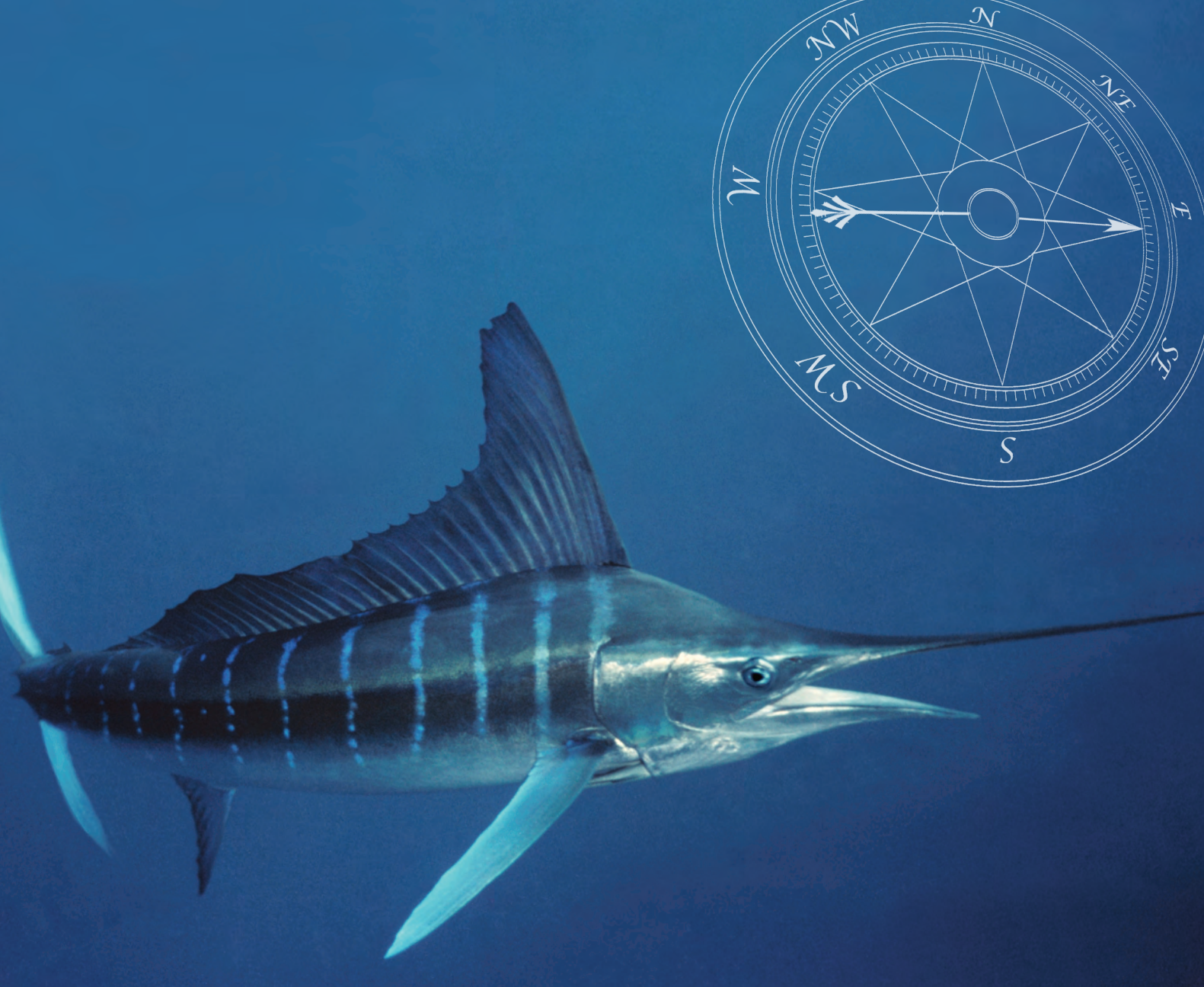

The East Marine Bioregional Plan

Bioregional Profile

A Description of the Ecosystems, Conservation Values and Uses of the East Marine Region

Australian Government

Department of the Environment, Water, Heritage and the Arts

Ministerial Foreword

Australia is responsible for around 60 000 kilometres of coastline and around 15 million square kilometres of ocean, an area almost twice the size of our continental land mass. As an island continent we have one of the biggest Exclusive Economic Zones of any country. The Australian people are known around the world for our connections with the ocean.

Australia's marine systems encompass the tropical seas of the north to the Antarctic ice-shelves of the south. The extraordinary natural diversity and biological richness of our oceans means that Australians are significant global stewards of marine biodiversity.

Our national record in marine conservation is a mixed one. We have certainly led the world in the protection of coral reef systems and in our protection of iconic marine animals such as whales, turtles and sea birds. Our marine protected area network, covering some 88 million hectares, is among the largest in the world. Our performance in other areas, such as halting the decline in ecologically important fish stocks and taking early action to address the cumulative impacts of human activities, including those onshore, has not been as effective.

The Government is committed to protecting the biological diversity in the oceans we manage and addressing the issues of ecologically sustainable use of ocean resources. This will benefit all Australians, both now and in the future. We have the opportunity to make a difference right now and lead the world in our approach to marine conservation. In so doing, we will also be one of the first countries to deliver a nationally representative network of marine protected areas by the internationally agreed goal of 2012.

Limited information about Australia's marine biodiversity, especially for the species and ecosystems of the more remote and deeper areas, has been a barrier to developing a strategic approach to the sustainable management of our oceans. Our lack of knowledge has also made it difficult to develop an effective response to both the large and small scale impacts of change in ocean ecosystems, such as those resulting from global warming.

Marine bioregional planning helps us to better understand and protect our marine environment, conserve biodiversity and deliver greater certainty to decision-makers and the wider community about Australia's marine conservation priorities. It also assists industries that rely on the oceans' natural resources, collectively worth billions of dollars each year to the Australian economy, to better plan and manage their activities.

The natural world carries profoundly strong cultural connections for Indigenous communities and sea country is an integral part of this world for coastal and islander communities. We will be working with Aboriginal people and Torres Strait Islanders to ensure their views and conservation goals are incorporated in the planning process.

This East Marine Bioregional Profile brings together, for the first time, the best available information for the East Marine Region. It consolidates our knowledge of the spectacular and varied features of the Coral and Tasman Seas, from Cape York Peninsula to southern New South Wales and stretching hundreds of kilometres from shore to include Lord Howe and Norfolk Islands. The East Marine Region is home to an amazing array of species, ecosystems and habitats including pristine coral reefs perched on broad undersea plateaus, deep canyons and trenches, quiet abyssal depths and whole ranges of seamounts beneath the ocean's surface.

The East Bioregional Profile is the starting point for developing a Marine Bioregional Plan for the Region, which I will be releasing in 2010. It is one of four Plans that together will identify the conservation values of our oceans and the actions we need to take to protect them, including the areas we will look to include in the national marine protected area network. Nowhere else in the world is marine conservation planning being undertaken at this scale and in this timeframe.

With the assistance and involvement of all stakeholders, I believe that bioregional planning can set a new standard in marine planning and management for Australia and the world.

Peter Garrett
Minister for the Environment, Heritage and the Arts

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Snakestar on coral. Photo: NORFANZ, Department of the Environment, Water, Heritage and the Arts, CSIRO, New Zealand's Ministry of Fisheries and NIWA.

Preface

Marine bioregional planning is the Australian Government's world-leading approach to protecting Australia's marine environment. Marine bioregional planning is underpinned by the principles of ecologically sustainable development and takes an ecosystem approach in managing Australia's marine biodiversity and environment.

This Bioregional Profile has been prepared by the Department of the Environment, Water, Heritage and the Arts as the first step in the development of a Marine Bioregional Plan for Australia's East Marine Region. It establishes the information base upon which the East Marine Bioregional Plan will be further developed. In particular, it focuses on the natural assets of the East Marine Region, describes its ecological characteristics, outlines its conservation values and explains how new marine protected areas will be identified. Additionally, it provides a broad description of the human activities that take place in the Region.

The Bioregional Profile complements information available on the Department's website <www.environment.gov.au>. The reports that underpin this Profile are an important step in building our information base for this poorly known marine region. These reports are available on the internet at <www.environment.gov.au/coasts/mbp/east>.

While every attempt has been made to gather the best available information and provide a comprehensive picture of the East Marine Region, there will certainly be other information sources available that will be helpful in the next stages of the planning process. The Department of the Environment, Water, Heritage and the Arts welcomes any contribution from the public about information and data that may be relevant to developing a Bioregional Plan for the East Marine Region.

Additional information, as well as any questions or comments you might have concerning this document, can be directed to:

eastmarineplan@environment.gov.au

Or mail to:

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A glossary has been developed to assist with technical terminology used in the Bioregional Profile. The glossary is located at the back of this document.

Separate large-format maps of the geomorphic and key ecological features of the Region can be found in the envelope inside the back cover.

Appendices are available on compact disc, which is also inside the back cover.

Grey nurse sharks. Photo: Peter Hitchins.

Executive Summary

This Bioregional Profile is the first step in the development of a Marine Bioregional Plan for Australia's East Marine Region. Marine Bioregional Plans will provide strategic guidance for Government decision-makers and marine users by:

- describing each Marine Region's ecological processes and conservation values, including mapping sites of importance for protected species and communities;
- identifying regional priorities for action, based on an assessment of threats to conservation values and long-term policy goals; and
- developing strategic guidance for proponents and decision-makers. For example, by providing a regional context for national guidelines to help proponents within a Region consider whether their action might result in a significant impact on matters of national environmental significance.

Information on marine bioregional planning and the East Marine Region Bioregional Profile can be found in chapter 1.

Marine bioregional planning is also the process through which the Australian Government identifies areas within Commonwealth waters for inclusion in the National Representative System of Marine Protected Areas. The guidelines the Government is using to develop the National Representative System of Marine Protected Areas have been agreed with the States and the Northern Territory, and are summarised in chapter 4. They can be found online at <www.environment.gov.au/coasts/mpa>.

The Region comprises the Commonwealth waters from the Coral Sea and Tasman Sea, from the northern tip of Cape York to southern New South Wales, as far east as Norfolk Island. It covers some 2 400 000 km^2 of tropical and sub-tropical waters, not including the Great Barrier Reef Marine Park. Australia's most extensive areas of marginal plateaus are found in the Region, extending over more than 1 000 000 km^2. Two long seamount chains run north-south through the Region, with a combined area more than 40 000 km^2, located in depth ranges between 5000 m deep and sea level.

This Bioregional Profile describes the environmental and socio-economic characteristics of the Region.

The environment of the East Marine Region

The Region is characterised by deep-water pelagic tropical and sub-tropical marine ecosystems. The Region is important for endemism and is home to globally significant populations of internationally threatened species.

The Region is dominated by the East Australian Current, the largest ocean current close to the coast of Australia. The East Australian Current forms in the Coral Sea and flows south, ferrying up to 30 million cubic metres per second in flows up to 500 m deep and 100 km wide. The current is strongest in summer, peaking in February at up to five knots and weakest in winter by as much as half the flow, and dissipates east of Tasmania. Ocean eddies generated by the current can be as broad as 200 km across and one kilometre deep, rotating mainly anti-clockwise at up to four knots at the edge and can have a life of up to a year. The current frequently crosses the continental shelf and causes upwellings at place like Cape Byron, Smoky Cape and Sugarloaf Point, drawing up nutrient-rich waters from depths of 200 m or more.

The variability of the East Australian Current both season-to-season and year-to-year has a significant influence on biological productivity in the Region. Phytoplankton and fish distributions are linked to the current. Generally, waters of the Region are low in nutrients. Upwellings created by currents and gyres interact with islands and seamounts and are significant for biological productivity. There is a tropical-temperate transition in species distributions at the 30 degrees South latitude associated with the Tasman Front where subtropical and temperate water masses meet.

The *Integrated Marine and Coastal Regionalisation of Australia Version 4.0* (IMCRA V4.0) is an ecosystem-based classification of Australia's marine and coastal environments that was developed through the collaborative efforts of State, Territory and Commonwealth marine management and research agencies. IMCRA provides a regional framework for planning resource development and biodiversity conservation. Provincial bioregions were classified based on fish, benthic (seabed) habitat and oceanographic data at a scale that is useful for regional conservation planning and management. IMCRA V.4.0 identifies 14 provincial bioregions in the Region. These are:

The Cape Province
(area 62 520 km²; max. depth 4200 m).
This provincial bioregion extends offshore from the boundary of the Great Barrier Reef Marine Park to the edge of the Exclusive Economic Zone. The formation of the Gulf of Papua Gyre over this provincial bioregion from the Hiri Current, and sediment flows from Papua New Guinea river systems influence biological productivity. Ashmore Reef and Boot Reef are distinct from other coral reefs in the Region due to the influence of the north-trending Hiri Current and Papua New Guinea river sediments. Approximately 300 species of demersal fish inhabit this provincial bioregion including 24 endemic species. The Cape Province is important for commercial fisheries operations, Indigenous activities, and recreational fishing.

The Northeast Transition
(area 132 490 km²; max. depth 4600 m).
This provincial bioregion extends offshore from the boundary of the Great Barrier Reef Marine Park to the edge of the Exclusive Economic Zone between the Cape Province and Northeast Province. The biological productivity of this provincial bioregion is influenced by the formation of the north-trending Hiri Current and the south-trending East Australian Current, ocean gyres and by frequent and high intensity cyclones. The coral reefs of Osprey Reef, Shark Reef, and Bougainville Reef have important coral reef biological communities including populations of nautilus. Approximately 400 species of demersal fish inhabit this provincial bioregion. The Northeast Transition is important for shipping, commercial fisheries operations, tourism and recreational fishing.

The Northeast Province
(area 422 460 km²; max. depth 4700 m).
This provincial bioregion extends offshore from the boundary of the Great Barrier Reef Marine Park to the edge of the Exclusive Economic Zone between the Northeast Transition and Kenn Transition. The formation of the Hiri Current and East Australian Current over this provincial bioregion, ocean gyres and high cyclone activity influence biological productivity. The coral reefs emerge as islands and cays over the carbonate platforms of the Queensland Plateau, and are important breeding, nesting and foraging sites for a number of marine turtles and seabirds. Approximately 440 demersal fish species inhabit this provincial bioregion, including 70 endemic species. The Northeast Province is important for shipping, commercial fisheries operations, tourism and recreational fishing.

The Kenn Transition
(area 377 130 km²; max. depth 4800 m).
This provincial bioregion extends offshore beyond the boundary of the Great Barrier Reef Marine Park to the edge of the Exclusive Economic Zone between the Northeast Province and Kenn Province. The formation of the Hiri Current and East Australian Current over this provincial bioregion, ocean gyres and the movements of a deep sub-Antarctic water mass influence biological productivity. There are regionally significant billfish populations associated with upwellings around the Cato Trough and seamounts. The Kenn Transition is important for shipping, commercial fisheries operations, defence, tourism and recreational fishing.

The Kenn Province
(area 57 420 km²; max. depth 2500 m).
This provincial bioregion extends offshore beyond the boundary of the Great Barrier Reef Marine Park to the edge of the Exclusive Economic Zone alongside the Kenn Transition. The formation of the Hiri Current and East Australian Current over this provincial bioregion, ocean gyres and the movements of a deep sub-Antarctic water mass influence biological productivity. Seamounts provide habitat for significant coral reef communities. The Kenn Province is important for commercial fisheries operations and recreational fishing.

The Central Eastern Transition
(area 44 840 km²; max. depth 4800 m).
This provincial bioregion extends offshore beyond Fraser Island and the boundary of the Great Barrier Reef Marine Park between the Central East Shelf Transition and the Kenn Transition. The biological productivity of this provincial bioregion is influenced by the movement of quartz sand from Fraser Island, ocean gyres and the movement of a deep sub-Antarctic water mass. The active canyons on the edge of the continental shelf provide unique habitat for benthic biological communities. Approximately 500 demersal fish species inhabit this provincial bioregion. The Central Eastern Transition is important for shipping, defence, commercial fisheries operations, tourism, sea dumping, and recreational fishing.

The Central Eastern Shelf Transition
(area 26 340 km²; max. depth 240 m).
This provincial bioregion extends over the continental shelf from the boundary of the Great Barrier Reef Marine Park around Fraser Island and offshore from Coffs Harbour. Upwellings around Cape Byron and Smokey Cape caused by the East Australian Current crossing the continental shelf and river sediments influence biological productivity. Tropical and temperate benthic species transition offshore from Tweed Heads. Few tropical species are found south of Coffs Harbour and few temperate species are found north of Fraser Island. The Central Eastern Shelf Transition is important for shipping, defence, Indigenous activities, sea dumping, commercial fisheries operations, tourism, and recreational fishing.

The Central Eastern Shelf Province
(area 14 470 km²; max. depth 240 m).
This provincial bioregion extends over the continental shelf from Nambucca Heads to Shellharbour. Upwellings caused by the East Australian Current crossing the continental shelf and river sediments influence biological productivity. Rocky caves and sand filled gutters around Forster provide habitats for regionally significant populations of critically endangered grey nurse shark (*Carcharias tauras*). The Central Eastern Shelf Province is important for shipping, defence, oil and gas, sea dumping, commercial fisheries operations, tourism and recreational fishing.

The Central Eastern Province
(area 233 820 km²; max. depth 5100 m).
This provincial bioregion extends offshore from the continental shelf between Brisbane and Ulladulla to the boundary of the South East Marine Region and Exclusive Economic Zone. Canyons along the edge of the continental shelf interact with currents and ocean gyres resulting in upwellings that influence biological productivity. Plankton blooms created by upwellings associated with ocean gyres attract populations of yellowfin tuna (*Thunnus albacares*), whales and albatross. Approximately 630 demersal fish species inhabit this provincial bioregion, including 56 endemic species. The Central Eastern Province is important for shipping, defence, sea dumping and commercial fisheries operations.

The Tasman Basin Province
(area 156 420 km²; max. depth 5100 m).
This provincial bioregion extends over the abyssal plains and seamounts of the Tasman Sea between the Central Eastern Province and Lord Howe Province. Interactions between currents, eddies and seamounts and the movements of the deep sub-Antarctic water mass influence biological productivity. The deep-reef coral communities on seamounts are dominated by filter-feeders and provide stepping stones for large oceanic species moving between breeding, nesting, calving and foraging sites. The Tasman Basin Province is important for shipping, defence and commercial fisheries operations.

The Lord Howe Province
(area 484 880 km²; max. depth 4500 m).
This provincial bioregion extends over the abyssal plains and seamounts of the Tasman Sea to the edge of the Exclusive Economic Zone. The mixing of warm-water and cold-water currents and eddies and their interactions with seamounts influence biological productivity. The southern-most coral reefs in the world are found in this provincial bioregion. The unique mix of tropical, sub-tropical and temperate species includes populations of Galapagos shark (*Carcharhinus galapagensis*) and black cod (*Epinephelus daemelii*). The Lord Howe Province is important for shipping, commercial fisheries operations, tourism and recreational fishing.

The Norfolk Island Province
(area 430 790 km²; max. depth 4300 m).
This provincial bioregion extends over the basins and ridges of the Tasman Sea to the edge of the Exclusive Economic Zone. The mixing of warm-water and cold-water currents and eddies and their interactions with seamounts influence biological productivity. Seamounts provide habitat for migratory whale and shark species, and Norfolk Island is an important breeding, nesting and foraging site for the red-tailed tropicbird (*Phaethon rubricauda*). The Norfolk Island Province is important for commercial fisheries operations, tourism and recreational fishing.

The Southeast Shelf Transition
(area 4270 km²; max. depth 240 m).
This provincial bioregion extends over the continental shelf from Shellharbour to Bermagui. Upwellings caused by the East Australian Current crossing the continental shelf and river sediments influence biological productivity. The Southeast Shelf Transition is important for shipping, defence, sea dumping, commercial fisheries operations, tourism and recreational fishing.

The Southeast Transition
(area 8800 km²; max. depth 5200 m).
This provincial bioregion extends offshore from the continental shelf between Ulladulla and Bermagui to the South East Marine Region. Canyons along the edge of the continental shelf interact with currents and ocean gyres resulting in upwellings that influence biological productivity. The Southeast Transition is important for shipping, defence, sea dumping and commercial fisheries operations.

A description of each of the provincial bioregions is given in chapter 2.

Conservation values of the East Marine Region

Conservation values of the Region include protected species and protected places, as well as a number of key ecological features in the Commonwealth marine environment identified as part of this planning process.

A total of 106 species that are known to occur in the Region are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), as either threatened, migratory, cetacean or listed marine species. Of these, 37 species are listed as threatened, including two critically endangered, eight endangered, 26 vulnerable species and 3 conservation dependent.

This Bioregional Profile identifies a number of key ecological features that are of conservation value because of the roles they play in the marine environment of the Region. They are given this value on the basis that they are:

- a species, group of species or a community with a regionally important ecological role (e.g. a predator, prey that affects a large biomass or number of other marine species); or
- a species, group of species or a community that is nationally or regionally important for biodiversity; or
- an area or habitat that is nationally or regionally important for:
  a) enhanced or high biological productivity (such as predictable upwellings),
  b) aggregations of marine life (such as feeding, resting, breeding or nursery areas),
  c) biodiversity and endemism; or
- a unique seafloor feature with known or presumed ecological properties of regional significance.

Key ecological features of the Region include:

Regionally significant geomorphic and oceanographic features:

- East Australian Current (important ecological role; enhanced biological productivity; important for biodiversity; aggregations of marine life);
- offshore chains of seamounts and rises (unique seafloor feature; important ecological role; important for biodiversity and endemism; enhanced biological productivity; feeding, resting, breeding and nursery aggregations);
- assemblage of scattered and diverse reefs and cays of the Coral Sea (important ecological role; important for biodiversity; feeding, resting, breeding and nursery aggregations); and
- canyons of the eastern continental slope and shelf edge rocky reefs (unique seafloor feature, important ecological role; enhanced biological productivity).

Regionally important communities and habitats:

- **temperate (reef) corals and sponges** (important ecological role; important for biodiversity)
- **pelagic squid** (important ecological role);
- **large pelagic predators (sharks, tuna and billfish)** (important ecological role);
- **east coast humpback whale population** (resting, breeding and nursery aggregations); and
- **herbivorous fish of coral reefs** (important ecological role).

The Lord Howe Island Marine Park is the only listed heritage site within the Region. The two listed RAMSAR wetlands sites within the Region are Coringa-Herald National Nature Reserve and Elizabeth and Middleton Reefs Marine National Nature Reserve. There are likely to be hundreds of historic shipwrecks in the Region but the precise locations of those presumed to occur in Commonwealth waters are unknown.

A description of the conservation values and key ecological features is given in chapter 3.

Marine Protected Areas in the East Marine Region

The six existing marine reserves in Commonwealth waters of the Region are: Coringa–Herald National Nature Reserve; Lihou Reef National Nature Reserve; Elizabeth and Middleton Reefs Marine National Nature Reserve; Solitary Islands Marine Reserve; Lord Howe Island Marine Park; and Cod Grounds Commonwealth Marine Reserve.

New Marine Protected Areas will be established to meet national guidelines under which all Australian governments are developing a comprehensive, adequate and representative reserve system. The Australian Government's goals for establishing the Marine Protected Area network are described in chapter 4, along with their application to the Region and an outline of the principles that will guide the identification, selection, design and zoning of representative Marine Protected Areas. Consideration of the socio-economic implications of potential Marine Protected Areas will inform the Government's decision about a final regional Marine Protected Area network.

Human activities and the marine environment

The Region is adjacent to the most heavily populated coastline in Australia. The majority of human activity in the Region occurs closest to the major population centres in New South Wales and south-east Queensland. The Region supports a range of human uses and activities.

The waters of the Region have been culturally important for Indigenous people for many thousands of years. Archaeological evidence indicates that the Indigenous

people arrived in eastern Australia at least 20,000 years ago. Indigenous coastal communities continue to maintain special links with their sea country through occupation, resource utilisation and cultural practice.

Captain James Cook made landfall at Botany Bay in 1770 and claimed Australia for England. The first European settlement was established in 1788 at Port Jackson on Sydney Cove. The first colony on Norfolk Island was also established in 1788 and a permanent settlement on Lord Howe Island followed in 1834. The first colony in what would later become Queensland was established at Moreton Bay in 1824.

Today the major marine industries include shipping, commercial fishing, recreational fishing and tourism. Other uses of the Region include Indigenous activities, border protection, offshore oil, gas and mineral exploration, sea dumping and the laying of submarine communication cables.

Eighteen fisheries are licensed to operate within the Region. The East Coast Otter Trawl Fishery and the Eastern Tuna and Billfish Fishery are the largest fisheries targeting prawns, scallops, tuna, billfish and sharks. The Region is also a popular destination for recreational and charter fishing.

Marine-based tourism in waters off Queensland and New South Wales is important to the economy and includes activities such as snorkelling, scuba diving, whale watching, and cruising.

The Region includes some major international sea routes and the ports adjacent to the Region handle almost 45 per cent of Australia's sea freight trade and include Australia's largest importing ports which supply goods and services to major population centres. Major industrial ports in the Region export high volumes of raw minerals, notably coal.

Little is known about the extent of oil, gas and mineral deposits in the Region and offshore areas are largely under-explored. Recoverable offshore gas deposits have been identified and there is potential for expansion in the Region.

Chapter 5 describes human activities in and adjacent to the Region.

Next steps

This Bioregional Profile will guide development of a Draft Marine Bioregional Plan for the Region. The Draft Plan will be released for a period of formal public comment, as required under the EPBC Act. Conservation measures and potential implications for people and industries will be considered and resolved through a process involving consultation with stakeholders and the wider public. A final Marine Bioregional Plan will then be developed for consideration and approval by the Minister for the Environment, Heritage and the Arts. Once finalised, the Minister will be guided by the Marine Bioregional Plan in all decisions made under the EPBC Act for which the Plan has relevance.

Although marine bioregional planning is an Australian Government program undertaken under Commonwealth legislation, the planning process occurs in consultation with State and Territory governments. This consultation is important because the governments of Queensland and New South Wales are also undertaking planning and Marine Protected Area development processes in State waters.

Chapter 6 describes the next steps in the marine bioregional planning process for the East Marine Region.

Spanish Dancer Nudibranch. Photo: Ian Hutton.

Chapter 1 Introduction

Marine bioregional planning is designed to better protect marine environments, conserve biodiversity and deliver greater certainty to resource users and decision-makers about the marine conservation priorities of the Australian Government. Under section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Minister for the Environment, Heritage and the Arts must have regard to a Marine Bioregional Plan when making relevant decisions.

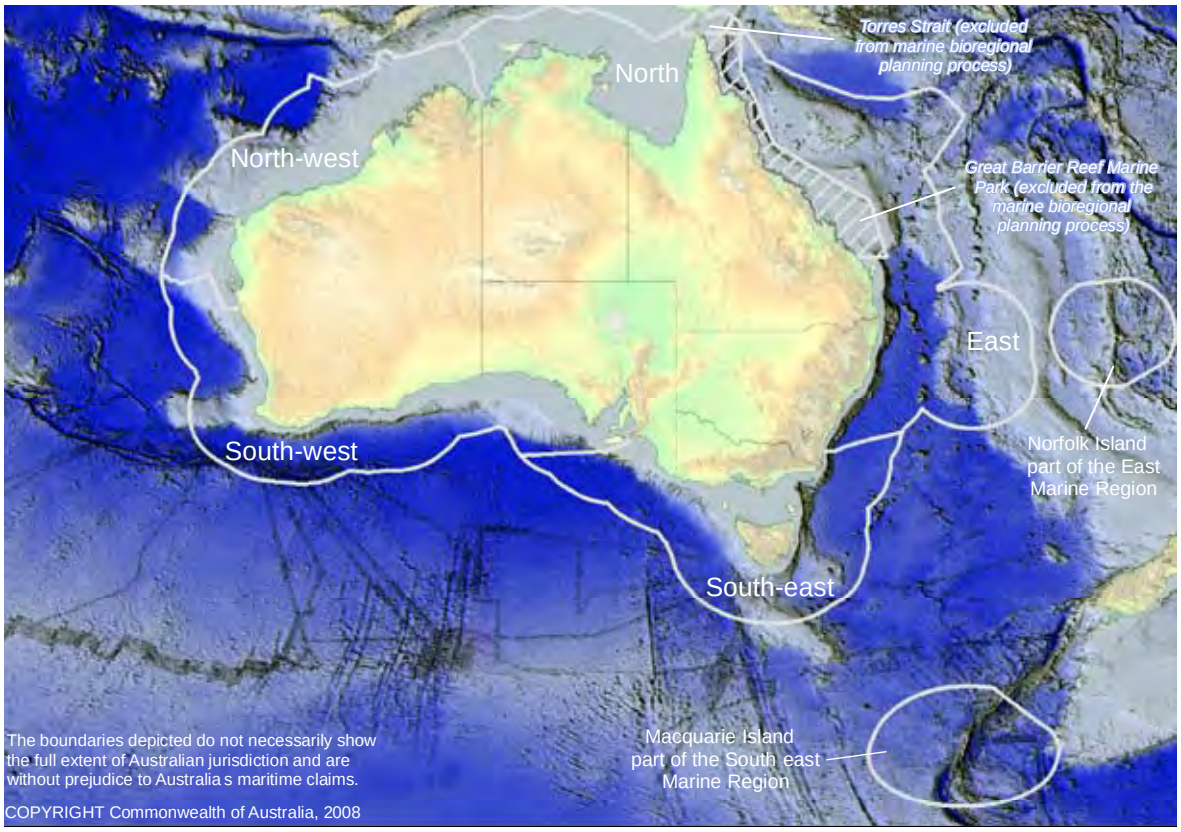
Marine bioregional planning is also the process through which the Australian Government identifies areas within Commonwealth waters for inclusion in the National Representative System of Marine Protected Areas. Guidelines to develop the National Representative System of Marine Protected Areas have been agreed with the States and the Northern Territory. See www.environment.gov.au/coasts/mpa/publications/nrsmpa-guidelines.

Marine Bioregional Plans guide Government decision-makers and marine users by:

- describing each Region's conservation values and ecological processes, including mapping sites of importance for protected species and communities;
- identifying priorities for action based on an assessment of threats to conservation values and long-term policy goals; and
- developing strategic guidance for proponents and decision-makers. For example, by providing a regional context for national guidelines to help proponents within a region consider whether their action might result in a significant impact (see appendix B). Plans may also include guidance on the types of information that should be included with referrals under the EPBC Act, or the monitoring that might be required for certain activities or locations within a Region.

There are five Marine Regions for planning, as shown in Figure 1.1.

Figure 1.1 Australia's Marine Regions



Soft coral and diver, Coral Sea. Photo: Mike Ball.

1.1 The Bioregional Profile of the East Marine Region

The East Marine Region encompasses Commonwealth waters offshore from the northern tip of Cape York to the southern New South Wales town of Bermagui. It includes the waters surrounding both Lord Howe and Norfolk Islands and the whole of the Coral Sea Islands Territory. For the purposes of marine bioregional planning, it does not include the waters within the boundary of the Great Barrier Reef Marine Park or State waters. The East Marine Region, which is described in more detail in chapter 2, covers 2.4 million km^2 of ocean and also includes the airspace above and the seabed below. In this Bioregional Profile, the terms *the Region*, and *the East Marine Region* are used interchangeably to refer to the Commonwealth waters defined above.

The objectives of the East Marine Region Bioregional Profile are to describe:

- ecological and biophysical features of the Region including major ecosystems, marine species, communities and places already specifically protected under legislation and those identified through the planning process as key ecological features;
- considerations and information that will guide the identification of Marine Protected Areas; and
- human activities in the Region.

In addition to this Introduction, the East Marine Region Bioregional Profile includes five other chapters, and five appendices:

Chapter 2 – *The Marine Environment of the East Marine Region* describes the biophysical and ecological characteristics of the Region, with particular focus on ecosystem structure and functioning within provincial bioregions.

Chapter 3 – *Conservation Values of the East Marine Region* summarises and describes the biodiversity and heritage features of the Region.

Chapter 4 – *Establishing New Marine Protected Areas in the East Marine Region* introduces the goals and principles the Australian Government is using to establish the Commonwealth component of the National Representative System of Marine Protected Areas and explains their application to the Region.

Chapter 5 – *Human Activities and the East Marine Region* outlines the human activities that take place in the Region. It also provides a short overview of the population and the historical development of the Queensland and New South Wales economies adjacent to the Region.

Chapter 6 – *Developing an East Marine Bioregional Plan: Next Steps* describes the stages of marine bioregional planning beyond the Bioregional Profile, and opportunities for stakeholder participation.

Appendix A – *International Conventions and Agreements on the Marine Environment* describes Australia's international commitments to manage the marine environment.

Appendix B – *An Overview of the Legislative Framework for Environmental Protection and Biodiversity Conservation in Commonwealth Waters* explains Australia's national legislation for managing its marine areas.

Appendix C – *Nationally Protected Species in the East Marine Region* lists all the species known to occur and those which may occur in the Region that are protected under the EPBC Act.

Appendix D – *East Marine Region Protected Species Group Report Cards* provides detailed information about species protected under the EPBC Act. Report Cards on species groups outline their ecology, areas of particular importance, interactions with human activities, threats to their survival and mitigation measures currently being used.

Appendix E – *Technology and Equipment Used in Commercial Fishing Operations* provides a summary of some of the modern technology used in Australian commercial fisheries as well a description of some more traditional pieces of equipment still in use today.

1.2 Supporting information

A number of reports were commissioned to support the development of this Bioregional Profile. These reports consolidate available information and provide further details on the natural environment and human uses of the Region and are available online at <www.environment.gov.au/coasts/mbp/east>.

Some key reports used in this Bioregional Profile include:

Sedimentology and Geomorphology of the East Marine Region of Australia – prepared by Geoscience Australia in 2008 to summarise all available information on the geology and sedimentology of the Region.

Ecosystems of the East Marine Region – a description of the eco-physical systems of the Region and how they function. This report gathers, reviews and summarises available information to identify and describe the ecosystems, sub-systems, functional groups and relationships, links across systems and large scale drivers of the Region.

Description of Key Species Groups in the East Marine Region – a description of the key marine species groups in the Region including their status, habitat and distribution, regional significance, threats and information gaps.

