiversity decline. However, it does not necessarily follow from the available evidence that current programs are failing to improve outcomes compared to what would occur if the programs did not exist. The lack of baseline information, which makes it difficult to make definitive statements on the condition of marine biodiversity, also makes it difficult to assess the effectiveness of many or most current programs.

Based on scientific information and following consultation, jurisdictions have decided to invest in programs to address marine biodiversity decline. A general inability to be conclusive about positive impacts of programs does not necessarily mean that programs should cease but lends support to the case for better monitoring and evaluation of program effectiveness.

2.3 Management challenges

A national approach to address broad-scale threats to marine biodiversity requires effective management regimes that engender industry and community support.

Current approaches to addressing marine biodiversity decline in Australia are largely focused on protecting rare, threatened and migratory species, preventing the spread of invasive species, addressing sector-based threats and establishing MPAs. To arrest ongoing biodiversity decline, the following areas will need to be continued and improved:

- national governance and cross-jurisdictional integration;
- ecosystem-based, bioregional planning;
- integrated management of rare, threatened and migratory species;
- coordinated habitat management;
- addressing knowledge gaps; and
- international, regional marine biodiversity cooperation.

Suggested responses to these challenges are outlined in Section 3. Here, each of the key areas is outlined in some detail.

2.3.1 National governance and cross-jurisdictional integration and coordination

The management of Australia's marine environment is shared between the Australian, state and Northern Territory governments, local government, Natural Resource Management (NRM) groups, Indigenous communities and other key stakeholder groups. The state and Northern Territory governments are primarily responsible for areas up to three nautical miles out from the territorial sea baseline. The Australian Government is responsible for all other waters within the outer limit of Australia's 200-nautical-mile exclusive economic zone (EEZ). In addition, agreements under the Offshore Constitutional Settlement (OCS) delegate responsibility for some aquatic resource management between three nautical miles and the EEZ (generally) to either the state or joint authorities.

National governance frameworks are essential to implementing a cross-jurisdictional and national approach to marine biodiversity management. Where national governance frameworks for marine biodiversity exist or are planned in Australia (i.e. protected species, invasive species, MPAs, threats), they are often poorly put into practice at the local level. National coordination of efforts on marine protected species, habitat conservation, marine pests and marine biodiversity will improve overall outcomes. Furthermore, national coordination will ensure that the many existing programs are complementary and not necessarily repetitive.

Across jurisdictional boundaries it is an ongoing challenge to ensure that conservation objectives are complementary and that planning and management activities are coordinated. Inter-governmental relationships need to be communicative and proactive in ensuring complementary on-ground actions. Government, industry and non-government organisations (NGOs) need to be working together to make the most of common conservation interests and requirements.

Case Study - Inter-Governmental Management of a Marine Protected Area (MPA)

The establishment of the Great Barrier Reef Marine Park, under the *Great Barrier Reef Marine Park Act 1975*, is the primary mechanism for achieving the protection and wise use of the Great Barrier Reef. The Marine Park lies within both Commonwealth and Queensland waters up to the low water mark. A Queensland marine park, the Great Barrier Reef Coast Marine Park, covers the area between the low and high water marks, as well as many areas within bays and inlets. Queensland has also established national parks in relation to many islands within the Great Barrier Reef World Heritage Area. The Commonwealth and state parks are regulated and managed cooperatively.

The obligations of the Australian and Queensland governments in the protection and management of the Great Barrier Reef Marine Park are outlined in the Emerald Agreement of 1979.

The Great Barrier Reef Marine Park Authority and the Queensland Parks and Wildlife Service (QPWS) are jointly responsible for the day-to-day management of the Great Barrier Reef Marine Park and World Heritage Area. The Day-to-day Management Program guides the field operations and routine activities required for its management. This program is primarily delivered through the QPWS by Marine Parks Officers – professional rangers and conservation staff working with industries and coastal communities. Protection of such a vast and diverse area is a challenging task.

Protection of the values of the reef against illegal activities is also achieved through strategic alliances with the Queensland Boating and Fisheries Patrol (QBFP), Queensland Water Police, Coastwatch and the Australian Maritime Safety Authority (AMSA).

There are around 100 QPWS Marine Parks Officers employed under the Day-to-day Management Program working out of 14 centres between Cooktown and Gladstone. The QPWS Marine Parks Officers manage the Great Barrier Reef Marine Park and World Heritage Area through:

- Resource protection programs;
- Visitor education and services;
- Park monitoring; and
- Surveillance and enforcement.

2.3.2 Ecosystem-based bioregional planning

The establishment of integrated, ecosystem-based planning and management across Australia's continental shelf and across jurisdictional boundaries is a key challenge for Australian governments. Marine bioregional planning would benefit from continued commitment and cooperation at a national level.

One way of preventing and addressing marine biodiversity decline is by planning conservation and management activities based on consideration of ecological structures and processes. Two ecosystem-based management efforts are the Australian Government's Marine Bioregional Planning program and ecosystem-based fisheries management (EBFM) regimes occurring in all jurisdictions.

The Australian Government's Marine Bioregional Planning program lends a strong ecosystem focus to legislative processes (such as species recovery) and conservation initiatives. Marine bioregional plans are prepared under the *Environment Protection and Biodiversity Conservation Act 1999* and provide a comprehensive bioregional information basis for future decisions and further government-funded environmental research in Commonwealth waters. Biodiversity conservation is central to the plans, which identify regional priorities to address ongoing and emerging threats.

The planning process takes into account all human activities and pressures at the bioregional scale to provide for integrated spatial management of oceans. The ecosystem-focused planning approach incorporates spatial management based on marine ecology, species distribution and oceanographic and seafloor characteristics.

Marine Bioregional Plans guide governments, industry and community by:

- describing conservation values region by region include mapping important sites for the protection of protected species, communities and ecological processes;
- identifying regional priorities for action, based on assessments of threats to conservation values and long-term policy goals;
- providing strategic guidance for industry and decision makers, for example by providing a regional context for national guidelines to help proponents of projects to consider whether an action may result in a significant impact on the marine environment;
- providing a monitoring (and indicators) strategy and identification of critical gaps in the information base; and
- including an evaluation of the economic and social costs and benefits of the actions in the plan (and any measures to address costs).

Marine bioregional planning is also the process through which the Australian Government identifies areas within Commonwealth waters for inclusion within a National Representative System of MPAs (NRSMPA). The guidelines for development of the NRSMPA have been agreed by state and Northern Territory governments. Queensland has had an MPA network, through its declared Fish Habitat Area system, since the late 1960s.

Some state and territory governments, such as those of South Australia, Western Australia and the Northern Territory, have begun programs of integrated ecosystem-based marine planning within their waters. These planning initiatives are increasingly being delivered through cooperative and complementary mechanisms.

The establishment of integrated, ecosystem-based planning and management across Australia's continental shelf and across jurisdictional boundaries is a key challenge for Australian Governments. Marine bioregional planning is an area that would benefit from continued commitment and cooperation at a national level.

Marine bioregional planning including the establishment of MPAs is only one of a range of ecosystem-based planning and management approaches. Fisheries management regimes that address sustainable management of target species, bycatch, by-product and ecosystem impacts exist in all jurisdictions. These regimes often include a focus on ecological risk assessments, bycatch management, and protected species.

2.3.3 Integrated management of rare, threatened and migratory species

Complementary policy, planning and coordinated actions for rare, threatened and migratory marine species is also required. Complementarity of actions to protect migratory species is particularly important because these species often live part of their lives in more than one jurisdiction. Coordination is essential internationally and nationally across Australia, to effectively recover threatened populations.

To address the ongoing decline of threatened marine species in Australia, recovery and management of marine species needs to address the following key challenges:

- A national approach to prioritising listing, monitoring and recovery planning for rare, threatened and migratory marine species. For example, there are currently no uniform approaches to either monitoring, reporting or managing data of turtles, dugongs or cetaceans; and
- Development of innovative economic instruments to ensure maximum benefit from biodiversity investment and foregone profit by industry.

Case study – Recovery and Management of Marine Turtles in Australia

Marine turtle management issues in Australia cut across national, state/territory, local government, Natural Resource Management (NRM) groups and Indigenous communities' boundaries, from land tenure, cross-cultural, legislative and local management perspectives. Threats to marine turtles arise from many sources, including fishing, coastal development, pollution and harvesting.

As such there is a need for an overarching national governance framework to be put in place at the state and local level. For example, although there is a national 'Recovery Plan for Marine Turtles in Australia' this plan has not been formally put into practice in Queensland, the Northern Territory or Western Australia.

Within a national framework a prioritised list of actions, research and monitoring coordinated amongst a range of funding bodies is required. Priorities should be determined through a clear, scientifically-based risk assessment process that considers all sources of mortality. Currently, local priorities and actions have been funded largely at the expense of national priorities and actions. Within such a prioritised list is the need to differentiate between socio-cultural and conservation outcomes and the need for recognition of the role Indigenous communities can play as key custodians and local managers of marine turtles in many parts of Australia. With this recognition is the need for capacity-building to allow traditional owners to undertake meaningful and effective conservation and management programs in Australia.

A prioritised list would also assist with the development of national reporting, monitoring standards and protocols. As with all management measures there is a need for regular review and audit of recovery plans. Nationally coordinated databases to assess the status and recovery of marine turtles in Australia will allow for efficient and integrated mechanisms for monitoring the effectiveness of recovery.

2.3.4 Coordinated habitat management

While significant progress has been made in conserving and protecting marine biodiversity through the attempt to establish the NRSMPA, far less effort has been directed towards nationally consistent approaches to 'off-reserve' management of marine habitats in Australia. For example, a particular marine habitat/community (e.g. seagrass) is often managed entirely differently between jurisdictions: in Queensland, mangroves have been protected since the 1914 *Fish and Oyster Act* for use in the then oyster industry. The Queensland *Fisheries Act 1976* extended the protection to

all marine plants, whether living or dead (including saltmarsh plants, mangroves, seagrass and algae) onto all lands, including outside of declared Fish Habitat Areas. This protection applies across all tenures and an approval must be obtained for any removal, disturbance or destruction of marine plants. Recently, New South Wales has developed specific legislation for the 'off-reserve' management of marine habitats (see Case Study – Habitat Protection Plans in New South Wales).

Effective 'off-reserve' marine habitat management in Australia would benefit from a national governance framework which would include nationally consistent approaches to advance the following:

Habitat protection and management plans
Like marine protected species, marine habitats in Australia would benefit from a national approach to habitat identification, valuation and management, through either building this into existing arrangements or the development of habitat management plans, which include prioritised actions and research priorities.

Development approvals and assessment guidelines for marine habitats
The direct and indirect impacts of developments on marine habitats and their biodiversity are assessed and managed differently across jurisdictions and agencies. Identical habitats/communities can be subjected to rigorous development assessment and approvals processes in one jurisdiction without any effective management in another jurisdiction.

'Off-reserve' management plans
'Off-reserve' management plans that recognise the full range of biodiversity impacts and provide guidance on how to engage industry in reducing impacts and offsetting losses would be a valuable instrument in marine habitat management.

Generalised marine habitat/communities classification systems
Marine habitat-biodiversity assessments, monitoring and reporting are currently hindered by the lack of a national classification of marine habitats and communities. This work should build on existing classification efforts (i.e. Integrated Marine and Coastal Regionalisation of Australia 2006 and other relevant marine biogeographical studies) and coordinate with current state of the environment and NRM monitoring and evaluation monitoring and reporting processes.

Standardised mapping, reporting, monitoring, databases
Habitat mapping and monitoring in Australia is currently undertaken by various NRM, government and university groups. Despite the identification of a set of national coastal, estuarine and marine indicators, there are currently no nationally consistent reporting, monitoring standards or protocols and, significantly, no national databases to assess the status and condition of habitats in Australia.

Identification of rare and threatened marine habitats/communities and key processes threatening Australia's marine habitats
Both on a national and regional basis, very little work has been undertaken to assess the conservation status of Australia's marine habitats/communities.

Case Study – Habitat Protection Plans in New South Wales

New South Wales has developed specific legislation for the 'off-reserve' management of marine habitats. Under the *Fisheries Management Act 1994*, key fish habitats can be protected through the development of Habitat Protection Plans (HPPs). These plans describe potential threats to fish habitat and recommend actions to mitigate the effects of potentially damaging activities. The plans can be developed for the protection of any fish habitat, whether it is critical for the survival of the species or required to maintain sustainable populations of fish for harvesting. The plans can focus on protecting habitats on a state, regional or local scale, or for particular communities or species.

The community is consulted during the preparation of an HPP, and the responsibilities of public authorities, including local councils, regarding the protection and management of the habitats are clearly set out. Significantly, once gazetted, the Minister and public authorities must have regard to any HPP that is relevant to the exercise of their functions. While the HPPs are largely unenforceable, public authorities must notify the Minister if undertaking activities inconsistent with an HPP.

NSW Fisheries has gazetted three plans to date:

- Habitat Protection Plan No. 1: General – An advisory document summarising various protective measures in relation to dredging and reclamation activities, fish passage requirements, and the protection of mangroves, other marine vegetation and snags.
- Habitat Protection Plan No. 2: Seagrasses – Deals specifically with the protection of seagrasses across New South Wales, and discusses activities which impact on seagrasses, including the construction of jetties, wharves and bridges, dredging and reclamation, and the collection of seagrasses.
- Habitat Protection Plan No. 3: Hawkesbury-Nepean River System – Outlines management strategies and protection measures for aquatic habitats essential for the spawning, nursery, shelter and feeding requirements of fish in the Hawkesbury-Nepean River.

Significantly, these plans have also been supported through relevant planning and assessment legislation (i.e. *Environmental Planning and Assessment Act*) and planning and development assessment policies (i.e. State Environmental Planning Policy No. 14 – Coastal Wetlands, Department of Urban Affairs and Planning).

Under the Seagrass Protection Plan (gazetted in 1997), all 10 species of seagrasses in New South Wales are protected from harm by any persons, including public authorities and corporations, and this protection applies to all seagrasses anywhere in the state. Protection is afforded under the plan by regulating all developments/activities that cause direct and indirect damage to seagrasses (for e.g. coastal structures, moorings, dredging, reclamation, aquaculture leases, commercial collection, bait digging, commercial fishing and point source pollution). Regulation is achieved through permits (and setting of permit conditions) to damage or remove seagrasses, and includes significant penalties for non-compliance (i.e. up to $110,000 fine for individuals and $220,000 for corporations) and the issuing of court or Ministerial remediation orders to remediate damage to seagrasses.

NSW Fisheries also enforces a 'no net loss' policy for marine vegetation and if seagrasses are lost, then a 2:1 habitat replacement policy is enforced (this may often require the taking of a bond).

2.3.5 Improving Awareness and Knowledge

Significant gaps exist in our knowledge and understanding of biodiversity, especially its composition and conservation status at a species and ecological community or ecosystem level, and some of the key threatening processes affecting it. Australia also lacks a systematic national-scale approach to monitoring biodiversity trends.

SoE 2006 highlights the need for a policy or framework for national monitoring and assessment of Australia's marine biodiversity status, stating:

> *The most all-pervading systemic problem that underpins almost all the issues of managing Australia's coasts and oceans is the lack of any systematic and strategic policy or operational framework that provides for the national-level monitoring and assessment of the condition of the ocean features, biodiversity or key resources.*[3]

The lack of long-term datasets on the biological condition of the marine environment complicates threat evaluation and biodiversity loss. A national approach to developing long-term datasets that can be used for monitoring is required. New remote sensing technologies for surface waters (satellite sensors), shallow waters (LIDAR) and deeper waters (multibeam swath bathymetry, remotely operated and autonomous underwater vehicles – ROV and AUV), mean that monitoring remote marine environments is becoming a realistic expectation of biodiversity management. These new technologies provide the mechanism to set up standardised reference sites at all depths that could be surveyed on a periodic basis to determine the scales of natural variability, long-term trends and the impacts of management. The Integrated Marine Observing System (IMOS), funded by the National Collaborative Research Infrastructure Strategy (NCRIS) provides one national approach to acquiring and developing these technologies.

Such a national-level monitoring and assessment will, however, have cost implications.

Despite a limited number of recent seabed surveys,[4] we know very little about the biodiversity of the seabed. Much of it, especially the deep seabed, is poorly known and unexplored. While evolutionary history and local conditions can be used to reliably predict the distribution of species on land to underpin landscape management, the same may not be true for the seabed, especially areas where even physical data are hard to obtain.

There is limited scientific understanding of marine species, habitats and ecosystems (structure and processes) and of baseline data. This lack of knowledge about the status of Australian marine biodiversity is an impediment to reducing, averting and in the first instance identifying marine biodiversity decline.

Baseline surveys of fauna, flora and habitats are required for a number of purposes, including environmental impact assessment and natural resource management. Detailed studies, especially of new habitats, often require extensive effort in taxonomy. Genetic analyses reveal a different dimension to biodiversity and can detect cryptic species, population trends and spatial structure.

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[3] Ward TJ & Butler A (2006) *Coasts and Oceans, theme commentary prepared for the 2006 State of the Environment Committee*, Department of the Environment and Heritage, Canberra, <http://www.environment.gov.au/soe/2006/publications/commentaries/coasts/conclusions.html> accessed 16 October 2007.

[4] Pitcher, CR et al. (2007) *Seabed Biodiversity on the Continental Shelf of the Great Barrier Reef World Heritage Area.* AIMS/CSIRO/QM/QDPI Final Report to CRC Reef Research.

There is also a need to develop a better understanding of the interaction between marine species, habitats and ecosystems, and also between these and present and emerging threats. Cataloguing biodiversity provides the ability to track change. The ability to understand future challenges requires a broader understanding of these interactions.

2.3.6 International, regional marine biodiversity cooperation

Many jurisdictions, agencies, researchers and NGOs are involved in marine biodiversity research or management of 'shared seas'. It is suggested that a regional, strategic approach to biodiversity conservation and management would be beneficial to the overall protection of marine biodiversity. Institutional frameworks or agreements to assist the regional management of areas of physical and ecological connectivity may be used to complement and strengthen existing species-specific, international and regional conservation mechanisms and agreements for marine protected or threatened species. Examples of these are. IOSEA Marine Turtle MOU, Convention of Migratory Species of Wild Animals Dugong MOU, CITES.

Case Study – Australia and South East Asia: Connectivity Leads to Cooperation

On the doorstep of South East Asia, Australia's northern maritime estate is situated adjacent to a region of high marine biodiversity globally – the Indo-Malay Triangle – the world's epicentre of marine biodiversity containing the highest recorded levels of tropical marine biodiversity (especially coral and fish) and some of the largest intact, coastal wetlands in South East Asia (e.g. Lorenz Wetlands and Trans-Fly Wetlands, Papua New Guinea).

Australia's northern ecosystems and marine biodiversity encompass the shallow, continental seas of the Arafura and Timor Seas (ATS), sharing its waters with three close, regional neighbours – Indonesia, Papua New Guinea and Timor Leste. There is well-developed regional-level connectivity in oceanographic processes and biodiversity in these waters, particularly in the movements of pelagic and migratory species. Globally significant populations of migratory protected species (i.e. turtles, dugongs, cetaceans) are found throughout the ATS region. This information has been critical in developing joint cooperative or complementary fisheries management arrangements in the ATS.

This strong regional ecological connectivity has resulted in shared fisheries, stocks and biodiversity. Consequently, there is a need for cross-jurisdictional management frameworks and cooperation at both the regional and international level. In the face of a continuing decline in the marine biodiversity of South East Asia, Australia will have a crucial role in helping to maintain and recover much of this globally-significant, regional biodiversity.

2.4 Key threats to marine biodiversity

While there may be a general awareness about the need to manage a particular marine environment, there is often inadequate information about key threats and management issues. This is complicated by the need to act, typically after decades of increasing human activity have changed the nature of the ecosystems and their capacity to accept human impacts.

Individual activities can and do impact on marine biodiversity; however, it is often the combined effects of multiple activities that drive biodiversity decline. Our ability to document this cumulative effect is hampered by lack of information about system-wide threats (e.g. climate change) and the fact that risk assessments are often undertaken for individual activities in isolation. For example, the impacts of petroleum exploration activities, commercial fishing, shipping, etc. are each assessed in isolation. While individual risk assessments may conclude that the specific activity is a low or manageable risk, there is no assessment of the cumulative (over time) or combined (simultaneous) impacts of these activities on an ecosystem or species. Additionally, risk assessments associated with these activities are typically undertaken for large iconic marine animals and individual species which have conservation or commercial significance, rather than for marine biodiversity more broadly.

It should be noted that although human activities are the basis for most of the key threats identified in this report 'natural' drivers of change do exist. Human activities are the main drivers of biodiversity decline that we can practically manage. In general, there is little understanding of 'natural' change in management areas, including what and how much change is expected in the absence of human activity. Furthermore, distinguishing the degree or extent of 'natural' change from the degree or extent of human-induced change is difficult; the sum may be greater or less than the parts.

In preparing this report each jurisdiction provided information on key threats to biodiversity conservation and identified potential and existing actions and programs that address these threats. The Working Group identified highest priority broad-scale threats to marine biodiversity. These are:

- climate change;
- resource use;
- land-based impacts;
- marine biosecurity; and
- marine pollution.

2.4.1 Climate change

The Natural Resource Management Ministerial Council in its *National Biodiversity and Climate Change Action Plan 2004–2007* has recognised that biodiversity, including that of marine, coastal and estuarine ecosystems, is among the most vulnerable of Australia's assets under climate change

The likely implications of climate change for the marine environment include, but are not limited to:

- loss, degradation of habitat or changes in its distribution and density;
- changes in ocean currents, upwellings and productivity;
- displacement, distributional and abundance changes of marine species;
- loss of synchronisation between essential climate/weather/seasonal events affecting biota (such as a mismatch between phytoplankton blooms and zooplankton growth);
- lower ocean productivity and disrupted/changed food chains; and
- ocean acidification (changing the ability of calcium carbonate-producing organisms to construct shells).

Evidence of climate change impacts on marine systems is mounting from the world's oceans. A number of examples include:

- coral bleaching associated with prolonged high sea surface temperatures;
- shifts or range extensions polewards in species distributions, linked to warming temperatures, in all trophic levels including demersal and pelagic fish, intertidal fauna, macroalgae, plankton and seabirds; and
- alteration of the timing of biological events, such as the peak spring phytoplankton bloom and the migration and breeding periods of marine animals.

Variations in species adaptability and the different responses of species to changes in climate may have severe consequences that could lead to a mismatch between trophic links, mistiming of critical life history events and, ultimately, a loss of biodiversity.

The impacts of climate change are likely to make retention, let alone restoration, of biodiversity and ecosystem function an even greater challenge. Global climate models project that the Tasman Sea will warm faster than other waters in the southern hemisphere. Cold-temperate species found in the waters off south-east Australia are considered particularly vulnerable to climate change, given the lack of shelf habitat further south for retreat as waters warm. Modelling of changes on the composition and extent of ecosystems indicates that even established reserves may require adaptive management to minimise impacts and retain their functionality into the future.

The distribution of many species and ecosystems is likely to change as the climate changes. Ecosystems or communities are unlikely to move en masse, but movement of certain components (species and processes) will result in the assembly of new or novel ecosystems with previously unknown effects on the ecosystem services that we depend on. Both positive and negative impacts are expected. As pressures from human activities mount on the marine environment, we urgently need to understand the mechanisms influencing biodiversity and ecosystems services.

Rising temperatures and ocean acidification due to climate change are considered major threats to tropical coral reefs and calcium carbonate-producing organisms more broadly. For example, experts concluded that coral reefs of the Great Barrier

Reef are particularly vulnerable to climate change. Disturbance by climate change, when combined with other existing human stressors, is likely to further degrade this valuable ecosystem, and threaten its resilience.[5]

It is estimated that degradation of Australian coral reefs may reduce international tourist income by as much as $8 billion over 19 years. Table 1 below outlines the potential biological impacts of climate change on Australian marine life.