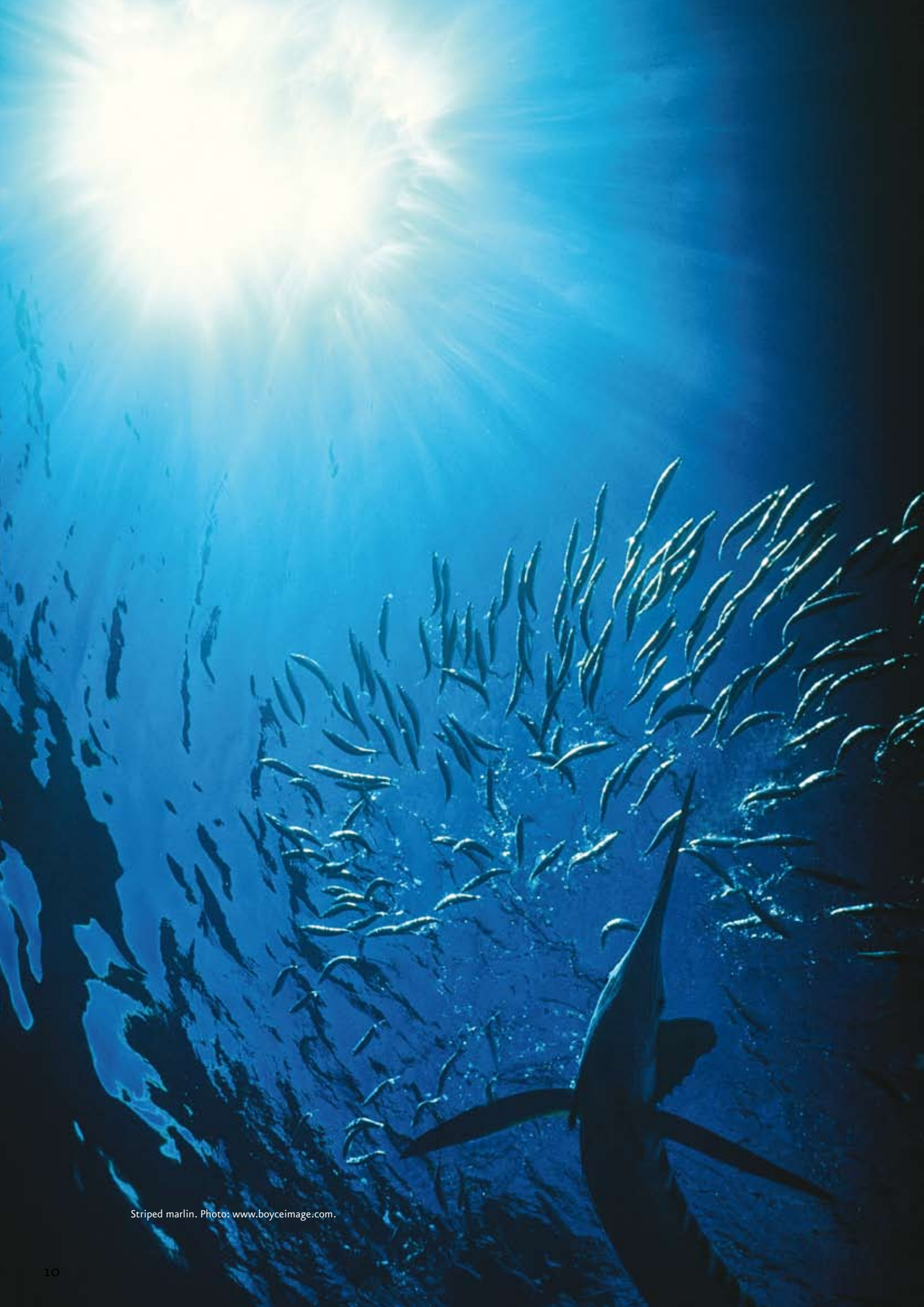
Description of Commercial, Recreational and Charter Fishing Activities in the East Marine Region – a high-level socio-economic overview of the role and value of commercial, recreational and charter fishing in the Region. This analysis includes the activities associated with both State and Commonwealth fisheries that operate within the Region.

Non-fisheries Resource Use Activities in the East Marine Planning Region – examines non-fisheries marine resource use activities in the Region. The report focuses on the socio-economic values of the Region and the importance of these activities to the adjacent coastal areas and to the nation as a whole.

As Far as the Eye Can See: Indigenous Interests in the East Marine Planning Region – a summary of Aboriginal interests in the Region, pre- and post-European contact, including community identity, marine resource use, past and current associations with the Region, current issues, and aspirations of these communities.

Characterisation of the Marine Environment of the East Marine Region – a summary of the discussions and outcomes of an expert workshop convened in Brisbane on 28–29 November 2007. The objective of this workshop was to characterise the marine environment of the Region and understand how its natural systems work. The workshop took stock of current knowledge and theory about the ecosystems of the Region and will ensure that the Bioregional Profile and the next steps in the planning process are based on the best information possible, with an explicit recognition of uncertainties due to gaps in the regional knowledge base. The outcomes of the workshop are available online at <www.environment.gov.au/coasts/mbp/east>.

This Bioregional Profile is intended to help stakeholders and the public participate in the development of the East Marine Bioregional Plan. The Department of the Environment, Water, Heritage and the Arts welcomes information from the public that may be relevant to bioregional planning within the East Marine Region. The Department of the Environment, Heritage and the Arts will consult with stakeholders to discuss the contents of the Bioregional Profile and explain subsequent steps in the planning process.



Striped marlin. Photo: www.boyceimage.com.

Chapter 2 The Marine Environment of the East Marine Region

The East Marine Region includes all Commonwealth waters from the eastern side of Cape York to just north of the New South Wales–Victoria border, as well as the waters around Norfolk and Lord Howe islands, and covers an area of some 2 400 000 km² of the Coral and Tasman seas. The Region is bounded inshore by the outer limit of State waters (generally around three nautical miles from the territorial sea baseline[1]) and the boundary of the Great Barrier Reef Marine Park, and offshore by the outer limit of the Australian Exclusive Economic Zone (see figure 2.1 for a description of maritime zones). The Region also includes the air space above its waters.

The Region is adjacent to, but does not cover, the State waters of Queensland and New South Wales, the Great Barrier Reef Marine Park, and Torres Strait. This chapter is focused primarily on describing features and ecological processes in Commonwealth waters. However, in some instances, features and ecological processes occurring in adjacent waters are identified, because:

- they are important to species listed as threatened or migratory under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Such species are protected as they are matters of national environmental significance (see chapter 3 and appendix B); or
- there is connectivity between features and ecological processes across marine jurisdictions.

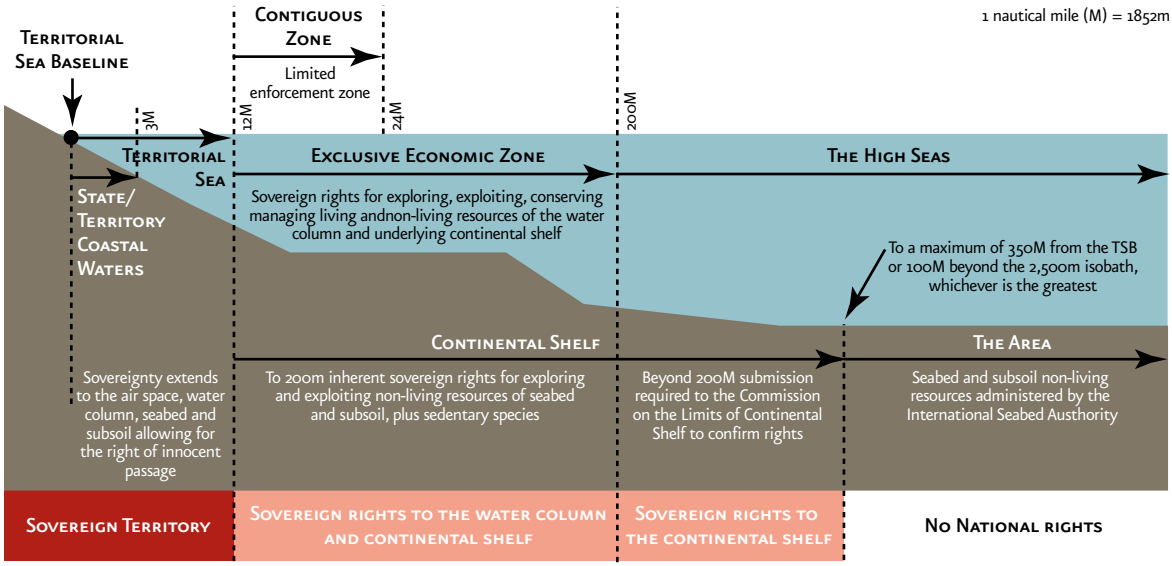
The majority of the Region encompasses waters over the continental slope having depths generally greater than 1000 m, although water depths do range from zero to over 5000 m.

From a global perspective, the Region is part of vast species-rich biogeographic zones stretching from the western Pacific to the east coast of Africa and to the Southern Ocean. The Southern Tropical Convergence and the Tasman Front at approximately 20 and 30 degrees South are water mass boundaries that mark the meeting of subtropical and temperate water masses, and on the continental shelf there is a tropical–temperate boundary between the northern tip of Fraser Island and Coffs Harbour. These physical barriers represent transition zones for the dispersal of tropical and temperate species.

Sea levels across the Region have periodically oscillated during recent geological times. Around 100 000 years ago much of the continental shelf was exposed. The periodic exposure and flooding of the continental shelf and offshore marginal plateaus is evident from the presence of large carbonate platforms formed by exposure of ancient reefs. Present-day reefs have formed on top of these carbonate platforms when they were again submerged. The East Australian Current (EAC) is the dominant oceanographic influence on ecosystems in the Region. Another factor is the different geomorphology resulting in a large range of depths across the Region as described in some detail in the following subsections.

2 While the territorial sea baseline is usually at the low water mark, the baseline extends across the openings of bays (e.g. Moreton Bay) and rivers, and extends around some coastal and offshore islands.

Figure 2.1 Australia's maritime zones



Geomorphology of the Region

The Region includes geomorphic features such as reefs, seamounts, offshore marginal plateaus and canyons, and covers extensive areas of shelf, slope and abyssal plain/deep ocean floor. These features formed during rifting and thinning of the continental crust of eastern Australia in the late Cretaceous between 110 and 80 million years ago, followed by a period of seafloor spreading up until the early Eocene (52 million years ago) with the formation of new basaltic ocean crust. The seafloor spreading and subsequent periodic volcanism and subsidence created the ocean basins, failed-rift troughs, ridges, plateaus and seamounts of the present day.

The Region went through significant fluctuations in climate, oceanography and sea level during the Quaternary (last 2 million years). Sea level was 70 to 120 metres below the present level for half of the past 300 000 years, and 40 to 80 metres below the present level for half of the last 100 000 years. Most of the present continental shelf was exposed during this time and there would have been a narrow shelf in the present Wollongong-Sydney-Newcastle area, with very little shelf anywhere else along the Queensland and New South Wales coast. The East Australian Current is likely to have been strong during the last glacial period and trade winds more intense.

The carbonate platforms, atolls and banks of the Queensland Plateau and Coral Sea would have been islands for more than half of the last 300 000 years and would have formed karst along with the Great Barrier Reef. The connection between the Coral Sea and Tasman Sea through the Cato Trough would have been reduced and Marion Plateau would have been a major promontory along the coastline. The reefs of Mellish, Frederick, Kenn, Wreck and Cato would have been slightly enlarged and exposed as islands. Norfolk and Phillip Islands would have been one larger island. The exposure of present living reefs during the last glacial period meant much lower productivity of the shallow water benthic community. Low carbonate and terrigenous mud were found for this period in cores taken from the Queensland Trough.

The Region is considered to have been tectonically stable during the Quaternary with no significant uplift, subsistence or faulting. Seamounts continue to subside, with younger seamounts in the southern end of the chains, including Lord Howe Island, subsiding faster but only at a rate of centimetres per thousand years.

Four geomorphic provinces occur in the Region. Slope makes up the largest area (77 per cent), abyssal plain/deep ocean floor (20 per cent), shelf (2 per cent), and rise (1 per cent). The region contains approximately 31 per cent of the area of slope in the entire Australian Exclusive Economic Zone. The Region has 18 of the 21 geomorphic features that have been identified on the Australian margin. Tidal sand wave/sand banks, sills and escarpments are not represented in the Region. Twenty six percent of the area of the Region–primarily abyssal plain and slope areas–have no geomorphic features identified with them. Sixty two percent of the Region is covered by basins, deepwater trenches/troughs, shallow and deep water terraces and plateaus. The Region has 69 per cent of the total area of plateaus, seamounts/guyots (42 per cent), saddles (65 per cent), basins (51 per cent), trenches/troughs (47 per cent) in the entire Australian Exclusive Economic Zone.

The sea in the Region is relatively deep with more than 80 per cent of the total area having water depths between 1000 and 5000 metres. Carbonate is dominant in 66 per cent of the sediment samples taken from the Region with carbonate content decreasing with increasing water depth and distance from the coast in the north.

Oceanography and other ecological drivers

The East Australian Current, which dominates the surface waters of the Region, is formed in the Coral Sea from the South Equatorial Current (SEC) (figure 2.2). Part of the SEC forms a clockwise circulation called the Hiri Current which flows northwards into the Gulf of Papua. The EAC flows south and is strongest between 25 and 30 degrees south. The flow of the EAC is directed off shelf at major headlands such as Fraser Island, Smoky Cape and Sugarloaf Point and is a significant process in sweeping sediments off the shelf edge.

The East Australia Current is the largest ocean current close to the coast of Australia and moves up to 30 million cubic metres per second of low-nutrient tropical water southwards down the Australian coastline towards the temperate regions, with a strong influence to 500 m depth and 100 km width. The current is strongest in summer, peaking in February at up to five knots, and weakest in winter, dropping to half its summer flow, its energy dissipating east of Tasmania. The low density, warm Coral Sea is almost one metre higher than the colder, denser Tasman Sea. The resulting slope between these two water masses gives strength to the EAC and determines the direction of flow.

The EAC frequently crosses the continental shelf in its southward run and moves close inshore, sometimes setting up northward-flowing currents on the shelf as a result of clockwise rotating 'cold core' eddies. As the

Tropical cyclone Ingrid approaching Cape York Peninsula. Image courtesy of MODIS Rapid Response Project at NASA/GSFC.

boundaries of the current fluctuate, advancing and retreating, large anti-clockwise 'warm-core' eddies with currents up to four knots at the edge are left behind. These eddies can be 200 km across and more than 1 km deep with a life of up to a year. The EAC causes upwelling of nutrient rich waters where it moves away from the coast at places like Cape Byron, Smoky Cape, and Sugarloaf Point. The current can be slowed or reversed by southerly winds within 10 nautical miles of the shore.

The differences between 'cold-core' and 'warm-core' gyres and eddies relates to the position of the nutricline (area of transition between nutrient-poor surface waters and nutrient-rich deep waters). Anti-clockwise 'warm-core' eddies position the nutricline below the euphotic zone (area where there is enough light to support photosynthesis), and therefore result in nutrient-poor conditions in surface waters. Clockwise 'cold core' gyres and eddies raise the nutricline within the euphotic zone resulting in nutrient-rich conditions in surface waters.

The strength of the East Australian Current decreases rapidly below 32° S and breaks up into 'warm-core' gyres or eddies. A 'warm-core' gyre forms along the Tasman Front at around 30° S. The Tasman Front is the interface between the warm waters of the Coral Sea and the cooler waters of the Tasman Sea and moves north-south seasonally between 30° S in winter and 34° S in summer. A 'cold-core' gyre originates in the southern part of the west Tasman Sea and meets subantarctic waters along the subtropical convergence (45° S). Surface waters of the EAC move south while deeper layers of waters, including the Antarctic Intermediate Water at 1000 metres depth and the Antarctic Bottom Water beneath it, move from south to north in the Region.

Figure 2.2 Major ocean currents in eastern Australian waters
Image courtesy of CSIRO Marine Research.

Grey reef shark. Photo: Photolibrary.

Biodiversity in the East Marine Region

Biological communities found in the provincial bioregions of the Region are closely associated with geomorphic and oceanographic features and can be grouped into six categories:

- Coral Sea cays/atolls/islets
- Coral and Tasman Seas seamounts/guyots/islands
- continental shelf
- abyssal plains and troughs
- cold-core and warm-core gyres and eddies
- continental plateaus.

Few sites within the Region have been intensively sampled and there follow detailed descriptions of only Coral Sea cays/atolls/islets, Coral and Tasman Seas seamounts/guyots/islands, and continental shelf biological communities. It is not possible to apply generalised descriptions to biological communities found in all provincial bioregions as they are based on only a few sites in the Region that have been the subject of detailed study and data gathering. The six categories of biological communities listed above are included in the provincial bioregion descriptions together with geomorphic and oceanographic features. No details are provided on the biological communities found in most provincial bioregions as they have not been the subject of detailed study and data gathering. The biological communities described below are referred to in the descriptions of provincial bioregions where they occur, with additional information on biological communities also provided for some provincial bioregions.

Coral Sea cays/atolls/islets

Coral Sea reefs, lagoons, sandy coral cays and islets support marine benthic flora and fauna that are distinct from those of the Great Barrier Reef. Algae are an important component, often covering a greater area than corals. Sixty-six species of algae have been recorded on North East Herald Cay, which is thought to be a fraction of the total present. This included 41 species of red algae, 23 species of green algae and two of brown algae. Halimeda, a calcified algae of warm seas, was a prominent feature on this cay. The near absence of brown algae was considered unusual.

In comparison to shallow reef areas of the Great Barrier Reef, a high abundance of sponges were recorded at Chilcott Islet and East Diamond Islets. Sponges have been recorded as being more abundant than corals, in places forming large and spectacular sponge gardens. Common sponge species include *Polyfibrospongia flabellifera*, *Carteriospongia lamellose*, *C. pennatula*, *and Phyllospongia pennatula*.

Hard corals are not especially abundant or diverse and cover a relatively small proportion of reef area compared to hard corals of the Great Barrier Reef. Average maximum coverage range from 19 per cent to 26 per cent. One hundred and forty species of coral have been found at the Coringa–Herald Reserve. Dominant hard coral species include *Acropora palifera*, *A. humilis* and *Pocillopora* species. Soft corals tend to be more important in sheltered areas such as the deeper reef slope areas and deep reef flats. Soft coral cover of 3.5 per cent has been recorded at North East Herald Cay, dominated by *Sarcophyton* species.

Marine molluscan fauna is moderately rich and is a subset of a more widely distributed tropical molluscan fauna. Seven hundred and forty-five species of marine molluscs have been recorded at North East Herald Cay, representing 118 families. Eighty-seven families of gastropod mollusc, 21 of bivalve mollusc, four of cephalopod mollusc, three of scaphopod mollusc, and one of amphineurid mollusc were represented. No endemic species have been recorded. *Rissopsis typica* and *Cypraea childreni* have been recorded as common in the Coral Sea while being rare over much of the rest of their range. Sponge-feeding molluscs such as Triphoridae and Cerithiopsidae were not abundant despite the presence of extensive sponge gardens.

One hundred and twenty-eight species of marine, semi-terrestrial and terrestrial decapod crustaceans were found at North East Herald Cay. Seventeen of these were new records for Australian waters. The marine crustaceans tended to be inconspicuous and not abundant, while the semi-terrestrial and terrestrial species were both conspicuous and abundant. Most species recorded had wide Indo–Pacific distribution, while many species that are common and widely distributed on the Great Barrier Reef were absent.

The hydroid fauna is considered remarkably rich compared with other reef areas. Fifty-five species have been found at North East Herald Cay, representing 14 families, with more species likely to be present. Eleven species were new records for Queensland reef waters and nine were new records for Australian waters. Starfish, brittle stars, feather stars, sea urchins, sea cucumbers and other invertebrate groups have been observed but no systematic surveys of their diversity and abundance have been undertaken. Crown-of-thorns starfish have been found in some of these communities but not in sufficient numbers to cause disturbance to indigenous reef fauna.

Fewer species of reef fish were found on some Coral Sea cays than in the Great Barrier Reef and not many endemics. The fish assemblages were distinct from those of the Great Barrier Reef. Three hundred and seventy-two species of fish have been found at the Coringa–Herald Reserve from 54 families. Six families: Labridae (wrasse), Pomacentridae (damselfish), Acanthuridae (surgeonfish), Chaetodontidae (butterfly fish), Serranidae (cod and coral trout), and Scaridae (parrotfish) comprised the most number of species.

The green turtle (*Chelonia mydas*) was found mating and nesting on cays and islets within the Coringa–Herald Nature Reserve and Lihou Reef Nature Reserve, and genetic studies have shown that they are of the same genetic stock as green turtles in the Great Barrier Reef and Torres Strait. Hawksbill turtles have been sighted but have not been observed nesting. The Coral Sea cays are included within the range of 12 cetacean species. A full list of cetacean species found in the Region is included in appendix D.

Most of the islets and cays are composed of sand, rocks and coral rubble that rise no higher than five metres above mean sea level. Some have grassland, herbfield, shrubland and forest habitats. Flowering terrestrial plants recorded are primarily widespread tropical shoreline species of the Indo–Pacific Region. The exception is *Digitaria ctenantha*, a grass native to northern Australia. Thirty terrestrial plant species have been found. Island isolation, weather patterns, island size, availability of freshwater lenses beneath cays, and frequency of 'washover' events, depositing seeds high enough on the islands for them to germinate influence the occurrence and abundance of plant species. Vegetated islets are fringed with the shrub *Argusia argentea* and have a grassy understorey dominated by *Lepturus repens*, *Stenotaphrum micranthum*, and *Sporobolus virginicus*.

Pisonia grandis shrub forest that occurs on some cays is relatively uncommon in Australia and globally despite its extensive Indo–Pacific distribution, since throughout much of its range, these forests have been cleared for subsistence agriculture and guano mining. Only 44 of the 950 islands within the Great Barrier Reef region have this forest left, it being most rare in the north of this region where it does not generally form monospecific stands. These forests provides significant habitat for nesting seabirds. Cyclones and outbreaks of scale insect (*Pulvinaria urbicola*) have damaged some forest areas.

Cave formation, Great Barrier Reef. Photo: Photolibrary.

The composition of terrestrial invertebrate fauna is not well known. Mites, spiders, spring tails, ants, flies and beetles were the most commonly recorded groups at North East Herald Cay. Of scientific interest is a species of pseudoscorpion belonging to the genus *Nannochelifer*, which was previously known from a single species in Kenya. A related species, *N. paralius*, was also found.

There are extensive seabird colonies of great significance to the Region. Fourteen seabird species breed on Coral Sea cays. The red-footed booby (*Sula sula*), least frigatebird (*Fregata ariel*), great frigatebird (*Fregata minor*), and red-tailed tropicbird (*Phaethon rubricauda*) that have an extensive distribution outside Australian waters but are uncommon within Australia, breed on these cays. Since 1992 a monitoring program focusing on these birds and the brown booby (*Sula leucogaster*), masked booby (*Sula dactylatra*), and black noddy (*Anous minutus*) has been conducted in Coringa–Herald and Lihou Reef National Nature Reserves.

Breeding of red-footed boobies, red-tailed tropicbirds and frigatebirds is largely seasonal, although eggs and chicks can be found at any time. Most breeding commences at the end of the cyclone season in March-April and continues during the cooler months. The red-footed booby population in the Coringa–Herald and Lihou Reef National Nature Reserves has remained stable at about 150 pairs in *Argusia* shrubland and 1000 pairs in the mixed *Pisonia-Cordia* forest. Three hundred and sixty-seven active nests of red-tailed tropicbird have been recorded at North East Herald Cay, making it the largest known population of this species in the Region and the second largest in Australia (after Christmas Island in the Indian Ocean). The buff-banded rail (*Gallirallus philippensis subsp.*) and the purple swamphen (*Porphyrio porphyrio*) are the only known land birds that breed on these cays. An additional 22 sea and land bird species have been found as regular or vagrant non-breeding visitors.

There are no known native terrestrial mammals recorded. The black rat (*Rattus rattus*), which is believed to have been introduced by mariners in the mid-20th century, persisted on some islets for many years. These were eradicated in 1991 and have not been recorded since. Geckos (*Gehyra mutilata*) are common on some islets.

Coral and Tasman Seas seamounts/ guyots/islands

Chains of volcanic seamounts in the Coral and Tasman Seas include the southernmost open ocean platform reefs in the world. A combination of isolation, exposure to convergent tropical and temperate ocean currents and climates has given rise to distinct and diverse assemblages of marine species, including endemics, on these seamounts. The isolation of the reefs on some seamounts has made them refuges for species such as the black cod (*Epinephelus daemelii*), once common along the New South Wales coast, but now rare. Some species found on Lord Howe Ridge and Norfolk Ridge appear to be relicts of groups believed to have disappeared in the Mesozoic. There seems to be low species overlap on different seamounts in the Region: they tend to be isolated marine systems with highly localised species distributions. Seamounts may be important sites of evolution and speciation in the otherwise deep sea.

Seamount-associated species of fish are typically slow-growing species which have exceptionally long life histories. They can be broadly categorised into those associated with the deepwater coral gardens (e.g. rockfish) that they use for refuge, and those associated with the seamount itself (e.g. orange roughy) that feed on other fish, squid and crustaceans brought in by the currents. Vertically-migrating plankton such as krill also becomes prey when they are trapped above the seamounts.

Islands cap some seamounts while other seamounts remain underwater as volcanic peaks or flat-topped guyots. Some of the islands and their surrounding waters are used as

Shy albatross. Photo: Dr Michael Double.

feeding grounds for a number of species of migratory seabirds and by green turtles (*Chelonia mydas*). The leatherback turtle (*Dermochelys coriacea*) may also be found foraging on seamounts. The common noddy (*Anous stolidus*) breeds on some islands. Other seabirds likely to forage around seamounts include the wandering albatross (*Diomedea exulans*), Antipodean albatross (*Diomedea antipodensis*), Campbell albatross (*Thalassarche impavida*), Gibson's albatross (*Diomedea gibsoni*), shy albatross (*Thalassarche cauta*), white-bellied storm-petrel (*Fregetta grallaria*), Kermadec petrel (*Pterodroma neglecta*), great-winged petrel (*Pterodroma macroptera*), white-necked petrel (*Pterodroma externa*), fleshy-footed shearwater (*Puffinus carneipes*), wedge-tailed shearwater (*Puffinus pacificus*), sooty shearwater (*Puffinus griseus*), masked booby (*Sula dactylatra*), sooty tern (*Sterna bergii*), and ruddy turnstone (*Arenaria interpres*).

Few of the seamounts in the Region have been intensively sampled. One hundred and twenty-two species of coral were recorded at Elizabeth and Middleton Reefs and the structure of these seamounts was found to consist of moderate hard coral cover with a low abundance of *Acropora* coral species, sandy lagoons, algal meadows (encrusting or turf algae) and small patches of seagrass (*Halophila ovalis*) in sheltered sandy lagoons.

There are thought to be more than 200 species of deep water ahermatypic corals found in the Region and where they occur they can be very abundant, reaching densities of up to 50 per square metre. Some reefs have been found to support an extremely rich and diverse algal flora, 18 taxa have been identified with a high potential for genetic uniqueness. Some of the sandy cays are vegetated with grass. Three hundred and twenty-four fish species have been found at Elizabeth and Middleton reefs.

Deep sea coral and sponge communities–sometimes highly diverse–have been found on seamounts, mid-ocean ridges, continental plateaus and slopes. Over 850 species of macro and megafauna have been found on seamounts in the Tasman and Coral Seas. Growth and reproduction in these deep sea communities is often very slow: some corals and sponges may live for centuries. Orange roughy (*Hoplostethus atlanticus*) has been found on some seamounts, and yellowfin tuna (*Neothunnus macropterus*) and swordfish (*Xiphias gladius*) aggregate around seamounts.

Fifteen per cent of Australian shark species such as mackerel sharks (Lamnidae), including great white sharks (*Carcharadon carcharias*), whaler sharks (Carcharhinidae), hammerheads (Sphyrnidae), and the Galapagos shark (*Carcharhinus*

galapagensis) are typically pelagic and may be found around seamounts. Holothurians (sea cucumbers) have been found at high densities on some reefs with *Holothuria whitmaei (nobilis)* (black teatfish) and *Holothuria atra* (lollyfish or black sea cucumber) the most common species found.

Sea-snakes of the Hydrophiidae and Laticaudidae families and seahorses, seadragons and pipefish of the Sygnathidae family may be found on seamounts. Three mollusc species have been found to be endemic to Elizabeth and Middleton Reefs, *Turbo cepoides*, *Astralium wallisi*, *Amphithalamus* species, and seven mollusc species have been found to be endemic to seamounts in the Tasman Sea. The Region's seamounts are included within the distribution range of thirty species of cetaceans (full list is included in appendix D).

Continental shelf

The continental shelf is generally at less than 200 m water depth and includes littoral/intertidal ecosystems, coral-fringed islands and rocky outcrops, subtidal reefs, pinnacles, and open ocean ecosystems. There is a tropical/temperate transition in the marine invertebrates found in the Region that is most evident on the continental shelf and becomes less distinct in deeper waters off the shelf (figure 2.3).

Tropical coral larvae are transported by the East Australian Current from the Great Barrier Reef and Coral Sea reefs to subtropical reefs in southeast Queensland and northern New South Wales as far south as the Solitary Islands near Coffs Harbour. The species composition of coral communities follows the tropical/temperate divide for benthic communities. Near Coffs Harbour, 77 species, or 85 per cent of coral species, are near the southern extent of their range, and 11 species, or 12 per cent of coral species, are subtropical species that are absent or rare in the Great Barrier Reef. Subtropical and temperate coral species are dominant in terms of percentage cover towards the southern limits of coral reefs on the continental shelf, and soft corals are less abundant, possibly due to higher wave action. Ninety species of hard coral, mostly from the genus *Acropora*, have been recorded at the southern limits of coral reefs, which is less than a quarter of the approximately 400 species recorded on the Great Barrier Reef.

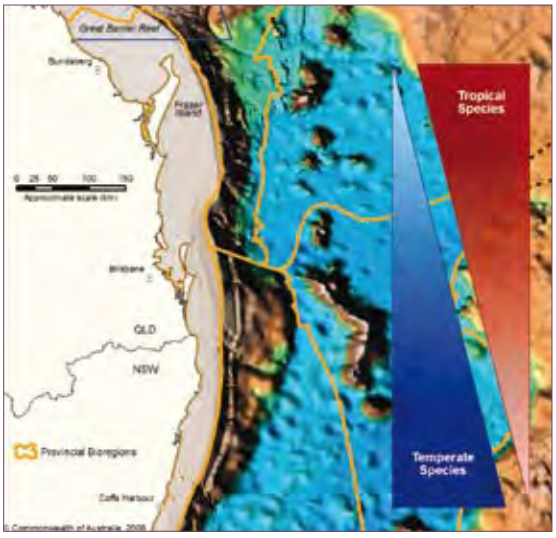
Decapod crustacean species, including shrimps, prawns, lobsters, bugs and crabs are particularly diverse, with 50 per cent of Australia's 2250 species found on the Queensland continental shelf. One hundred species of syngnathids, which includes seahorses, pipefish, pipehorses, and sea dragons, have been found in the Region. Most of the 1500 sponge species in the Region are found on the continental shelf. The distribution of decapod crustaceans, echinoderms, syngnathids, and sponges follows the tropical/temperate transition between tropical and temperate species off Tweed Heads.

Five hundred and fifty species of mollusc (octopus, squid, cuttlefish, scallop, and nautilus) have been recorded for the Region. Twenty-five species of sea snake are found in the Region, mostly confined to tropical areas. Temperate neritic (coastal) species assemblages of marine phytoplankton are found in coastal waters off New South Wales. There is natural enrichment of oceanic waters within the Region resulting from upwelling along the outer margin of the Great Barrier Reef, the New South Wales coast between the Queensland border and Port Stephens, and northern

Figure 2.3 Transition of tropical/temperate benthic species on Australia's eastern continental shelf

The continental shelf off Tweed Heads, New South Wales is a major tropical/temperate transition zone for benthic communities in the Region:

- the occurrence of **tropical benthic species** ranges from approaching 100 per cent at the northern tip of Fraser Island, to almost zero at Coffs Harbour.
- the occurrence of **temperate benthic species** ranges from approaching 100 per cent at Coffs Harbour, to almost zero at the northern tip of Fraser Island.



Lord Howe Island Group. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

New South Wales continental shelf off Smoky Cape near Diamond Head, Forster and Seal Rocks. These areas support rich phytoplankton assemblages.

The fairy penguin (*Eudyptula minor*) nests on islands along the coast of New South Wales and Victoria and ranges northwards to subtropical coastal waters. Thirty species of petrel, shearwater, prion and diving-petrel are found in the Region, with several of these species breeding on islands along the coast. No albatross breed in the Region, but they are found in temperate waters along eastern Australia. Five species of storm-petrel occur in the Region, mainly in temperate and subtropical areas. The white-faced storm-petrel (*Pelagodroma marina*) breeds on islands along the south- east coast.

Two species of frigatebird nest on islands in the Great Barrier Reef and Coral Sea and move into subtropical areas to forage. The osprey (*Pandion haliaetus*) occurs along almost the entire mainland coast of the Region down to Coffs Harbour. There are three breeding species of gull, and 15 species of tern, nine of which breed within the Region. Four species of skua and jaeger are found in the region but do not breed near the Australian mainland. Fourteen sandpiper and three plover species are found in the Region. The white-faced heron (*Egretta novaehollandiae*) breeds in small numbers in the Region, and the cattle egret (*Ardea ibis*) and two species of oystercatcher occur in the Region.

Six species of marine turtle are found in the Region, including the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), olive ridley turtle (*Lepidochelys olivacea*), flatback turtle (*Natator depressus*), and leatherback turtle (*Dermochelys coriacea*). All marine turtle species forage on the continental shelf. Large concentrations of foraging loggerhead turtles have been found in the Hervey Bay/Moreton Bay area and they migrate to nesting beaches in the southern Great Barrier Reef and mainland beaches near Bundaberg. Small numbers breed in northern New South Wales and New Caledonia.

Green turtles are most abundant on the Queensland continental shelf but are found as far south as the Victoria/ New South Wales border. Most migrate to nesting beaches in the southern Great Barrier Reef, with small numbers migrating to breed in the northern Great Barrier Reef, New Caledonia and Vanuatu. Most hawksbill turtles are found within continental shelf waters of Torres Strait and the Great Barrier Reef but are found as far south as northern New South Wales. Breeding sites for hawksbill turtles found in southern Queensland and northern New South Wales have not been determined but there are known breeding

Loggerhead turtle laying eggs. Photo: Lochman Transparencies.

sites in the northern Great Barrier Reef, Solomon Islands and Vanuatu. Flatback turtles are found on the continental shelf as far south as Hervey Bay and migrate to breed on beaches between Townsville and Bundaberg. Olive Ridley turtles found as far south as Hervey Bay do not breed in the Region. Leatherback turtles are mainly an oceanic species, but will forage on the continental shelf from near the Sunshine Coast in south Queensland to Bass Strait. Nesting sites for these turtles have not been determined for the Region although there are known nesting sites for leatherback turtles in northern Papua New Guinea and the Solomon Islands.