Table 1. Potential biological impacts of climate change on Australian marine life

The ratings in this table are based on the expected responses to predicted changes in Sea Surface Temperature (SST), salinity, wind, pH, mixed layer depth and sea level, and from literature reviews for each species group. The implicit assumption underlying this table is that Australian marine species will respond in similar ways to their counterparts throughout the world.[6]

Groups	Distribution/ Abundance	Phenology	Physiology/ Morphology/ Behaviour	Impacts on biological communities	Examples of impacts
Phytoplankton	High	High	Medium	High	Temperate phytoplankton province will shrink considerably
Zooplankton	High	High	Medium	High	Acidification will dissolve planktonic molluscs
Seagrasses	Medium	Low	High	Medium	Increased dissolved carbon dioxide may increase productivity
Mangroves	Medium	Low	Medium	High	Sea level rise will destroy mangrove habitat
Kelp	High	Medium	High	High	Ranges will shift southwards as SST warms
Rocky reefs	High	Medium	High	Low	Ranges will shift southwards as temperature warms
Coral reefs	High	Medium	High	High	Acidification and warming will cause calcification problems and coral bleaching
Cold water corals	High	Low	Low	High	Ocean acidification will dissolve reefs
Soft bottom dwelling fauna	Medium	Medium	Medium	Medium	Modified plankton communities or productivity will reduce benthic secondary production
Seafloor dwelling and demersal fishes	High	Medium	Medium	High	Southward movement of species along the east and west coast of Australia
Pelagic fishes	Medium	Low	Medium	Low	Pelagic tunas will move south with warming
Turtles	High	Medium	High	Low	Warming will skew turtle sex ratios
Seabirds	Medium	Medium	Low	Low	Shift in timing of peak breeding season as temperatures warm
Total number of high impact habitats or species groups	**8**	**2**	**5**	**7**	High impacts are expected for distribution, physiology and community processes

[5] Johnson JE and Marshall PA (editors) (2007) *Climate Change and the Great Barrier Reef,* Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia

[6] Hobday, AJ, Okey, TA, Poloczanska, ES, Kunz, TJ & Richardson, AJ (eds) (2006) *Impacts of Climate Change on Australian Marine Life*, CSIRO Marine and Atmospheric research report to the Australian Greenhouse Office, Canberra.

Given the potential scale of climate change and its possible social, ecological and economic impacts, it is important that integrated management options are explored and that the solutions address the whole system.

2.4.2 Resource use

Our surrounding oceans and seas support Australian industries worth around $30 billion each year, including fisheries, aquaculture, shipping, offshore oil and gas, and marine tourism. Sustainable resource use can co-exist with the maintaining of marine biological diversity. However, as Australia's marine waters are comparatively low in productivity, fishing and the other uses of marine resources must be maintained at relatively low levels to provide ongoing access to these resources. Effective conservation of marine biodiversity and habitats must be recognised as essential for sustainable resource management.

Resource-use activities encompass:

- fishing (recreational, commercial and Indigenous);
- illegal, unreported and unregulated (IUU) fishing;
- aquaculture/mariculture;
- dredging and spoil dumping;
- mineral, and oil and gas exploration and extraction;
- shipping; and
- tourism.

An expanding human population, and the dwindling availability of fresh water for terrestrial primary production, is generating an increased demand on the food production capability of Australia's oceans. Within and beyond the Australian Fishing Zone, IUU fishing (fishing which does not comply with national, regional or global fisheries conservation and management obligations) continues to threaten the Australian harvest of fish stocks and the long-term viability of fishing industries and communities. Improved surveillance and collaboration with neighbouring countries, however, will increasingly assist in minimising the illegal take within Commonwealth waters.

The pressures associated with fishing and aquaculture include:

- marine community changes resulting from physical habitat disturbance and changes to community structures;
- the unintentional take of non-target species in nets and gear;
- the use of 'artificial' food sources typically derived from wild-caught fish;
- the incorporation of antifoulants and antibiotics into marine ecosystems;
- water quality; and
- changes resulting from the selective removal of predators, prey or competitors by specific fisheries.

Marine ecological communities and habitats may be disturbed by dredging, shipping, spoil disposal, tourism activities, mineral and petroleum resource exploration and extraction, and installing infrastructure. The additional pressure that new prescription drugs and industrial chemicals, produced by the emerging pharmaceuticals and biotechnology industries, will place on our marine resources is largely unknown.

The implications of threatening extractive processes and actions on the marine environment include, but are not limited to:

- alterations to ecosystem function;
- changes in distribution and quality of habitat;
- depletion of commercial stocks to unrecoverable levels;
- destabilisation of community structure through extraction at specific trophic levels;
- changes to size and abundance of target species;
- displacement, distribution and density changes in marine species;
- disruption of competitive interactions and predator–prey relationships;
- reduction in relative abundance of top-order predators in marine ecosystems; and
- reduced local genetic diversity within species and local species extinctions.

Commercial tour operators undertake a wide variety of activities, including chartered fishing, scenic cruises, island and reef trips, glass-bottomed boat rides, snorkel and diving trips, and marine thrill rides. Trips may last an hour or less, or extend for a few days, weeks or even months in vessels of varying size and type. The potential benefits of marine tourism include increased information about local marine fauna populations, increased awareness by tourists (Australian and overseas) of conservation and management actions, and greater potential for conservation initiatives through economic potential of wildlife-based eco-tours.

Recreational use of the marine environment tends to be concentrated around major regional centres along the Australian coast. A diverse range of recreational activities occur in marine areas including fishing, diving and snorkelling; yachting; boating; water sports; island visits; bird, turtle, dugong, whale and dolphin watching; spearfishing; and shell collecting.

While the drivers and impacts of recreational use of the marine environment are not well understood, the intensity and frequency of tourism needs to be managed. There is evidence that marine mammal watching and feeding can affect the behaviour of marine mammal populations and scuba diving can impact on substrata and affect behaviour of some species.

Case Study – The Commonwealth Fisheries Harvest Strategy Policy

The Australian Government's Commonwealth Fisheries Harvest Strategy Policy specifies the risk levels in allowing access to and use of fishery resources in Commonwealth fisheries.

The Harvest Strategy Policy sets out management actions that monitor, assess and control the fishing intensity in a given fishery to achieve defined biological and economic objectives. A harvest strategy manages the species' relationship with others in the food web or community.

Harvest strategies are commonly based around two types of reference points: 'target' reference points and 'limit' reference points. Target reference points express the desired status of stocks (B_{TARG}) and desired fishing intensity (F_{TARG}). Limit reference points (BLIM and B_{TARG}) express situations to be avoided, because they represent a point beyond which the risk to the stock forming the basis of a commercial fishery is regarded as unacceptably high.

Harvest strategies are designed to:
- maintain fish stocks, on average, at a target biomass point (BTARG or a proxy) equal to or greater than the stock size required to produce maximum economic yield (BMEY). If a stock is below the target, then corrective action must be taken to rebuild biomass to or above the BTARG.
- ensure fish stocks will remain above a biomass level where the risk to the stock is regarded as too high (BLIM or a proxy). Fish stocks may not fall below BLIM with a likelihood of more than 10% in one generation time.

2.4.3 Land-based impacts

Human activities on land pose a major threat to the health, productivity and biodiversity of the marine environment. Globally, about 80% of marine pollution is generated from land-based activities, including diffuse pollution from urban and agricultural areas, point source emissions and solid wastes. Types of pollution include hydrocarbons, pesticides, other persistent organic pollutants, heavy metals, pathogens, nutrients, sediments and litter. Land-based activities and pollutants from land-based sources can adversely impact marine life and ecosystems, and also marine-dependent industries (e.g. tourism, fisheries and mariculture), public health, foreshore stability, recreation and aesthetics. Once in the marine environment, the pollutants are absorbed by marine life, settle in river mouths and on the ocean floor, or follow currents and eddies to distant locations, which may be within a different jurisdiction to the source of the pollutant.

The condition of marine ecosystems within inshore waters, bays and estuaries varies considerably. Particular problem areas are those near large coastal population centres and those receiving waters from highly modified agricultural catchments. In these areas, the ongoing effects from existing activities and additional impacts from new development place greater pressure on marine ecosystems and on the economic and social services they support.

The extensive clearing of floodplains in lower catchments has also exacerbated the impacts of high natural loads of sediment and nutrients by removing the major abatement mechanism these floodplains provided. The feasible rate of rehabilitation of riparian and wetland areas cannot substantially reduce these heightened ‘natural’ loads, much less the high additional loads from land development and clearing.

These land-based activities have created increasing numbers of localised ‘pollution halos’ around inshore areas, including the seasonal plume of nutrient-rich sediments from the north-east coastal rivers such as the Burdekin River (Queensland), the contamination in Port Phillip (Victoria) and the toxic sediments at the bottom of the Derwent Estuary (Tasmania) and Sydney Harbour (New South Wales) where dioxin levels in some fish and seafood have been high enough to suspend all commercial fishing in Port Jackson and its tributaries.

The Murray-Darling and Snowy are the only major river systems in Australia that cross state borders and terminate in the marine environment. As a consequence, and unlike most other system-wide threats to the marine environment, addressing the threats from land-based sources can generally be tackled by individual state jurisdictions. Constitutionally the states have a clear mandate to address the land use activities that generate the pollution that impacts on marine ecosystems. However, given the marine receiving waters are a nationally shared resource, it is important that all jurisdictions agree on the suite of remedial and preventative measures and implement these in parallel.

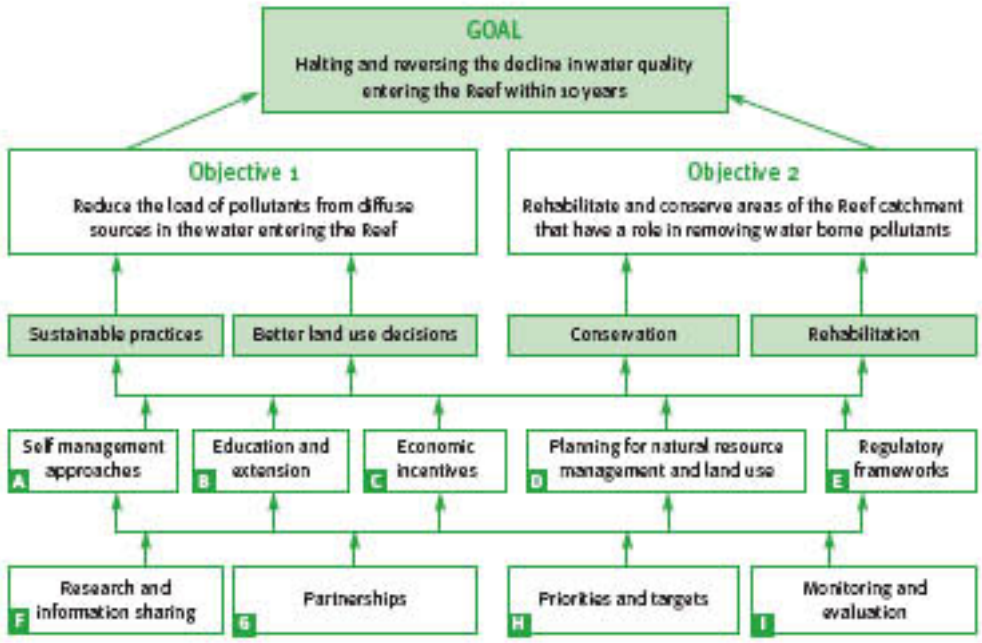
The Natural Resources Ministerial Council prepared *Australia’s National Programme of Action for the Protection of the Marine Environment from Land-based Activities,* which was released in October 2006. The plan discusses major challenge for Australian jurisdictions and proposes solutions that are being pursed by relevant institutions. Major challenges highlighted by the plan include catchment degradation, coastal development, industrial development and habitat loss.

Case Study – Great Barrier Reef Water Quality Protection Plan

The Great Barrier Reef is a nationally and internationally significant area. Over the past 150 years the adjacent catchments have been extensively developed for urban infrastructure, and resources exploited for agricultural production, tourism and mining. This has led to significant increases in pollutant loads in waterways. The balance of evidence is that sediment and nutrients from land-based sources are affecting the inshore reefs and seagrass areas of the Great Barrier Reef.

In response to this, the Australian and Queensland governments released the Great Barrier Reef Water Quality Protection Plan (Reef Plan) in December 2003. The Reef Plan is an intergovernmental initiative that involves the community and key industry groups in improving the quality of water flowing into the Great Barrier Reef.

The Reef Plan contains nine strategies. Five main strategies contribute directly to the plan's objectives and ultimately to its goal, underpinned by the other four strategies.



Achievements to date include:

- the development of an integration framework to guide the collection of information on water quality, using spatial and process linkages between catchment management, water quality and the health of the reef to guide setting targets, monitoring changes and reporting outcomes;
- the formation of a Reef Water Quality Partnership to coordinate and support water quality target-setting, monitoring and reporting that links management actions in the reef catchments to the health of the reef;
- the promotion of best management practice through education and extension services, incentive schemes and conservation agreements and covenants with industry, regional natural resource management bodies and government; and
- the Australian and Queensland governments increasing the area of land placed under conservation agreements, implementing successful management strategies on public land, mapping and classifying Queensland's wetlands to support the rehabilitation and conservation of wetlands and riparian zones, monitoring water quality and ecosystem changes in the marine environment, and continuing to support sustainable agricultural practices among land managers in the reef catchment through actions such as the Reef Extension Initiative.

2.4.4 Marine biosecurity

Marine biosecurity is a broad-scale threat to marine biodiversity. The implications of introduced marine pests include, but are not limited to:

- changes in distribution and density of habitat;
- displacement, distribution and abundance changes in marine species assemblages;
- disrupted food chains;
- establishment and spread of new aquatic disease, pathogens and parasites;
- hybridisation;
- increased competition with native species for resources;
- loss and degradation of habitat; and
- predation and domination of native species by introduced species.

The threats of new incursions of introduced marine pests, or translocations of existing pests to new locations within Australia, are real and immediate. There are potentially similar threats of species native to Commonwealth waters being translocated outside their natural ranges – primarily as a result of climate change.

Marine pests can attach themselves to boat hulls, anchor chains, fishing gear, recreational equipment and internal compartments of boats (biofouling). Pests can also be transported in seawater systems of boats, including inside pipes and in bilge and ballast water. Once established in Australia, a marine pest may then pose a threat to other locations, e.g. the Northern Pacific seastar in Tasmania and Victoria is a threat to South Australia and Western Australia. The threat extends to New Zealand, which now imposes special quarantine restrictions on Australian vessels arriving from Hobart and Melbourne.

Invasive marine species now dominate many Australian places. New Zealand screw shells (*Maoricoplus roseus*) have smothered an area of seabed larger than Tasmania at densities sometimes reaching thousands of shells per square metre, and at the same time a native screwshell has become rare.

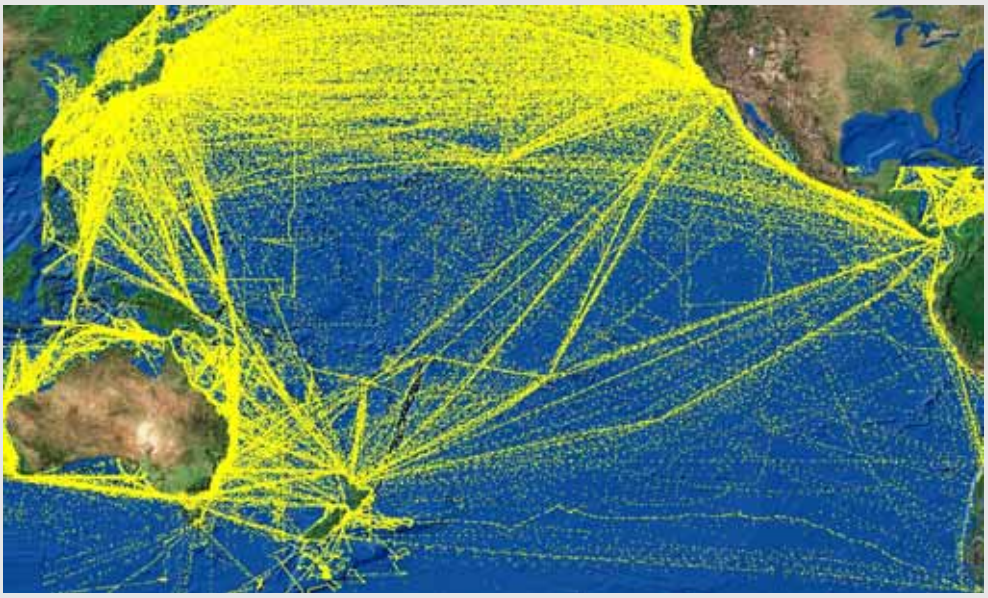
Wild fisheries, aquaculture production, human health, shipping and ports, tourism, coastal amenity, and species and ecosystem health and diversity are all impacted by invasive marine species. The economic impact of introduced marine pests is very serious. The International Maritime Organization (IMO) has estimated that marine invaders translocated by both ballast water and biofouling are costing the world tens of billions of US dollars each year. The black-striped mussel outbreak in Darwin in 1999 cost more than $2 million to control, and required 187 tonnes of liquid sodium hypochlorite and 7.5 tonnes of copper sulphate to poison the local marinas in Australia's first successful eradication of an established marine invasive species. This species could have resulted in significant economic damage. For example, it had the potential to decimate the pearling industry (valued at around $225 million in 1998) and to require substantial continuing mitigation costs as it is a fouling organism of vessels, water outlet pipes and so on.

Most eradication attempts are not successful. Past efforts to eradicate the Northern Pacific seastar from the Derwent Estuary had little effect on the overall population and the pest has spread to Port Phillip Bay, where the population is thought to have exceeded 100 million individuals at one point, although it has dropped substantially since then. Currently the only option is to limit the spread of the seastar around temperate Australia and to other temperate ports in the southern hemisphere.

Case Study – Invasive Marine Species

More than 130 invasive marine species have been identified in Australian waters, the invasion status of a further 300 identified species is uncertain, and many species are yet to be identified. Meanwhile, more invasive marine species are arriving and establishing with an estimated 3 or more new species establishing every year in Victoria's Port Philip Bay alone. Shipping ports have been a main entry point for invasive species and water picked up in international ports to ballast commercial vessels is seen as a major vector when the water is discharged into an Australian port. Of 1593 marine species identified as having an invasive history worldwide, ballast water was a vector for at least 623. At any one time, ballast water may transport more than 10,000 species between marine bioregions worldwide.

A National System for the Prevention and Management of Marine Pest Incursions is being implemented to reduce impact of marine pests. The National System will include measures to prevent the introduction and translocation of marine pests through ballast water and biofouling, emergency response capability to respond to an incursion and ongoing control of established invasive marine species within Australia. Supporting arrangements covering monitoring, research and development, communications and evaluation and review are also being implemented. Australia reduced the risk of further ballast water mediated marine invasions by introducing ballast water management requirements, under the *Quarantine Act 1908,* in July 2001. These require that ships carrying internationally sourced ballast water undertake ballast water management – through the exchange of ballast water sourced from coastal environments for open ocean ballast water. Requirements for the management of biofouling on all vessels entering Australia are also being developed, with an implementation date of 1 July 2008 proposed.



Shipping vessel traffic in the Pacific, 2000, Trevor Gilbert, Australian Maritime Safety Authority

2.4.5 Marine pollution

The implications of marine pollution for marine biodiversity include, but are not limited to:

- degradation or loss of seafloor habitats and poorer water quality;
- displacement of marine species and changes in their distribution and density;
- increased concentrations of contaminants in marine organisms and resultant morphological or other effects; and
- reduction in relative abundance of top-order predators in marine ecosystems.

The major types of marine pollutants are oil, sewage, marine debris, pesticides, nutrients (e.g. agricultural fertilisers and nutrients from finfish farming), residues in industrial wastewater, antifoulants, antibiotics, metals, radioactive waste and thermal pollution. The activities that cause marine pollution generally include shipping, boating (e.g. vessel maintenance activities and littering), oil and gas exploration, mineral resource extraction, stormwater run-off and poor land management practices. The impacts of land management practices are highlighted in Section 2.4.3, while this section focuses on marine-based sources of marine pollution including the effects of toxic substances, oil spills and marine debris.

The sea is the ultimate destination for many toxic substances produced or used on land. In addition, some toxic substances may be introduced directly into the sea (e.g. industrial waste and sewage discharges). Some of the more common chemical contaminants include biocides (e.g. tributyl tin, or TBT) and hydrocarbons (e.g. oil).

Toxic chemicals introduced into the marine environment can become incorporated into the prey that marine animals consume and accumulate in the predators (i.e. bioaccumulation). Toxic chemicals can also affect marine biodiversity indirectly (e.g. by affecting various levels of food webs).

Case Study - Persistent Pollutants in Crabs

An excerpt from *SoE 2006*:

In coastal Queensland, Mortimer (1999) quantified the trace metals, metalloids and pesticide content in intertidal Burrowing Crabs (*Australoplax tridentata*) and the large Mud Crab (*Scylla serrata*). Estuaries between Cairns and Brisbane were sampled and residues of dieldrin were found at all locations, and heptachlor epoxide and DDT were recorded at most. Calculations of ambient exposures to organochlorines based on residues in crab tissues indicated that dieldrin exceeded national water quality guidelines for protection of aquatic ecosystems at all sampling locations, but exposure to DDT and its metabolites was below the threshold of concern. Use of DDT, dieldrin and heptachlor is banned in Australia.

The primary former uses of dieldrin included treating crops for the control of root fly larvae, locusts, crickets and grasshoppers; the building industry to control termites; and to control disease vectors such as cockroaches, fleas and mosquito larvae. Use of dieldrin was progressively restricted from 1973 and banned in June 1994. Heptachlor was used as a soil treatment to control ants and grubs in sugar cane areas; the Banana Weevil Borer (*Cosmopolites sordidus*) in banana plantations; and to control termites in buildings and other structures. Agricultural use of heptachlor ceased in 1987, but it was still used for termite control in Queensland until June 1995. DDT was used extensively in agriculture to control both crop and livestock pests. It was also used for domestic control of fleas, lice, mites and lawn grubs. Domestic uses were banned in 1973, and agricultural use was progressively restricted until it was banned in 1987. Dieldrin, heptachlor and DDT are extremely hazardous to humans and biodiversity.

Oil spills may result in both direct and indirect impacts on marine biodiversity. Oils vary in their toxicity. The effects of exposure to oil generally include acute poisoning (e.g. through inhaled vapours or consumption of oiled prey), chronic poisoning, and damage to skin and mucous membranes. Some oils release toxic vapours that can damage respiratory tissues. Harmful oil fractions may be ingested or consumed through eating contaminated prey. Organisms and environments can be further adversely affected by vigorous clean-up activities.

Although major oil spills pose serious risks to marine ecosystems, including marine biodiversity, small but frequent operational discharges, such as those from outboard motors, introduce large quantities of oil into the sea on an annual basis. The toxic effects of oil on marine biodiversity can include immuno-suppression, reproductive impairment, developmental or behavioural abnormalities, disease (including tumours) and death.

Rubbish such as plastics and fishing line can entangle wildlife, often resulting in strangulation, limb amputation or drowning. Small pieces of rubbish, like cigarette butts and plastics, can be swallowed by marine animals (e.g. marine turtles) and cause internal blockages, often resulting in other complications and starvation. Rubbish accumulating on beaches also has economic impacts, including the loss of aesthetic values in recreational areas that rely on tourism-generated income.

Case Study – The Carpentaria Ghost Net Program

Ghost nets are fishing nets that have been lost accidentally, deliberately discarded or simply abandoned at sea. Floating in the ocean and washing into the coast, the abandoned nets fish indiscriminately and may trap protected and threatened species.

In the Gulf of Carpentaria, ghost nets (mostly from foreign fishing vessels) are a major threat to the continued survival of turtles. Much of the coastline in the Gulf is the breeding and foraging ground for six species of vulnerable or threatened marine turtles, so managing these populations is vital for both Australia and the region.

To put the severity of the 'turtles versus net' threat into perspective, gill nets have been retrieved weighing around five tonnes and estimated to be as much as four kilometres long, and hundreds of turtles have been caught in the nets over the past few years.

To address the problem, Indigenous Sea Rangers in the Gulf of Carpentaria have collaborated with NGOs to establish a project to:

- clean up existing nets along the Gulf coastline to stop them re-entering the ocean;
- collect information about these nets to assist international negotiations by various parties to stop fishing nets becoming ghost nets; and
- build the capacity of Indigenous Sea Rangers to continue solving the problem of ghost nets beyond the life of this project.

The project, now funded with $2 million from the Natural Heritage Trust, is managed by the Northern Gulf Resource Management Group.

Section 3: Objectives and priority actions of a national approach

3.1 Objectives of a national approach

The overall objective of a national approach is to improve the environmental, social and economic outcomes of marine biodiversity conservation. Embedded within this objective, a national approach to assessing and monitoring marine biodiversity and addressing the key threats to it would provide multiple benefits. These would range from more targeted research to better implementation of cost-effective programs and policies. A national approach would encourage partnerships and consultation between governments, industries and other stakeholders in the marine environment. It would fill gaps, reduce overlaps, ensure programs complement each other and provide good guidance on setting priorities.

This report has identified five high-priority, broad-scale threats to marine biodiversity, namely: climate change, resource use, land-based impacts, marine biosecurity and marine pollution. In this section priority actions to respond to these key threats are outlined. They include both new initiatives and the extension or continuation of current initiatives, where it is considered that current initiatives should be supported.

The implementation of any proposals in the report should follow consultation with jurisdictions and stakeholders on the detail, including cost implications.