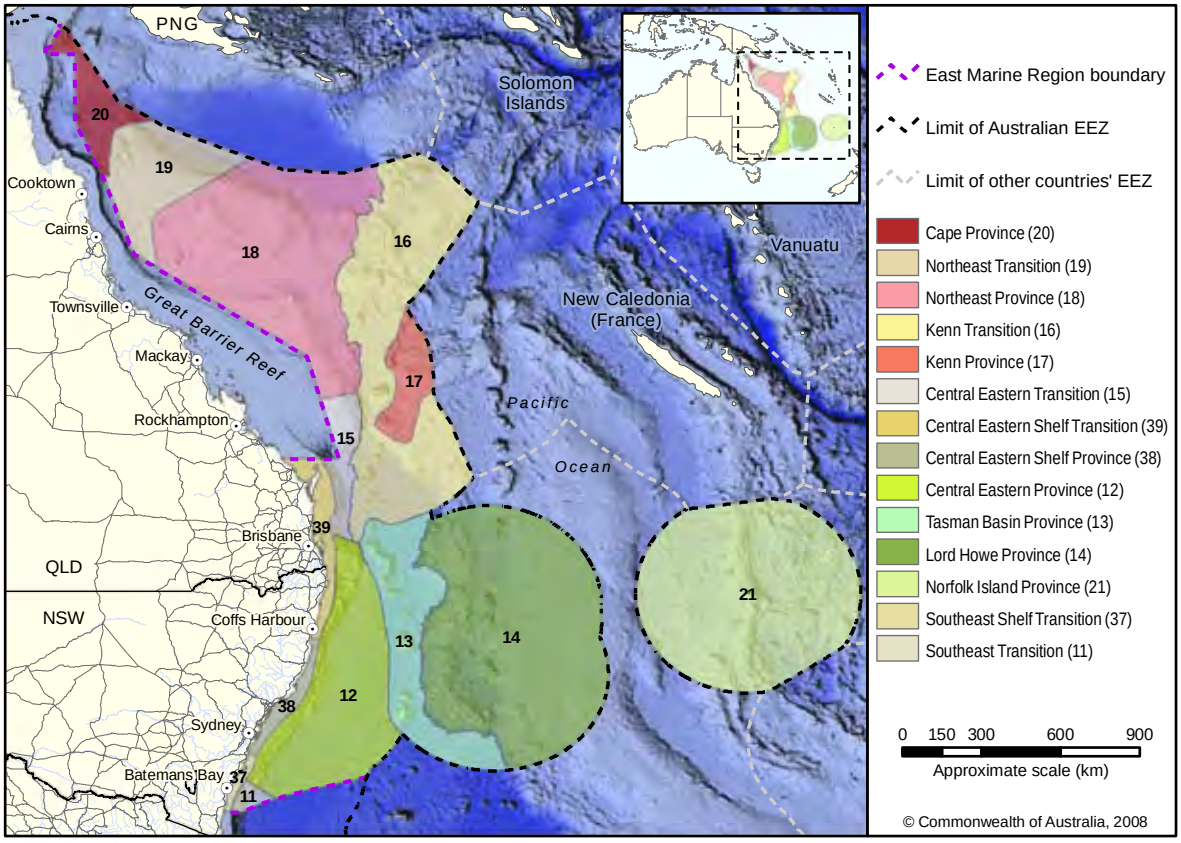
Around 200 species of shark, ray and chimaerid (ghost shark and elephant fish) have been found in waters off New South Wales and eastern Queensland. Eighty per cent of Australia's sharks and rays are demersal species. Harrison's dogfish (*Centrophorus harrissoni*) and the purple eagle ray (*Myliobatis hamlyni*) are endemic to the region. The grey nurse shark (*Carcharias taurus*), listed as critically endangered in the Region, is found in the vicinity of inshore rocky reefs and islands where there are gutters in reefs and submarine caves. The great white shark (*Carcharodon carcharias*), also found on the continental shelf, is listed as vulnerable.

Common seafloor fish species include the blue-spot flathead (*Platycephalus speculator*) and red-spot whiting (*Sillago flindersi*). Common pelagic fish species include slimy mackerel (*Scomber australisicus*), kingfish (*Seriola lalandi*), Spanish mackerel (*Scomberomorus commersoni*), and tuna species. Rare fish species include the giant Queensland groper (*Epinephilus lanceolatus*), Bleekers devil fish (or blue devil fish) (*Paraplesiops bleekeri*), and the black cod (*Epinephilus damelii*). High densities of anemone fish have been recorded in some sites, including the black anemone fish (*Amphiprion melanopus*), Barrier Reef anemone fish (*Amphiprion akindynos*), and the subtropical anemone fish (*Amphiprion latezonatus*). These species are associated with sea anemones, coral and sponges of subtidal reef habitats.

The continental shelf in the Region is included within the range of 25 cetacean species. A full list of cetacean species found in the Region is included at appendix D. Seals likely to occur include the Australian fur seal (*Artocephalus pusillis*), New Zealand fur seal (*Artocephalus forsteri*), leopard seal (*Hydrurga leptonyx*), and southern elephant seal (*Mirounga leonia*). There are no known breeding colonies of seals in the Region. Montague Island and Steamers Head, Jervis Bay are major haul-out sites for Australian and New Zealand fur seals. Australian fur seals are the most abundant seal species in the Region. Dugongs (*Dugong dugon*) have been recorded on the continental shelf, mainly in coastal waters.

2.1 The provincial bioregions of the East Marine Region

Figure 2.4 Provincial bioregions of the East Marine Region (IMCRA v.4.0)



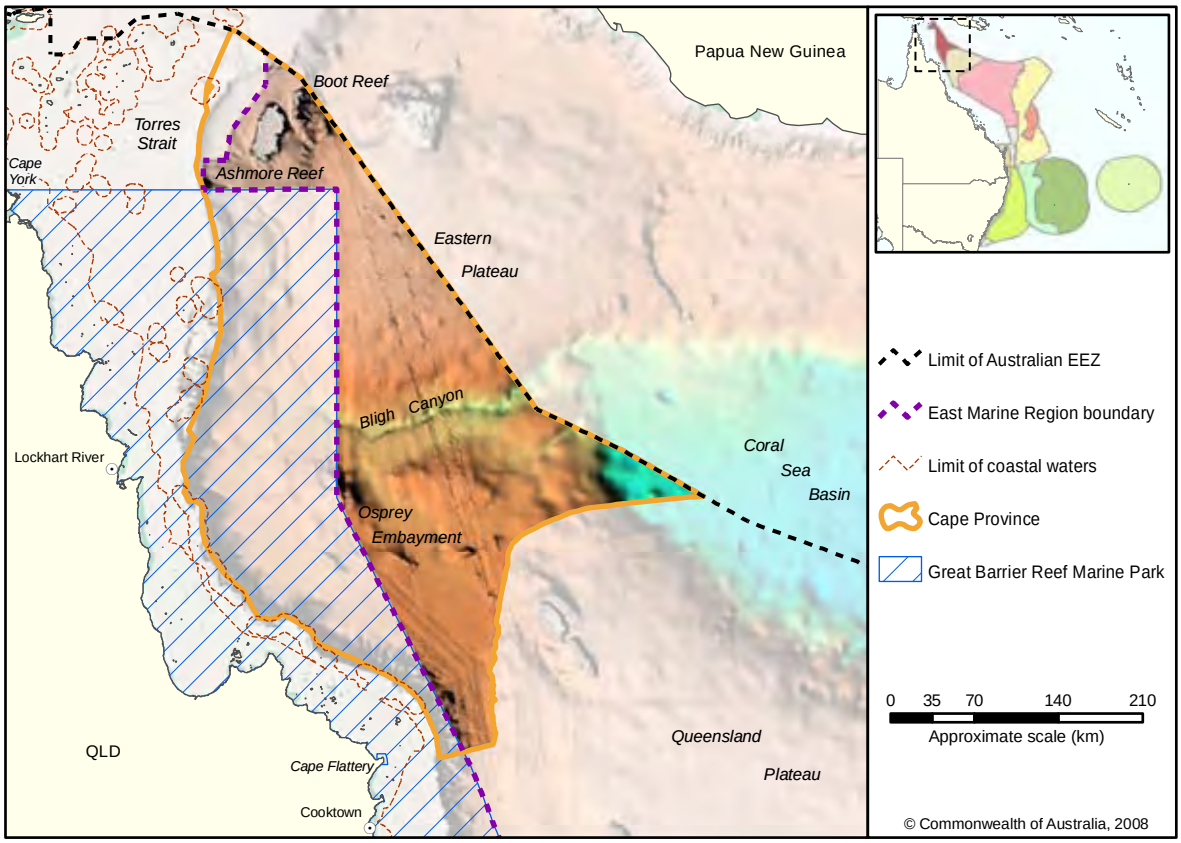
The Integrated Marine and Coastal Regionalisation of Australia Version 4.0 (IMCRA v.4.0) identifies fourteen provincial bioregions in the Region (see figure 2.4). This regionalisation represents the distribution patterns of marine life in the Region at a broad scale. The provincial bioregions described in this Bioregional Profile, beginning with the northernmost, are:

- Cape Province
- Northeast Transition
- Northeast Province
- Kenn Transition
- Kenn Province
- Central Eastern Transition
- Central Eastern Shelf Transition
- Central Eastern Shelf Province
- Central Eastern Province
- Tasman Basin Province
- Lord Howe Province
- Norfolk Island Province
- Southeast Shelf Transition
- Southeast Transition

Each provincial bioregion is described below in terms of the characteristics of its marine environment, including its physical environments, biological communities and ecological processes.

2.1.1 Cape Province

Figure 2.5 The Cape Province



The Cape Province is located on the continental shelf between Cape York and Cape Flattery. It covers a total area of 109 340 km². Fifty-seven per cent (62 520 km²) of the provincial bioregion is within the East Marine Region, with the remainder in the Great Barrier Reef Marine Park, Torres Strait, and Queensland State waters.

Geomorphology

The Cape Province has a high proportion of the deep/hole/valley and ridge features found within the East Marine Region with the majority of the provincial bioregion deep water between 1000 and 4000 m. The main features include the Osprey Embayment, Eastern Plateau, and Ashmore and Boot Reefs. The provincial bioregion receives significant sediment flows from Papua New Guinea river systems. Carbonate mud is the dominant sediment type in the Cape Province though carbonate content of sediments is low in comparison to other offshore provincial bioregions in the Region.

The portion of the Osprey Embayment within this provincial bioregion is an area of deep water valleys and troughs that extends 300 km from the Great Barrier Reef east to the abyssal plain of the Coral Sea Basin. It is 200 km from north to south and includes Bligh Canyon which is 3600 m at its deepest point and runs east-west along the northern margin of the Osprey Embayment for 160 km. The Queensland Trough that runs adjacent to the Great Barrier Reef boundary from the south drains into Bligh Canyon as does Bligh Trough adjacent to the Great Barrier Reef to the north. Sediments entering the Cape Province from the Great Barrier Reef and offshore plateaus move through the system of deep water valleys and troughs in the Osprey Embayment to drain into the Coral Sea Basin.

The south-west corner of the Eastern Plateau–one of the three large marginal plateaus offshore of the Great Barrier Reef that formed during the break-up of the continental crust and subsequent seafloor spreading–falls within this provincial bioregion. These plateaus have been impacted by tectonic subsistence in the early Miocene and ancient reefs have formed broad limestone platforms on large areas of the drowned plateaus.

The atoll reefs of Ashmore and Boot Reefs are examples of reefs formed on limestone platforms of the Eastern Plateau. These reefs rise from depths of 1000 to 1500 m on their eastern side to form carbonate platforms less than 100 m underwater. The platforms are north-south elongate 45 by 20 km (Ashmore) and 20 by 10 km (Boot). Both platforms

are surrounded by deep water valleys and troughs between 500 and 700 m deep. The platforms are 10 km apart separated by a narrow 700 m deep channel.

Up to 50 per cent of sediments on the Eastern Plateau may be organic-rich, causing the carbonate content of sediments in Cape Province to be diluted.

Oceanography

This provincial bioregion is situated in tropical waters. The westerly flow of the South Equatorial Current through the Coral Sea, and the variation in this current caused by north-west monsoonal winds from November to May and south-east trade winds from June to October, influence the tropical provincial bioregions in the Region. The southerly direction of the north-west monsoonal winds can be maintained over a number of months from its onset, while there may be periods of relative calm–often referred to as 'doldrums'–from December to April. The South Equatorial Current bifurcates between 13° S and 22° S, creating the north-trending Hiri Current and the south-trending East Australian Current.

The Cape Province falls within the range of the bifurcation of the South Equatorial Current and is part of a 'formation phase' region for both the East Australian Current and the Hiri Current. The Hiri Current influences this provincial bioregion more than any other provincial bioregion in the Region and creates the east-trending Gulf of Papua Gyre.

Biological Communities

The Cape Province has Coral Sea cays/atolls/islets biological communities associated with Ashmore and Boot reefs. There are abyssal plain and trough biological communities

Bigeye trevally. Photo: Photolibrary.

Dwarf minke whale–The dwarf minke whale (*Balaenoptera acutorostrata* unnamed *subsp.*) is not listed under the EPBC Act. However, at the species level, the minke whale (*B. acutorostrata*) is listed as both cetacean and migratory under the Act.

Dwarf minke whale, Great Barrier Reef. Photo: Matt Curnock.

Between March and October, dwarf minke whales are seen in Cape Province and the northern Great Barrier Reef, with about 80% of sightings in June and July. Scattered sightings and strandings from southern Queensland and northern New South Wales early in the season (May-June) and late in the season (September) give hints of a migration along the east Australian coast but records are incomplete to document movements of the whales.

Dwarf minke whales are known for their curiosity. A swim-with-whales industry has recently developed in waters of the northern Great Barrier Reef based on the voluntary approaches of dwarf minke whales. Here people may swim with whales only if the whales initiate the encounter. A range of management measures govern people's behaviour during an encounter. Research is focussed on learning more about the dwarf minke whales, their interactions with swimmers and on monitoring any potential impacts of this activity on the whales.

Red-tailed tropicbird. Photo: Mark Holdsworth.

associated with the Osprey Embayment, and cold-core and warm-core gyre and eddy biological communities associated with the Gulf of Papua Gyre and Hiri Current eddies. The biological communities in this provincial bioregion have not been the subject of detailed study or data gathering. Approximately 300 species of demersal fish are found in the Cape Province, and 24 endemic species.

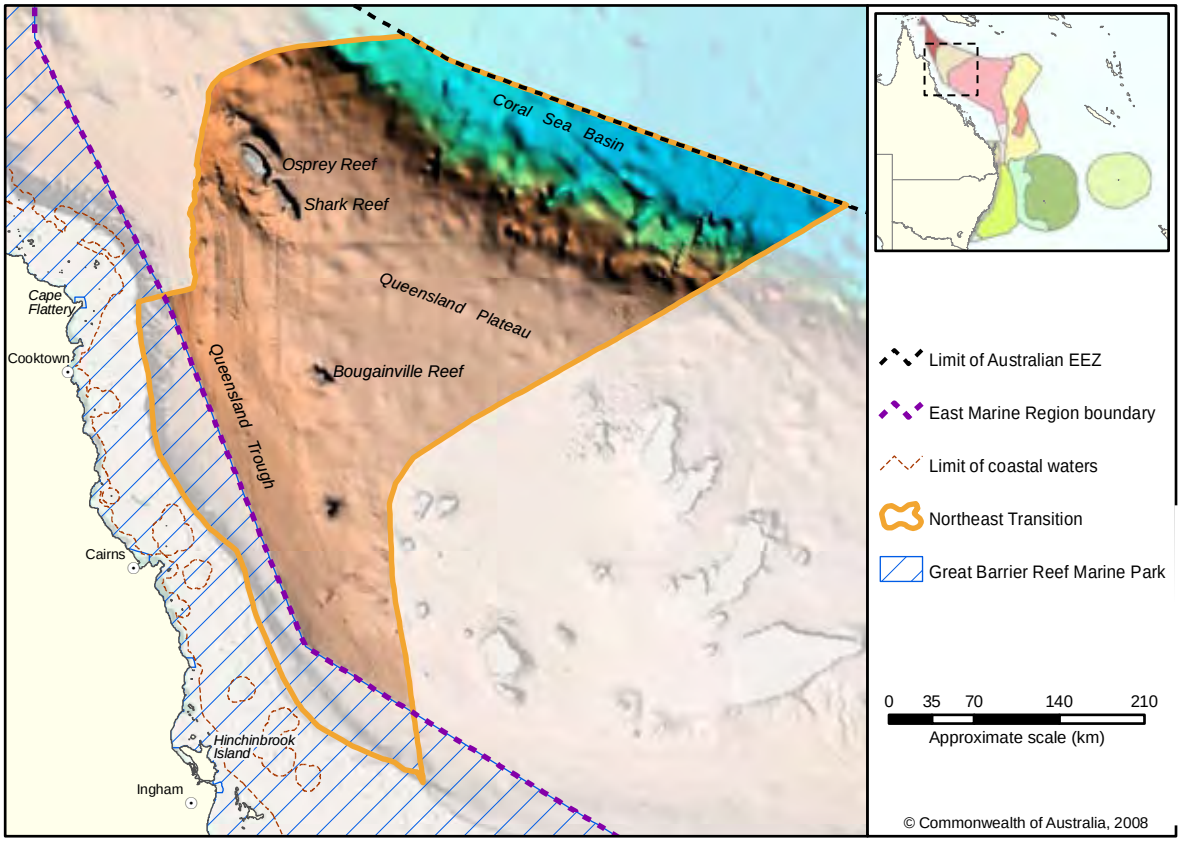
Ecosystem Processes

The Cape Province is influenced by the bifurcation of the Southern Equatorial Current that, at its northern divergence, becomes the Hiri Current. The Torres Strait Islands and Papua New Guinea form a barrier to the northern movement of the Hiri Current. The flow of the Hiri Current as it hits these barriers is diverted in a north-easterly direction and forms a gyre over the Cape Province. The ecological significance of this gyre and the flow of the Hiri Current is not clear but the biological communities on the northern reefs may be distinct from reefs in southern provincial bioregions that are more heavily influenced by the southern divergence of the South Equatorial Current as it becomes the East Australian Current. The Cape Province biological communities may be distinct from those of the Torres Strait and Papua New Guinea region since the Hiri Current moves in a clockwise direction so is not likely to encourage recruitment from this region, though there may be some connectivity between billfish populations.

This is the most geologically active provincial bioregion in the East Marine Region. The continental crust underlying this provincial bioregion is subsiding and a significant supply of sediment from Papua New Guinea's river systems enters the Cape Province from the north. This flow of sediments contributes significant levels of nutrients and, in combination with the gyre formed by the Hiri Current, is likely to increase the productivity of the Cape Province. However, the influence of sediments is probably restricted to the northern part of Cape Province where it has buried reefs, its inflence declining towards the southern parts. The Ashmore and Boot reefs are similar to atolls, growing in elevation at the same rate as the underlying continental crust is subsiding. Some deep valleys in the southern part of the Cape Province channel sediments flowing off the northern Great Barrier Reef into the Coral Sea Basin. Sediments moving down these valleys contribute nutrients to the Cape Province and may be significant in supporting benthic communities.

2.1.2 Northeast Transition

Figure 2.6 The Northeast Transition



The Northeast Transition is located off the shelf between Lockhart River and Hinchinbrook Island. The provincial bioregion covers a total area of 148 700 km², 89 per cent (132 490 km²) of it within the East Marine Region, with the remainder in the Great Barrier Reef Marine Park.

Geomorphology

This provincial bioregion has the largest area of rise of any provincial bioregion in the Region yet the majority of it is deep water, greater than 1000 m. The main features of the Northeast Transition include the Queensland Trough, Queensland Plateau, Shark, Osprey and Bougainville Reefs. Carbonate mud is the dominant sediment type.

The Queensland Trough is a rift basin that extends 550 km in a north-south direction between the Great Barrier Reef and the Queensland Plateau to a depth of 2900 m. The trough is broader in the south and narrows north of Bougainville Reef before widening again as it drains into the Osprey Embayment. Organic-rich sediments flushed through the Great Barrier Reef from the continental shelf are found in the Queensland Trough.

The Queensland Plateau is one of the three large marginal plateaus offshore of the Great Barrier Reef that formed during the break-up of the continental crust and subsequent seafloor spreading. On the basis of water depth, the Queensland Plateau can be divided into a north-west half that falls in this provincial bioregion and a south-east half that falls in the Northeast Province. The north-west half of the plateau is 1000 to 2000 m deep and the south-east half is less than 1000 m deep. The northern edge of the plateau falls steeply to the abyssal plain of the Coral Sea Basin at around 4000 m deep. The western side of the plateau drops down to the Queensland Trough at around 2900 m deep. Prominent terraces occur at 450 to 500 m depth, and carbonate platforms that provide foundations for present reefs are at 50 m depth. There are numerous drowned reefs on the platform, and some large isolated pinnacles on the western edge of the plateau. Osprey Reef rises steeply from over 2000 m on its western side to reach sea level.

Oceanography

The Northeast Transition has a transitional water mass ranging from tropical to warm temperate.

Nautilus–Two species of nautilus, *Nautilus pompilius* and *N. stenomphalus* (taxonomy being revised—now proposed as morphs of the same species, *N. pompilius*) occur in the waters of the East Marine Region (Tzioumis and Keable 2007).

Having survived relatively unchanged for millions of years, nautilus represent the only living members of the subclass Nautiloidea, and are often considered to be "living fossils". Today the nautilus only occurs in areas where shallow coral reefs are close to deeper water. They are mobile benthic animals that live at depths of 300 to 500 m during the day and rise to shallower waters (about 200 m) at night to feed (Norman 2000, Norman and Reid 2000, Jered and Roper 2005). They are generally scavengers feeding on animal remains as well as smaller live prey such as hermit crabs.

Their strong complex shell is used as both protection and as a tool for buoyancy control. They have the ability to hang midwater without having to constantly swim.

The population of nautilus at Osprey Reef is approximately 7500 animals (Undersea_Explorer 2008). Since Osprey is so remote and surrounded by such deep waters, it is very unlikely that the animals would migrate on or off the reef.

Nautilus. Photo: Gavin Leese, QLD Department of Primary Industries and Fisheries Fishery Observer Program.

In essence, they are "imprisoned' by the 1500 m deep surrounding waters and their lack of a larval dispersal phase, which means that it is particularly important to ensure the conservation of this small, long-lived, and slow-growing population (Undersea_Explorer 2007).

Nautilus are not of commercial interest in Australia but are intensively harvested for the ornamental shell trade elsewhere in the Indo–Pacific (e.g. Indonesia, Fiji, New Caledonia and the Philippines) (Jered and Roper 2005).

Studies currently underway of the Coral Sea populations of nautilus (at Osprey Reef and other locations) are providing information on life history, movement patterns and population structure that will aid the management of Nautilus fisheries in the Indo–Pacific region (Andy Dunstan, *pers comm*).

This provincial bioregion falls within the range of the bifurcation of the South Equatorial Current and is part of a 'formation phase' region for the East Australian Current and the Hiri Current. Surface currents are known to form ocean gyres in the Queensland plateau region. High frequency and high intensity cyclones occur in this provincial bioregion, sometimes generating wind-driven north-directed current flows in excess of 2.5 knots that erode the seabed and influences sediment deposition.

Biological Communities

The Northeast Transition has Coral Sea cays/atolls/islets biological communities associated with Osprey, Shark and Bougainville reefs. There are abyssal plain and trough biological communities associated with the Queensland Trough, continental plateau biological communities associated with the Queensland Plateau, and cold-core and warm-core gyre and eddy biological communities associated with Hiri Current and East Australian Current eddies. Biological communities in this provincial bioregion have not been the subject of detailed study but approximately 400 species of demersal fish have been found.

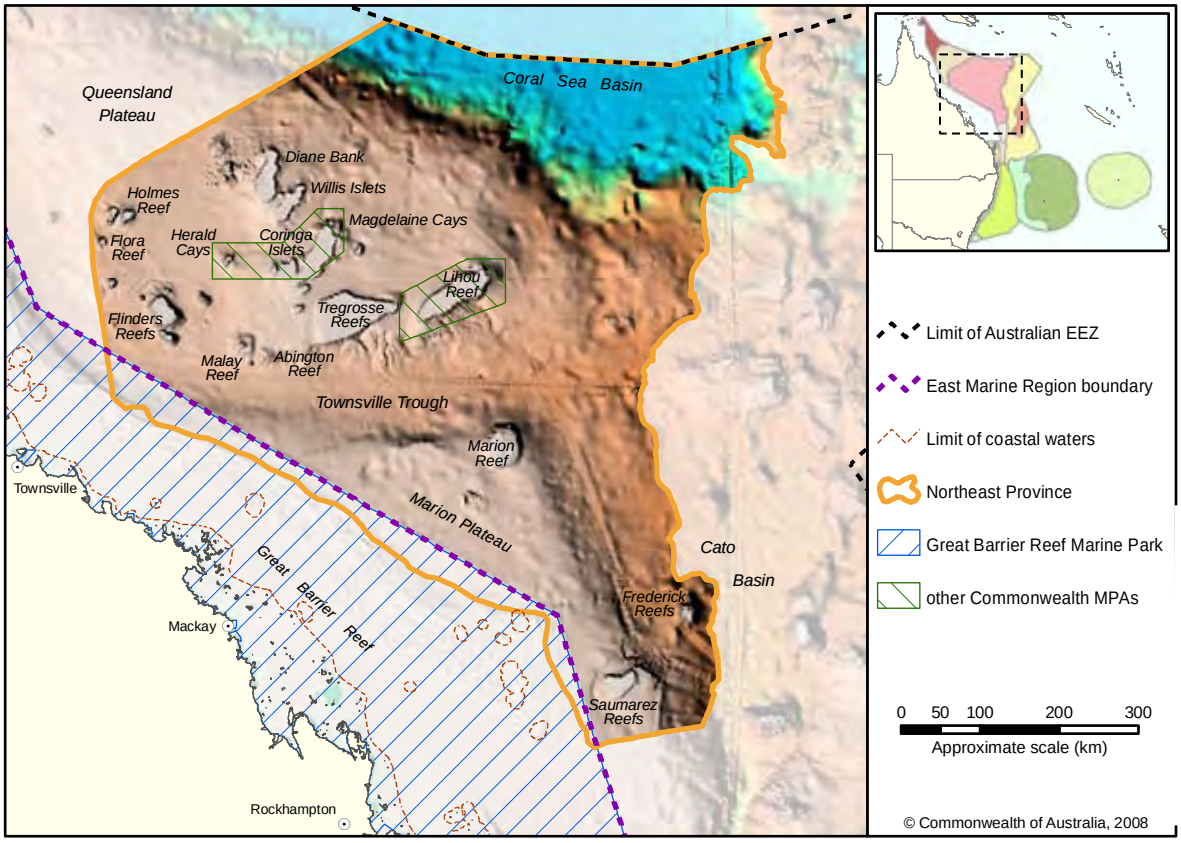
Ecosystem Processes

The bifurcation point of the Southern Equatorial Current moves into and out of the Northeast Transition, with the northern divergence becoming the Hiri Current and the southern divergence becoming the East Australian Current. Both currents can have an impact on the provincial bioregion depending on where the bifurcation point of the Southern Equatorial Current is. The variability in the currents in the provincial bioregion may have a significant influence on the biological communities of Osprey and Shark reefs.

The northern part of the Queensland Plateau lies in this provincial bioregion and is one of the most important submerged ecological features of all the tropical provincial bioregions in the East Marine Region. The Queensland Plateau is like a 'biogeographic island' at about 1000 m depth surrounded on all sides by deeper waters. The reefs built on top of the Queensland Plateau are emergent reefs and may have relict fauna dating back to the Pleistocene era. Recruitment into these biological communities is from the Southern Equatorial Current, and, in their turn, the Queensland Plateau communities are important sources of recruitment for the Great Barrier Reef as the Hiri and East Australian Currents move across the Plateau. Nutrients on the Queensland Plateau are primarily derived from the water column. The Plateau is generally nutrient-poor except where upwelling of deeper nutrient-rich waters occurs where deep water currents interact with reef structures. The Queensland Trough running along the western side of the Queensland Plateau may be found to support some significant deep water coral communities.

2.1.3 Northeast Province

Figure 2.7 The Northeast Province



The Northeast Province is located on the slope and abyssal plain/deep ocean floor to the east of the Great Barrier Reef. It covers a total area of 442 870 km², 95 per cent (422 460 km²) of which lies within the East Marine Region, with the remainder in the Great Barrier Reef Marine Park and Queensland State waters.

Geomorphology

The Northeast Province contains the largest area of reefs in the Region and a high proportion of the trench/trough, terrace, and apron/fan features found in the Region. The majority of the Northeast Province ranges from 10 to 2000 m deep. Key features include the Coral Sea Basin, Queensland Plateau, Townsville Trough, Marion Plateau, Marion and Saumarez Reefs, Frederick Seamount, Tregrosse and Lihou complex of reefs, and Coringa Bank and Diane–Willis complex of reefs. Carbonate mud is the dominant sediment type, with carbonate content highest near the Great Barrier Reef.

The Coral Sea Basin makes up 13 per cent of the area of the Northeast Province and lies in 4000 to 5000 m deep water. The basin is the only area of the Region that has evidence of diatoms in significant quantities within its sediments. Most sediment is derived from the deltas along the Papua New Guinea coast which mix with sediments coming off the Queensland Plateau and Great Barrier Reef.

The Queensland Plateau is one of the three large marginal plateaus offshore of the Great Barrier Reef that formed during the break-up of the continental crust and subsequent seafloor spreading. The shallower south-east half falling within the Northeast Province is mostly less than 1000 m deep. The north side of the plateau drops steeply to the abyssal plain of the Coral Sea Basin at 4000 m deep. The plateau drops less steeply on its south east side, where there is a rise extending out from the base of the slope and two terraces form at depths of 1400 to 1600 m and 2200 m east of Lihou Reefs. The south side of the plateau drops steeply down to the Townsville Trough at 2000 m deep and is cut by many canyons. Ancient reefs have formed broad limestone platforms that extend over approximately half of the Queensland Plateau. Present day reefs have developed on these platforms to cover 10 to 15 per cent of the area of the plateau. The Tregrosse and Lihou complex of reefs form the largest platforms on the Queensland Plateau. They are each nearly 100 km long from east to west, and are 50 and 25 km wide, respectively. They rise steeply from greater than 1000 m deep near the edge of the plateau. The smaller Coringa Bank and Diane–Willis complex of reefs further north rise up from 500 m deep.

South West Herald Cay, Coringa-Herald National Nature Reserve. Image courtesy of Australian Customs.

Green Turtle–The green turtle (*Chelonia mydas*) is listed as a marine species, a threatened species, and a migratory species under the EPBC Act.

As iconic marine megafauna, marine turtles are an attraction to the broader community wherever they are encountered. All marine turtles are slow growing with delayed maturity (Chaloupka 1998, Chaloupka and Musick 1997, Chaloupka and Limpus 1997, Limpus and Chaloupka 1997): they can take about 35 years from hatchling to first breeding.

Green turtles nest, forage and migrate across tropical northern Australia, usually preferring to stay between the 20°C isotherms although individuals sometimes stray into temperate waters.

The green turtle is a widespread and common breeding species within north-eastern Australia and the Western Pacific Ocean. There are currently eight recognised genetic stocks of green turtle identified as breeding in north-eastern Australia and the adjacent western Pacific Ocean (Dethmers et al. 2006, FitzSimmons et al. 1997). One of these, the Coral Sea stock (many hundreds to thousands of females are estimated to breed annually) is restricted to breeding on the Coral Sea National Nature Reserves within the Northeast Province.

Green turtle hatchling. Photo: Robert Thorne.

Breeding adults migrate to their traditional nesting beaches in eastern Australian from dispersed foraging areas scattered within a 3000 km radius of these beaches (as far as Eastern Indonesia, Papua New Guinea, Vanuatu, New Caledonia, Fiji, Northern Territory, Queensland and New South Wales) (Limpus et al. 1992).

Green turtles spend their first five to ten years drifting on ocean currents. During this pelagic (ocean-going) phase, they are often found in association with rafts of Sargassum (a floating marine plant) (Carr and Meylan 1980).

Adult green turtles eat mainly seagrass and algae, although they will occasionally eat other items including mangroves (Forbes 1994, Limpus and Limpus 2000, Pendoley and Fitzpatrick 1999), fish egg cases (Forbes 1994), jellyfish (Limpus et al. 1994) and sponges (Whiting et al. 2000).

Marine turtles have varying significance within aboriginal communities. For some they are totemic while for others they play a significant part of the cultural practices such as use in initiation ceremonies or for traditional food.

The Townsville Trough separates the Queensland Plateau from the Marion Plateau to the south and extends eastward from the Great Barrier Reef to the Cato Basin and on into the Mellish Plateau. The trough is wide and deep (2000 m) in the east and narrows near the Great Barrier Reef where it is shallower at 900 m deep.

The Marion Plateau is one of the three large marginal plateaus offshore of the Great Barrier Reef that formed during the break-up of the continental crust and subsequent seafloor spreading. Most of the plateau is 300–400 m deep. The north-east corner of the Marion Plateau falls within this provincial bioregion and slopes gently north-east from 300 m deep to 600 m deep down to the Cato Basin at 3000–3500 m deep. It gradually drops down in the north to the Townsville Trough at 900–2000 m deep. Half the surface area of the plateau is covered by two major and two minor carbonate platforms formed by ancient reefs that were drowned in the Pliocene. Marion Reef is built on the northern minor carbonate platform and Saumarez Reef is on the seaward margin of the southern platform. Both reefs are ancient, dating back to the Pliocene drowning of the platforms. Off the eastern edge of the plateau, Frederick seamount rises up from the Cato Basin at a depth of 3000 m. Frederick seamount is capped by a living reef that reaches present sea level.

Oceanography

The Northeast Province is situated in tropical waters.

This provincial bioregion is within the 'formation phase' region where the South Equatorial Current bifurcates to form the East Australian Current and the Hiri Current. Surface currents are known to form ocean gyres in the Queensland Plateau region, while the Marion Plateau is strongly influenced by tidal processes and the East Australian Current as it is directed around the plateau forming a slow-flowing clockwise eddy. Tidal flooding drives upwelling of deeper nutrient-rich waters onto the inner plateau. High intensity cyclones occur with a relatively high frequency in this provincial bioregion. The northward movement of a deep sub-Antarctic water mass from the Tasman Sea Basin may influence the east side of the Marion plateau and the Cato Basin.

Biological Communities

The Northeast Province has Coral Sea cays/atolls/islets biological communities associated with the Tregrosse–Lihou, Coringa–Herald, Diane–Willis reef complexes; the Marion and Saumarez reefs; and Coral and Tasman Seas seamounts/guyots/islands biological communities associated with Frederick Seamount. There are abyssal plain and trough biological communities associated with the Townsville Trough and Coral Sea Basin; continental plateau biological communities associated with the Queensland and Marion Plateaus; and cold-core and warm-core gyre and eddy biological communities associated with the Hiri and East Australian Current. The Tregrosse–Lihou and Coringa–Herald reef complexes have been the subject of detailed study and data gathering, and descriptions of these biological communities are found at the beginning of this chapter in the Coral Sea cays/atolls/islets section. Approximately 440 species of demersal fish are found in the Northeast Province, including 70 endemic species.