Priority actions to address climate change, resource use and land-based impacts have been proposed in this section of the report. These proposed actions have been grouped into eight key directions for a national approach. These key directions are presented below beneath broader themes:

Theme 1 – Improving the Effectiveness of Delivery

Key Direction 1 – Foster collaborative relationships amongst jurisdictions to ensure complementary responses to the causes of marine biodiversity decline.

Key Direction 2 – Review and evaluate national coordination across jurisdictions of responses to marine biodiversity decline with respect to key threats.

Key Direction 3 – Promote cooperative and complementary, ecosystem-based planning and management approaches across jurisdictions.

Theme 2 – Measuring Success

Key Direction 4 – Work towards a nationally consistent marine and coastal biodiversity and fisheries monitoring and reporting framework with baseline/reference sites in and out of Marine Protected Areas.

Theme 3 – Improving Knowledge

Key Direction 5 – Develop a targeted strategy to address key gaps in knowledge of marine biodiversity and improve access and sharing of knowledge and data.

Theme 4 – Responses to key threats: protecting ecosystems, habitats and species and increasing resilience

Key Direction 6 – Improve the understanding of the vulnerability of marine biodiversity to climate change focusing on ecosystems and species that are at particular risk.

Key Direction 7 – Develop regional climate adaptation policies and plans based on predictive modelling and integrate them into marine bioregional planning processes.

Key Direction 8 – Progress the integrated management of the coastal zone including monitoring coastal marine biodiversity.

3.2 Responses to management challenges

Responses to the management challenges should include improving the effectiveness of program delivery through better coordination, improving the capacity to understand the state of marine biodiversity and improving knowledge of what makes up Australia's marine biodiversity.

Effective Delivery

There is scope to improve to the effective delivery of marine biodiversity conservation through better integration of planning and management across jurisdictional boundaries. The challenge is to ensure that planning and management objectives are aligned and complementary and that inter-governmental relationships are cooperative and based on good communication.

This would provide for better outcomes, for example, with the management of rare, threatened and migratory species and management of key habitats.

The establishment of integrated, ecosystem-based planning and management across Australia's continental shelf and across jurisdictional boundaries is suggested as an approach to improving the consistency of responses to marine biodiversity decline.

Measuring Success

The value of a nationally consistent system for marine monitoring and assessing the condition of marine biodiversity has been highlighted in this report and in *SoE 2006*. There is considerable scope for building synergies between monitoring and evaluation frameworks that already exist, are being developed or have been identified as a need including, for example:

- marine bioregional planning and networks of MPAs that include monitoring and evaluation as a key requirement;
- the estuarine- and coastal-focused monitoring and evaluation framework;
- data collected for the purposes of the ecologically sustainable management of fisheries; and
- oceanographic and atmospheric observing and monitoring systems.

Improving Knowledge

A coordinated national approach should include addressing key gaps in the knowledge of marine biodiversity and improving access and sharing of data.

This would assist relevant jurisdictions to set research priorities that contribute to filling gaps in our knowledge that inhibit our response to and management of key threats.

A national approach will also provide an opportunity to improve Australia's marine data. Developing standard protocols, sharing and in some cases consolidating marine data that various jurisdictions hold can improve access, broaden our knowledge, and lead to cost savings.

3.3 Responses to key threats

3.3.1 Climate change

The Natural Resource Management Ministerial Council has endorsed a National Biodiversity and Climate Change Action Plan to help coordinate the response and adaptation activities of the various Australian governments. Actions will include gathering knowledge, minimising impact on biodiversity and incorporating knowledge and harm minimisation strategies into the management of natural resources and land use. It could be argued that climate change represents the major challenge to marine biodiversity in the 21st century. Much of the Action Plan is being implemented through existing programs and projects that are underway.

In 2007, the Australian Government prepared a five-year Climate Change Action Plan to minimise the impact of climate change on the Great Barrier Reef and has provided $8.9 million towards its implementation. This Plan identifies a range of actions to increase the resilience of the Great Barrier Reef, and which supplement existing actions under the Reef Water Quality Protection Plan and the Great Barrier Reef Marine Park Zoning Plan. Significant funding ($8.9 million) has been allocated under the National Climate Change Adaptation Framework to implement the Action Plan by 2011.

A meeting of the Council of Australian Governments (COAG) in April 2007 endorsed a Climate Change Adaptation Framework which identifies that climate change will have a significant impact on Australian commercial fisheries and aquaculture. The framework details two proposed actions for the next three to five years for Australian fisheries and aquaculture. These are: the development of a national fisheries action plan and supporting further research to address numerous knowledge gaps. The Fisheries and Climate Change Action Plan will be considered by the Natural Resource Management Ministerial Council in late 2008.

In December 2007, COAG agreed to establish a Working Group on Climate Change and Water which will drive a nationally cooperative approach to long-term adaptation to climate change including accelerating implementation of actions under the framework.

The following priority actions are proposed to achieve a greater understanding of climate change impacts on marine biodiversity and adaptive management approaches:

- improve our understanding of the vulnerability of marine biodiversity to climate change and prioritise future activities:
    - identify species and systems at particular risk from climate change (such as local endemics restricted to a small area of suitable habitat like the spotted handfish) or unique ecosystems with unique evolutionary origins

unlikely to be replicated in another area (e.g. Bathurst Harbour, south-west Tasmania);
    - identify processes threatened by climate change (e.g. tightly coupled processes that become decoupled due to changes in timing; chemical changes in the oceans caused by acidification; and coral bleaching caused by increased temperature maxima); and
    - develop regional climate models and scenario modelling, to assess the potential effects of major regional climate change on marine activities (particularly fisheries and aquaculture) and biodiversity.
- adapt management approaches to the impacts of global climate change on Australia's marine biodiversity:
    - develop regional marine climate adaptation plans that identify climate risks and vulnerabilities and also marine management scenarios and adaptations for marine industries and activities (fisheries, aquaculture, coastal development);
    - integrate current knowledge of regional climate change risks and vulnerability into current large-scale bioregional planning and decision-making processes; and
    - develop a national governance framework to assess and review the integration of current understanding of marine climate change into marine management frameworks and directions.

The Bureau of Meteorology and the CSIRO are developing tools within the Australian Climate Change Science Program that will assist with responding to climate change. The Australian Government, in consultation with States and Territories is also looking at piloting regional adaptation case studies to explore possible integrated solutions for addressing climate change impacts at a regional level.

3.3.2 Resource use

The marine environment is highly connected and interdependent and, in some circumstances, resource management measures will need to take place over large scales to be effective. This will require inter-jurisdictional cooperation, data collection, interpretation, policy, management and monitoring to sustainably manage available marine resources and maximise cost savings across jurisdictions. A stable, long-term funding base within government is likely to be increasingly pursued in the future, which will encourage co-investment from private-sector resource users.

Australian fisheries agencies are progressively working towards implementing ecosystem-based fisheries management. This approach considers the broader and cumulative impacts of fishing including impacts on bycatch, by-products, protected species, habitats and ecosystems. Risk assessments are being used to focus effort and resources on addressing the highest risks. Actions to address biodiversity decline in the marine environment and protect fisheries stocks must consider a range of management measures at appropriate scales, and be supported by progressively implementing the NRSMPA.

The individual and cumulative ecological effects of the various uses of Australia's marine resources must continue to be carefully assessed and managed, and our responses must adapt to changing environmental and market conditions. To meet the growing need for fish, we must make better use of the fish we catch and encourage environmentally responsible entrepreneurs in our fishing and aquaculture sectors. As these industries are heavily influenced by market trends, better education of the end users to encourage informed and responsible purchasing will increasingly drive innovations in sustainable harvesting and production methods.

The following priority actions are proposed to achieve sustainable resource use:

- Progress efforts to ensure the ecological sustainability of Australia's fisheries including:
    - investigate options and mechanisms to extend the ecological risk analysis of fisheries (and associated revisions to management approaches) to all developed and active Australian fisheries including recreational fisheries;
    - ensure that ecological sustainability assessments for fisheries pay particular attention to managing impacts on top-order predators;
    - promote national standards for fisheries monitoring and reporting (commercial, recreational and Indigenous harvests);
    - develop management arrangements for all fisheries based on ecologically sustainable development principles;
    - develop and expand plans that address the impacts of fishing on marine biodiversity (e.g. bycatch action plans, recovery plans, threat abatement plans and national plans of action);
    - continue to implement the National Recreational Fishing Policy; and
    - continue to implement the National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.
- Develop a national network of baseline/reference sites by establishing the National Representative System of Marine Protected Areas including highly protected areas and providing periodic monitoring.
- Develop high-level links between industry, government, conservation organisations and other relevant stakeholders to identify the most cost-effective and environmentally beneficial approaches to conserving biodiversity assets and marine resources, while minimising disruption to industry.
- Progress further development of national fisheries databases, at ecologically relevant scales, where necessary for enhanced reporting and management purposes, and develop national protocols to maximise data sharing between agencies.
- Build capacity in Indigenous communities for sustainable management of Indigenous fishing.
- Promote effective institutional arrangements for managing marine resources and habitats, both within Australia and with our neighbours, including improved fisheries management and monitoring, and control and surveillance of remote areas of the EEZ.
- Increase seafood consumer education to promote purchase of sustainably harvested local species and to readily identify at-risk species or fisheries. Adopt a national seafood eco-labelling scheme for all seafood sold in Australia (domestic and imported) and promote the reporting of inappropriately and illegally labelled seafood products.

3.3.3 Land-based impacts

The *Australia's National Programme of Action for the Protection of the Marine Environment from Land-based Activities* report released in October 2006 discusses the lessons learned from the initiatives addressing land-based impacts. It points out that common in many jurisdictions is the absence of high-level coordination of research, education or monitoring initiatives aimed at either point or diffuse sources of marine pollution. This represents a significant gap in any approach to reducing marine pollution and habitat destruction.

This report considers that the following issues should be addressed through an integrated and targeted program of priority actions:

- diffuse rural pollution from agriculture and grazing;
- diffuse urban pollution run-off from existing and developing urban areas;
- point source pollution from regulated and unregulated emission sources; and
- protection of foreshore and neighbouring areas from land use changes, which may require future intervention to stop natural coastal processes from threatening inappropriately located infrastructure.

The following priority actions are proposed:

Diffuse Rural Pollution

- Prepare and implement environmental values and water quality objectives for catchments where sediment, pesticide and nutrient loads are significantly elevated above natural levels.
- Encourage the development of comprehensive rural industry and catchment-specific programs to facilitate the uptake of best practice-based farm management systems by a majority of agricultural enterprises (e.g. over 90%) in targeted catchments within set time frames (e.g. five years). Best practice includes maximising biodiversity and water quality values at the 'paddock' scale. Programs will include a mix of incentive, market and regulatory-based mechanisms.
- Conduct an audit of Commonwealth and state rural support schemes to identify any that create negative impacts on the marine environment. Provide advice to government where these schemes may be having a negative impact on the marine environment.

Diffuse Urban Pollution

- Prepare statutory environmental values and water quality objectives for all urban coastal catchments (e.g. those towns with a population greater than 5000).
- Encourage the preparation and implementation of statutory storm-water management plans for all urban catchments with populations greater than 10,000, or greater than 5000 if located within 10 kilometres of the coast or tidal waterways.
- Encourage the further development of planning instruments that ensure urban developments of 'greenfield' sites are designed, constructed and operated to achieve, at a minimum, no net decrease in the current water quality of the receiving waters, or do not exceed statutory water quality objectives.
- Encourage the development of planning requirements to prohibit development in areas at risk from coastal erosion over the long term, except for coastal-dependent uses and temporary facilities for recreation or safety purposes.

Point Source Pollution

- Encourage the development of planning instruments to substantially reduce emissions to waterways from regulated and unregulated point sources (e.g. to zero within 15 years), supported by programs that use a mix of incentive, market-based and regulatory mechanisms.

3.3.4 Marine biosecurity

Governments have initiated the development and implementation of The National System for Prevention and Management of Marine Pest Incursions (the National System) as a comprehensive approach to minimise the risk posed by marine pests to

Australia's marine environment and industries. This report does not propose any priority actions beyond those being implemented under the National System.

The main vectors for marine pests arriving in the Australian marine environment are biofouling and ballast water as outlined in Section 2.4.4.