Ecosystem Processes

The northern part of this provincial bioregion is dominated by the Queensland Plateau and has the same characteristics as described for the Queensland Plateau in the Northeast Transition Province. A number of the emergent reefs on the Queensland Plateau within the Northeast Province break the surface as islands and cays and are important breeding areas for sea birds and marine turtles.

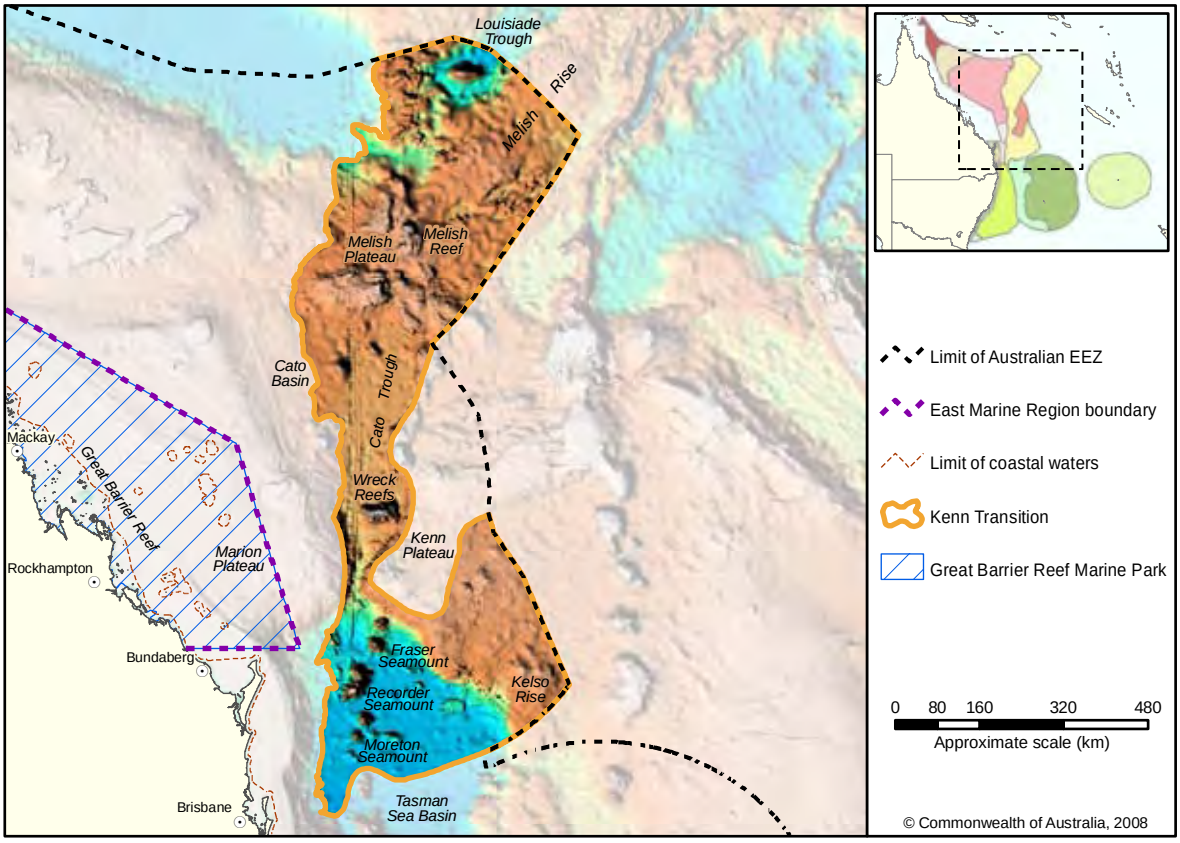
The southern part of the Northeast Province includes the north-east section of the Marion Plateau with some significant reefs on its outer edge. At depths of between 100 and 600 m, the Marion Plateau is much shallower than the Queensland Plateau. There is likely to be some connection between demersal fauna on Marion Plateau and the Great Barrier Reef.

A semi-permanent gyre forms towards the south-east corner of the Northeast Province. This gyre may have a significant impact on productivity of the biological communities of the outer reefs on the Marion Plateau by encouraging upwelling of deeper nutrient-rich waters around the outer reefs.

Severe storm events in this provincial bioregion are likely to be important for the dispersal of demersal fauna between the islands and reefs of the provincial bioregion and the Great Barrier Reef for those species that do not have a pelagic larva stage. 'Cyclone alley'–an area of the Coral Sea where many cyclones form and approach the coast–lies across this provincial bioregion and the Northeast Transition Province.

2.1.4 Kenn Transition

Figure 2.8 The Kenn Transition



Masked Booby - The masked booby (*Sula dactylatra*) is listed as a marine and migratory species under the EPBC Act. It is widespread in tropical waters between 30° N and 30° S in the Pacific, Indian and Atlantic Oceans (Marchant and Higgins 1990).

The masked booby is often observed far from land over deep tropical and subtropical waters.

Breeding colonies are usually situated on tropical oceanic islands, atolls and cays, far from the mainland. They can use very small low-lying cays and reefs, such as Mellish Reef* and Wreck Reefs in Kenn Transition Province, washed over by highest tides and storm waves. These cays and reefs are sometimes physically unstable, changing size and shape under the action of winds, currents, waves and tides. Preferred nesting areas are located on exposed, open, level ground so that they can take off directly into the wind (Hutton 1991). The proximity of deep water tends to be an important determinant in the selection of breeding grounds (Marchant and Higgins 1990).

Masked booby. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

Masked boobies may range widely from their breeding islands in search of food (Hutton 1991), and individuals have been sighted foraging at upwellings of cool nutrient-rich waters (Marchant and Higgins 1990).

The diet of the masked booby is primarily comprised of fish with some squid (Marchant and Higgins 1990). Food is obtained by deep plunging in the ocean from a height of 10 m or more (Hutton 1991).

* Mellish Reef is approximately 10 km long by 3 km wide but it is totally submerged when the sea is above half tide. The only land mass is Herald Beacon Islet, a 600 m long by 120 m wide sand cay which stands two metres above the high water line.

The Kenn Transition is located on the lower slope and abyssal plain/deep ocean floor offshore between Cooktown and North Stradbroke Island. It covers a total area of 377 130 km^2, all of which lies within the East Marine Region.

Geomorphology

This provincial bioregion has a high proportion of the seamount/guyot and saddle features found in the Region. The majority of the provincial bioregion is deep water, between 2000 and 5000 m deep. The main features include the Kenn Plateau, the Cato Trough, Cato Basin, the Tasman Sea Basin, and seamounts/guyots of the Tasmantid Seamount Chain. The Mellish Rise, Louisiade Trough, and Mellish Plateau are significant features. Carbonate mud is the dominant sediment type, with a higher carbonate content found in sediments in the north of the provincial bioregion.

The Kenn Plateau is one of three tectonic blocks of continental crust that form the eastern margin of the Tasman Sea Basin. Part of the south-west of the Kenn Plateau falls within the Kenn Transition. The plateau consists of a series of ridges that are shallower than 2000 m deep, and basins with depths between 1800 and 3000 m. The plateau drops steeply down to the Cato Trough at 3000 m deep on its west side, and down to the Tasman Sea Basin at 3750 m deep on its south side.

The Cato Trough extends 550 km from the Tasman Sea Basin in the south to the Mellish Plateau in the north and separates Kenn Plateau from Marion Plateau. The trough is narrowest in the south where, for 50 km of its length, it is only 10 km wide and 3400 to 3500 m deep. The trough opens up to the Cato Basin in the north. The Kenn Plateau rises steeply from the 3000 m deep Cato Basin and on its east side has many small and large canyons flowing into the basin off the Kenn Plateau. The basin is around 3000 m deep and has Wreck seamount rising up out of it. Wreck seamount is capped by limestone reefs and forms Bird Island, part of the Tasmantid Seamount Chain.

Three southern seamounts, Fraser, Recorder, and Moreton are included in this provincial bioregion and rise up out of the Tasman Sea Basin abyssal plains from depths between 4000 and 4600 m but do not reach sea level. Fraser's summit is 360 m below sea level; Recorder has two platforms at its summit which are 400 and 1170 m below sea level; and Moreton's summit is 753 m below sea level and is another volcanic peak. The seamounts are progressively younger southwards along the chain.

Oceanography

The Kenn Transition has a transitional water mass (tropical–warm temperate).

This provincial bioregion falls within the range of the bifurcation of the South Equatorial Current, part of a 'formation phase' region for the East Australian Current and the Hiri Current. Surface currents are known to form ocean gyres in the Queensland Plateau region. The northward movement of a deep sub-Antarctic water mass from the Tasman Sea Basin may influence this provincial bioregion as it moves through the Cato Basin to the Mellish Plateau. A semi-permanent ocean gyre forms near the Cato Trough at the south-east edge of the Marion Plateau coinciding with Cato Island and Kenn Reef, and creating an area of high biological productivity off Fraser Island.

Biological Communities

The Kenn Transition has Coral and Tasman Seas seamounts/guyots/islands biological communities associated with Mellish, Wreck, Fraser, Recorder, and Moreton reefs and seamounts. There are abyssal plain and trough biological communities associated with the Cato and Louisiade Troughs and Cato and Tasman Sea Basins, continental plateau biological communities associated with the Mellish Rise and Mellish and Kenn Plateaus, and cold-core and warm-core gyre and eddy biological communities associated with the East Australian Current. The biological communities in this provincial bioregion have not been the subject of detailed study.

Ecosystem Processes

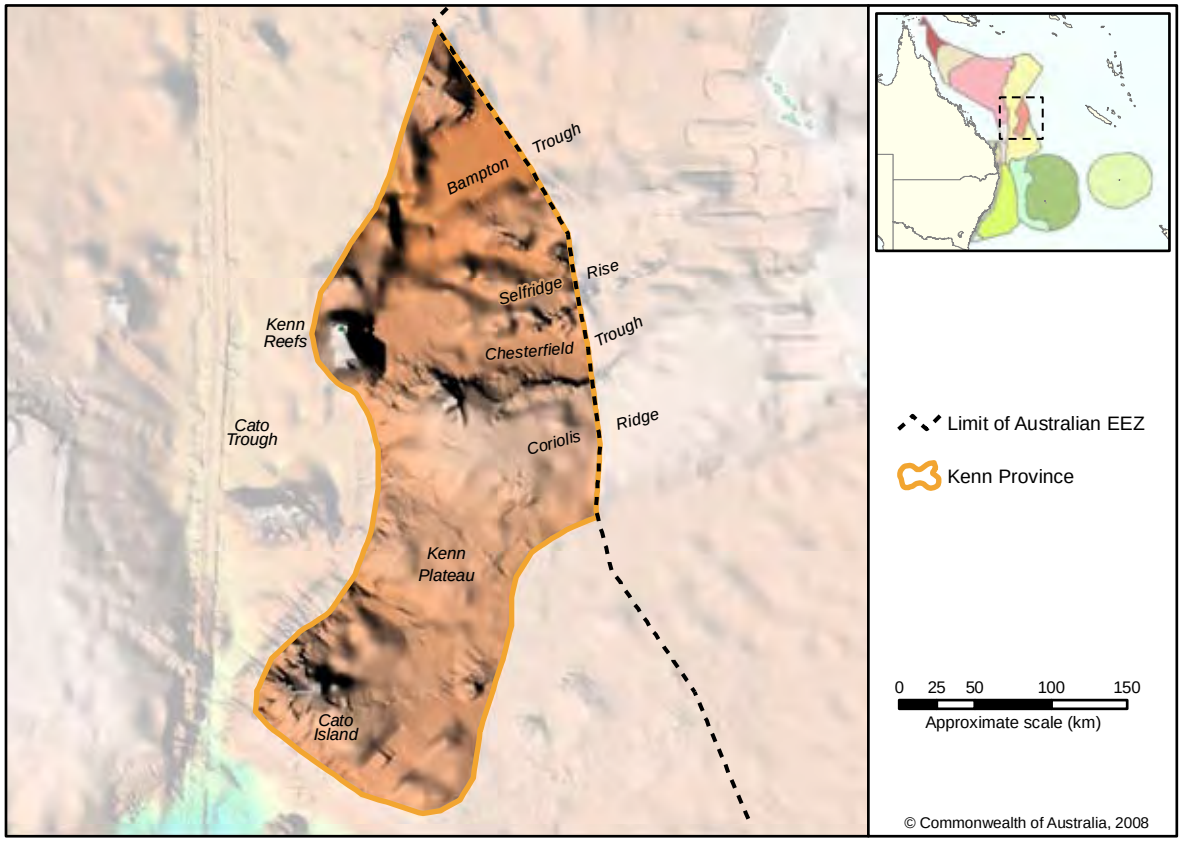
The Cato Basin and the northern Tasman Basin form the deep water western margin of this provincial bioregion. They are linked by the narrow Cato Trough. East of the Cato Trough is the Kenn Plateau. North-flowing sub-Antarctic waters move through the Cato Trough and interact with the south-flowing East Australian Current to create areas of high productivity around structures such as Wreck Reef, and other seamounts and islands.

The seamounts rising up from the Kenn Plateau differ from the more southerly seamounts of the Region in that they break the sea surface as islands and are older. Recruitment between seamounts in this chain is likely to occur over long (geological) time scales giving rise to distinctive ecological communities on different seamounts.

The narrow Cato Trough is an area of highly dynamic interactions between a semi-permanent gyre, the south-flowing East Australian Current, and north-flowing sub-Antarctic waters. These interactions create upwelling of nutrient-rich waters that support high productivity including regionally significant billfish populations.

2.1.5 Kenn Province

Figure 2.9 The Kenn Province



The Kenn Province is located on the Kenn Plateau at the junction of the Coral and Tasman Seas. It covers a total area of 57 420 km² and is all within the East Marine Region.

Geomorphology

Important geomorphologic features of the Kenn Province are seamounts/guyots and plateaus. The majority of the Kenn Province occurs in water depths between 1000 and 3000 m. Carbonate mud is the dominant sediment type. The main features include Kenn Plateau, Cato Island and Kenn Reef.

Dolphin. Image courtesy of CSIRO.

Kenn Plateau is one of three tectonic blocks of continental crust that form the eastern margin of the Tasman Sea Basin. The central western section of the plateau is included in this provincial bioregion. The plateau consists of a series of ridges at less than 2000 m deep and basins with depths between 1800 and 3000 m. Coriolis Ridge at around 1000 m deep has fields of sand dunes which are four to five metres high. Three seamounts rise up from the plateau, namely Kenn, Chesterfield, and Cato. Kenn and Cato rise above present sea level from depths of 3000 and 1500 m, respectively, and have living reefs on limestone caps.

Oceanography

The Kenn Province is situated in tropical waters.

This provincial bioregion falls within the range of the bifurcation of the South Equatorial Current and is part of a 'formation phase' region for the East Australian Current and the Hiri Current. Surface currents are known to form ocean gyres in the Queensland plateau region. A deep sub-Antarctic water mass moves northward from the Tasman Sea Basin through the Cato Basin to the Mellish Plateau. A semi-permanent ocean gyre forms near the Cato Trough at the south-east edge of the Marion Plateau coinciding with Cato Island and Kenn Reef, creating an area of high biological productivity off Fraser Island.

Frigate bird. Photo: A. Dunn

Giant Trevally–The giant trevally (*Caranx ignobilis*) is the largest species of trevally frequenting the warm tropical waters of Australia. It can grow up to 1.7 m (60 kg), but is generally caught at much smaller sizes.

Giant trevally. Photo: Dr. Dwayne Meadows, NOAA/NMFS/OPR.

The giant trevally, or GT as it is often known, is usually seen cruising along reef drop-offs in tropical marine waters. It is a pelagic fish, occurring over the tropical continental shelf and offshore reefs, and sometimes venturing further offshore into southern waters. Most individuals of this species aggregate in large schools. Larger individuals tend to be solitary, and prefer to feed at night.

The giant trevally is a highly-prized game fish. International visitors in particular, undertake specialised charters to the Coral Sea, to areas like Kenn Reef and Cato Island, to fish for this species.

Biological Communities

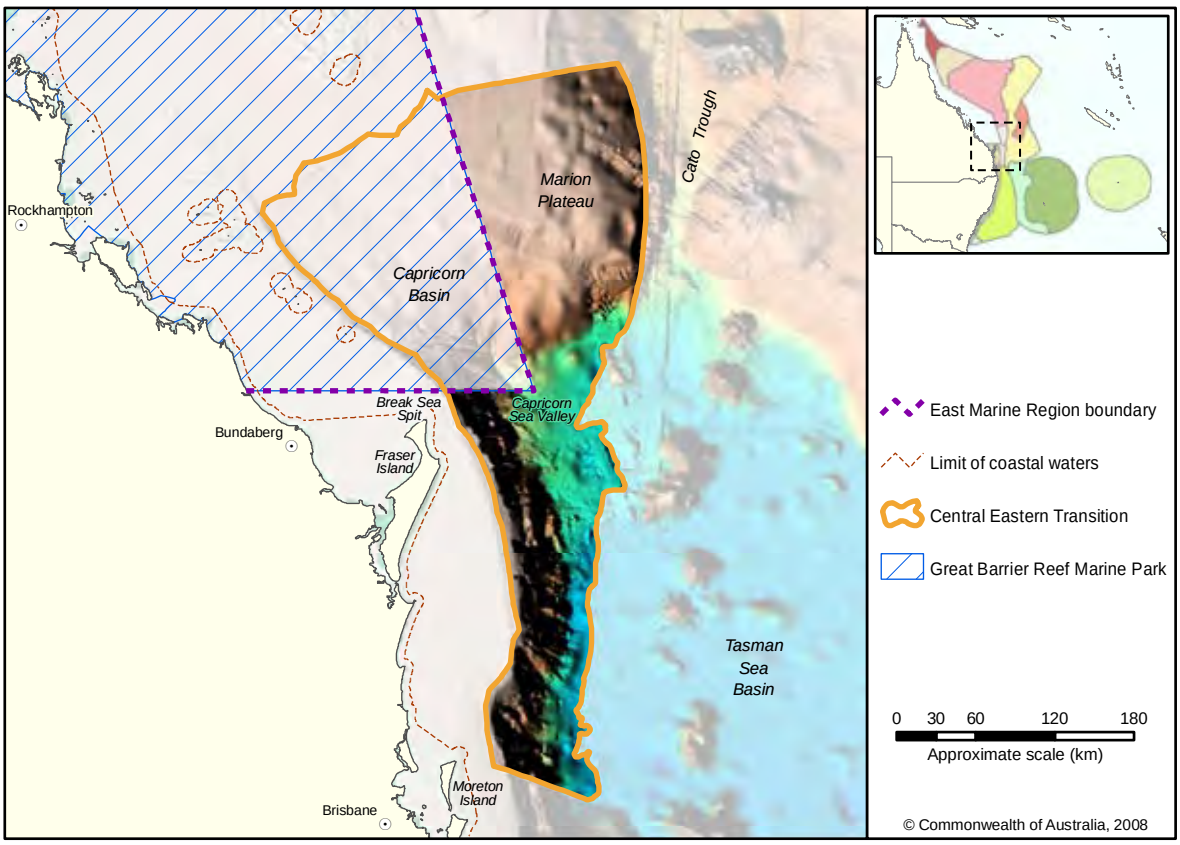
The Kenn Province has Coral and Tasman Sea seamounts/guyots/islands biological communities associated with Kenn Reefs and Cato Island. There are continental plateau biological communities associated with Kenn Plateau, and cold-core and warm-core gyre and eddy biological communities associated with the East Australian Current. The biological communities in this provincial bioregion have not been the subject of detailed study.

Ecosystem Processes

Part of the Kenn Plateau lies within this provincial bioregion and includes Kenn reefs and Cato Island. The ecological significance of Kenn Plateau is not known but the reefs and islands on the western edge of the Plateau are likely to support significant biological communities. Plankton communities around Cato Island may also be distinctive.

2.1.6 Central Eastern Transition

Figure 2.10 The Central Eastern Transition



The Central Eastern Transition is located on the slope and rise to the east of Fraser Island, and to the south-east of the Great Barrier Reef Marine Park. It covers a total area of 67 150 km². Sixty-seven per cent (44 840 km²) of the provincial bioregion is within the East Marine Region, with the remainder in the Great Barrier Reef Marine Park.

Geomorphology

Important geomorphic features of the Central Eastern Transition are slope, rise, submarine canyons, and terraces. This provincial bioregion has the second largest area of rise in the Region. Water depth over the provincial bioregion ranges from around 2000 m deep on slope, around 4000 m deep on the rise, and around 420 m deep on terraces. Carbonate sand is the dominant sediment type. Main features include Marion Plateau, Tasman Sea Basin, and active submarine canyons along the slope.

Marion Plateau is one of the three large marginal plateaus offshore of the Great Barrier Reef that formed during the break-up of the continental crust and subsequent seafloor spreading. Most of the plateau is 300 to 400 m deep. The south-eastern corner of the plateau falls within this provincial bioregion. The south margin of the plateau runs east-west for 100 km and is steep and rough, descending from 800 m to 3600 m deep. One large submarine canyon forms the Capricorn Sea Valley that cuts the margin to a depth of 4700 m and runs for over 120 km. The east side of the Marion Plateau drops steeply to the Cato Trough at 3500 m depth. The northwest section of the Tasman Sea Basin in this provincial bioregion is shallower than in the south due to the accumulation of a thick sequence of pelagic sediments. The continental shelf along the western edge of the provincial bioregion is one of only two areas along the Australian coast where significant amounts of sediment are moving across the continental shelf and reaching the heads of the submarine canyons.

Oceanography

The Central Eastern Transition has a transitional water mass (tropical–warm temperate).

The northward movement of a deep sub-Antarctic water mass from the Tasman Sea Basin may influence this provincial bioregion as it moves along the steep continental shelf and around the south east margins of the Marion Plateau through the Cato Trough. A semi-permanent ocean gyre forms near the Cato Trough at the south-east edge of the Marion Plateau coinciding with Cato Island and Kenn Reef, and creating an area of high biological productivity off Fraser Island.

Yellow-bellied Sea Snake–The yellow-bellied sea snake (*Pelamis platurus*) is listed as a marine species under the EPBC Act. It possesses a colour pattern that is unique amongst the sea snakes–the dorsal surface of the body is black or brown which contrasts with the cream, yellow or pale brown of the ventral surface.

This is the most widely distributed sea snake in the world (Cogger 1996), found in both the Pacific and Indian Oceans. It ranges from the East coast of Africa through the Indian and Pacific Oceans to the West coast of the Americas (Kropach 1975, Cogger 1996). It is found in most Australian waters with the exception of the colder southern coastline (Cogger 1996). Biggest populations exist south of the tropics (Cogger 1975, Cogger 1996) where the yellow-bellied sea snake is commonly found on beaches after storms (Storr 1986).

Yellow bellied sea snake. Image courtesy of the Australian Institute of Marine Science.

The yellow-bellied sea snake is the only true pelagic sea snake. It inhabits the slicks and drift lines of ocean currents where it feeds on fish attracted to the body of the snake resting motionless on the surface (Kropach 1975).

The yellow-bellied sea snake is often washed ashore by a combination of ebbing tides and onshore winds (Guinea 1992). It is quite helpless on land and sea snakes washed onto beaches during storms seldom manage to return to the sea.

The species is caught incidentally in commercial and research trawling operations in Australia. Sea snake species may have a low capacity to recover from fishing and are potentially threatened by the impacts of trawling (Marsh et al. 1993), due mainly to their low fecundity and longevity.

Biological Communities

The provincial bioregion has continental shelf biological communities associated with active and non-active canyons. There are abyssal plain and trough biological communities associated with the Tasman Sea Basin, continental plateau biological communities associated with the Marion Plateau, and cold-core and warm-core gyre and eddy biological communities associated with the East Australian Current. The biological communities in this provincial bioregion have not been the subject of detailed study or data gathering. Approximately 500 demersal fish species are found in this provincial bioregion.

Ecosystem Processes

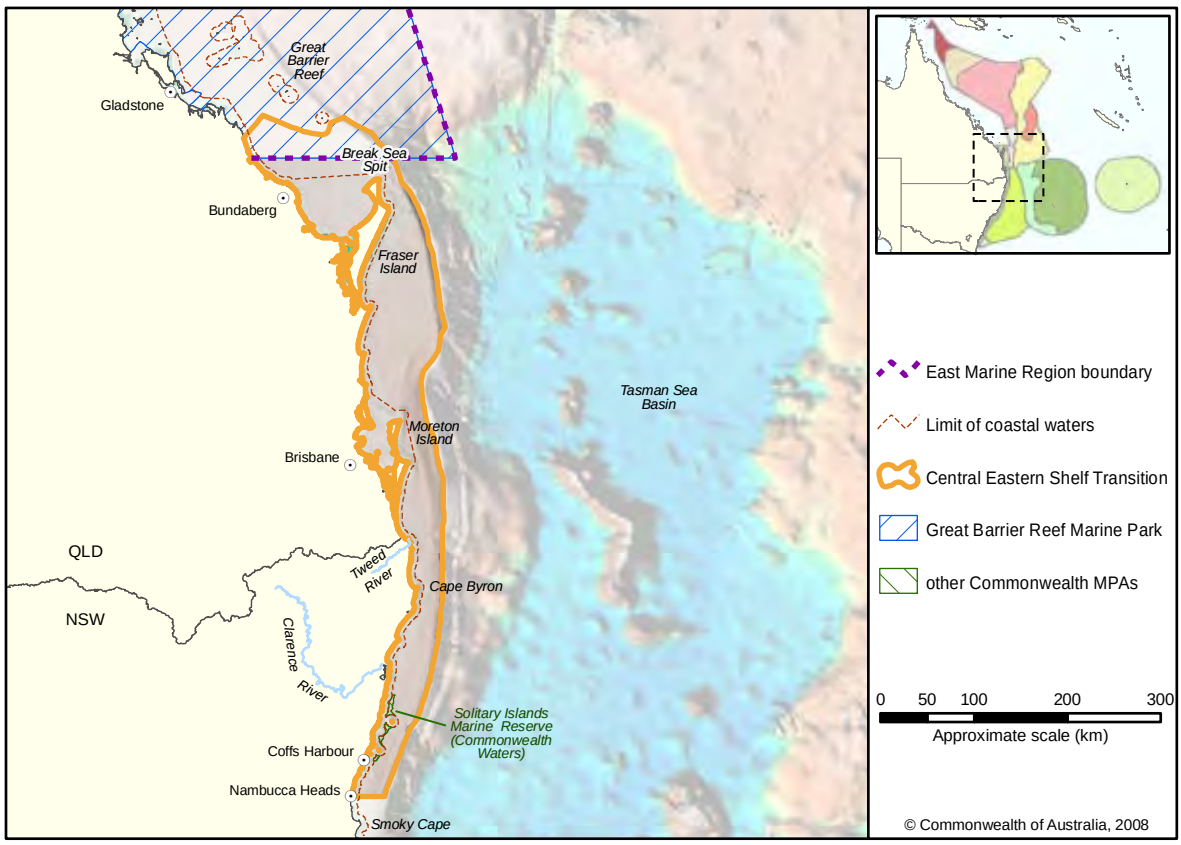
The slope and canyons off southern Queensland are geologically younger than areas further south. The slope is incised with small canyons (less than 500 m deep). The different characteristics of these canyons compared to those found further south result in different biological communities being associated with them. Limestone ridges (old reefs) form exposed scarps on the upper slope.

Quartz sand originating from Fraser Island is being fed down the slope into the provincial bioregion, and into a deep sea valley on the abyssal plain. The movement of this sediment is an important ecological driver in that associated species have adapted to this unstable environment. The canyons off Break Sea Spit that are feeding into the deep sea valley are examples of modern active canyons; the only other example of an active canyon in Australia is in Bass Strait. The northerly extent of the larger inactive canyons is to the north of Moreton Island.

Humpback whale. Photo: Dave Paton.

2.1.7 Central Eastern Shelf Transition

Figure 2.11 The Central Eastern Shelf Transition



The Central Eastern Shelf Transition is located on the continental shelf between Fraser Island and Nambucca Heads. It covers a total area of 43 030 km². Sixty-one percent (26 340 km²) of the provincial bioregion is within the East Marine Region, with the remaining percentage in the Great Barrier Reef Marine Park, and in New South Wales and Queensland State waters.

Geomorphology

The Central Eastern Shelf Transition is located predominantly on the continental shelf (78 per cent) and includes a small section of upper slope. The shelf varies in width from 130 km to the north of Fraser Island to less than 25 km adjacent to Macksville (near Nambucca Heads). Significant features include: three shallow water terraces that run parallel to the coast, separating the shelf from the upper slope; a small area of reef to the north of Fraser Island; and two submarine canyons that occur on the slope offshore of Coolangatta and extend offshore of the provincial bioregion boundary into the Central Eastern Province.

Break Sea Spit, north of Fraser Island, is the shallowest point, with a depth of one metre. The deepest point in the provincial bioregion is 240 metres. This provincial bioregion is the shallowest on average of all the shelf provincial bioregions in Australian Commonwealth waters.

Sediment texture is relatively homogenous, dominated by sand with localised gravel deposits and negligible mud. Sand is the dominant sediment type associated with the geomorphic features found in this provincial bioregion including shelf, slope and shallow water terraces. Shallow water terraces in this provincial bioregion also contain a significant proportion of gravel. The carbonate content of seabed sediments is moderate (approximately 40 to 60 per cent) and increases towards the outer shelf and upper slope.

Most of the shelf in the Region can be divided on the basis of water depth into an inner shelf (less than 60 m water depth), middle shelf (60 to 120 m) and an outer shelf (120 m to shelf break). In general, the inner shelf is relatively steep down to 60 m water depth, the middle shelf has a more gentle slope seaward and the outer shelf is a flat, near-horizontal plain.

Oceanography

This provincial bioregion has a transitional water mass (tropical–warm temperate).

Although generally moving in a southerly direction, the path of the East Australian Current meanders across different areas of the shelf depending on a number of seasonal conditions such as the strength of the East Australian

Current and the seasonal location of the South Equatorial Current bifurcation point in the Coral Sea.

Biological Communities

The Central Eastern Shelf Transition has continental shelf biological communities associated with it, and gyre and eddy biological communities associated with the East Australian Current eddies that pass through the provincial bioregion.

The provincial bioregion includes the continental shelf off Tweed Heads, New South Wales. This area is a transition zone for benthic communities and represents a major tropical/temperate divide for the Region. The Central Eastern Shelf Transition has been the subject of detailed study, and descriptions of the biological communities are found at the beginning of this chapter under the continental shelf section.

The reef building capability of corals reduces toward the south of this provincial bioregion, with the southern limit of coral reef growth being the Solitary Islands. While some coral species that are found associated with reefs further north are also found south of the Solitary Islands, these species do not build reefs south of this point due to limiting temperatures, reduced winter day length and available calcium carbonate for skeleton formation.

Ecosystem Processes

The major ecosystem processes are similar across the three shelf provincial bioregions of the Region: the Central Eastern Shelf Transition; the Central Eastern Shelf Province; and the Southeast Shelf Transition.

The East Australian Current's movement along and away from the shelf causes upwelling of nutrient-rich, cool water onto the shelf, resulting in phytoplankton growth and increased primary production. A region of relatively predictable upwelling is known to occur in the region between Cape Byron and Smokey Cape in New South Wales, which has resulted in a large seasonal variation in the surface temperature across the area and a number of submarine canyons being created along the shelf edge.

Riverine sediments occurring along the length of the coast, for example from the Shoalhaven, Hawkesbury, Hunter, Clarence and Tweed rivers are deposited as mud on the continental shelf off the mouths of these rivers. Longshore drift and wave action move sand north along the inner shelf, forming the Moreton and Fraser sand islands. Further offshore, sediment on the shelf is carried southwards by the East Australian Current.

Geomorphology and sediment types are the primary determinates of the distribution of benthic organisms. Pelagic species distribution is more closely linked with variations in water masses.

Ecological connections across the shelf provincial bioregions in the Region are driven by the southward-moving East Australian Current and the northward-moving longshore drift in the inshore area. These shelf provincial bioregions also have connections to the slope provincial bioregions of the Region by the movement of the Tasman Front and the associated eddy fields extending out into the Tasman Sea.

Humpback Whale–The humpback whale (*Megaptera novaeangliae*) is listed as a cetacean, and as a threatened and migratory species under the EPBC Act.

Each year between April and November, humpback whales migrate along Australia's eastern coastline. After a summer of feeding on krill in Antarctic waters, the whales migrate north to sub-tropical waters where they mate and give birth. During their annual migration of up to 10 000 km, humpbacks attract thousands of visitors to coastal towns such as Eden, Sydney and Byron Bay in New South Wales, and the Gold Coast and Hervey Bay in Queensland.

Humpback whale, Hervey Bay. Photo: Mark Farrell.

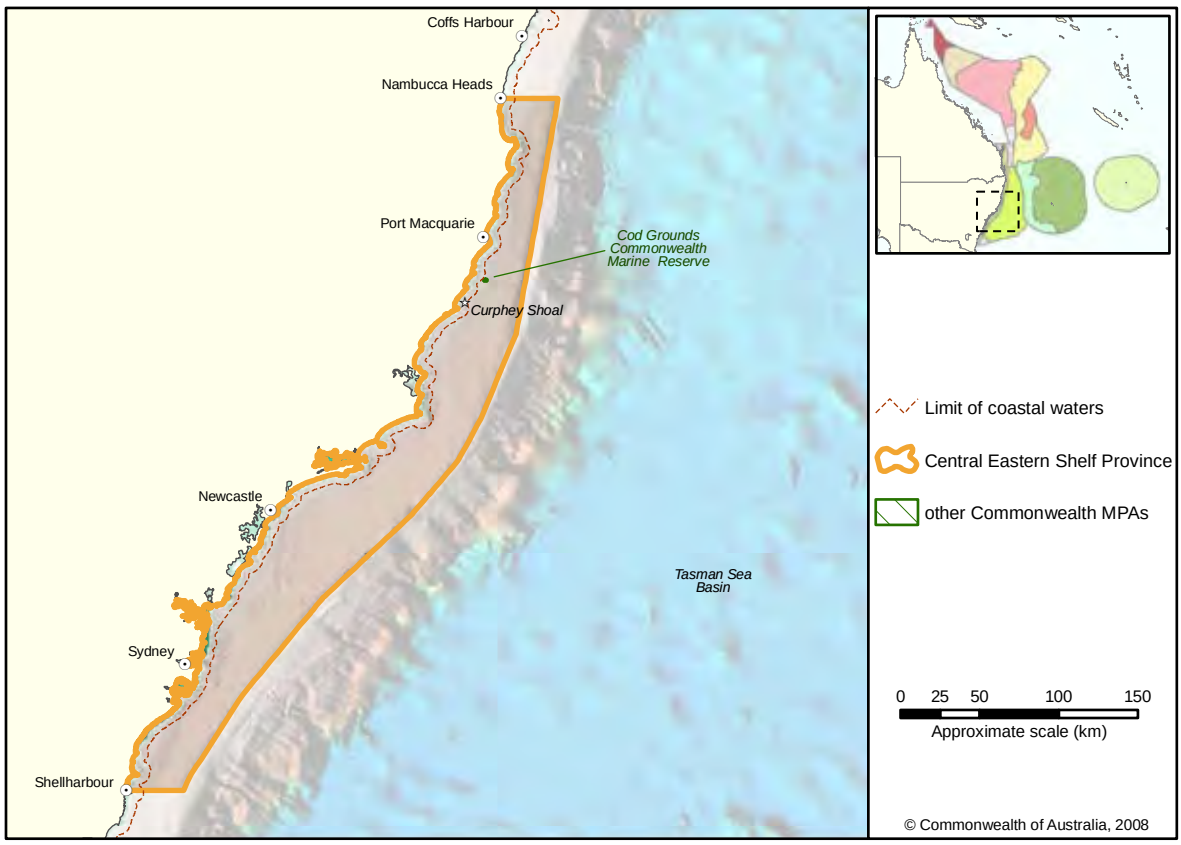
The exact timing of the migration period can vary from year to year depending on water temperature, sea ice, predation risk, prey abundance and the location of their feeding ground. The majority of humpbacks in Australian waters migrate north from June to August, and back towards the Southern Ocean from September to November.