The Australian, state and Northern Territory governments have committed to the establishment of the National System. The roles and responsibilities for implementing it were agreed in an intergovernmental agreement signed by the Australian, state (except New South Wales) and Northern Territory governments in 2005. The National System is currently being implemented and consists of three components:

- Prevention: prevention systems to reduce the risk of introduction and translocation of marine pests;
- Emergency response: a coordinated emergency response to new incursions and translocations; and
- Ongoing control and management: managing introduced marine pests already in Australia.

Prevention

The prevention element of the National System has two main aspects: international or incursion risks to Australia, and domestic or translocation risks within Australia. Strategies to minimise these risks are aimed at managing all potential vectors by addressing the ballast water and biofouling risks for commercial ships; and the biofouling risks for recreational, non-trading, petroleum and fishing vessels, marine aquaculture operations, and port, harbour and marina facilities; and the aquarium trade.

The Australian Government has had ballast water management requirements, under the *Quarantine Act 1908,* in place for international ships since 2001. Consistent national legislation is being put in place by the states and the Northern Territory for the management of ballast water between Australian ports. Australia's requirements will also be consistent with the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004.

The Australian Government is developing requirements for the management of biofouling on all international vessels arriving in Australia. These requirements, to be implemented through the *Quarantine Act 1908*, are expected to be in place from 1 July 2008. National Best Practice Biofouling Guidelines for each sector (covering commercial ships, non-trading vessels, commercial fishing vessels, recreational vessels, the petroleum industry, aquaculture, ports, marinas and slipways) will be implemented for all domestic vessels on a voluntary basis by the states and the Northern Territory.

Emergency Response

The emergency preparedness and response element aims to contain or eradicate any new marine pest incursions to Australia. These efforts are coordinated by the Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE). CCIMPE's charter is limited to new incursions or significant new translocations of introduced marine pests of concern. Funding for these eradication responses is split on a 50:50 basis between the Australian Government and the state and Northern Territory governments. The Northern Territory's and national response to the black-

striped mussel incursion into Darwin in 1999 was the first successful eradication of an established marine invasive in the world (see Section 2.4.4).

Ongoing Management and Control

The ongoing management and control element of the National System aims to contain and control any introduced marine pests that have established viable populations within Australia and are having, or are expected to have, a significant impact on the marine environment, industry, human health or amenity. National Control Plans are being developed for six established species, including:

- Northern Pacific seastar (*Asterias amurensis*);
- European shore crab (*Carcinus maenas*);
- Asian date mussel (*Musculista senhousia*);
- Mediterranean fan worm (*Sabella spallanzanii*);
- Japanese seaweed (*Undaria pinnatifida*); and
- European clam (*Varicorbula gibba*).

Supporting Activities

Four other components of the National System are being implemented to support the three main elements. These are:

- Research and Development: targeted research to underpin policy and management.
- Monitoring for the presence of target species to an agreed national standard in 18 priority locations.
- Communications: industry and community awareness and education.
- Evaluation and Review: to evaluate the effectiveness of the National System.

Full implementation of the National System by all jurisdictions is expected to address the primary threats to Australia's biodiversity posed by invasive marine species. Additional strategies targeting threats in a specific area or to specific species or communities may need to be considered in particular instances.

3.3.5 Marine pollution

The task of addressing marine pollution around Australia will vary markedly from place to place. However, nationally an integrated and targeted approach to build the public's understanding of the value of marine biodiversity, and specifically address marine debris, would play a major role in combating this issue. This report does not propose priority actions additional to existing initiatives to address marine pollution.

Communication strategies are essential to raise stakeholder and community awareness of the issues of marine pollution and to persuade both groups to reduce individual impacts on marine biodiversity. It may be worthwhile to consider developing incentive schemes to ensure best-practice management of sewage discharge and schemes to minimise marine debris.

Within Australia, some of the existing strategies for combating the effects of marine pollution include the following:

- A Threat Abatement Plan is being developed to provide a national framework to guide the coordinated implementation of measures to prevent and mitigate the impacts of harmful marine debris on marine species. 'Injury and fatality to

vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris' was listed in August 2003 as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

- The New South Wales and Victorian governments have listed marine debris as a key threatening process under state legislation.
- The *International Convention for the Prevention of Pollution from Ships 1973 and its Protocol 1978* (MARPOL 73/78) is the principal international measure regulating waste disposal at sea.
- The commercial and recreational fishing industries have both adopted codes of practice, which include actions to reduce marine debris. The commercial industry's code is based on the UN Food and Agriculture Organisation's *Code of Conduct for Responsible Fisheries*.
- The *National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances* is a national integrated government and industry organisational framework that enables effective responses to marine pollution incidents. The Australian Maritime Safety Authority (AMSA) manages the National Plan, working with the states and Northern Territory governments, the shipping, oil, exploration and chemical industries, and emergency services to maximise Australia's marine pollution response capability. The National Plan Management Committee (NPMC) provides strategic management of the National Plan while the National Plan Operations Group (NPOG) handles operational functions.

A key mechanism for ensuring the effective implementation of these national initiatives is for government jurisdictions to work collaboratively with industry to implement on-ground changes to practices that are producing marine pollution.

Conclusions

This report outlines key aspects of what is known about the current status of Australia's marine biodiversity, identifies the key threats to this biodiversity and identifies several impediments to effective government responses to marine biodiversity decline. It sets out a national approach to addressing key causes of marine diversity decline and to improving the effectiveness of responses.

This report draws on *SoE 2006* and other sources that assess the current condition of marine biodiversity and describe trends in its condition. Despite the lack of comprehensive information, a point highlighted in *SoE 2006*, there is sufficient evidence to conclude that Australia's marine biodiversity is in decline.

Decline in marine biodiversity occurs despite the combined efforts of Australia's governments, industries, stakeholders and the community. Several longstanding strategies and programs across all jurisdictions that are concerned with conservation specifically or with the ecological sustainability of marine industry sectors are already in place.

The opportunity exists to act now to limit and reverse current trends of decline, mitigate against emerging threats and to maintain viable and productive marine biodiversity into the future.

The aim of a national approach should be to reduce further losses, increase resilience and to allow damaged ecosystems an opportunity to recover. The imperative to increase the resilience of ecosystems is made more critical by the projected effects of climate change and the view of science that marine biodiversity that is in the best shape possible will be more resilient to climate change.

The national approach to addressing marine biodiversity decline outlined in this report focuses on five significant, broad-scale threats to marine biodiversity: climate change, resource use, land-based impacts, marine biosecurity and marine pollution.

The report concludes that while it is important to continue to focus responses on key threats, there is scope to improve coordination of efforts to address these threats, to strengthen our understanding of marine biodiversity and to continue to address knowledge gaps in a strategic manner.

The Working Group proposes the following key directions for the national approach. Working towards these could enhance current efforts to minimise impacts on marine biodiversity or improve the capacity of governments to understand and respond to marine biodiversity decline. Suggested key directions are listed under broad themes below.

Theme 1 – Improving the Effectiveness of Delivery

Key Direction 1 – Foster collaborative relationships amongst jurisdictions to ensure complementary responses to the causes of marine biodiversity decline.

Key Direction 2 – Review and evaluate national coordination across jurisdictions of responses to marine biodiversity decline with respect to key threats.

Key Direction 3 – Promote cooperative and complementary, ecosystem-based planning and management approaches across jurisdictions.

Theme 2 – Measuring Success

Key Direction 4 – Work towards a nationally consistent marine and coastal biodiversity and fisheries monitoring and reporting framework with baseline/reference sites in and out of Marine Protected Areas.

Theme 3 – Improving Knowledge

Key Direction 5 – Develop a targeted strategy to address key gaps in knowledge of marine biodiversity and improve access and sharing of knowledge and data.

Theme 4 – Responses to key threats: protecting ecosystems, habitats and species and increasing resilience

Key Direction 6 – Improve the understanding of the vulnerability of marine biodiversity to climate change focusing on ecosystems and species that are at particular risk.

Key Direction 7 – Develop regional climate adaptation policies and plans based on predictive modelling and integrate them into marine bioregional planning processes.

Key Direction 8 – Progress the integrated management of the coastal zone including monitoring coastal marine biodiversity.

Priority actions have been identified in respect to climate change, resource use and land-based pollution. Agreed integrated strategies for action for marine biosecurity and marine pollution exist and are being implemented, and no additional actions are proposed. The report proposes both new actions and actions that require continuation and extension of the current work of governments.

While the report proposes key directions and related priority actions it should be noted that the implementation of any proposals in the report should follow consultation with jurisdictions and stakeholders on the detail. Some proposals such as those under the Measuring Success theme will have cost implications.

Further reading

Allen Consulting Group (2004) *Assessing the Benefits of Regional Marine Planning*. Allen Consulting Group, Melbourne, Victoria.

Australian Biosecurity Group (2005) *Invasive weeds, pests and diseases: solutions to secure Australia*, CRC for Pest Animal Control, CRC for Australian Weed Management & WWF– Australia, Canberra.

Australian Maritime Safety Authority (n.d.) *The National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances*, Australian Maritime Safety Authority, Canberra, <http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/> accessed 15 June 2007).

Australian Marine Sciences Association (2005) 'Marine Taxonomy in the New Millennium', Discussion Paper for the Oceans Policy Science Advisory Group, May 2005.

Australian State of the Environment Committee (2006) *Australia State of the Environment 2006*, independent report to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage, Canberra.

Beeton, RJS (Bob), Buckley, KI, Jones, GJ, Morgan D, Reichelt RE, Trewin D (2006 Australian State of the Environment Committee) 2006, *Australia State of the Environment 2006*, Independent report to the Australian Government Minister for the Environment and Heritage, Department of the Environment and Heritage, Canberra.

Chin, A (2004) 'Coral Reefs', in: *The State of the Great Barrier Reef On-line*, ed. A.Chin, Great Barrier Reef Marine Park Authority, Townsville <http://www.gbrmpa.gov.au/corp_site/info_services/publications/sotr/latest_updates/corals> accessed 22 October 2007.

Chin, A (March 2005) 'Seagrasses', in: *The State of the Great Barrier Reef On-line*, ed. A.Chin, Great Barrier Reef Marine Park Authority, Townsville http://www.gbrmpa.gov.au/publications/sotr/seagrasses/index.html accessed 22 October 2007.

Coles, R.G, McKenzie, LJ, Rasheed, MA, Mellors, JE, Taylor, H, Dew, K, McKenna, S, Sankey, TL, Carter, AB & Grech, A (2007) 'Status and Trends of seagrass in the Great Barrier Reef World Heritage Area: Results of monitoring in MTSRF project 1.1.3', Marine and Tropical Sciences Research Facility, Cairns (108 pp).

Coles, RG, McKenzie, LJ & Campbell, SJ (2002) 'The seagrasses of eastern Australia', in: EP Green, FT Short & MD Spalding (eds), *The World Atlas of Seagrasses: present status and future conservation*. University of California Press, Chap. 11, pp. 131–147.

Coles, RG, Smit, N, McKenzie, LJ, Roelofs, AJ, Haywoood, M & Kenyon R (2004) 'Seagrasses', Chap. 2, in: 'A description of key species groups in the Northern Planning Area – Background paper', National Oceans Office, Hobart, pp. 9–22.

Currie, DR & Small, DJ (2005) 'Macrobenthic community responses to long-term environmental change in an east Australian sub-tropical estuary', *Estuarine, Coastal and Shelf Science* 63, pp. 315–331.

Department of Agriculture, Fisheries and Forestry – Australia (2003) *Looking to the future*. A review of Commonwealth fisheries policy, Department of Agriculture, Fisheries and Forestry – Australia, Canberra.

Department of Agriculture, Fisheries and Forestry (2007) Commonwealth Fisheries Harvest Strategy, Policy and Guidelines. Department of Agriculture, Fisheries and Forestry, Canberra.

Dakin, WJ, *Whalemen Adventurers*, Sirius Book, Sydney 1964.

Edyvane, K (2003) *Conservation, Monitoring and Recovery of Threatened Giant Kelp (*Macrocystis pyrifera*) Beds in Tasmania – Final Report*. Department of Primary Industries, Water and the Environment, Tasmania.

Eyre, BD & Ferguson, AJ (2006) 'Impact of a flood event on benthic and pelagic coupling in a sub-tropical east Australian estuary (Brunswick)', *Estuarine, Coastal and Shelf Science* 66, pp.111–122.

Green, EP & Short, FT (2003) *World Atlas of Seagrasses*. Prepared by the UNEP World Conservation Monitoring Centre, University of California Press, Berkeley, USA.

Halliday & Robins (2007) *Environmental flows for sub-tropical estuaries*. Final report. Fisheries Research Development Corporation Project No. 2001/022.