It is estimated that when the Australian east coast whaling industry ended in 1963, the east coast population of humpbacks had been reduced to a little over 100 individuals. This population has shown steady recovery of around 10 to 11 per cent a year, and in 2006 was estimated at around 8000.

The recovery of the humpback population has contributed significantly to the rapid growth of Australia's whale-watching industry. The Australian National Guidelines for Whale and Dolphin Watching 2005 have been developed to minimise impacts on whales, dolphins and porpoises and to give people the best opportunity to enjoy and learn about them.

2.1.8 Central Eastern Shelf Province

Figure 2.12 The Central Eastern Shelf Province



The Central Eastern Shelf Province is located on the eastern Australian shelf between the towns of Nambucca Heads and Shellharbour. It covers an area of 13 310 km² or one per cent of the East Marine Region. Seventy-nine per cent of the provincial bioregion is in the Region, with the remaining area in New South Wales state waters.

Geomorphology

The Central Eastern Shelf Province runs parallel to the coast and includes an elongate area of continental shelf ranging in width from 10 to 60 km. A series of small terraces run parallel to the shoreline at the shelf edge covering over 15 per cent of the Central Eastern Shelf Province area.

The deepest point in the provincial bioregion is 240 metres. Curphey Shoal is the shallowest point at 19 metres. Sediment texture of the Central Eastern Shelf Province is dominated by sand with localised deposits of gravel in the north of the provincial bioregion. Sand is the dominant sediment type associated with the geomorphic features found in this provincial bioregion including shelf, slope and shallow water terraces. High mud contents are located offshore of Sydney and Newcastle. The carbonate content of seabed sediments is high and increases towards the outer shelf and upper slope.

Oceanography

The Central Eastern Shelf Province is situated in warm temperate waters.

The oceanography is very similar along the shelf provincial bioregions, and is driven by the southerly movement of the East Australian Current that meanders across the shelf depending on its strength and other seasonal conditions.

Biological Communities

The Central Eastern Shelf Province has continental shelf biological communities associated with it, as well as some gyre and eddy biological communities associated with the East Australian Current eddies that pass through the bioregional province. The Central Eastern Shelf Province has been the subject of detailed study and data gathering, and descriptions of its biological communities are found at the beginning of this chapter under the continental shelf section.

Ecosystem Processes

The major ecosystem processes described for the Central Eastern Shelf Transition also apply to this provincial bioregion. The upwelling described in the Central Eastern Shelf Transition between Byron Bay and Coffs Harbour can also occur in the northern portion of the Central Eastern Shelf Province.

Grey Nurse Shark (East Coast population)–the grey nurse shark (east coast population) (*Carcharias tauras*) is listed as a threatened species (Critically Endangered) under the EPBC Act.

In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern New South Wales and the other around the south-west coast of Western Australia. It is believed that the east and west coast populations do not interact and ongoing research will probably confirm that the populations are genetically different.

Grey nurse sharks gather at a number of key sites along the coast of New South Wales and southern Queensland, including – from north to south – Wolf Rock, Moreton Island, Stradbroke Island, Byron Bay, Solitary Islands, South West Rocks, Laurieton (Cod Grounds), Forster, Seal Rocks, Port Stephens, Sydney, Bateman's Bay and Narooma. These sites have gravel or sand filled gutters, or rocky caves, and are close to inshore rocky reefs or islands. The sharks have been recorded at various depths, but are mainly found in waters between 15 and 40 m deep, with the majority of time spent in waters less than 30 m deep.

Grey nurse sharks in the Looking Glass at Broughton Island. Photo: David Harasti.

Despite their fierce appearance, grey nurse sharks are not a threat to divers or swimmers unless provoked. They are a passive species, mainly active at night, with teeth designed for capturing prey such as fish, squid and crustaceans. Their placid nature, combined with their occupation of shallow inshore reef areas, has allowed diving with grey nurse sharks to become the focus of an ecotourism industry.

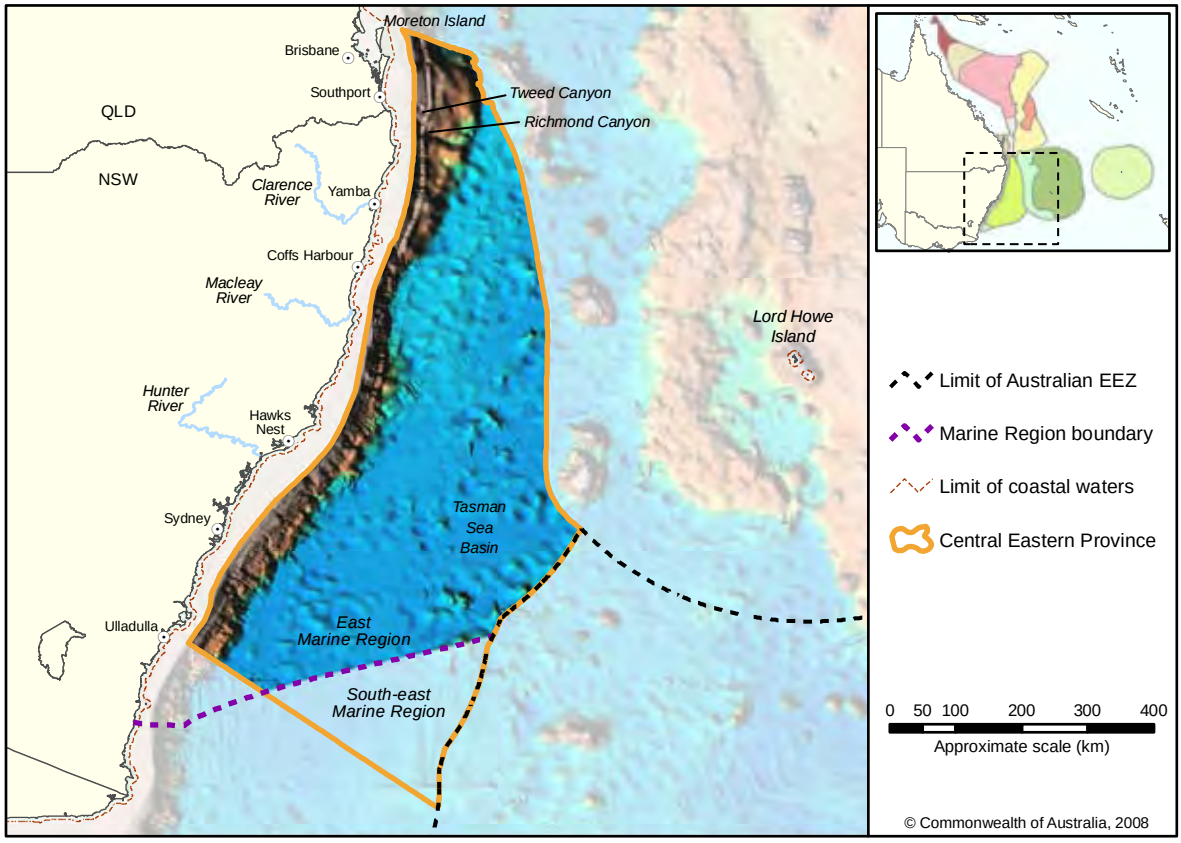
Although the sharks are protected today, they were commercially fished quite extensively in the past. Current threats to the species are believed to be incidental catch in other shark fisheries, recreational fishing and to a much lesser extent, beach meshing.

The Cod Grounds Commonwealth Marine Reserve was declared on 10 May 2007 to protect important habitat of the critically endangered grey nurse shark. This Marine Protected Area covering an area of about 300 ha is managed as an IUCN Category 1a (no take) Sanctuary Zone.

Floating anemone. Photo: Matt Carr.

2.1.9 Central Eastern Province

Figure 2.13 The Central Eastern Province



The Central Eastern Province is located offshore between North Stradbroke Island and Ulladulla. It covers a total area of 266 590 km². Eighty-eight percent (233 820 km²) of the provincial bioregion lies within the East Marine Region. The remaining 12 per cent lies within the South-East Marine Region.

Geomorphology

The Central Eastern Province is located predominantly on the abyssal plain/deep ocean floor, and to a lesser extent the eastern continental slope. Geomorphic features in this area include submarine canyons, terraces, pinnacles, knolls/abyssal hill/hill/mountain/peaks, and bank/shoals. Although pinnacles and submarine canyons comprise less than one per cent and less than two per cent of the total area of the provincial bioregion respectively, they represent 17 per cent and four per cent of the total area of these features in the Region.

Pinnacles cluster on the upper slope adjacent to Yamba and are also scattered across the abyssal plain/deep ocean floor. A series of canyons extend from the upper slope to the abyssal plain/deep ocean floor and are oriented broadly orthogonally to the coast. They include the Tweed and Richmond Canyons on the slope in northern New South Wales. Elongate shallow water terraces run parallel to the coast on the upper slope. These are similar to terraces in the Central Eastern Shelf Transition and Central Eastern Shelf Province.

The abyssal plain of the Central Eastern Province occupies the western part of the Tasman Sea Basin where it extends from the base of the slope to a sharp boundary with abyssal hills on the deep ocean floor. The floor of the basin is unusual in that the greatest depths are adjacent to the slope off New South Wales where the seabed is around 4900 to 5000 m below sea level.

A characteristic of the Australian continental shelf is the lack of depositional fans at the base of the slope. The only submarine fans identified along the western margin of the basin are very small, less than 30 km wide, and located off the Hunter River at Newcastle, Macleay River at Smoky Cape and the Clarence River at Yamba in this provincial bioregion, and off Breaksea Spit at Sandy Cape, Fraser Island to the north. Other features on the abyssal plain are isolated basement outcrops forming seamounts and ridges, debris deposits/channels at the base of the slope on the western margin of the continental shelf, and elongate drift mounds on the plain itself.

Along its south-eastern margin the abyssal plain is up to 50 m lower than the sediment draped abyssal hill region. In the south the plain extends more than halfway across the basin and the surface of the plain rises gradually to the north. It is 200 to 250 km wide in the southern part of the Region where it extends eastward to Taupo, Barcoo, and Derwent Hunter Seamounts, located in the Tasman Sea Province.

Water depths in the Central Eastern Province range from 170 to 5100 m. Water depths are between 4000 and 5000 m over approximately 80 per cent of the area of the provincial bioregion. Terraces are located in water depths of 165 to 780 m and banks/shoals in depths of 200 to 290 m. Pinnacles on the upper slope occur in water depths of 200 to 400 m, and pinnacles on the abyssal plain/deep ocean floor in water deeper than 4000 m.

Sediment texture of the Central Eastern Province is variable and grades from sand on the upper slope to mud on the abyssal plain/deep ocean floor. The gravel content of sediments in this provincial bioregion is generally less than five per cent, being highest to the north of Hawks Nest.

At a depth of 200 to 1500 m, the sediment found on the slope is formed of foraminiferal/calcareous ooze. Sediment wedges and a few submarine canyons exist at the top of the slope where there is evidence of echinoderm and sponge communities. On the mid-slope at depths of 1500 to 3500 m there are terraces and exposed bedrock. Canyon heads incise these terraces and the sediments are the remains of foraminifera and coccolith plankton. On the lower slope, at depths in excess of 3500 m, the submarine canyons amalgamate into larger canyon complexes that extend down to the abyssal plain at 5000 m. The sediment in these areas is primarily made up of coccolith ooze and there is evidence of siliceous sponge communities.

Oceanography

The Central Eastern Province is situated in warm temperate waters.

The main component of the East Australian Current leaves the Australian coast at about 34° S to flow around the north of New Zealand and then down the east coast of that country when it becomes the East Auckland Current. Southward of the separation point, a portion of the current remains connected to the coast and continues south past the east coast of Tasmania.

The Tasman Front, the path of the East Australian Current between Australia and New Zealand, separates the cooler waters of the Tasman Sea and the warmer, more saline

Great-winged petrel. Photo: Dr Peter Milburn.

waters of the Coral Sea. Along the southern edge of the Tasman Front, west-bound Rossby speed eddies are shed that move southward with the smaller component of the East Australian Current as they travel over the continental slope and reach the Australian coast. As these eddies travel southward they may be consumed and integrated within the East Australian Current or remain as separate entities.

Biological Communities

There is strong distinctiveness in the structure of demersal outer shelf and slope fish assemblages (40–2000 m) in this provincial bioregion, distinctiveness implying evolutionary relatedness and some likelihood of endemism among the fish fauna. Typically narrow-ranging, endemic species identified within this provincial bioregion, from Southport in Queensland to Ulladulla in New South Wales, include flathead (*Bembrops morelandi*), sea toad (*Chaunax* species), batfish (*Halieutopsis* species, *Solocisquama* species and *Malthopsis* species), sharp head perch (*Lepidoperca magna*), snailfish (*Paraliparis eastami*), piedtip cucumberfish (*Paraulopus okamurai*) and skate (*Dipturus* species). Of the more than 630 demersal species found in this provincial bioregion, approximately 56 have been identified as endemic.

Indicator species have been used to vertically separate the continental slope into Upper Slope, Mid-upper Slope and Mid Slope. For the Central Eastern Province, this categorisation resulted in the following biomes:

- The Upper Slope biome (280–490 m): a biome characterised by the distribution of the longnose houndshark, *Iago garricki*);
- The Mid-upper Slope biome (610–830 m): a biome characterised by the distribution of the lined lanternshark, *Etmopterus dislineatus*; and
- The Mid Slope biome (910–1080 m): a biome characterised by the distribution of the deep-sea lizardfish, *Bathysaurus ferox*).

Given the predominance of abyssal plain in this provincial bioregion and the path of the East Australian Current, abyssal plain and trough biological communities and gyre and eddy biological communities associated with the Current are significant in the provincial bioregion. Myctophid, crustacean and squid communities characteristic of the northern provincial bioregions in the Coral Sea, are found in this provincial bioregion.

Ecosystem Processes

Depth and related parameters such as light availability, temperature and pressure, as well as substrate and deep water currents are fundamental factors that influence the biological communities in this provincial bioregion.

Canyons within the slope are important for the ecology of this provincial bioregion as they have important influences on the faunal abundance and composition. These canyons channel upwelling water over the slope and shelf, while downwelling flows may also seasonally reverse the flow through these structures. Canyons provide key habitat for a range of species, including whales, and comprise a range of biomes differentiated by depth.

Warm-core eddies resulting from the pinching off of the East Australian Current tend to form over the slope and are a highly variable, annual event that influences the ecology of the Central Eastern Province. Eddy features have been identified as having an influence on biological distribution patterns due to the relative distributions of trapped nutrients, notably upwelling or downwelling at the eddy core leads to nitrate enrichment and high phytoplankton concentrations. Various fauna are dependent on seasonal mixing and the interaction of the eddy with the slope and shelf. Pelagic tunicates and coelenterates are drawn to these blooms and are themselves prey for a wide array of species including albatross and crustacean, as well as fish such as the blue grenadier, blue warehou and banded whiptail. Without the presence of these eddies it would be unlikely that yellowfin tuna would be found in the southern Tasman Sea as it is well below the usual thermal range of this species.

Connections between communities in an east-west direction is related to the seasonal variation in water temperatures caused by north-south variations in the location of the Tasman Front and eddies spawned at the junction of the East Australian Current and the Tasman Front.

Sunfish – the ocean sunfish (*Mola mola)* belongs to the family Molidae and is one of three species of sunfish known to occur within the East Marine Region. The other two species are the southern ocean sunfish (*Mola ramsayi*) and the slender sunfish (*Ranzania laevis*). The fourth Australian species, the sharptail sunfish (*Masturus lanceolatus*) occurs in southern waters of South Australia and Western Australia.

The common name, sunfish, refers to the animal's habit of "sunbathing" at the surface of the water. The ocean sunfish resembles a fish head without a tail, and the species presently holds the record for the world's heaviest bony fish–a 3.1 m long specimen weighing 2235 kg–was struck by a boat off Sydney in September 1908 (Carwardine 1995). Typically, a mature ocean sunfish has a length around 1.8 m and weighs around 1000 kg.

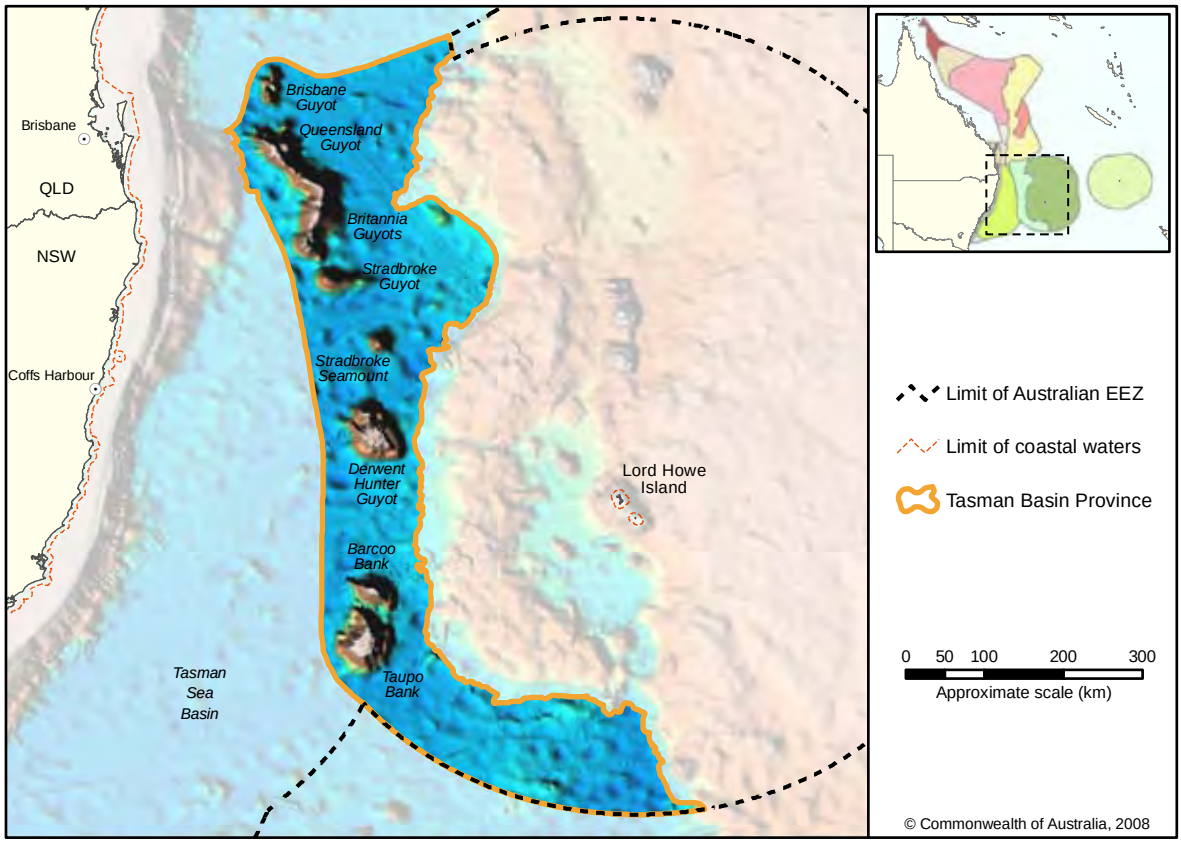
Sunfish. Photo: U.S. National Oceanic and Atmospheric Administration.

The ocean sunfish occurs in temperate marine waters worldwide. In Australia, it has been recorded from the central coast of New South Wales to Tasmania and west to Mandurah, Western Australia. Ocean sunfish are usually found in oceanic waters, but occasionally come inshore. Sunfish are often seen at the surface where they may be mistaken for sharks because of the large dorsal fin.

Adult sunfish are vulnerable to few natural predators, but sea lions, orcas and sharks will consume them. Sunfish are considered a delicacy in some parts of the world, including Japan and Taiwan. Sunfish are frequently, accidentally caught in gillnets, and are also vulnerable to harm or death from ingesting floating marine debris.

2.1.10 Tasman Basin Province

Figure 2.14 The Tasman Basin Province



Snakestar on coral. Photo: NORFANZ, Department of the Environment, Water, Heritage and the Arts, CSIRO, New Zealand's Ministry of Fisheries and NIWA.

The Tasman Basin Province of 156 420 km² is located offshore between North Stradbroke Island and Sussex Inlet (south of Jervis Bay). It lies wholly within the Region, representing six per cent of the Region's total area. It includes part of the Tasmantid Seamount chain, which runs from the south of this provincial bioregion into the Kenn Transition in the north.

Geomorphology

The Tasman Basin Province is the only provincial bioregion in Australian Commonwealth waters to occur entirely on abyssal plain/deep ocean floor. Within this area, three geomorphic features are identified: seamounts/guyots (18 480 km²); knolls/abyssal hills/hills/mountains/peaks (1120 km²); and pinnacles (210 km²). Water depth ranges between 120 m and 5100 m in this provincial bioregion. The deepest point occurs in eroded channels along the eastern margin of the basin and in depressions south of Taupo Seamount.

The upper surface of the abyssal plain is generally smooth, with patches of sediment that appear to form ribbons of silt separated out by abyssal currents. Sediments on the abyssal plain/deep ocean floor are composed almost entirely of mud. Carbonate content of the mud is around

50 per cent–similar to sediments found at greater than 4000 m depths in the adjacent Lord Howe Province.

The Tasmantid Seamount chain runs north-south at approximately 155° E longitude beginning with Fraser Seamount in the Kenn Transition. Included in the Tasman Basin Province, moving southward, are the Brisbane Guyot and Brittania Guyots constituting the Queensland Guyot, Stradbroke Guyot, Stradbroke Seamount, Derwent–Hunter Guyot, Barcoo Bank and Taupo Bank. All these features are flat-topped, with the seamounts to the south having limestone caps formed by ancient drowned reefs over volcanic basalt bases.

The seamounts rise from depths of 4800 m to 5000 m, which is deeper than the northern Tasmantid seamounts located to the north of this provincial bioregion. Taupo Seamount is the largest in the Region at 60 km in diameter at its base. It rises from 4800 m to a flat top only 120 m below sea level. This shallow platform with relief of less than 10 m is approximately 40 km north to south and up to 15 km wide. The seamounts tend to be a complex of several volcanoes forming a volcanic chain. There are many smaller unnamed and unsurveyed seamounts along this chain as well as subsidiary cones on the flanks of larger edifices.

The slopes on the side of the seamounts are commonly in the range of 10 to 20 degrees but locally can be much steeper or form a flat terrace cut at sea level. These slopes consist of rugged rock outcrops with boulders and blocks covered by a relatively thin layer of sediment. The seamounts shed sediment to the adjacent seabed to form an apron at their base. In some cases this apron is removed by bottom currents to form a moat.

Basalt samples from Taupo Bank to Queensland Guyot reveal ages of 6.4 to 24 million years, i.e. early to late Miocene. Samples are progressively older to the north confirming they were formed as the crust moved over a hot-spot in the mantle.

Oceanography

The Tasman Basin Province lies in warm temperate waters.

As with the other temperate provincial bioregions of the East Marine Region, the main physical drivers are the Eastern Australian Current eddy field and the Tasman Front.

Biological Communities

The Tasman Basin Province has Coral Sea and Tasman Sea biological communities associated with the Tasmantid seamount chain. There are also abyssal plain and trough biological communities associated with the Tasman Basin, and gyre and eddy biological communities associated with the East Australian Current. These biological communities have not been extensively studied.

Scalloped Hammerhead Shark - the scalloped hammerhead shark (*Sphyrna lewini*) is one of four hammerhead sharks found in Australian waters, and is one of the most visible pelagic sharks in the East Marine Region. The scalloped hammerhead is found in tropical and warm temperate waters from Geographe Bay in Western Australia, around the tropical north, and south to Sydney in New South Wales.

As a coastal pelagic and semi-oceanic species, this shark occurs over continental and insular shelves as well as adjacent deep water. It has been observed close inshore as well as offshore to depths of at least 275 m.

The seamounts of the Tasman Basin Province provide refugia for prey species, and consequently feeding locations for associated predator species, including hammerhead sharks (Hixon and Beets 1993, Norse and Crowder 2005, Richer de Forges 2000). Seamounts also serve as rendezvous points where scalloped hammerhead sharks can converge to mate and spawn (Klimley 1995).

Scalloped hammerhead shark. Photo: Graham Edgar, University of Tasmania.

Scalloped hammerheads feed primarily on teleost fish and a variety of invertebrates as well as other sharks and rays. Adults occur singly, in pairs, and in small schools while young scalloped hammerhead sharks live in large schools.

The scalloped hammerhead is distinguished from other hammerheads by an indentation located centrally on the front margin of the broadly arched head. Two more indentations flank the main central indentation, giving this hammerhead a "scalloped" appearance.

The status of scalloped hammerhead shark on the IUCN Red List of threatened species was heightened from Near Threatened to Endangered in February 2008, noting their susceptibility to overfishing.

Wandering albatross. Photo: Dr Michael Double.

The northern seamounts in the Tasman Basin Province are more similar, ecologically speaking, to the southernmost seamounts in the Kenn Transition than to the southern seamounts of this provincial bioregion. For the southern seamounts, there is limited information available on their biota, although what is known suggests that the biota here is different to that found in the nearby Elizabeth-Middleton Reefs area to the east.

Ecosystem Processes

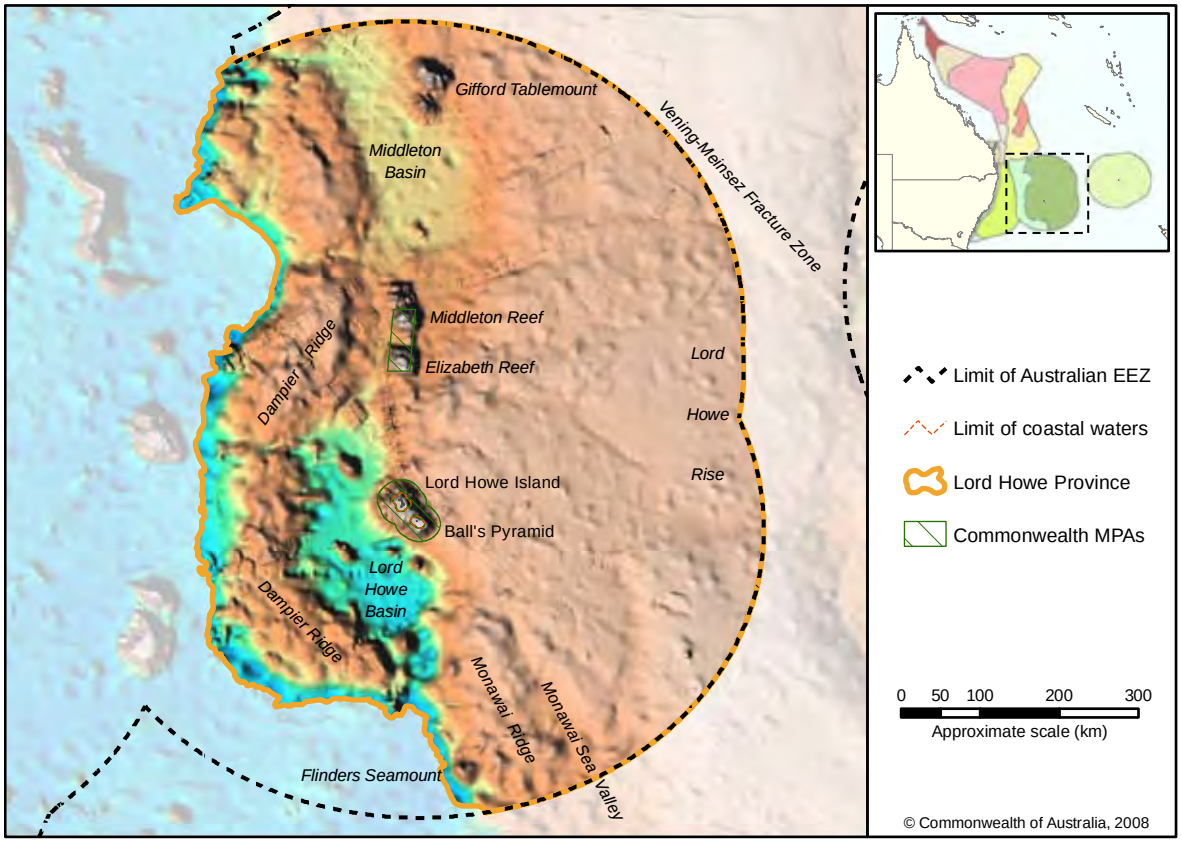
The Tasmantid Seamounts comprise a unique deep-sea environment characterised by substantially enhanced currents and a fauna that is dominated by suspension feeders such as corals. Seamounts are an iconographic marine habitat which provides topographical structure across the continental slopes and abyssal plains of the deep sea, altering oceanic circulation patterns with local upwellings, turbulent mixing and closed circulation cells. Topographically-induced upwelling at seamounts and the interaction between eddies and seamounts can create conditions that lead to concentration of pelagic productivity around seamounts and conditions conducive to the establishment of deep-reef communities dominated by filter-feeders. Flow acceleration is favourable for recruitment and growth of passive suspension feeders, as shown by the relatively high abundance of corals on seamount peak edges where periods of flow acceleration have been observed.

Many large oceanic species spawn, nest, or calve only in places where they can optimise the balance between food availability and predation risk for their young. To reach breeding areas they journey hundreds or even thousands of kilometres; seamounts are therefore ideal 'stepping stones' within the open ocean.

Ecological connections in a north-south direction are influenced by the southerly flowing East Australian Current and associated eddies that move waters across the Tasmantid seamounts. Ecological connections in an east-west direction are influenced by the Tasman Front and associated eddy fields.

2.1.11 Lord Howe Province

Figure 2.15 The Lord Howe Province



The Lord Howe Province is located in the Tasman Sea, on the slope surrounding Lord Howe Island. Covering an area of 484 880 km², it is the largest provincial bioregion in the East Marine Region, representing 20 per cent of its total area. Adjacent to the western border of Lord Howe Province are the southern seamounts of the Tasman Basin Province and to the east is the New Caledonia Basin, which is part of the Norfolk Island Province.

Geomorphology

The entire Lord Howe Province occurs on the slope and contains several geomorphic feature types. Significant features identified for the Lord Howe Province include basins, ridges, seamount/guyots, plateaus and saddles. Plateaus are the most dominant feature covering 80 per cent of the provincial bioregion. Basins cover greater than 13 per cent of the Lord Howe Province, representing 18 per cent of the total area of basins in the Region. While ridge, seamount/guyot and saddle features cover relatively small proportions of this large provincial bioregion (less than 5 per cent), the areas of these features represents significant proportions of the total areas of each feature in the Region as a whole. For example, ridges in the Lord Howe Province represent 20 per cent of the total area of ridges, and saddles represent 25 per cent of the area of saddles in the Region. Water depths in Lord Howe Province range from zero to 4100 m. Over 90 per cent of the total area occurs in water deeper than 1000 m.

The approximately 80 km wide Dampier Ridge extends south from the southern Kenn Plateau for 900 km. It can be divided into four plateaus at 2000 to 3400 m water depth representing four continental fragments joined by narrow saddles 20 to 40 km wide at 3500 to 3600 m water depth. The western margin of the Dampier Ridge is generally steep, with scarps of 1000 to 1500 m common, reflecting its plate tectonic origin. Along the margin there are small canyons eroding the slope and scarps caused by slumping or faulting. The southern Dampier Ridge is continental crust but there is evidence that the more rugged northern part is volcanic, perhaps of the same age or even younger than the Tasmantid Seamounts.

Between the Dampier Ridge and the Lord Howe Rise lies a depression that is divided into two basins, the Lord Howe Basin in the south and the Middleton Basin in the north. Both basins have a relatively flat seabed and small canyons occur on the slopes around the margins of the basins.

The Lord Howe Province extends approximately two-thirds (400 km) of the way across the Lord Howe Rise and

extends north-south for over 800 km. In the southern part of the plateau water depth is less than 1000 m, while to the north it is mostly 1200 to 1500 m. In general the seabed on the plateau is draped by thick sediment gradually sloping to the west into the basins, although in the south the margin with Lord Howe Basin can be steep and rugged. Along this slope are small seamounts protruding through the sediment cover, and small scale roughness on the seabed indicating erosion and mass movement of sediment. In the north-east of the provincial bioregion the Lord Howe Rise is cut by the north-west trending Vening-Meinsez Fracture Zone resulting in linear scarps, rough topography and seamounts. Erosion by bottom currents has created moats in the sediments at the base of these ridges. The Rise is draped with pelagic calcareous sediments known as oozes.

In the south the Monawai Ridge is a linear north-west trending feature 100 km wide on the south-western flank of the Lord Howe Rise extending into the Lord Howe Province for 160 km. On its western side it rises from the abyssal floor depths of the Tasman Basin from about 5000 m to 2000–3000 m with steep scarps up to 1500 m high. Flinders Seamount is a volcanic intrusion along this scarp and rises from water depths of approximately 5000 m in the Tasman Basin to a depth of 1740 m at its summit giving a relief of over 3000 m. The seabed on its eastern side is at a depth of 2300 m. Between the Monawai Ridge and the Lord Howe Rise proper is the broad 100 km wide Monawai Sea Valley.

The Lord Howe seamounts form a north-south chain along the western flank of the Lord Howe Rise from Balls Pyramid and Lord Howe Island in the south to Elizabeth Reef, Middleton Reef and Gifford Guyot in the north. This chain is parallel to the Tasmantid Chain some 300 km to the west. It is believed that this chain is also formed by the northward movement of the Australian Plate over a 'hot spot' in the mantle. The older seamounts to the north have subsided below sea level allowing reefs to develop limestone platforms on their summits. Gifford Guyot near the northern boundary of the Lord Howe Province is a 2000 m high guyot that comes to within approximately 300 m of the surface and is capped by a drowned limestone platform. Other smaller and unnamed seamounts occur both along this chain and adjacent to it in the Lord Howe Basin.