Hayes, K, Sliwa, C, Migus, S, McEnnulty, F & Dunstan, P (2005) *National priority pests – Part II*. *Ranking of Australian marine pests*, an independent report for the Department of the Environment and Heritage by CSIRO Marine Research, Canberra.

Haynes, D, Brodie, J, Christie, C, Devlin, M, Michalek-Wagner, K, Morris, S, Ramsay, M, Storrie, J, Waterhouse, J & Yorkston, H (2001) *Great Barrier Reef Water Quality Current Issues*. Great Barrier Reef Marine Park Authority, Townsville.

Haynes, D, Ralph, P, Müller, J, Prange, J, Michalek-Wagner, K & Waterhouse, J (2000) 'The occurrence and impact of herbicides in the Great Barrier Reef, Australia', *Reef Research* 10, pp. 3–5.

Hewitt, CL, Campbell, ML, Thresher, RE, Martin, RB, Boyd, S, Cohen, BF, Currie, DR, Gomon, MF, Keough, MJ, Lewis, JA, Lockett, MM, Mays, N, McArthur, MA, O'Hara, TD, Poore, GCB, Ross, DJ, Storey, MJ, Watson, JE & Wilson, RS (2004) 'Introduced and cryptogenic species in Port Phillip Bay, Victoria, Australia', *Marine Biology* 144(1), pp. 183–202.

Hobday, AJ, Okey, TA, Poloczanska, ES, Kunz, TJ & Richardson, AJ (eds) (2006) *Impacts of climate change on Australian marine life*, CSIRO Marine and Atmospheric research report to the Australian Greenhouse Office, Canberra, Australia.

Hoegh-Guldberg, O, Mumby, PJ ,Hooten, AJ, Steneck, RS, Greenfield, P, Gomez, E, Harvell, CD, Sale, PF, Edwards, AJ, Caldeira, K, Knowlton, N, Eakin, CM, Iglesias-Prieto, R, Muthiga, N, Bradbury, RH, Dubi, A, Hatziolos, ME (2007) 'Coral reefs under rapid climate change and ocean acidification', *Science* 318(5857), pp. 1737–1742.

Johnson, C, Ling, S, Ross, J, Shepherd, S & Miller, K (2005) *Establishment of the long-spined sea urchin (Centrostephanus rodgersii) in Tasmania: first assessment of potential threats to fisheries*. FRDC Final Report, 2001/044, 79 pp.

Johnson JE & Marshall PA (eds) (2007) *Climate Change and the Great Barrier Reef*. Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia.

Klaer, NL (2001) 'Steam trawl catches from south-eastern Australia from 1918 to 1957: trends in catch rates and species composition', *Marine and Freshwater Research* 52, pp. 399–410.

Limpus, CJ. & Couper, P (1994) 'Loggerheads: a species in decline', *Wildlife Australia*, 30, pp. 11–13.

Marsh, H & Lawler, IR (2001a) 'Dugong distribution and abundance in the Northern Great Barrier Reef Marine Park, November 2000'. Great Barrier Reef Marine Park Research Publication No. 77, Townsville, 62 pp.

Marsh, H & Lawler, IR (2001b), 'Dugong distribution and abundance in the Southern Great Barrier Reef Marine Park and Hervey Bay: results of an aerial survey in October–December 1999'. Great Barrier Reef Marine Park Authority Research Publication No. 70, Townsville.

Marsh, H, De'ath, G, Gribble, N & Lane, B (2001) 'Shark control records hindcast serious decline in dugong numbers off the urban coast of Queensland'. Great Barrier Reef Marine Park Authority, Townsville, 22 pp.

Marsh, H, De'ath, G, Gribble, N & Lane, B (2005) 'Historical marine population estimates: triggers or target for conservation? The dugong case study', *Ecological Applications* 15,pp. 481–492.

Marsh, H, Lawler, IR, Kwan, D, Delean, S, Pollock, K & Alldredge, M (2003) 'The status of the dugong in Torres Strait in November 2001'. Final Report to Torres Strait Fisheries Scientific Advisory Committee, AFMA/JCU, Canberra, 48 pp.

Marsh, H, Lawler, IR, Kwan, D, Delean, S, Pollock, K & Alldredge, M (2004) 'Aerial surveys and the potential biological removal techniques indicate that the Torres Strait dugong fishery is unsustainable', *Animal Conservation* 7, pp. 435–443.

Natural Resource Management Ministerial Council (2004a) *Draft Framework for a National Approach to Integrated Oceans Management* (endorsed on 3 December 2004), Natural Resource Management Ministerial Council, Australian Government, Department of the Environment and Heritage, Canberra.

Natural Resource Management Ministerial Council (2004b) *National Biodiversity and Climate Change Action Plan 2004–07*, Natural Resource Management Ministerial Council, Australian Government, Department of the Environment and Heritage, Canberra.

Natural Resource Management Ministerial Council (2006) *Australia's National Programme of Action for the Protection of the Marine Environment from Land-based Activities*, Natural Resource Management Ministerial Council, Australian Government, Department of the Environment and Heritage, Canberra.

Parra, G.J, Corkeron, PJ & Marsh, H (2004) 'The Indo-Pacific humpback dolphin, Sousa chinensis (Osbeck, 1765), in Australian waters: a summary of current knowledge', *Aquatic Mammals* 30, pp. 197–206.

Parra, GJ, Azuma, C, Preen, AR, Corkeron, PJ & Marsh, H (2002) 'Distribution of Irrawaddy Dolphin, Orcaella brevirostris, in Australian waters', *The Raffles Bulletin of Zoology*, Supplement, 10, pp. 141–154.

Pitcher, CR, et al. (2007) *Seabed Biodiversity on the Continental Shelf of the Great Barrier Reef World Heritage Area*. AIMS/CSIRO/QM/QDPI Final Report to CRC Reef Research. 315 pp.

Ponder et al. (2002) *Overview of The Conservation of Australian Marine Invertebrates*, A Report For Environment Australia, <http://www.austmus.gov.au/invertebrates/pdf/marineoverview.pdf>.

Ribbe, J (2007) 'A study into the export of saline water from Hervey Bay, Australia', *Estuarine, Coast and Shelf Science* (in press)

Robbins, WD, Hisano, M, Connolly, SR & Choat, JH (2006) 'Ongoing collapse of coral-reef shark populations', *Current Biology* 16, pp. 2314–2319.

Roberts, CM (2007) *The Unnatural History of the Sea*, Island Press, Washington DC p. 105.

Schaffelke, B, Waterhouse, J & Christie, C (2001) 'A review of water quality issues influencing the habitat quality in Dugong Protection Areas. Research Publication No. 66'. Great Barrier Reef Marine Park Authority, Townsville.

The Endeavour Journal of Joseph Banks 1768–1771, 'Some Account of That Part of New Holland Now Called New South Wales', Public Library of New South Wales, 26 August 1770, <http://setis.library.usyd.edu.au/ozlit/pdf/p00021.pdf>.

Ward TJ & Butler A (2006) *Coasts and Oceans*, theme commentary prepared for the 2006 State of the Environment Committee, Department of the Environment and Heritage, Canberra, <http://www.environment.gov.au/soe/2006/commentaries/coasts/index.html>.

Worm, B et al. (2006) 'Impacts of biodiversity loss on ocean ecosystem services', *Science* 314, 3 November 2006, p. 787.

Wyatt, ASJ, Hewitt, CL, Walker, DI & Ward, TJ (2005) 'Marine introductions in the Shark Bay World Heritage Property, Western Australia: a preliminary assessment', *Diversity and Distributions* 11, pp. 33–44.

Appendix 1

Terms of Reference for the Marine Biodiversity Decline Working Group

(as agreed by the Natural Resource Management Ministerial Council – April 2006)

The role of the Marine Biodiversity Decline Working Group is to oversee the development of a report that identifies system-wide threats to biodiversity and causes of marine biodiversity decline.

The Chair of the Marine Biodiversity Decline Working Group will be a representative from the Australian Government's Department of the Environment and Heritage.

The Marine Biodiversity Decline Working Group will:

- take the overall responsibility for ensuring that a report is delivered through the Marine and Coastal Committee to Ministerial Council that meets requirements at its November 2007 meeting; and
- draft the report and conduct the analysis supporting the report.

It is envisaged that the marine biodiversity report would include:

- identification of 'system-wide' threats to marine biodiversity from existing information, including information from the *Australia State of the Environment 2006* report;
- identification of high-level gaps in information on threats to marine biodiversity; and
- a list of current programs to address causes of marine biodiversity decline.

Appendix 2

Examples of marine biodiversity decline

Many of these examples are drawn from current scientific studies and from *SoE 2006,* which provides a more comprehensive account of the condition of Australia's marine biodiversity.

Threatened species

- As of March 2008, 66 marine species have been listed as threatened (i.e. endangered, vulnerable or conservation dependent) under the *Environment Protection and Biodiversity Conservation Act 1999*, and the number is likely to increase.
- It is not yet possible to predict whether protection alone will allow some of these species to recover.

Fisheries

- Reports on Commonwealth commercial fisheries by the Bureau of Rural Sciences (BRS) have shown an increase in the number of stocks considered to be overfished since the 1990s. However, the BRS *Fisheries Status Reports 2006* shows show a small reversal in this trend reflecting positive and effective management intervention.

Marine pests

- Ballast water from shipping has been responsible for introducing more than 250 species and possibly more than 500 species, into Commonwealth waters.[7]
- Three introduced species with major impacts on biodiversity, community structure and functioning (e.g. production) of soft-sediment communities in south-eastern Australia are the Northern Pacific seastar (*Asterias amurensis*), New Zealand screw shell (*Maoricolpus roseus*) and European green crab (*Carcinus maenus*).
- The Northern Pacific seastar is estimated to cover an area of the seabed equivalent in size to Tasmania.
- In some of Australia's marine World Heritage Areas, there are substantial populations of introduced marine invertebrates.[8]

Birds

- *SoE 2006* states that of the limited number of bird species studied (some waterbirds, coastal shorebirds, island birds and seabirds) in a narrow range of monitored habitats, seven species appear to be stable, seven are declining, four have declined but appear to be rising or stabilising again, and five have expanded either their population or their range in at least one location.

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[7] Department of Environment and Water Resources, *Australia State of the Environment 2006*, Coasts and Oceans: Pressures on Australia's Coasts and Oceans, <http://www.environment.gov.au/soe/2006/publications/report/coasts-2.html> accessed 9 January 2008.

[8] Wyatt, ASJ, Hewitt, CL, Walker, DI & Ward, TJ (2005) 'Marine introductions in the Shark Bay World Heritage Property, Western Australia: a preliminary assessment', *Diversity and Distributions* 11, pp. 33–44.

- However, these data, some of which are compiled at the national level, are difficult to interpret in the absence of a better understanding of natural fluctuations in populations, particularly between species in the same habitat.

Seagrasses

- Australia's seagrass meadows, an important habitat in shallow waters right around Australia, have steadily declined over the past three decades.
- Causes included episodic pressures (e.g. floods and cyclones), nutrient enrichment, heavy metals and toxins, changes in hydrology, sediment run-off, mining, dredging, moorings, boat propellers and introduced species.
- Many major estuaries in New South Wales have lost as much as 85% of their seagrass beds in the past 30 to 40 years.[9]
- Major seagrass losses have been documented in Queensland,[10] Victoria, South Australia and Western Australia.[11]
- Loss of seagrass may contribute to declines in the abundance and diversity of fish and invertebrates in estuaries and in the coastal zone.

Coral

- Coral reefs are already being impacted by climate change. There is a direct link between unusually warm seawater temperature and bleaching of reef-building corals around the world.
- The waters surrounding the Great Barrier Reef have warmed by approximately 0.4 °C since the 19th century and the reef has experienced two major coral bleaching events (1998 and 2002).[12]
- Coral bleaching was again observed in the 2006 summer, particularly in the southern Great Barrier Reef, where local water temperatures reached approximately 1–2 °C above the seasonal average.
- Monitoring in the Great Barrier Reef and in Ningaloo Reef shows considerable local damage and changes in resident species from cyclones, bleaching, fishing, sedimentation and pollution.
- The Great Barrier Reef could be 1–3 °C warmer by the end of this century and, as it warms, conditions conducive to bleaching could occur annually within approximately 20–30 years.[13]
- Changing ocean chemistry (e.g. increased ocean acidification) due to rising carbon dioxide is likely to alter the makeup of marine ecosystems and weaken coral reef structures.[14]
- The Inter-governmental Panel on Climate Change (IPCC) released a report which warned that the Great Barrier Reef would be 'functionally extinct' within decades.