Within the Lord Howe Province, the largest of the seamounts in this chain is the Lord Howe Island/Balls Pyramid volcanic edifice. It is a basaltic volcano built between 6.9 and 6.4 million years ago with a base about 40 km wide by 80 km long. It rises steeply from water depths of over 3000 m on its western and southern sides; on its eastern side it merges with the Lord Howe Rise at water depths of less than 2000 m. There is a broad shelf around both Lord Howe Island and Balls Pyramid due to marine planation. The shelf around Lord Howe Island has a well-established coral reef–the southernmost occurrence of coral reefs in the world. Coralline algae are the dominant sediment component with coral and algal rhodoliths common, and gravelly muds occuring within the lagoon. Balls Pyramid shelf has no reef. It is 4 km south-east of the Lord Howe shelf, and is linked to it by a 500 m deep sill.

The Commonwealth Marine Protected Areas of Middleton Reef and Elizabeth Reef are located on the saddle that joins the Dampier Ridge with the Lord Howe Rise and separates the Middleton Basin from the Lord Howe Basin. The two reefs have roughly circular bases with diameters approximately 40 km and they rise steeply from 2500 m water depth. Both reefs have undergone wave erosion as they subsided below sea level resulting in a planated surface for coral growth to form oval shaped rim reefs

Black Cod–the black cod (*Epinephelus daemelii)* is found in warm temperate and subtropical waters of the south-western Pacific. In Australia, its distribution ranges from southern Queensland to northern Victoria, including offshore of Lord Howe Island. Isolated populations of black cod are also found in waters offshore of Elizabeth and Middleton Reefs, and Norfolk Island.

Black Cod, Middleton Reef. Photo: Ian Kerr and the Department of the Environment, Water, Heritage and the Arts.

The black cod is a large reef-dwelling groper that can grow up to two metres in length and more than 80 kg in weight, although it is more common to see smaller individuals 40–80 cm in length. Small black cod are females and change sex at 100 –110 cm to become males. Black cod are slow-moving, opportunistic carnivores that prey on fish and crustaceans, and can change colour from light to dark within seconds according to mood and background.

The black cod is most commonly found in caves, gutters and on rocky reefs in coastal waters at least 50 m deep. It is a curious, highly territorial species and individuals may occupy one particular cave for most of their adult lives, which makes them susceptible to line and spear fishing. Their populations have been greatly reduced over the last 100 years.

Sooty terns at North Bay, Lord Howe Island. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

enclosing lagoons. Elizabeth Reef is an oval atoll oriented NW-SE 10.7 km long by 6.2 km wide. It is slightly larger than Middleton Reef which is 9.3 by 5.7 km and oriented NE-SW. The lagoons have a maximum depth of 30 m, but are mostly in-filled with sediment and on average are less than five metres deep. Sediments from the seabed and within the lagoons of Middleton and Elizabeth Reefs are characterised by gravelly sands with some mud in the deepest parts. Local sediment is composed of coral and coralline algae with lesser amounts of Halimeda, molluscs and foraminifers.

Oceanography

The Lord Howe Province is situated in warm temperate waters.

The Lord Howe Province is impacted upon by the southerly flow of the East Australian Current and the anti-clockwise warm core eddies (the Tasman Front) it forms at its point of divergence. The Tasman Front can be followed eastwards across the Lord Howe Rise. Upon initial contact with the Lord Howe Rise that lies on the western side of the plateau, the current flow has been observed to dissipate and part of the flow is deflected northward. As the main flow continues over the platform towards the west coast of New Zealand however, it regains its energy.

The surface currents of the East Australian Current bring warm tropical surface water into the provincial bioregion. This inflow of low density tropical water causes water temperature to fluctuate between 18 and 23 degrees Celsius and salinity to change on a seasonal basis.

Biological Communities

This provincial bioregion supports a unique mix of tropical, sub-tropical and temperate species and includes the southernmost coral reefs in the world. The presence of tropical species suggests linkages to northern waters along the Chesterfield range of seamounts or inflow of tropical or sub-tropical water and larvae through eddies of the East Australian Current. Gyre and eddy biological communities may be expected to occur in the Lord Howe Province.

The Lord Howe Province has seamounts and reef systems with associated biological communities (see description of Coral and Tasman Seas seamounts/guyots/islands biological communities, p 16). High numbers of Galapagos sharks (*Carcharhinus galapagensis*) are present at Elizabeth and Middleton Reefs and around Lord Howe Island. The presence of the sharks is significant as this species is unlikely to be present at other Australian reef systems. Size data suggest that Elizabeth and Middleton reefs are

important nursery areas for Galapagos sharks. Both these reefs have been intensively sampled: detailed descriptions of their biological communities are found at the beginning of this chapter under the Coral and Tasman Seas seamounts/guyots/islands sub-heading.

There are continental plateau biological communities associated with the Lord Howe Plateau but data on their composition are limited, particularly for the demersal environment. The platform is expected to be dominated by its relatively featureless seabed and sparse population. It is probably dominated by epi-benthic detritivores and filter-feeders. Where the appropriate conditions are met, including availability of hard sediment and suitable delivery of organic matter via bottom currents, the platform is likely to support deep water reef communities. These deep reefs would be expected to be dominated by filter-feeding epifauna (i.e. sponges, bryozoans, azooxanthellate corals), which may in turn support demersal consumers such as crustaceans, echinoderms, bivalves, cephalopods and fish.

The pelagic environment of the Lord Howe Plateau includes transient populations of highly migratory, secondary and tertiary pelagic consumers, notably small fish schools and pelagic predators such as yellow-fin tuna (*Thunnus albacares*), blue marlin (*Makaira nigricans*) and striped marlin (*Tetrapturus audax*).

Ecosystem Processes

Lord Howe Island together with Norfolk Island and the Kermadec Islands are the only three subtropical island groups in the south-west Pacific Ocean, with species diversity of tropical and temperate fish, corals and other marine organisms declining across these island groups from west to east.

The incoming stream of warm tropical surface water carried by the East Australian Current allows the Lord Howe Province to support the southernmost coral reefs in the world. Transportation of planktonic larvae and larger vagrant and migratory species across the provincial bioregion, including many tropical species from the north, is facilitated by this current.

The western edge of the Lord Howe Rise is bordered by a series of discontinuous escarpments. The scarps have a shallower gradient in the north, becoming steeper in the south in the vicinity of Flinders Seamount. The western side of the Lord Howe Ridge is a more energetic environment than in the east, however, most of this energy is at the top of the water column. A slow-moving sub-Antarctic water mass moves north along the western edge of the ridge and is known to cause upwellings of cold nutrient-rich water on the Dampier Ridge. This is also likely to occur in other locations along the western escarpments.

The area to the northeast of the Lord Howe Rise has a stable water mass with a uniform thermocline that may be the result of the Lord Howe Rise sheltering the area from the effects of the eddy fields to the west. This enables the area to support a relatively stable and homogenous pelagic and benthic environment–a large desert-like plain covered in calcareous pelagic ooze, with small seamounts poking through the sediments. The seamounts–some as young as two million years old–are biological hotspots in the area; however, extensive bioturbation has occurred on the plain itself. There is evidence of localised scouring around the seamounts, while on the plain soft sediment deformation has occurred due to dewatering. It is likely that this environment extends south along the length of the eastern side of the Lord Howe Rise.

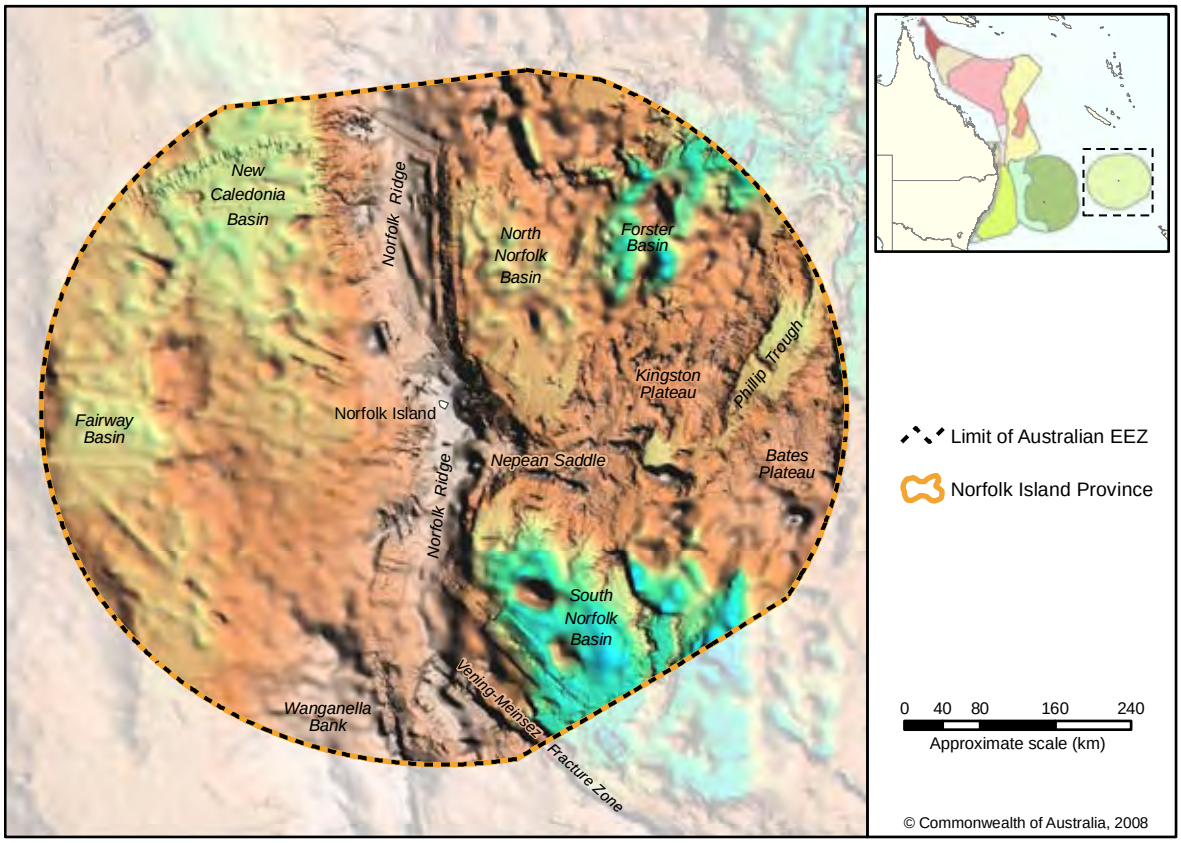
Ecological connections are in a north-south direction and are influenced by southward moving surface currents passing along the Chesterfield chain of seamounts in the Coral Sea (outside the Exclusive Economic Zone) and by north-moving sub-Antarctic currents along the sea floor beside the Lord Howe Ridge.

Ecological connections in an east-west direction are associated with the Tasman Front and associated eddies that generally migrate across the northern portion of the Lord Howe Province.

Connectivity in the demersal environment across the Lord Howe Province and into neighbouring provincial bioregions is relatively low. The steep rise of the Dampier Ridge and the Lord Howe Plateau can act as a physical barrier to most demersal species inhabiting adjacent basins and the western border of the Norfolk Island Province.

2.1.12 Norfolk Island Province

Figure 2.16 The Norfolk Island Province



The Norfolk Island Province is situated in the central Tasman Sea, approximately midway between New Caledonia and New Zealand. It surrounds Norfolk Island but is separated from the rest of Australia's Exclusive Economic Zone by a strip of seabed approximately 100 km wide that is not within Australian waters. Norfolk Island Province covers an area of 430 790 km², which represents 18 per cent of the East Marine Region.

Geomorphology

The Norfolk Island Province is located predominantly on slope, with a very small area of shelf that surrounds Norfolk Island. The Norfolk Island Province contains a complex geomorphology with thirteen geomorphic features identified on the slope. Fourteen per cent of slope, 99 per cent of banks/shoals, 12 per cent of trenches/troughs, 45 per cent of basins, 40 per cent of knoll/abyssal hills/hills/mountains/peaks, 11 per cent of seamount/guyots, 32 per cent of pinnacles, 17 per cent of plateaus, and 31 per cent of saddles within the Region are located within the Norfolk Island Province. Together basins and plateaus cover 345 470 km², or 80 per cent of the Norfolk Island Province. This area includes the Kingston Plateau, New Caledonia Basin, North Norfolk Basin, and South Norfolk Basin.

Water depths in the Norfolk Island Province range from zero to 4300 m with approximately 80 per cent of the Province having water depths greater than 2000 m. Bank/shoals generally occur in relatively shallow areas of the slope at depths less than 1000 m, while other features – plateaus, seamount/guyots, pinnacles, saddles, knoll/abyssal hills/hills/mountains/peaks, trench/troughs, and basins – all occur at significantly greater depths (over 2000 m).

The geomorphology in the Norfolk Island Province is dominated by north-south trending rugged volcanic ridges separated by basins partly filled by sediments. The major feature is the Norfolk Ridge which bisects the region and is comprised of a complex system of ridges and basins, extending from New Caledonia in the north to New Zealand in the south. The volcanically formed Norfolk Island is situated on the central section. The Ridge is approximately 70 km wide and at depths shallower than 1500 m. It is mostly flat-topped with steep sides sloping into the New Caledonia Basin on the west and Norfolk Basin on the east. Numerous small canyons cut these slopes. There are three shallower plateaus along its length. The most southern of these is called the Regina Ridge and its north-east margin is part of the Vening-Meinsez Fracture

Green turtle. Photo: Robert Thorne and the Department of the Environment, Water, Heritage and the Arts.

Zone. A 2000 m deep narrow (20 km) gap separates this ridge from the Wanganella Bank (water depth 100 to 1000 m) on West Norfolk Ridge at the southern margin of the Province. Wanganella Bank comprises a significant area of pinnacles shallower than 500 m.

The north-south trending New Caledonia Basin is an area of very flat seabed 3500 m deep at the northern margin where it is 150 km wide and narrowing to the south where it is 2500 m deep. The West Norfolk Ridge forms the basin's southern margin. This ridge continues NNW across the Region as a discontinuous bathymetric feature known as the Northern West Norfolk Ridge and separates the New Caledonia Basin on its east from the 100 km wide, 3000 m deep Fairway Basin on its west. This ridge is probably volcanic and consists of steep-sided ridges and seamounts with steep relief of 1000 m where it rises from the 3200 m abyssal floor of the New Caledonia Basin.

East of the Norfolk Ridge is a zone of complex topography on the seafloor known generally as the Norfolk Basin but composed of plateaus, seamounts, basins, depressions and fault-bounded troughs.

Along the northern boundary of the Norfolk Island Province is the North Norfolk Plateau 2000 to 3000 m deep. South of this plateau is the North Norfolk Basin (3000 to 3500 m deep) separated from the deeper South Norfolk Basin (4000 to 4250 m) by the 50 km wide Nepean Saddle that is 900 to 1400 m deep. Numerous small seamounts on the Nepean Saddle have a linear east-west trend that may correspond to a fault at this location. The basin floors are flat due to sediment fill of several hundreds of metres that is thickest at the margins and at the base of ridges. Numerous volcanic ridges protrude from the basin floor with varying relief.

East of the North Norfolk Basin and separated from it by a ridge is the deeper Forster Basin (water depth greater than 4000 m) that continues its north-east trend outside the Province to the Cook Fracture Zone. A large seamount in the Foster Basin has a summit only 800 m below the sea surface. South of the Forster Basin is the Kingston Plateau, a large, irregular shaped area approximately 200 by 150 km between 2000 and 3000 m below the sea surface. This plateau has many seamounts, some rising to within 1000 m of the sea surface. South-east of the

Red-tailed Tropicbird (or Bosun Bird)–The red-tailed tropicbird (*Phaethon rubricauda)* is an oceanic seabird widely distributed through the tropical Pacific and Indian Oceans.

The red-tailed tropicbird is a pelagic or ocean-going species that inhabits tropical, marine waters. This species prefers waters of between 24° and 30°C, but is recorded occasionally in cooler waters, following warm currents (Marchant and Higgins 1990). Nests are located on isolated islands in inaccessible places such as cliffs. The species is present on Norfolk Island all year, where breeding takes place in the summer on Norfolk, Phillip and Nepean Islands).

Red-tailed tropicbird. Photo: Mark Holdsworth.

The red-tailed tropic bird nests individually or in small breeding colonies and is territorial (Marchant and Higgins 1990). Nests are simple scrapes that may be surrounded by plant material and stones (Hutton 1991).

The birds forage on fish and squid (Barker and Vestjens 1989) by diving deeply into the water. The adult red-tailed tropicbird is predominantly white with a pink sheen of varying intensity. Central tail feathers are characteristically bright red and elongated, into streamers.

Kingston Plateau is the Bates Plateau separated by the Philip Trough, 3000–3500 m deep and 20 –50 km wide with an irregular boundary. Bates Plateau is similar to the Kingston Plateau having a relatively smooth surface at water depths of 2100 to 2600 m with low relief crenulations and the general absence of abyssal hills or ridges. However, they do have many seamounts, some part of linear volcanic ridges along the margins of the plateaus where slopes are up to 30 degrees. The eastern margin of the Bates Plateau has a chain of seamounts in the Norfolk Island Province with three of them rising to depths of 800, 840 and 570 m respectively. South of Bates Plateau and separated from the South Norfolk Basin by a ridge is an unnamed group of small basins deeper than 4000 m and separated by ridges.

Sediments in this provincial bioregion are dominated by pelagic carbonates consisting mostly of the remains of foraminifers and coccoliths. There is also a small contribution from the siliceous plankton (radiolarians and diatoms). Volcanic ash and pumice make a minor contribution forming non-biogenic particles. Boulders, blocks, and rock fragments are common near rock outcrops.

Oceanography

The Norfolk Island Province is situated in warm temperate waters.

The Norfolk Island Province is situated within the Tasman Front. The Tasman Front, which splits off from the East Australian Current at approximately 34° S to flow in an easterly direction, passes through the south of the Norfolk Island Province. The North Tasman flow, a current filament which detaches from the East Australian Current at approximately 31° S, loops northward over the Lord Howe Rise before entering the deep waters of the Norfolk Basin, then veers diagonally north-westward between 165° E and 170° E. This diversion is caused when the North Tasman flow encounters the subsurface westward flow on the northern edge of the Norfolk Eddy. This quasi-permanent eddy is a stationary feature in the Norfolk Island Province. Within the thermocline, the Norfolk Eddy has a temperature and salinity signature of more than one degree Celsius and 0.05 practical salinity units, and is still evident as a distinct feature at 1500 m.

The Norfolk Island Province is also affected by the warm currents from New Caledonia which flow from October through to May each year.

Biological Communities

The Norfolk Island Province has seamounts and reef systems with associated biological communities (see description of Coral and Tasman Seas seamounts/guyots/islands biological communities ,p 16).

Species diversity of tropical and temperate species of fish, corals and other marine organisms around Norfolk Island is very similar to those found in the reefs surrounding Lord Howe Island, but with lower diversity. Two very common fish species are endemic to Norfolk Island – a bigeye cardinalfish (*Archamia leai*) and a blenny (*Parablennius serratolineatus*). Both species are found in large numbers around coral bommies and vertical reef faces.

At these latitudes there is significant competition for space between corals and seaweeds (marine algae). The balance appears to be maintained by algal grazers, the most significant of which are sea-urchins, and some fish species of the families Scaridae, Acanthuridae and Siganidae. Coral cover and diversity increase dramatically within 50 m of the stream outflow at Kingston on Norfolk Island. Kingston lagoon contains a unique and diverse sub-

tropical coral fauna that includes at least 32 species of reef-building corals from 11 of the 16 coral families.

In 2003 a joint Australian–New Zealand survey, termed NORFANZ, attempted to identify the biodiversity and endemicity of the benthic seamount fauna at six locations on the Norfolk Ridge. From this survey, 516 species of fish and macro-invertebrates were collected, 36 per cent of which were new to science and potentially endemic to the Norfolk Ridge. The survey also found that there were few similarities between biological communities sharing the same type of habitat on different seamounts in the area. It may be that these species have adapted to the small size and the isolation of the seamount, which restricts species dispersal and concentrates site-specific populations.

There are also abyssal plain and trough biological communities and continental plateau biological communities associated with the geomorphology of this provincial bioregion, and gyre and eddy biological communities associated with the East Australian Current eddies and the Norfolk Eddy. What little is known about demersal communities at sub-tropical and temperate latitudes throughout the Pacific Ocean, is evident in this provincial bioregion.

Migratory species which have been seen in the Norfolk Island Province include humpback, killer and right whales. Large sharks, including white pointers, have been seen and caught in Norfolk Island waters. Other sightings in the area include sei, fin, pilot and sperm whales. The most interesting marine mammal sightings are of what might be Longman's beaked whale, *Mesoplodon pacificus*, in the waters east of Norfolk Island.

Ecosystem Processes

World-wide there are few isolated oceanic islands at similar latitudes to Norfolk Island and there are few coral reefs further than this from the equator.

The Norfolk Island Province is geologically active and much younger than Lord Howe Island. The Norfolk Ridge includes many scarps and has been heavily eroded. There is evidence that currents move sediments from the crest of the Norfolk Ridge to its flanks where canyons have formed.

The area is influenced by the east-moving eddies associated with the Tasman Front that transport Coral Sea biota including corals, crustaceans and molluscs, to this provincial bioregion.

The south-east area of the Norfolk Island Province has relatively high productivity and biodiversity. The seamounts and pinnacles in this area are distinct from the rest of the

Goblin shrimp. Photo: NORFANZ, Department of the Environment, Water, Heritage and the Arts, CSIRO, New Zealand's Ministry of Fisheries and NIWA.

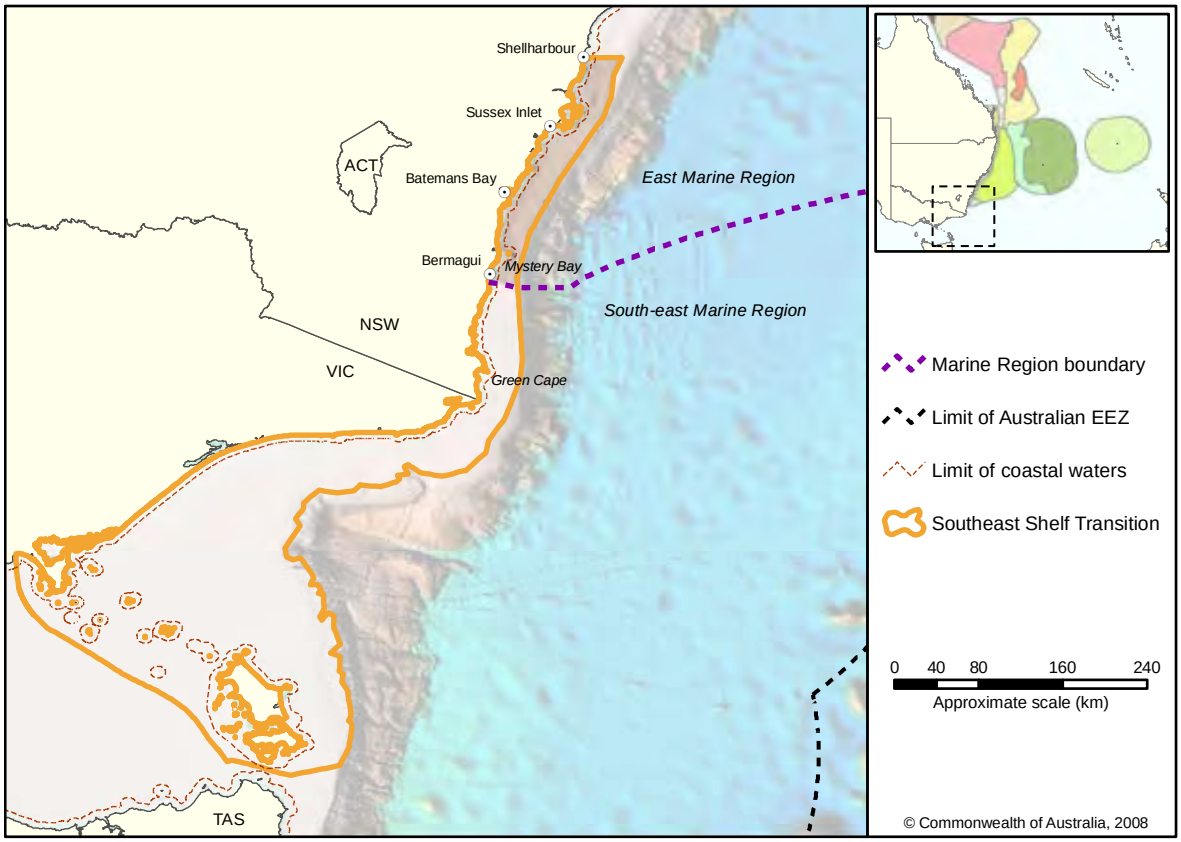
Norfolk Island Province due to the influence of the quasi-permanent Norfolk Eddy. The Eddy breaks down over time but is seasonally replaced. This creates a set of stable conditions different to those found in other areas of the Norfolk Island Province. The seamounts and pinnacles in the north-east of the Norfolk Island Province are deeper and are influenced by lower steric heights.

Increased larval residence time in waters overlying seamount and pinnacle structures has been attributed to the Norfolk Eddy, allowing eggs and larvae to successfully establish on suitable hard substrate. Geographic isolation may eventually modify the life-histories of resident fauna towards reproductively-isolated endemics. Given that the Norfolk Eddy's physical conditions exist down to 1500 m, the potential for larval retention from the seamounts of the Nepean Saddle, Bates Plateau and South Norfolk Basin region is high and is therefore likely to contribute to high levels of endemism in the area immediately under the eddy.

Due to it's isolation from the other provincial bioregions of the Region, connectivity between the Norfolk Island Province and these provincial bioregions is not clear, but there is possibly a connection with the Lord Howe Island Province.

2.1.13 Southeast Shelf Transition

Figure 2.17 The Southeast Shelf Transition



The Southeast Shelf Transition is located predominantly on the continental shelf with a small section on the upper slope between Kiama and Bermagui. It is the most southerly shelf provincial bioregion in the East Marine Region with an area of 59 620 km² of which 4270 km² (seven per cent) lies within the Region. This provincial bioregion contributes less than one per cent to the total area of the Region, falling mainly within the South-East Marine Region and the state waters of New South Wales and Victoria.

Geomorphology

The Southeast Shelf Transition is physically homogeneous relative to other provincial bioregions, with only two geomorphic features identified. Shelf covers 3931 km² or 92 per cent of the provincial bioregion and slope covers 342 km² or eight per cent. The provincial bioregion is relatively narrow, 5 to 30 km wide, and runs parallel to the coast. The narrowest sections occur adjacent to Sussex Inlet and Mystery Bay. The maximum water depth in the Southeast Shelf Transition is 240 m and the shallowest point is Sir John Young Banks at 16 m.

Seabed sediments of the provincial bioregion are dominated by sand, with mud and gravel forming less than 20 per cent. Carbonate content is high and increases towards the outer shelf and upper slope.

Oceanography

This provincial bioregion has a transitional water mass (warm temperate–cold temperate).

As with the other shelf provincial bioregions in the Region, the main oceanographic driver is the southerly movement of the East Australian Current as it meanders along the coastline. There is a predictable eddy field in this area which is associated with mixing cold and warm temperate water masses.

Biological Communities

The Southeast Shelf Transition has continental shelf biological communities associated with it, as well as some gyre and eddy biological communities. The Southeast Shelf Transition has been the subject of detailed study and data gathering,

Black-browed Albatross – the black-browed albatross (*Thalassarche melanophris*) is listed as a marine species, a threatened species, and a migratory species under the EPBC Act.

The black-browed albatross is a medium-sized albatross, characterised (in adults) by comparatively long wings, short tail, a white head and short neck, a bright yellow-orange bill and neat black eyebrows that give it a frowning look. The black-browed albatross has a circumpolar distribution and is found over Antarctic, sub-Antarctic and sub-tropical waters. It is a common vagrant in the northern hemisphere. The birds are most abundant in south-eastern Australian and Tasmanian waters (Marchant and Higgins 1990).

Within the Australian jurisdiction, black-browed albatrosses breed in colonies at a number of sub-Antarctic locations, namely Heard Island, McDonald Island (historically so, but there is now some doubt as recent extensive volcanic activity has reshaped the island), Macquarie Island, and the nearby Bishop and Clark Islands. During the summer breeding season, black-browed albatrosses forage in sub-Antarctic waters around the breeding colonies. Over winter, adults from the Australian breeding colonies, and from breeding colonies in other jurisdictions, generally disperse northwards and forage in coastal waters off southern Australia from Perth on the west coast, to north of Brisbane on the east coast, as well as off New Zealand, South Africa and South America.

Black-browed albatross. Photo: Dr Michael Double.

Black-browed albatrosses forage in the coastal waters of continents, over upwellings or boundaries of currents and are often found sheltering in harbours, bays or channels. The species is usually associated with mixed flocks of other seabirds, including other albatrosses and giant petrels (Marchant and Higgins 1990).

Black-browed albatrosses fly fairly low and take food from the sea surface or just below. They eat mostly krill and fish, with some salps, jellyfish and cephalopods. They are also enthusiastic scavengers (Marchant and Higgins 1990). The species is gregarious at sea and will accompany fishing boats to scavenge offal, waste and bait (Robertson and Gales 1998). They are highly vulnerable to longline fishing without seabird bycatch mitigation measures.

and descriptions of these biological communities are found at the beginning of this chapter under the continental shelf section.

As a transition zone, this provincial bioregion shares many species with its neighbouring provincial bioregions, although the portion of the Southeast Shelf Transition within the East Marine Region is more likely to have species in common with its neighbouring provincial bioregions to the north and east than to the south. In the area of Green Cape, to the immediate south of the Region, there is a change in the inshore species composition of some groups of organisms. Eastern warm temperate species are replaced by species with distributions primarily in southern and western warm temperate, and southern cool temperate areas.

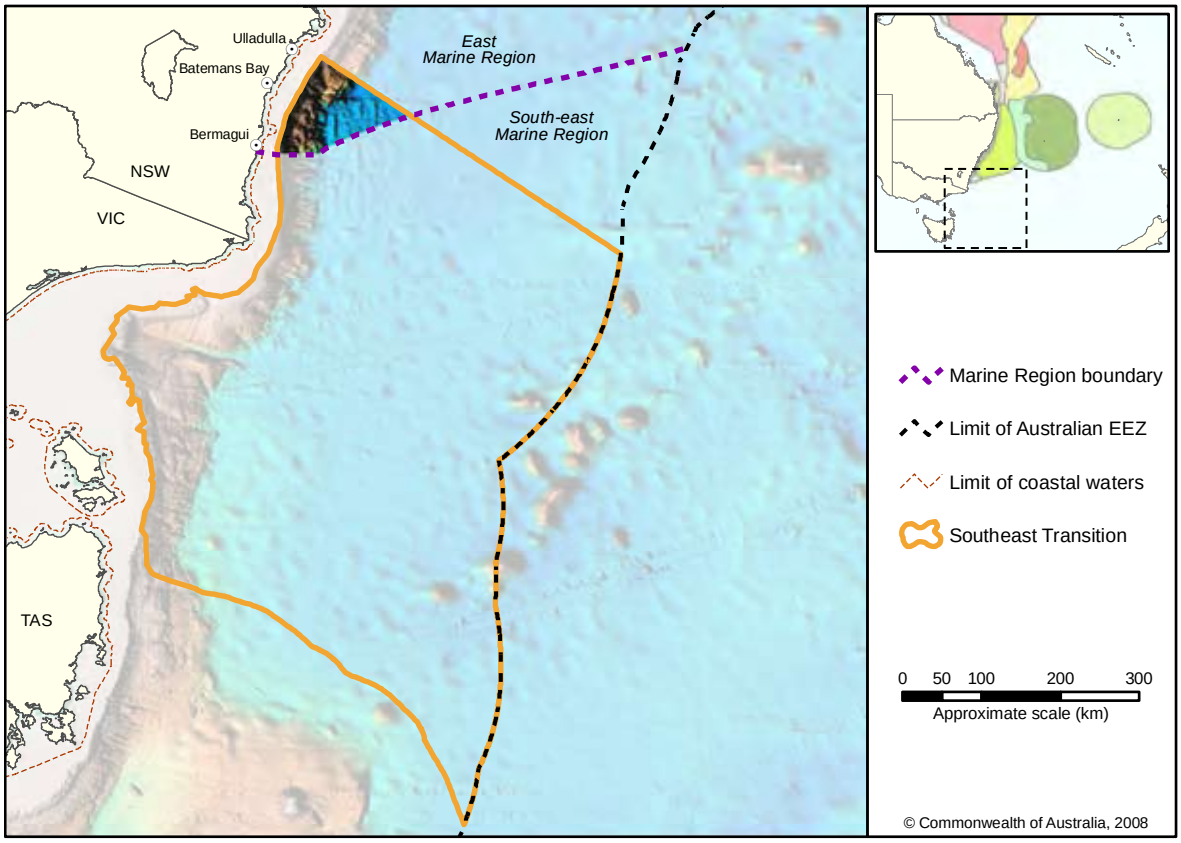
Ecosystem Processes

The major ecosystem processes described under the Central Eastern Shelf Transition also apply to this provincial bioregion.

White's seahorse. Photo: Photolibrary.

2.1.14 Southeast Transition

Figure 2.18 The Southeast Transition



Striped marlin – the striped marlin (*Tetrapturus audax)* is a migratory pelagic billfish that is distributed throughout the Pacific Ocean (40° S to 40° N) and Indian Ocean (north of 40° S). Satellite and archival tagging studies have demonstrated that this species spends the majority of its time inhabiting the surface layer to depths of around 150 m (Holts and Bedford 1989, Domeier and Dewar 2003).

The striped marlin is a large species that can grow to over 200 kg weight and over 3 m in length. Off the east coast of Australia, striped marlin is present from the Coral Sea to Tasmania depending on currents and seasons.

The fish are opportunistic predators. They have a very varied diet consisting mostly of species that inhabit the surface layers of the pelagic ecosystem. Generally the diet consists of a mix of fish and squid, with relative proportions of these changing with season and region (Ueyanagi and Wares 1975).

Striped marlin. Photo: www.boyceimage.com.

The striped marlin is generally perceived as an "enigmatic" billfish species by both recreational and commercial fishers.

A recreational fishery for striped marlin has existed off the east coast of Australia since the 1930s, and has become a very important species in tournament fishing, charter fisheries, and for gamefishers in general.

Japanese longliners took substantial catches of striped marlin from waters of the East Marine Region prior to their withdrawal from the area in November 1997. Catches of striped marlin by the domestic longline fleet off the east coast of Australia tripled between 1996 and 2000, making it one of the top five species taken annually in the Eastern Tuna and Billfish Fishery.