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[9] Department of Environment (Commonwealth), Seagrasses of Australia, 1997, <http://www.environment.gov.au/soe/techpapers/series1/pubs/seagrass.pdf>.

10 Coles, RG, McKenzie, LJ, Rasheed, MA, Mellors, JE, Taylor, H, Dew, K, McKenna, S, Sankey, TL, Carter, AB & Grech, A (2007) *Status and Trends of seagrass in the Great Barrier Reef World Heritage Area: Results of monitoring in MTSRF project 1.1.3.* Marine and Tropical Sciences Research Facility, Cairns (108 pp).

[11] Green, EP & Short, FT (2003) *World Atlas of Seagrasses*. Prepared by the UNEP World Conservation Monitoring Centre, University of California Press, Berkeley, USA.

[12] Australian Institute of Marine Science, Coral reefs and climate change 2007, <http://www.aims.gov.au/pages/about/communications/issues/coral-reefs-and-climate-change-2007.html> accessed 9 October 2007.

[13] Australian Institute of Marine Science, Coral reefs and climate change 2007, <http://www.aims.gov.au/pages/about/communications/issues/coral-reefs-and-climate-change-2007.html> accessed 9 October 2007.

[14] Hoegh-Guldberg, O *et al.* (2007) 'Coral reefs under rapid climate change and ocean acidification', *Science* 318(5857), pp. 1737–1742.

Mangroves

- Mangroves are declining in some places as they are cleared for coastal development, and expanding in certain areas, especially northern Australia. But the extent to which they are expanding into other ecosystems is unclear.

Kelp Forests

- Giant kelp (*Macrocystis*) declined, both in overall area and in number of beds, in some places, until the 1990s with only slight recovery since then.
- *Macrocystis* forests have declined by >50% along the east coast of Tasmania, both in overall area and in number of beds, between 1944 and 1999,[15] with only slight recovery since then (See Case Study on Loss of Giant Kelp Forests in Tasmania).
- In South Australia, it is estimated that up to 55% of kelp forests (*Ecklonia radiata*) have been lost from the Adelaide metropolitan coast since major urbanisation.

Case Study - Loss of Giant Kelp Forests in Tasmania

Giant Kelp (or *Macrocystis*) forests are species/habitats of outstanding ecological and economic significance, representing areas of high biodiversity and productivity. They provide key habitats for the recruitment of economic species (i.e. abalone, rocklobster) and one of the greatest diving experiences in temperate waters. Kelp forests are found throughout the world in shallow open coastal waters (with sea temperatures less than 20 °C). In Australia, dense beds are found along the inshore subtidal reefs of south-east South Australia, Victoria and Tasmania. Tasmania has the largest forests of Giant Kelp in Australia.

Kelp beds are particularly susceptible to environmental changes and, hence, are very good indicators of the ecological health of coastal waters, particularly oceanographic conditions (i.e. pollution, climate change) and also trophic processes (i.e. overfishing). Overseas, major declines in *Macrocystis* have been observed due to prolonged El Niño events and storm events. While the microscopic gametophyte life phase of *Macrocystis* is also strongly susceptible to the effects of marine pollution (particularly sedimentation). Kelp forests are also influenced by the abundance of grazers (i.e. sea urchins, abalone) and their predators (i.e. lobsters, otters, seals).

Climate change is a major driver of the loss of *Macrocystis* beds in Tasmania. A recent study on the historical distribution of kelp beds along the east and south coast of Tasmania has indicated a dramatic decline (>50%) in *M.pyrifera* over the past 50 years, with potentially large-scale, ecological and economic consequences. Greatest losses have occurred in the region under the influence of the Eastern Australian Current (EAC), i.e. north-eastern Tasmania. Further, major kelp loss episodes coincided with strong El Niño events (i.e. 1972, 1982–1983 and 1987) and also storm events. Analysis of historical inshore oceanographic and meteorological data revealed significant ENSO-related changes along the east coast of Tasmania over the period 1944–1999, due to the greater southerly penetration of the EAC. This included a 1.5–2 °C rise in minimum temperatures, a declining influence of subantarctic waters, and declining rainfall (post-1979) and increased mortality from storms due to increased frequency (and severity) of El Niño episodes. Kelp forests were also likely affected by increased urchin populations along the east coast, particularly *Centrostephanus rodgersii;* and spread of the Japanese sea kelp (*Undaria pinnatifida*). Importantly, the abundance of *Centrostephanus* (and urchin barrens) is linked to exploitation of lobster and abalone resources and emphasises the need for integrated management of kelp and fisheries resources.

[15] Edyvane, K (2003) *Conservation, Monitoring and Recovery of Threatened Giant Kelp (Macrocystis pyrifera) Beds in Tasmania – Final Report*. Department of Primary Industries, Water and the Environment, Tasmania.

In addition to the loss of kelp forests, large-scale, community-level shifts (to warm-water species) have also been detected in the zooplankton and fish assemblages of eastern Tasmania. Reports also indicate loss of other coldwater kelp species in the region, such as the bull kelp (*Durvilleae*) on King Island and also off the southern New South Wales coast (~80 km). In light of these results, there is an urgent need to monitor and assess the direct and indirect ecological (and economic) impacts of large-scale, marine climate change and ecosystem shifts, in south-eastern Australia, and develop appropriate climate-adaptation strategies.

Dugongs

- Australia is the world's last stronghold for dugongs. The dugong's range extends around the coastal waters of northern Australia from Shark Bay in Western Australia to Moreton Bay near Brisbane.
- The rate of dugong bycatch in nets is a measure of the population and the catch rate declined by 9% a year between 1962 and 1999 so that catch rates are now only 3% of the initial rate (Figure 1). Aerial surveys suggest that populations in this region have now stabilised at this very low level.
- The decline in dugong numbers has been caused by hunting, entanglement in fishing nets, habitat loss and a range of other causes.
- Although shark control nets set on swimming beaches to protect bathers between Cairns and Brisbane have contributed to the decline in numbers, incidental captures in these nets have been declining since the review of the program in the mid-1990s.
- Modelling suggests that the Indigenous harvest is unsustainable in Torres Strait and off the east coast of Cape York. Governments are working collaboratively with traditional owners to address this issue and to ensure the long-term sustainability of dugong populations.
- Detailed information about the status of dugongs is known for a few areas in Australia (e.g. Shark Bay, Torres Strait, Great Barrier Reef); however, there are significant knowledge gaps in most of Western Australia and the Northern Territory and throughout much of this region but there is cause for concern.

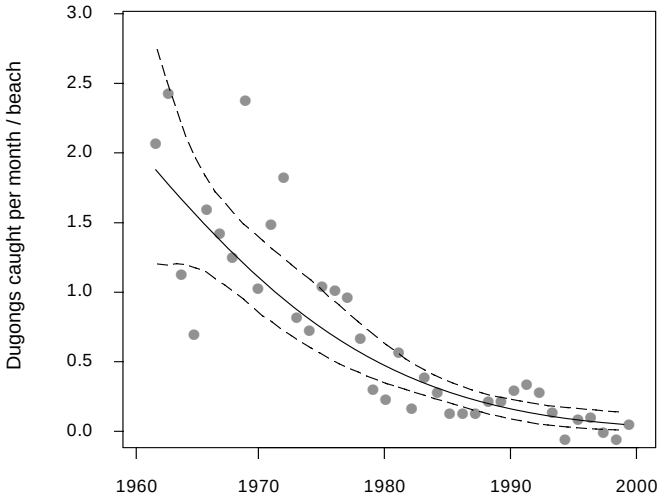

Figure 1 The annual estimated mean numbers of dugongs caught in shark nets 1962–1999. The balanced dataset from six contract areas shows a strong overall decline in the number of

dugongs caught per month per beach. The confidence bands have a 95% point-wise coverage.[16]

Sharks and Rays

- Throughout Australia's EEZ, the effects of target catch, bycatch, and possibly habitat degradation, in Commonwealth and state-managed fisheries, have had a major impact on sharks and rays.[17]
- Declines in abundance of two reef shark species in the northern Great Barrier Reef have been reported.[18]
- There is a high level of concern over the illegal catch of sharks by foreign fishing vessels from tropical waters primarily for harvesting their fins.
- A recent risk assessment of northern Australian sharks and rays identified those species at higher risk from fishing activity.[19] This information is being incorporated into fisheries management strategies in relevant jurisdictions.

Marine Turtles

- All marine turtle species are experiencing serious threats to their survival.
- The main threats vary geographically and it is the cumulative effect of all these threats that hinders the recovery of these populations.
- Broadly, the main threats are incidental capture in fishing gear, pollution, habitat loss and degradation (e.g. coastal development and light pollution close to nesting sites), unsustainable and/or illegal harvest, entanglement in or ingestion of marine debris and vessel strike.

[16] Marsh, H, De'ath, G, Gribble, N, & Lane, B, Shark Control Records Hindcast Serious Decline in Dugong Numbers off the Urban Coast of Queensland & Dugong Distribution and Abundance in the Southern Great Barrier Reef Marine Park and Hervey Bay: Results of an Aerial Survey in October–December 1999, August 2001, p 14.

[17] Ward, TJ & Butler, A (2006) *Coasts and Oceans*, theme commentary prepared for the 2006 State of the Environment Committee, Department of the Environment and Heritage, Canberra, http://www.environment.gov.au/soe/2006/commentaries/coasts/index.html

[18] Robbins, WD, Hisano, M, Connolly, SR & Choat, JH. 2006 'Ongoing Collapse of Coral-Reef Shark Populations', *Current Biology* 16, pp. 2314–2319.

[19] Salini, J, McAuley, R, Blaber, S, Buckworth, R, Chidlow,J, Gribble, N, Ovenden, J, Peverell, S, Pillans, R, Stevens, J, Stobutzki, I, Tarca, C & Walker, T *Northern Australian sharks and rays: the sustainability of target and byctach fisheries, Phase 2*. Final report for Project 2002/064. Fisheries Research and Development Corporation and CSIRO Marine and Atmospheric Research.

Case Study - Loggerhead Turtles

All six species of marine turtle are threatened by a variety of human activities and are protected by Commonwealth and state government legislation. Since surveys began in the late 1970s the number of nesting loggerhead females has steadily declined by 50-80% from about 1000 breeding females to a few hundred. The east Australian population of loggerhead turtles used to represent the bulk of the South Pacific stock (one of about eight loggerhead stocks globally). If this population disappears, it would mean the effective removal of the South Pacific stock. As female turtles return to nest in the area where they hatched, it is highly unlikely that a population that has 'died out' would be recolonised by turtles from another population somewhere else in the world.

Management efforts have been focused on the protection of nesting and foraging sites through National Parks, the rezoning of the Great Barrier Reef Marine Park, on the development of methods to reduce mortality in trawl fisheries and shark control programs, baiting programs to reduce the incidence of fox predation adjacent to important nesting beaches and on the continuation of status monitoring. Early indications are that the decline has halted although full recovery of the loggerhead population is likely to take several decades.

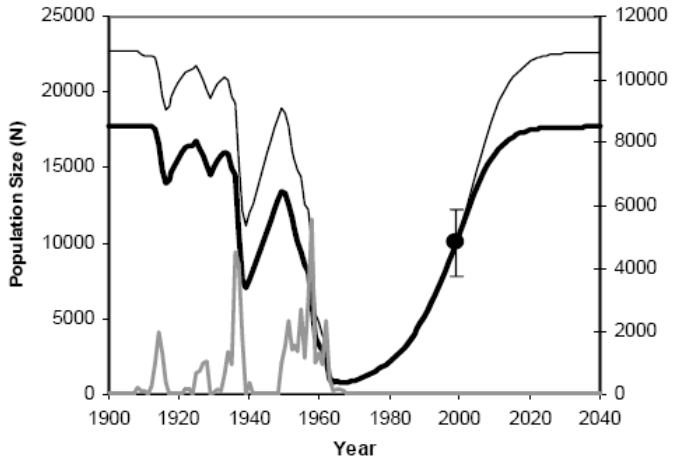

Fig. 4. Population trajectories (medians) of the base case assessment modelling results for Breeding stock D for the Core (solid thick line) and Fringe (solid thin line) feeding ground catch allocation hypotheses. Models are fit to the "Paxton" recent abundance estimate (shown as the dot with its 95% CI) and the IWC (1996) trend data. The historic catch series (Fringe) is shown as a gray line. [The total Core catch series is some 25% less than the Fringe.]