Striped marlin is rarely discarded in the eastern fisheries and there is evidence of opportunistic targeting, probably due to the presence of strong domestic and foreign (sashimi) markets for this species (Bromhead et al. 2004).

Australian fur seal. Image courtesy of CSIRO.

The Southeast Transition is located offshore between Ulladulla and Bermagui. It covers a total area of 241 910 km² of which 8800 km² (four per cent) is located within the East Marine Region, contributing to less than one per cent of the total area of the Region. Ninety six per cent of the provincial bioregion falls within the Southeast Marine Region

Geomorphology

The area of the Southeast Transition in the Region occurs on the slope and abyssal plain/deep ocean floor. Two geomorphic features are identified within the area of the slope: canyons (14 per cent of the provincial bioregion); and knoll/abyssal hills/hills/mountains/peak in the south of the region (greater than one per cent). No features occur on the abyssal plain/deep ocean floor.

The deepest point in the Region at 5200 m is found in the Southeast Transition. More than 80 per cent of the provincial bioregion lies in water depths greater than 2000 m.

Oceanography

The Southeast Transition has a transitional water mass (warm temperate–cold temperate).

Biological Communities and Ecosystem Processes

As the majority of this provincial bioregion is in the neighbouring South-East Marine Region, the fragment of this provincial bioregion that does occur in the Region is essentially the same as the bordering provincial bioregion, the Central Eastern Province, described in Section 2.1.8.

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Map Acknowledgements
Figures 2.3 – 2.18
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Projection: Geographics, Datum: GDA94.
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Southern right whale. Photo: Dave Watts.

Chapter 3 Conservation values of the East Marine Region

Marine Bioregional Plans will identify those components of marine biodiversity and heritage that are recognised as conservation values by the Australian Government. Knowing what the conservation values for each Region are will help in making decisions about proposed developments and other ongoing activities.

For the purpose of marine bioregional planning, conservation values are defined as those elements of the Region that are either specifically **protected** under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the *Historic Shipwrecks Act 1976* (for further information on the legislative framework see appendix B), or have been identified through the planning process as **key ecological features** in the Commonwealth marine environment. Key ecological features are not specifically protected under the EPBC Act, although the marine environment as a whole is a matter of national environmental significance under the Act. Key ecological features are being identified as conservation values within Commonwealth waters to help inform decisions about the marine environment in any given Marine Region.

Matters specifically protected under Part 13 and Part 15 of the EPBC Act that are relevant to the marine environment of the Region are recognised as conservation values. These may include listed threatened, migratory and marine species, listed threatened ecological communities, cetaceans (whales, dolphins and porpoises), World and National Heritage Places and Commonwealth marine reserves. Historic shipwrecks are also identified as conservation values by virtue of their protection under the *Historic Shipwrecks Act 1976*.

The marine conservation values identified in this section will be the subject of assessment during the development of the Draft East Marine Bioregional Plan to:

- understand the threats posed by current and emerging activities; and
- provide guidance for future decisions under the EPBC Act on potentially significant impacts on listed threatened and migratory species or the Commonwealth marine environment of the East Marine Region.

The nature and location of the conservation values will also be considered in the establishment of Marine Protected Areas as part of the National Representative System of Marine Protected Areas (see chapter 4). However, conservation values will not automatically be included in Commonwealth marine protected areas. In accordance with the Regional Specifications (chapter 4.2), only those marine conservation values for which spatial protection is both desirable and appropriate will be considered in developing the Marine Protected Area network for the Region.

South West Coringa Islet. Image courtesy of Australian Customs.

3.1 Key ecological features of the marine environment

Under the EPBC Act, the 'marine environment' of the Commonwealth marine area is a **matter of national environmental significance** (see Part 3, Division 1, Section 23 of the Act). This means that any action that will have, or is likely to have, a significant impact on the Commonwealth marine environment must be referred to the Minister for the Environment, Heritage and the Arts for assessment and approval. National guidelines have been developed to help in determining whether actions are likely to have a significant impact and these can be found at <www.environment.gov.au/epbc/protect>.

Key ecological features are those features of the marine environment that are not specifically protected under the EPBC Act, but are considered to be important or unique characteristics of the Region potentially deserving of conservation, monitoring or management. For the purpose of marine bioregional planning, key ecological features of the marine environment meet one or more of the following criteria:

- a species, group of species or a community with a regionally important ecological role (e.g. a predator, or a prey species that affects a large biomass or number of other marine species);
- a species, group of species or a community that is nationally or regionally important for biodiversity;
- an area or habitat that is nationally or regionally important for:
  a) enhanced or high biological productivity (such as predictable upwellings),
  b) aggregations of marine life (such as feeding, resting, breeding or nursery areas),
  c) biodiversity and endemism; or
- a unique seafloor feature with known or presumed ecological properties of regional significance.

Within the East Marine Region, key ecological features have been identified from the important ecological features recognised for each of the provincial bioregions in chapter 2.1. The Australian Government has drawn on the best available information to select and describe key ecological features, including advice from scientists and technical experts, and published and unpublished literature and reports on the Region and adjacent areas. Important sources of information used to identify key ecological features in the Region include the *Description of Key Species Groups in the East Marine Region*, *Ecosystems of the East Marine Region* and *Sedimentology and Geomorphology of the East Marine Region of Australia*, commissioned by the Department of the Environment, Water, Heritage and the Arts.

A scientific workshop was conducted in November 2007, bringing together marine scientists with specific experience and expertise in the Region. The workshop explored what is currently known about the ecosystems of the Region, and scientific understanding of likely interactions and ecosystem processes. The outcomes of the workshop and the commissioned reports mentioned above are available at <www.environment.gov.au/coasts/mbp/publications/east>.

Table 3.1 identifies key ecological features in the East Marine Region determined during the development of this Bioregional Profile, and summarises the rationale used to identify a specific feature as a conservation value in the Region (chapter 2 provides further context for understanding the role of different features in the ecosystem). The collection of further and finer-scale information during the next stage of the planning process will be used to improve our understanding of key ecological features in the Region, and to confirm and refine those features identified during the development of this profile. This information will underpin the analysis of the threats that the marine environment may face over the next 10 to 20 years. The Draft East Marine Bioregional Plan will include a refined list of key ecological features.

Nine key ecological features have been identified in the Region. These include four regionally significant features and five regionally important communities or habitats (table 3.1). Figures 3.1 and 3.2 provide location details for the features identified in table 3.1.

Black-tip reef sharks, Coral Sea. Photo: Mike Ball.

Figure 3.1 Key ecological features (1-5) of the Region

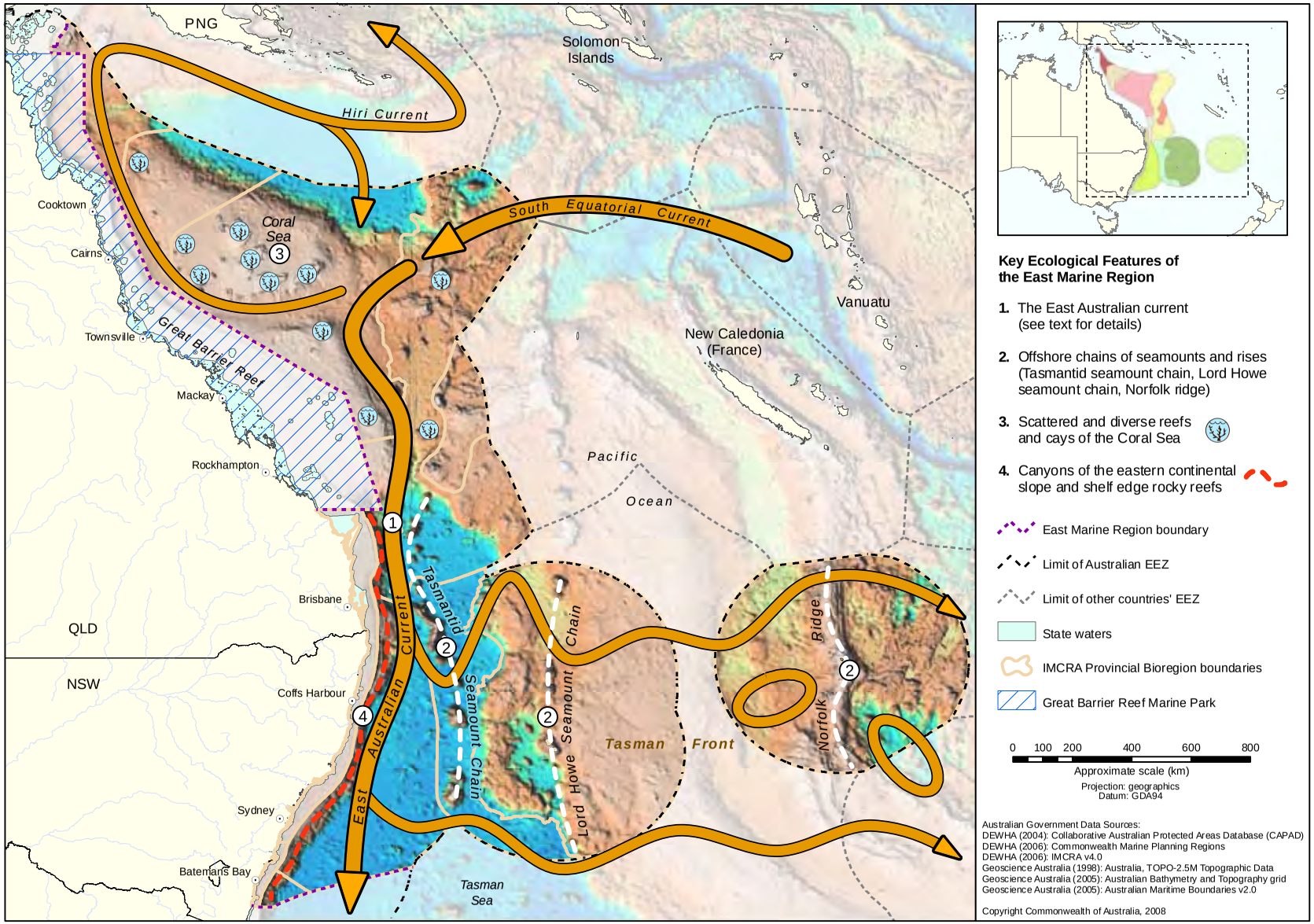


Figure 3.2 Key ecological features (6-9) of the Region

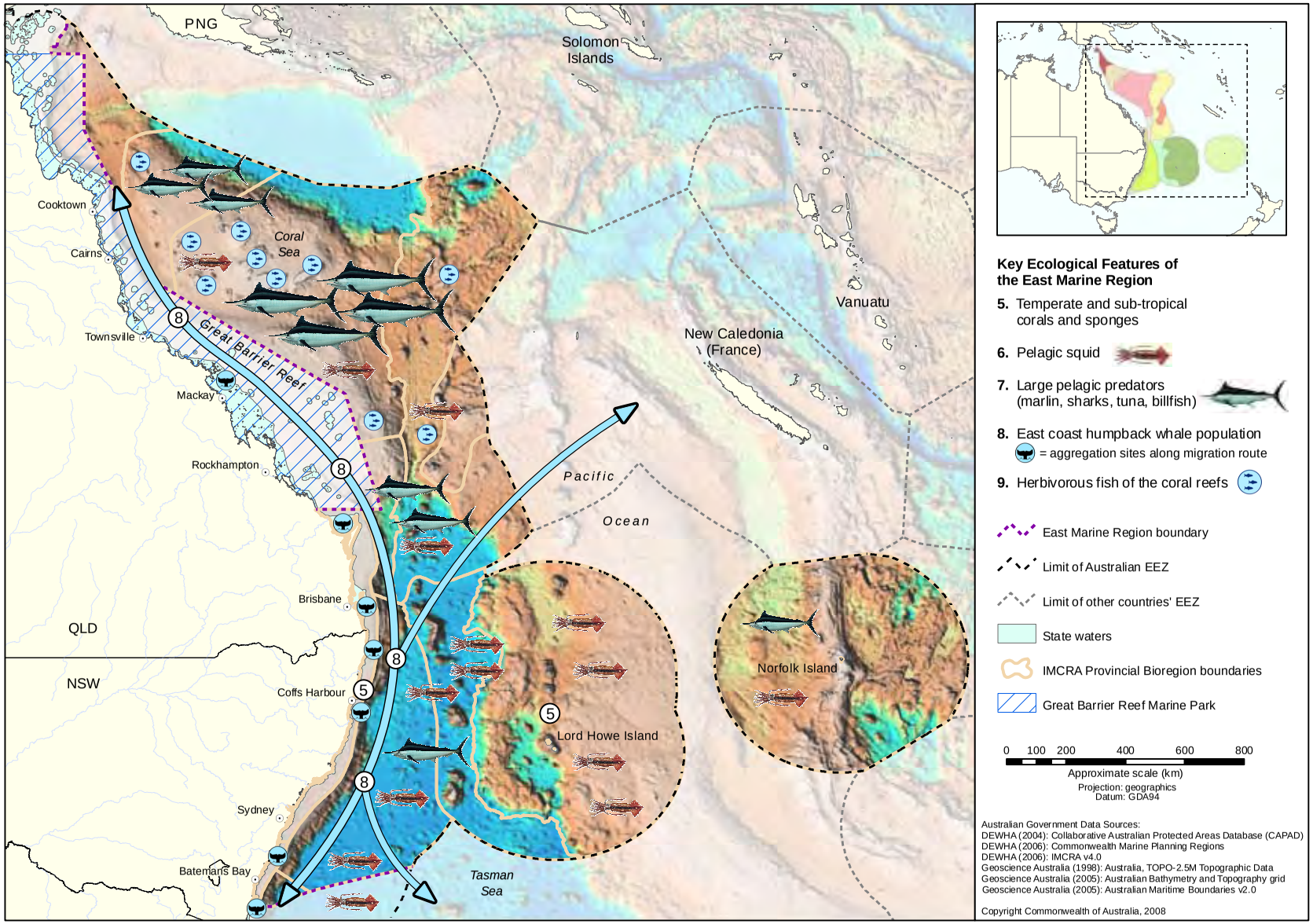


Table 3.1 Key ecological features of the Region

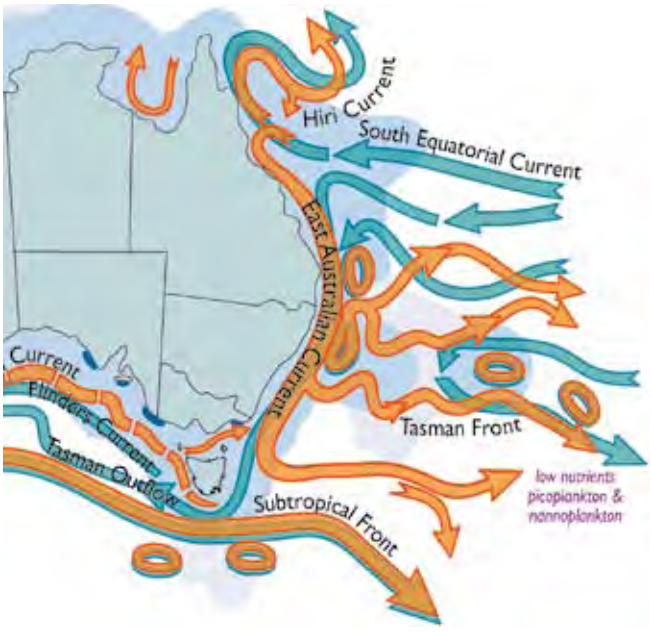
Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
REGIONALLY SIGNIFICANT FEATURES		
1 The East Australian Current	All	**Important ecological role; enhanced biological productivity; important for biodiversity; aggregations of marine life** The most obvious pelagic feature in the East Marine Region is the East Australian Current (EAC), an iconic oceanographic feature that originates in the north of the region and migrates south. The EAC is formed by the westerly flowing Southern Equatorial Current, which moves into the East Marine Region from the Pacific Ocean through the Coral Sea. It hits the continental shelf between 13oS and 22oS latitude where it bifurcates into the northward flowing Hiri Current and the much larger EAC. The EAC and its associated gyres and eddies that peel off into the Tasman Sea along the way, is the primary process whereby low-nutrient warm waters are delivered to southern coastal waters and to the outlying Lord Howe and Norfolk Islands to drive the abundance, distribution and dispersal of pelagic and shelf-slope demersal organisms. Towards the southern extent of the East Marine Region, the warm EAC collides with the cold Tasman Front, creating an eddy field that is an iconic and ecologically significant feature of the East Marine Region. Large eddies* can be semi-permanent features that migrate eastwards and can have the effect of trapping and transporting plankton and creating transient fronts and conditions that can attract pelagic fish and other species, including predators and seabirds. The EAC causes upwelling where it moves away from the coast at places like Cape Byron, Smoky Cape and Sugarloaf Point in NSW, drawing nutrient rich water from a depth of 200 m or more. The EAC is the largest ocean current close to the coast of Australia. It is strongest in summer, peaking in February, and weakest – by as much as half its peak flow – in winter, its energy dissipating east of Tasmania. By comparison, the Leeuwin current off Western Australia carries a quarter as much water when peaking in May-June.  Image courtesy of CSIRO Marine Research.

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
2 Offshore chains of seamounts and rises (including the Tasmantid Seamount Chain, Lord Howe Seamount Chain and Norfolk Ridge).	Kenn Transition, Kenn Province, Tasman Basin Province, Lord Howe Province, Norfolk Island Province	**Unique seafloor feature; important ecological role; high biodiversity and endemism; enhanced biological productivity; feeding, resting, breeding and nursery aggregations** Seamounts are underwater mountain ranges and pinnacles, the peaks of which rarely reach the surface. Deep ocean currents can concentrate nutrients around seamounts resulting in abundant marine life. These habitats can contain rich deep-sea coral reefs and sponge fields inhabited by unique fauna that is often peculiar to the area. Seamounts are also known to provide aggregation sites for deep-water fin-fish, including orange roughy. Running north-south in the East Marine Region, at approximately 155oE longitude, is the Tasmantid Seamount Chain, a prominent chain of submarine volcanoes extending into the Tasman Basin (Harris et al. 2005). Included in this chain, moving southward, are Fraser Seamount, Recorder Seamount, Moreton Seamount, Brisbane Guyot and the Brittania Guyots, incorporating Queensland Guyot, Stradbroke Guyot, Stradbroke Seamount, Derwent-Hunter Guyot, Barcoo Bank and Taupo Bank. All these features are flat-topped, with the northern seamounts rising from the seabed to summit at water depths of 150 to 400 m (Harris et al. 2005). The southern seamounts are deeper: Stradbroke Seamount rises to 900 m water depth, while Barcoo Bank is at 1400 m water depth (Harris et al. 2005). The Tasmantid Seamounts form a unique deep-sea environment, characterised by substantially enhanced currents and a fauna that is dominated by suspension feeders such as corals (Richer de Forges et al. 2000). Seamounts are an iconic marine habitat that provides topographical structure across the continental slopes and abyssal plains of the deep sea, altering oceanic circulation patterns with local upwellings, turbulent mixing and closed circulation cells. Further east, the Lord Howe seamount chain extends to the north as shallow banks and reefs and to the south as several small seamounts. At its southern end the chain includes Lord Howe Island, an eroded basaltic volcano. These submerged mountains were most likely formed as the result of the Indo-Australian Plate moving northward over a static hotspot of volcanic activity. The Lord Howe seamount chain supports the southernmost coral reefs in the world (Speare 2004). Further east again, the Norfolk Ridge is a contiguous north-south feature at depths of 1000 to 2000 m connecting New Zealand, Norfolk Island and New Caledonia with seamounts and other elevated features at 500–1000 m depth**.
3 The assemblage of scattered and diverse reefs and cays of the Coral Sea	Northeast Transition, Northeast Province, Kenn Transition	**Important ecological role; important for biodiversity; feeding, resting, breeding and nursery aggregations** An assemblage of atoll-like reefs occurs on a deep shelf (the Queensland and Marion plateaus) between Australia and New Caledonia in the Coral Sea. These coral reefs and atolls sit in very deep clean water and are under the influence of strong oceanic waves and cyclones. Some reefs have coral cays, which are all uninhabited except for a weather station on Willis Island. The reefs are remote from any land influences which has effectively protected them against many of the pressures facing near-shore reefs. The isolated, relatively pristine reefs support resident, or at least narrow home-range species that are often site-attached. Biological communities, for example demersal fish assemblages appear to be distinct from those of the Great Barrier Reef (Oxley et al. 2003, Byron and Thompson 2001)

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
3 The assemblage of scattered and diverse reefs and cays of the Coral Sea continued…		The Queensland Plateau is situated off Cairns and covers some 165 000 km² (Harris et al. 2003). Approximately half of the plateau surface lies in waters less than 1000 m deep and living reefs occur over 10–50 percent of its surface (Davies et al. 1989). The reef habitats of the Coringa–Herald and Lihou Reef National Nature Reserves support marine benthic flora and fauna that are distinct from those of the Great Barrier Reef. A diverse range of marine algae, sponges, soft and hard corals, crustaceans, starfish, sea urchins, sea cucumbers, and fish have been recorded within the Reserves. The Green Turtle (Chelonia mydas) breeds in the Reserves and a number of species of dolphins and whales are known to occur in the area. The Marion Plateau is situated off the central Queensland coast in the Mackay–Rockhampton region. The plateau covers an area of 36 808 km² and lies in the warm tropical waters of the Coral Sea at depths of 100 to 600 m. It includes two major reefs: Marion Reef (in the north) and Saumarez Reef (in the south) that are the largest of the several small drowned reef-like features on the plateau (Symonds et al. 1983).
4 Canyons of the Eastern Continental Slope and shelf edge rocky reefs	Central Eastern Transition, Central Eastern Province	**Unique seafloor feature; important ecological role; enhanced biological productivity** The eastern continental slope – which extends from Hervey Bay in Queensland to Bermagui in New South Wales (the southern extent of the East Marine Region) – encompasses a large number of canyons (although not in the density of those in the Southeast Marine Region). The canyons on the eastern slope are topographic features that are believed to favour high biodiversity or endemism. They are also areas of topographically-induced upwelling. The canyons of the eastern slope are of two general types: those that have developed wide 'box' heads in the mid slope at approximately 1500 m (e.g. Newcastle Canyon), and those like Sydney Canyon that have linear segments, few tributaries and have their heads in the upper slope. The Newcastle Canyon and box canyons off Jervis Bay also have small, narrow tributary canyons that have incised the upper slope to the shelf break. Canyons are important influences on faunal abundance and composition along the continental shelf and slope. Fisheries along the coast associate good fishing conditions with cold currents at depths, with the most productive grounds clustered around canyons or other abrupt topographical features such as promontories, seamounts and bluffs (Brewer et al. 2007). Canyons channel upwelling water over the slope and shelf, while seasonal downwelling may reverse the flow through these structures (Prince 2001). Winter cooling enhances the difference in density between the coastal and oceanic waters and produces pronounced downwelling in these topographic features, e.g. Tweed Canyon. Generally associated with low nutrient regimes, downwelling of coastal waters may play an important role in breaking down shelf-edge fronts, displacing deeper oceanic slope water and consequently pushing relatively nutrient-rich water towards the photic zone. These topographic features, therefore, create hotspots of productivity for the main commercial shelf-based fisheries (abalone, lobster, scallops, shark, squid, prawn and tuna) and many oceanic predators, including seabirds. Deep sea or submarine canyons are known to occur in the north of the East Marine Region where the Queensland Plateau drops into the Coral Sea Abyssal Basin, and also in the Cape Province bioregion. Here the canyons are very sparse, in much deeper water, and the faunal assemblages associated with these deep sea canyons are not well known (Brewer et al. 2007).

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
REGIONALLY IMPORTANT COMMUNITIES AND HABITATS		
5 Temperate (reef) corals and sponges.	Lord Howe Province, Central Eastern Shelf Transition	**Important ecological role; important for biodiversity** The hermatypic corals[#] are a critical species group in the temperate reefs of the East Marine Region since they are 'reef-building' i.e. they produce much of the calcium carbonate which makes up the reefs. While calcium carbonate is laid down by a variety of reef organisms, it is likely that without corals, these reefs would cease to exist. With a greatly reduced calcium carbonate production the reefs would be susceptible to erosion from physical (e.g. wave action) and biological (e.g. boring molluscs) processes and, in the longer term, would be unable to keep pace with rising sea levels. Corals also form much of the 'habitat' on reefs, providing shelter and food for a wide range of invertebrates and fish. Outside of the tropics, opportunities for reef building are limited by water temperature, reduced day length in winter, and available calcium carbonate for skeleton formation (Kleypas et al. 1999). Hermatypic coral diversity gradually decreases with latitude to 31°S, after which no further reefs exist and only a small number of coral species occur. The southern limit of reef development is seen at Lord Howe Island; however, many hermatypic coral species are present in non-reef environments in coastal areas such as Moreton Bay (Qld) and the Solitary Islands (NSW) and a few species exist right down to the southern limit of the East Marine Region. Ahermatypic corals are present in deeper waters throughout the East Marine Region continental shelf, slope and offslope regions, to well below the limit of light penetration. Unlike some other marine invertebrate phyla, there are no apparent latitudinal gradients of sponge species richness from temperate to tropical waters, with both having patchy mosaics of very rich and poor faunas. Ecologically, sponges are a highly significant component of temperate reef ecosystems as they are: • generally the most efficient seawater filtering recyclers • the dominant primary producers in some marine systems (Wilkinson 1983) • the predominant bioeroders and recyclers of calcium carbonate back into the system in coralline habitats (Schönberg and Wilkinson 2001) • important refuges for many small invertebrates and microbes (Wilkinson 1984b, Wilkinson 1984a) • used as protection by fish and larger invertebrates. ***The Solitary Islands*** The Solitary Islands region contains the southernmost extensive coral communities in coastal eastern Australia (Zann 2000). Tropical coral larvae are transported by the East Australian Current, possibly from the southern Great Barrier Reef and the subtropical reefs in south-east Queensland and far northern New South Wales. However, it is likely there is also some local recruitment of subtropical species from within the region.

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
5 Temperate (reef) corals and sponges continued…		***Lord Howe Island*** While sparse coral growth may be present at other areas farther south, Lord Howe Island is regarded as the world's southernmost locality exhibiting a well-developed barrier coral reef community and associated lagoon (Allen et al. 1976). Many of the species that have been recorded from waters of Lord Howe Island are extremely rare in that area, and may have resulted from chance recruitment of only a few larvae which did not establish a self-seeding population (Harriott et al. 1993). There is some debate as to whether Lord Howe Island reefs are reliant on replenishment of larvae from the Great Barrier Reef or from local brooding corals (Veron and Done 1979, Harriott 1992).
6 Pelagic squid	All	**Important ecological role** Squid are the dominant cephalopod[##] in the open pelagic environment over the continental shelves, slopes and in the open ocean, including the deep sea. Squid are voracious eaters, all are predators and cannibalism is not uncommon. In the marine food web they serve as both important predators and prey. While they prey on many fish, crustacean and cephalopod species, they in turn serve as important prey for a variety of vertebrate predators such as oceanic birds, sharks, tuna, billfish, seals and cetaceans. Squid are important in the food pyramids of our eastern oceans. Squid play a central role in many pelagic food webs by linking the massive biomass of micronekton, particularly myctophid fish, to many oceanic predators, including seabirds. Characterised by short life spans and fast growth rates, squid may respond more readily to changes in the environment and the trophic structure than any other mid-trophic-level organism in the open ocean (Olsen and Young 2006). In this Region, the Southern Squid Jig Fishery operates south of latitude 240 30' S. The marine species targeted is the arrow squid. Catches are mainly taken between Queenscliff and Portland, off the Victorian coastline and south of Kangaroo Island, off the South Australian coast with some historical activity reported from the waters around Tasmania. Squid is also taken as bycatch in the South East Trawl Fishery. Due to ecological interactions and lack of knowledge about the lifecycles and interdependences of the different species, sustainable management of squid fisheries is particularly challenging. Overharvesting could be disadvantageous from both economic and conservation viewpoints. For example, the direct contribution of squid to fisheries could be less valuable than their indirect contribution through ecological enhancement of fish production and production of species of non-consumptive value (Hunsicker et al. 2006).
7 Large pelagic predators (sharks, tuna and billfish)	All	**Important ecological role** Pelagic predators occupy one of the largest ecosystems on the planet – the surface and water column of the open ocean. While pelagic predators range throughout the East Marine Region, the East Australian Current is a major avenue of connectivity between the northern and southern parts of the Region. Aggregations of pelagic predators are often found around seamounts, which provide refugia for prey species and consequently feeding locations for associated pelagic predators (Richer de Forges et al. 2000, Hixon and Beets 1993, Norse and Crowder 2005).

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
7 Large pelagic predators (sharks, tuna and billfish) continued…		Some of the large pelagic predators that occur in the East Marine Region include tuna, billfish (e.g. swordfish and marlin) and sharks. These species are often at the end of long food chains, where they have a crucial role in maintaining and determining the health of ecosystems. Top predators that are migratory or disperse widely have the potential to transfer energy across wide areas (Zainuddin et al. 2006). Thus, they may be important connections between mostly separate foodwebs. Tunas, billfish and sharks are valuable species economically and socially, representing high value to both commercial and recreational fishers in the East Marine Region. In the Coral Sea, seasonal increases in the abundance of pelagic predators – billfish in particular – forms the basis of a significant recreational and commercial fishery. Indeed, Kenn Reef and Wreck Reef are areas where game fishing charters fish for large pelagic predators such as billfish, tuna and giant trevally. One large pelagic predator is the black marlin *Makaira indica*, which is distributed throughout the tropical and sub-tropical Indian and Pacific Oceans and generally near landmasses. Black marlin spawning aggregations in the Cairns-Lizard Island region between September to December, are important as the only recognised spawning events for this species. Between January and March black marlin are found along the continental slope off New South Wales and during April to August, they move to waters of the Solomon Islands and eastern Papua New Guinea. Juvenile black marlin spend the early stages of growth on the Great Barrier Reef before migrating out into the Pacific Ocean. The black marlin in the north-western Coral Sea are thought to be part of much larger stocks which inhabit the Western and Central Pacific Ocean. Black marlin can live to 20 years or more, grow to 4.5 metres long and weigh 700 kilograms. Mature female black marlin are larger than the males, which grow to maximum of 250 kilograms. References: *Russell, M. and Walsh, A. (unpublished) Billfish and Swordfish in the Great Barrier Reef Marine Park Game Boat Fishery - A compendium of information and basis for the development of policies and strategies for the conservation of target game boat fishery species. Great Barrier Reef Marine Park Authority, Townsville.* *Speare, P. 2009, AIMS Research – Black Marlin, <http://www.aims.gov.au/pages/research/marlin/black/pages/bm-00.html> accessed 23/03/2009.*
8 The East Coast Humpback whale population	All except for Norfolk Island Province and Lord Howe Province	**Resting, breeding and nursery aggregations** Each year, between April and November humpback whales can be seen migrating along the east coast of Australia. These animals undertake an annual migration of 10 000 km between the waters of the Southern Ocean where they feed on krill and the warmer waters of their calving grounds in the Great Barrier Reef. The majority of humpbacks migrate north from June to August and south from September to November. The exact timing of the migration period can change from year to year and may be influenced by a number of factors including water temperature and prey abundance. Typically, groups of young males lead the migration of the majority of humpbacks while pregnant cows and cow/calf pairs follow behind.

Table 3.1 Key ecological features of the Region

Key ecological features	Provincial bioregions (IMCRA v.4.0)	Rationale
8 The East Coast Humpback whale population continued…		At a maximum of 16 m in length, the humpback whale isn't the largest of the whales that occurs in Australian waters but it is arguably the most iconic. Australians have a particularly strong affinity with this species whose acrobatic displays and ease of recognition have made it popular with the whale watching industry. It is not uncommon to see humpback whales from a beach or headland along the Australian east coast between April and November. For a closer encounter, whale watching operators take people out on the water and closer to the migration path of humpback whales. Whale watching boats operate out of many coastal towns along the east coast including Eden, Sydney and Byron Bay in New South Wales and the Gold Coast and Hervey Bay in Queensland.
9 Herbivorous fish of coral reefs	All except for Tasman Basin Province, Central Eastern Shelf Province, South-east Shelf Transition, and Southeast Transition	**Important ecological role** Herbivorous fish form a functional group that is significant for maintaining the ecological resilience of coral reefs to disturbances. Herbivorous fish along with sea turtles and a range of other organisms graze on algae on coral reefs and help maintain the domination of corals. The decline in the abundance of sea turtles over the East Marine Region has emphasised the importance of herbivorous fish as the primary grazers of algae on coral reefs. The removal of herbivorous fish from coral reefs in other areas of the world has led to a regime shift from a coral-dominated reef system to an algae-dominated reef system. Once this shift occurs it may be very difficult to reverse (McCook 1999). A regime shift from coral-dominated to algae-dominated reefs in Australian waters would mean major losses in biodiversity, ecosystem function, tourism values, and loss of habitat for key fishery species. Maintaining the diversity and abundance of herbivorous fish on coral reefs is also important for the recovery of coral reefs from disturbances such as coral bleaching events, fertiliser run-off, cyclones, and crown-of-thorns starfish outbreaks. With herbivorous fish, disturbed coral reefs may recover over a space of 5–20 years, but without herbivorous fish the system can quickly become dominated by algae beds which may be irreversible (McCook 2008). Some of the key families of herbivorous fish that occur on coral reefs in the East Marine Region include members of the families Scaridae (Parrotfish); Acanthuridae (Surgeonfish); Pomacentridae (Damselfish); and Siganids (Rabbitfish); Kyphosidea (Chubs); and Ephippidae (Batfish). These species are not targeted as food species in Australia, although some fish are taken by spearfishers and marine aquarium fishers. There is an Asian seafood market for these fish which has put pressure on their survival on reefs in other areas (Hughes et al 2003; Berkes et al 2006).

* Ocean eddies can be 200 km across, rotating mainly anti-clockwise at up to four knots at the edge, and can be more than 1 km deep and have a life of up to a year.

** A joint Australian–New Zealand survey, NORFANZ, was carried out in 2003, to identify the biodiversity and endemicity of the benthic seamount fauna on the Norfolk Ridge. During this survey, 516 species of fish and macroinvertebrates were recorded, 36 percent of which were new to science and potentially endemic to this region (Williams et al, 2006).

Hermatypic ('reef building') corals contain and depend upon zooxanthellae (algae) for nutrients. Ahermatypic corals do not contain zooxanthellae, and rely mainly on plankton for nutrients. They are generally smaller than hermatypic corals and often solitary.

Cephalopods include octopus, cuttlefish, nautilus and squid.

3.2 Nationally protected species

Species listed under the EPBC Act are commonly referred to as 'protected species' because it is an offence to kill, injure, take, trade, keep or move a listed species without authorisation. Under the EPBC Act, species can be listed as threatened, migratory, cetaceans or marine:

- *Threatened species* – are those species that have been identified as being in danger of becoming extinct;
- *Listed Migratory species* – are those species that are listed under:
  - the *Convention on the Conservation of Migratory Species of Wild Animals 1979* (also known as the CMS or Bonn Convention);
  - the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA);
  - the *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986 (CAMBA)*;
  - the *Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds 2007* (ROKAMBA); or
  - any other international agreement, or instrument made under other international agreements approved by the Minister for the Environment, Heritage and the Arts[2].
- *Cetaceans* (including whales, dolphins and porpoises) – all species of cetacean are protected under the EPBC Act to ensure their long-term conservation;
- *Listed Marine Species* – species belonging to taxa that the Australian Government recognises as requiring protection to ensure their long-term conservation (in accordance with Section 248 of the EPBC Act). Listed marine species occurring in the Region include:
  - sea snakes (families Elapidae and Colubridae);
  - marine turtles (families Cheloniidae and Dermochelyidae);
  - fur seals (family Otariidae);
  - seahorses, pipefish, pipe horses and sea dragons (family Syngnathidae); and
  - birds (seabirds, shorebirds, waterbirds and a number of other coastal or migratory birds that occur naturally in marine environments).

[2] Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided in Appendix A

Species can also be listed under more than one category; for instance albatrosses and some marine turtles are listed as threatened species, migratory species and marine species.

All protected species are also included under Part 13A of the EPBC Act which regulates the international movement of wildlife and wildlife products, including the:

- export of Australian native species other than those identified as exempt;
- export and import of species included in the appendices to the *Convention on International Trade in Endangered Species on Wild Fauna and Flora 1973* (CITES); and
- import of live plants and animals that (if they became established in Australia) could adversely affect native species or their habitats.

Under the EPBC Act species listed as 'threatened' or 'migratory' are matters of national environmental significance. Species listed in the extinct or conservation dependent categories are not matters of national environmental significance under the EPBC Act. Proposals for activities that will, or are likely to have, a significant impact on matters of national environmental significance must be referred to the Minister for the Environment, Heritage and the Arts for approval.

Significant Impact Guidelines – Matters of National Environmental Significance has been published to advise proponents on when referrals should be submitted for approval. These guidelines provide advice about the kinds of actions likely to have a significant impact on threatened and migratory species. The guidelines also provide specific advice about the kinds of actions likely to have a significant impact on the Commonwealth marine environment. Under these guidelines for the Commonwealth marine environment, any actions that will, or are likely to, 'have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (e.g. breeding, feeding, migratory behaviour, life expectancy) and spatial distribution' are identified as actions that should be referred for approval. The guidelines are available at **<**www.environment.gov.au/epbc/protect**>.**

Species listed under the EPBC Act are also protected from adverse interactions with commercial fishing operations. Under the EPBC Act all fisheries managed under Commonwealth legislation, and State-managed fisheries that have an export component, must be assessed to ensure that fisheries are managed in an ecologically sustainable way. These fisheries assessments are conducted using the *Guidelines for the Ecologically Sustainable Management of Fisheries*. These guidelines specify that fisheries must be conducted in a manner that does not threaten by-catch species and that 'avoids mortality of, or injuries to, endangered, threatened or protected species'.

Further information about fisheries assessments carried out under the EPBC Act is available at <www.environment.gov.au/coasts/fisheries/publications/assessments.html>.

The EPBC Act includes other forms of protection for listed species to ensure that human activities do not threaten their survival in the wild (see appendix B for further information and relevant links).

3.2.1 Protected species in the East Marine Region

The East Marine Region is an important area for many species that are protected under the EPBC Act. Many of the species listed under the EPBC Act are also protected under State and Territory legislation; for instance, marine turtles are protected under the EPBC Act, and under Queensland and New South Wales legislation.

There are 106 species protected under the EPBC Act that are known to occur in the Region: 37 species listed as threatened, 82 as migratory, 30 cetaceans and 71 listed as marine[3] (table 3.2). In addition, there are other species that may infrequently occur in the Region. Species that may infrequently occur in the Region are defined as those that:

- are accidental visitors to the Region; or
- are considered as species that may occur in the Region on the basis of available information about their range.

Appendix C lists all species protected under the EPBC Act that are known to occur and all that may infrequently occur in the Region. Note that, at the time of completing this Bioregional Profile (2008), there are no species known to have become extinct in the Region.

Protected species group report cards have been prepared for each of the broad taxonomic groups listed under the EPBC Act that are known to occur in the Region (appendix D). The report cards identify the threatened and migratory listed species that are known to occur in the Region, describe their ecology, identify the important areas for them within the Region, explain what processes and activities pose a threat to their continued survival and identify how these threats are being mitigated. The report cards also point to relevant references and research for further reading. The report cards are available on the internet at <www.environment.gov.au/coasts/mbp/east> and will be updated as new information becomes available. Protected species group report cards are available for sharks, bony fish (including seahorses, pipefish, pipehorses and sea-dragons), reptiles (marine turtles and sea snakes), seabirds, pinnipeds (fur seals, seals and sea lions) and cetaceans (whales, dolphins and porpoises) occurring in the East Marine Region.

[3] Species can be listed in more than one category under the EPBC Act. For instance, the Humpback Whale is listed as a cetacean, a threatened species (Vulnerable), and a migratory species.

Table 3.2 Number of protected species known to occur in the Region by broad taxonomic group (as of February 2008)

Threatened Species					Migratory Species	Cetaceans (whales, dolphins & porpoises)	Listed Marine Species
	Critically Endangered	**Endangered**	**Vulnerable**	**Conservation Dependent**			
Sharks	1		2		2		
Bony Fish				1			All sygnathids
Reptiles (marine turtles and seasnakes)		2	4		6		6 turtle species and all seasnakes
Seabirds	1	4	17		63		63
Pinnipeds (fur seals, seals and sea lions)							2
Cetaceans		2	3		11	30	
	37				82	30	71

Grey nurse shark. Photo: David Harasti.

Important areas for species listed as 'threatened' or 'migratory' under the EPBC Act (i.e. those protected species that are matters of national environmental significance) have been identified to assist in understanding the factors that may impact on their conservation during development of the Draft East Marine Bioregional Plan. There are areas within the East Marine Region that have been recognised as important sites for national protected species. The coastal lands and State waters adjacent to the Region contain many areas known to be important for protected species. Table 3.3 describes the known breeding, nursery, calving, feeding and resting areas, and other known aggregation sites within and adjacent to the Region that are important for listed threatened and migratory species. These areas were identified on the basis of available information and expert advice for:

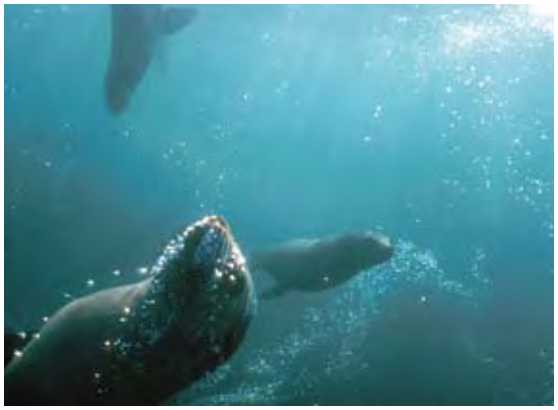
- Sharks: nursery grounds and feeding areas
- Fish (orange roughy): aggregations
- Reptiles (marine turtles): foraging areas
- Seabirds: rookeries and known feeding areas are identified
- Pinnipeds (seals, fur seals and sea lions): breeding colonies and surrounding waters
- Cetaceans (whales, dolphins and porpoises): feeding, calving and resting areas on migratory routes in the Region.

Further important areas may be identified for species protected under the EPBC Act during the next stage of the planning process, as more detailed information about the Region and the current and potential threats to protected species becomes known. The Draft East Bioregional Plan will include any important areas that are identified.

Table 3.3 Important breeding, feeding and resting areas for species listed as threatened or migratory under the EPBC Act

Important Areas	Species and rationale
Inshore waters off New South Wales and southern Queensland	**Critical habitat – grey nurse shark** Specific critical habitat locations adjacent to the Region at Byron Bay, Brooms Head, Solitary Islands, South West Rocks, Forster, Seal Rocks, Port Stephens, Sydney, Bateman's Bay and Narooma are known key aggregation sites for grey nurse sharks. The Cod Grounds off Laurieton and Pimpernel Rock near the Solitary Islands are the two critical habitat locations within the East Marine Region. Critical habitat sites in Queensland adjacent to the Region exist off Moreton and Stradbroke Islands and Rainbow Beach. **Juvenile habitat – white shark** Areas adjacent to the Region off Garie beach, Wattamolla and Port Stephens. Newcastle (New South Wales) and some areas off southern Queensland appear to be seasonally important for juvenile white sharks.
Upper-mid slope of the continental shelf off central and southern New South Wales	**Aggregation area** – Harrisson's, endeavour and southern dogfish and orange roughy spawning areas
Islands and reefs within the Coral Sea	**Nesting and foraging area – marine turtles** One of eight Australian and south-west Pacific green turtle populations are identified as regularly nesting on the islets of the Coringa–Herald National Nature Reserve. The hawksbill turtle occasionally uses these locations for nesting. **Nesting and foraging area – seabirds** The islets and coral reefs in the Coral Sea Islands Territory including the RAMSAR-listed Coringa–Herald and Lihou Reef National Nature Reserves.
Montague Island and Steamers Head off New South Wales	**Foraging areas and haul-out sites – Australian and New Zealand fur-seals** Although Montague Island and Steamers Head fall within the waters managed by the New South Wales Government, they are immediately adjacent to the East Marine Region and are the only haul-out sites for Australian and New Zealand fur-seals within close proximity to the Region. Seals using these haul-out sites are known to forage in the waters of the Region.
The Great Barrier Reef, Whitsunday islands, Hervey Bay, Stradbroke Island, Cape Byron, Coffs Harbour, southern coast of NSW	**Calving area and migration route – whales** The Great Barrier Reef which is adjacent to the Region is a calving ground for humpback whales. Also adjacent to the Region, the Whitsunday islands, Hervey Bay, Stradbroke Island, Cape Byron, Coffs Harbour and the southern coast of New South Wales are key localities for humpback whales as aggregation and resting areas along their eastern migration route. The northern Great Barrier Reef is a key locality for dwarf minke whales to aggregate in winter.
Lord Howe Island and Elizabeth and Middleton Reefs	**Seabird nesting and foraging, unique marine assemblages** Lord Howe Island is managed by the New South Wales Government but is an important nesting site for seabirds that forage in the Region. The waters around Lord Howe Island and the nearby Elizabeth and Middleton Reefs are Commonwealth Reserves protected under the EPBC Act. These Reefs – the southern-most open-ocean platform coral reefs in the world – contain a unique mix of rare fish such as the black cod, maori wrasse and galapagos sharks

Hawksbill turtle. Photo: Paradise Ink.



Australian fur seals. Image courtesy of CSIRO.

3.3 Protected Places

The Australian Government has responsibility for the conservation of Australia's natural, Indigenous and historic heritage including the management of protected places on World, National and Commonwealth Heritage Lists and the Register of National Estate. Protected places likely to occur in the marine environment include Marine Protected Areas and historic shipwrecks.

Within, or immediately adjacent to, the East Marine Region there are six Commonwealth Marine Protected Areas, two World Heritage Properties[4], three National Heritage Places[5], two internationally important wetlands, and there are likely to be hundreds of historic shipwrecks[6].

The Great Barrier Reef Marine Park is the largest living organism in the world, stretching for over 2000 km and containing the world's largest collection of coral reefs. It is a Marine Park, a World Heritage Property and a National Heritage Place. More information on the Great Barrier Reef, including its zoning, is available at: <www.gbrmpa.gov.au>.

3.3.1 Marine Protected Areas

The history of Marine Protected Areas in Australia's (Commonwealth) waters extends back to 1975 when the Great Barrier Reef Marine Park was established. In the following decades, a number of additional Marine Protected Areas were declared, each nominated because they contained conservation features identified as being of particular significance. In the East Marine Region, there are six Commonwealth Marine Protected Areas from Coringa–Herald Marine Park in the north to Lord Howe Island Marine Park in the south (figure 3.4). A brief description of these is given below.

In addition, there are a number of marine reserves in State waters adjacent to the East Marine Region. For instance, the New South Wales Government has protected six areas along its coastline, including; Cape Byron Marine Park, Solitary Islands Marine Park, Port Stephens–Great Lakes Marine Park, Jervis Bay Marine Park, Batemans Marine Park, as well as the Lord Howe Island Marine Park, to conserve marine biological diversity, marine habitats and ecological processes.

4 The Great Barrier Reef Marine Park and Fraser Island are immediately adjacent to the East Marine Region.

5 The Great Barrier Reef Marine Park, Fraser Island, and Kingston and Arthurs Vale Historic Area (KAVHA) Norfolk Island are immediately adjacent to the East Marine Region.

6 Any as yet undiscovered shipwrecks older than 75 years are protected under the *Historic Shipwrecks Act 1976*.

Coringa–Herald National Nature Reserve

The Coringa–Herald National Nature Reserve lies in the Coral Sea, about 400 km east of Cairns.

Coringa–Herald National Nature Reserve is 100 km from Lihou Reef National Nature Reserve: collectively they are known as the Coral Sea National Nature Reserves. They lie in a remote oceanic environment on the Coral Sea Plateau, which is separated from the Great Barrier Reef by an area of deep water known as the Queensland Trough.

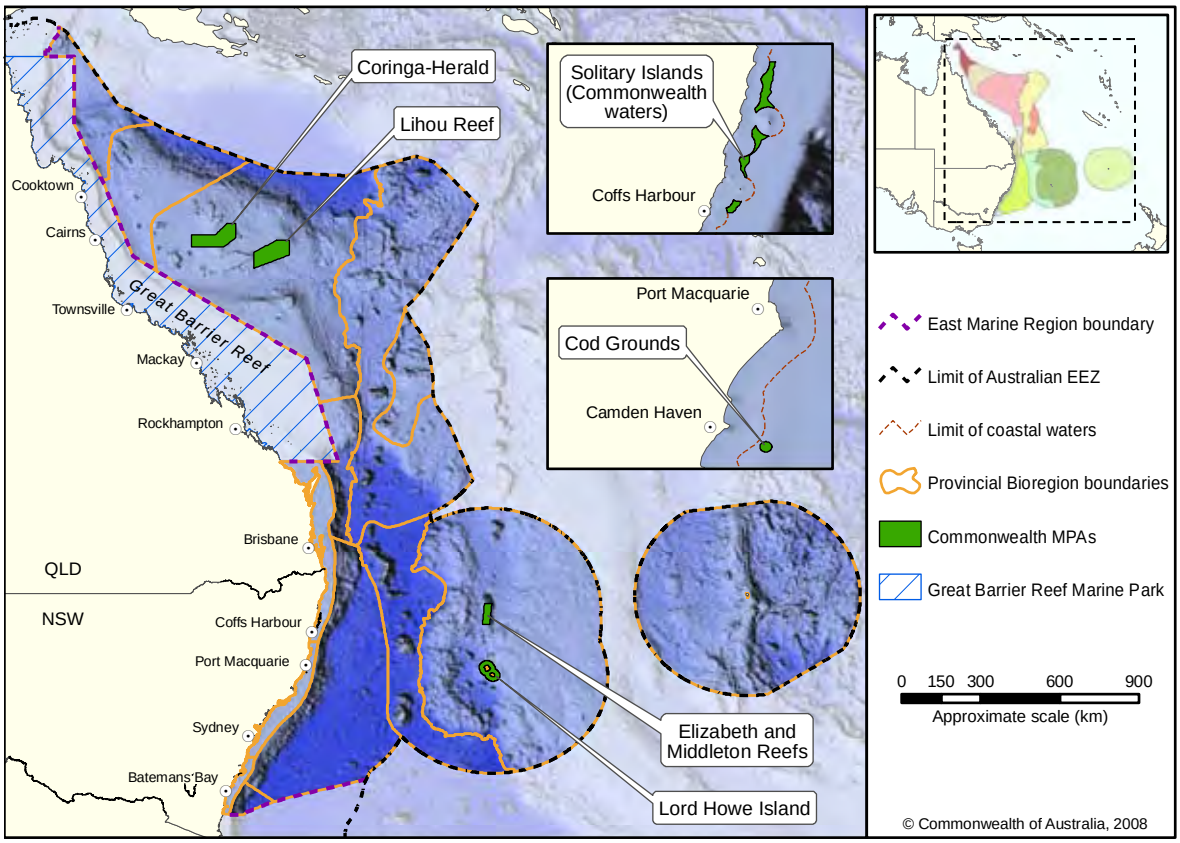
The islands in the Coringa–Herald National Nature Reserve include the only forested cays in the entire Coral Sea Islands Territory. During the breeding season, large concentrations of migratory seabirds congregate on the small isolated islands. The reserve also contains near pristine and internationally significant reef ecosystems, cays and important undisturbed habitat for nesting green turtles.

Proclamation date	16 August 1982
Size	885 261 ha (*8 852 km²*)
IUCN category	Ia (*Strict Nature Reserve*)
Provincial Bioregion	Northeast Province

Further information on the Coringa–Herald National Nature Reserve is available at <www.environment.gov.au/coasts/mpa/coringa/index.html>.

Brown booby. Photo: Fusion Films.

Figure 3.3 Marine Protected Areas of the East Marine Region



Lihou Reef National Nature Reserve

The Lihou Reef National Nature Reserve is located in the Coral Sea, some 630 km ESE of Cairns. The reserve comprises about 8440 km² of seabed and a horseshoe-shaped reef system containing 18 cays.

Lihou Reef National Nature Reserve is 100 km from Coringa–Herald National Nature Reserve in a remote oceanic environment on the Coral Sea Plateau, separated from the Great Barrier Reef by an area of deep water known as the Queensland Trough.

The Lihou Reef National Nature Reserve is the largest reef structure in the Coral Sea. It is best known for its:

- pristine environmental condition;
- shelf-edge oceanic reef;
- rich and diverse marine flora and fauna, including potentially undescribed species;
- spectacular and unusual underwater topography;
- internationally significant populations of breeding seabirds; and
- undisturbed habitat for nesting green turtles.

The reef habitat supports marine benthic flora and fauna that are distinct from those of the Great Barrier Reef.

A diverse range of marine algae, sponges, soft and hard corals, crustaceans, starfish, sea urchins, sea cucumbers, and fish have been recorded within the Reserve. The green turtle breeds in the Reserve and a number of species of dolphins and whales are also known to occur in the area.

Proclamation date	16 August 1982
Size	842 896 ha (*8 428 km²*)
IUCN category	Ia (*Strict Nature Reserve*)
Provinical Bioregion	Northeast Province

Further information on the Lihou Reef National Nature Reserve is available at <www.environment.gov.au/coasts/mpa/lihou/index.html>.

Anne Cay, Lihou Reef National Nature Reserve. Image courtesy of Australian Customs.

Solitary Islands Marine Reserve (Commonwealth Waters)

Solitary Islands Marine Reserve (Commonwealth Waters) is located 600 km NNE of Sydney, between Coffs Harbour and Plover Island. It is adjacent to the Solitary Islands Marine Park (New South Wales) and extends from the 3 nautical mile State limit seaward to the 50 m depth contour. It encompasses the waters, seabed and subsoil beneath the seabed to a depth of 1000 m. The Park is 710 km² in area with the Reserve covering a further 160 km².

Most of the Reserve is a General Use Zone (IUCN category VI) with two special management zones in the northern section of the Reserve – a Sanctuary Zone (IUCN category Ia – strict nature reserve), and a Habitat Protection Zone (IUCN category IV – habitat/species management area).

The Solitary Islands Marine Reserve protects and conserves a relatively undisturbed, distinct and species-rich ecosystem associated with open ocean, subtidal reef and soft substrate habitats.

Pimpernel Rock is the most significant feature in the Reserve. It is a submerged pinnacle that rises from the seabed to within a few metres of the surface, providing habitat for benthic communities, pelagic fish, grey nurse sharks, black cod, and marine turtles.

The Reserve is located in a mixing zone between tropical and temperate environments, and many species are at, or close to, either their southern or northern geographical limits.

Proclamation date	3 March 1993
Size	16 000 ha (*160 km²*)
IUCN category	Includes three Zones as follows: **Sanctuary Zone – IUCN Category Ia (79 ha or 0.79 km2)** **Habitat Protection Zone – IUCN Category IV (3746 ha or 37 km²)** **General Use Zone – IUCN Category VI (11 930 ha or 119 km²)**
Provincial bioregion	Central Eastern Shelf Transition

Further information on the Solitary Islands Marine Reserve (Commonwealth Waters) is available at <www.environment.gov.au/coasts/mpa/solitary/index.html>.

Elizabeth and Middleton Reefs Marine National Nature Reserve

Elizabeth and Middleton Reefs Marine National Nature Reserve is located in the Tasman Sea approximately 600 km east of Coffs Harbour. The reserve includes two separate reefs, Elizabeth Reef and Middleton Reef.

Elizabeth Reef is at latitude 29° 56'S and longitude 159° 05' E. Middleton Reef is at latitude 29° 27'S and longitude 159° 07' E.

Elizabeth and Middleton Reefs, together with reefs around Lord Howe Island 150 km to the south, are regarded as the southernmost coral reefs in the world. Their location where tropical and temperate ocean currents meet contributes to an unusually diverse assemblage of marine species.

Elizabeth and Middleton Reefs are on the peaks of volcanic seamounts. There are more than 20 such peaks in the Tasman Sea, but few rise above sea level. At high tide, when the Elizabeth and Middleton Reefs are almost totally submerged, they appear as only rings of white breakers, except for a small sand cay at Elizabeth Reef.

The reefs are among the few last remaining strongholds of the black cod. The black cod is widely distributed throughout most habitats at Elizabeth and Middleton Reefs, which are also the southernmost limit of the Queensland Groper.

Proclamation date	23 December 1987
Size	187 726 ha (*1877 km²*)
IUCN category	Habitat Protection Zone - Category II, Sanctuary Zone - Category Ia
Provincial bioregion	Lord Howe Province

Further information on the Elizabeth and Middleton Reefs Marine National Nature Reserve is available at <www.environment.gov.au/coasts/mpa/elizabeth/index.html>.

Elizabeth Reef. Photo: Richard Chesher Ph.D.

Lord Howe Island Group. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

Lord Howe Island Marine Park (Commonwealth Waters)
The Lord Howe Island Marine Park (Commonwealth Waters) is located in the Tasman Sea, some 700 km north-east of Sydney.

The perimeter of the Lord Howe Island Marine Park roughly corresponds to the 1800 m depth contour that follows the base of the seamounts that underlie Lord Howe Island and Ball's Pyramid. The sea area of the Park is 300 510 ha and includes the sea-bed to a depth of 100 m.

Lord Howe Island and Ball's Pyramid are part of a chain of seamounts that are the remnants of a once-extensive volcanic system active in the late Miocene. The Island is part of the State of New South Wales and is surrounded by State waters (out to 3 nautical miles) and Commonwealth waters out to a distance of 200 nautical miles.

The Commonwealth marine park complements the existing State marine park and World Heritage Area and extends protection to the deeper water environment, benthic habitats and attendant flora and fauna.

The primary objective of the Park is to protect the seamount system and its conservation values of marine biodiversity, habitats and ecological processes. Such protection ensures the long-term maintenance of the high quality marine environment important to the Island's tourism industry, as well as the traditions and lifestyle of the local community.

Due to its distance from any large landmass, the Island's marine ecosystem is largely in an undisturbed, natural state. The alternating influences of warm and cool currents create a transition zone between temperate and tropical regions that contributes to an unusual mix of tropical, sub-tropical and temperate marine fauna and flora and a high level of endemism.

Proclamation date	21 June 2000
Size	300 500 ha (*3005 km²*)
IUCN category	Habitat Protection Zone - Category IV, Sanctuary Zone - Category Ia
Provincial bioregion	Lord Howe Province

Further information on the Lord Howe Island Marine Park (Commonwealth Waters) is available at <www.environment.gov.au/coasts/mpa/lordhowe/index.html>.

Cod Grounds Commonwealth Marine Reserve

The Cod Grounds Commonwealth Marine Reserve is located about four nautical miles off Laurieton in New South Wales.

The Cod Grounds Commonwealth Marine Reserve was declared to protect important habitat of the critically endangered grey nurse shark. The Reserve has been declared an IUCN Category 1a (no take) Sanctuary Zone for 1000 m radius from a point at 152° 54' 37" E, 31° 40' 52" S (an area of about 300 ha).

The area known as the Cod Grounds is a series of underwater pinnacles which is a significant aggregation site for the grey nurse shark. The Cod Grounds provide prime habitat for the sharks which are often observed in large numbers in or near deep sandy-bottomed gutters between the Cod Ground pinnacles. The Cod Grounds support a larger proportion of female grey nurse sharks than at other aggregation sites surveyed off the New South Wales coast and also provide habitat for prey species preferred by the grey nurse shark.

Proclamation date	10 May 2007
Size	Approximately 300 ha
IUCN category	IUCN Category 1a (*Sanctuary zone*)
Provincial bioregion	Central Eastern Shelf Province

Further information on the Cod Grounds Commonwealth Marine Reserve is available at <www.environment.gov.au/coasts/mpa/cod-grounds/index.html>.

3.3.2 Australia's World, National and Commonwealth Heritage

Australia has long recognised the importance of preserving its rich and diverse natural and cultural heritage and was one of the first signatories to the *Convention Concerning the Protection of the World Cultural and Natural Heritage* ('World Heritage Convention').

As of March 2008, 17 Australian properties were on the World Heritage List[7], one of which, the Lord Howe Island Group, occurs within the East Marine Region. Two other properties, the Great Barrier Reef and Fraser Island, occur immediately adjacent to the East Marine Region.

[7] There are 11 convict sites (known as the Australian Convict Sites) that make up Australia's 2008 World Heritage nomination to UNESCO. One of these sites is the Kingston and Arthur's Vale Historic Area on Norfolk Island.

The significance of Lord Howe Island and its marine environment was recognised by its addition to the UNESCO World Heritage List in 1982. Some of the World Heritage values of the Lord Howe Island group specific to the marine environment include:

- the unusual combination of tropical and temperate marine flora and fauna, including many species living at their distributional limits, reflecting the extreme latitude of the coral reef ecosystems which comprise the southernmost true coral reefs in the world;
- the diversity of marine benthic algae species, including at least 235 species of which 12 per cent are endemic;
- the diversity of marine fish species, including at least 500 species of which 400 are inshore species and 15 are endemic;
- the diversity of marine invertebrate species, including more than 83 species of corals and 65 species of echinoderms of which 70 per cent are tropical, 24 per cent are temperate and 6 per cent are endemic.

Australia's national heritage comprises exceptional natural and cultural places which help give Australia its national identity. Such places are a living and accessible record of the nation's evolving landscapes and experiences and reveal the richness of Australia's extraordinarily diverse natural heritage.

The National Heritage List has been established comprising natural, historic and Indigenous places that are of outstanding national heritage value. Each place on the List is assessed by the Australian Heritage Council for national heritage values then protected and managed under a range of Commonwealth powers. A place entered on the National Heritage List is a National Heritage place.

As of June 2008, 79 Australian places were on the National Heritage List, one of which, the Lord Howe Island Group, is within the East Marine Region. Three other places, the Great Barrier Reef, Fraser Island, and Kingston and Arthurs Vale Historic Area (KAVHA) Norfolk Island, are immediately adjacent to the East Marine Region.

The Commonwealth Heritage List is a list of natural, Indigenous and historic heritage places owned or controlled by the Australian Government. These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation. A number of historic and natural heritage places on Norfolk Island are on the Commonwealth Heritage List.

Kingston and Arthurs Vale Historic Area, Norfolk Island. Photo: Mark Mohell and the Department of the Environment, Water, Heritage and the Arts.

Further information on Australia's World, National and Commonwealth Heritage is available at <www.environment.gov.au/heritage>.

3.3.3 Wetlands of International Importance

Wetlands include swamps, marshes, billabongs, lakes, saltmarshes, mudflats, mangroves, coral reefs, fens, peatlands, or bodies of water – whether natural or artificial, permanent or temporary. Water within these areas can be static or flowing, fresh, brackish or saline.

Wetlands are vital to Australia. They protect our shores from wave action, reduce the impacts of floods, absorb pollutants and provide habitat for animals and plants.

The Convention on Wetlands of International Importance was signed in 1971 in the small Iranian town of Ramsar[8]. The broad aims of the convention are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. It encourages the designation and protection of sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity.

Under the Ramsar Convention a wide variety of natural and human-made habitat types, ranging from rivers to coral reefs, can be classified as wetlands.

There are currently (February 2008) 65 Australian wetlands listed under the Ramsar Convention, covering approximately 7.5 million hectares, two of which occur within the East Marine Region. These are the Coral Sea Reserves (Coringa–Herald and Lihou Reefs and Cays), and Elizabeth and Middleton Reefs Marine National Nature Reserve.

Further information about wetlands and Australia's Wetlands of International Importance is at <www.environment.gov.au/water/environmental/wetlands>.

[8] Since then, the Convention on Wetlands has taken the common name Ramsar Convention.

Monrey Frontier wreck on Middleton Reef. Photo: Director of National Parks.

3.3.4 Historic Shipwrecks

Australia has a rich maritime history which dates back to the arrival of Aboriginal people some 60 000 years ago. It includes later visits by Macassans – Indonesians from the trading centre of Macassar in Java – who came to fish Australia's northern waters for trepang (sea cucumbers).

In the 17th century, Europeans, including the Dutch, English, French, Spanish and Portuguese began arriving on the coast of the southern continent, having braved extraordinary distances in small sailing boats. The flow of ships to and from Australia has grown enormously since that time, but not without difficulties, and at times, disasters.

Today, the waters off Australia's coasts bear testament to this shipping heritage, holding fast to more than 6500 wrecks. Few of us will ever see them, but each has its own unique story and forms an important part of our heritage.

While information about the location of shipwrecks is often approximate - as the positions of many wrecks are unknown or estimated, there are likely to be hundreds of historic shipwrecks that occur within the East Marine Region.

A more precise figure on the number of historic shipwrecks in the East Marine Region will not be available until late 2008, pending the completion of a major program between the Department and the state historic shipwreck agencies, to update Australia's National Shipwrecks database <www.environment.gov.au/heritage/shipwrecks/database.html>.

Historic shipwrecks are recognised and protected under the *Historic Shipwrecks Act 1976* that protects historic wrecks and associated relics found in waters from the low water mark to the edge of the continental shelf. Under the Act, all wrecks more than 75 years old are protected, together with their associated relics regardless of whether their actual locations are known. The Minister for the Environment, Heritage and the Arts can also make a declaration to protect any historically significant wrecks or articles and relics that are less than 75 years old.

The Act aims to ensure that historic shipwrecks are protected and maintained for their heritage values, and for recreational and educational purposes. It also regulates activities that may result in the damage, interference, removal or destruction of an historic shipwreck or associated relic. Under the Act:

- anyone who finds a shipwreck or relics associated with a shipwreck is required to give notification of the location as soon as practicable to the Minister for the Environment, Heritage and the Arts; and
- historic relics must not be removed, or the physical fabric of a wreck disturbed, unless a permit has been obtained.

The Act also provides for protected zones to be declared around wrecks that are at particular risk of interference. Permits are required to enter protected zones, which can extend up to a radius of 800 m from the site of the wreck.

Further information about historic shipwrecks can be found at <www.environment.gov.au/heritage/shipwrecks>.

3.4 Consideration of pressures on regional conservation values

There are a range of pressures currently impacting or likely to impact upon conservation values in the Region. While appendix D describes some of the threats relevant to species listed under the EPBC Act, it is in the next stage of the bioregional planning process – development of the Draft Bioregional Plan – that threats to all conservation values will be considered in detail.

Australia's marine biodiversity is under increasing 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 exists. Increasing population globally, regionally and locally result in increasing threats to biodiversity and pressures on resources.

Australia's oceans have been the subject of significant recent research activity but large gaps in our knowledge remain. Based on available knowledge, Australia's marine biodiversity is probably in better condition than that of many other countries, however, there are significant concerns about decline in some key species and localised impacts on habitats and conditions.

Despite limitations in knowledge of what resources exist and their current condition and pressures, there is evidence of a cumulative decline in marine biodiversity. A number of threatening processes are causing declines in habitats, changes in ecosystems and loss of species. Key pressures on marine biodiversity include climate change, resource use, land-based impacts, marine biosecurity, and marine pollution.

You can find an overview of the types of pressures impacting on marine biodiversity in the 'Coasts and Oceans' chapter of the *2006 State of the Environment Report* at <www.environment.gov.au/soe/2006/publications/report/coasts.html>.

Chapter 6 of this Bioregional Profile contains more information about how and when in the process, stakeholders' input will be sought to inform the development of the Draft Plan.

A catch of orange roughy. Image courtesy of CSIRO.

Climate change impacts on marine life

Climate change is expected to have considerable impact on marine life and marine ecosystems. There will inevitably be flow-on implications for human societies and economies, particularly those in regional Australia highly dependent on the marine environment and its resources.

Evidence concerning impacts on Australian waters is sparse, mainly due to a lack of historical long-term data collection. Little modelling has been conducted to predict future changes in Australian marine ecosystems and this remains a critical gap; however, valuable information on climate change impacts and adaptation in the marine environment can be found in the 2006 CSIRO report *Impacts of Climate Change on Australian Marine Life* <www.greenhouse.gov.au/impacts/publications/marinelife.html>.

Three general findings emerged from the study:

- although particular factors such as temperature stand out as prominent drivers of observed changes in Australia's marine flora and fauna, it is the combined effects of climate and oceanographic factors that will shape Australia's marine life in the future;
- Australia's marine life is currently affected strongly by stressors such as fisheries, coastal run-off and pollution. The ecological effects of these stressors will serve to reduce ecosystem resilience to climate change so that an integrated and adaptive management approach is required to deal with these combined effects; and
- both monitoring of time series data and modelling of climate change impacts in Australia's marine ecosystems are extremely limited at present. Such activities are crucial components of policy and management strategies.

While it reported on the impacts of climate change for a specific location, the report, *Climate Change and the Great Barrier Reef: A Vulnerability Assessment* <http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/climate_change_vulnerability_assessment/climate_change_vulnerability_assessment> is a useful resource for the East Marine Region since similar habitats and species are found in the Coral Sea, Lord Howe Island and South East Queensland, This vulnerability assessment provides substantial detail on the full range of climate change impacts for all components of tropical marine ecosystems and identifies management (including planning) recommendations for adaptation strategies.

Coral bleaching and a white-tip reef shark, Back Reef Anne Cay, Lihou Reef. Photo: Mike Emslie, Australian Institute of Marine Science and the Department of the Environment, Water, Heritage and the Arts.

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Figures 3.1, 3.2 and 3.3
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Data sources:
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Lord Howe Island Group. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

Chapter 4 Establishing New Marine Protected Areas in the East Marine Region

Australia is committed to the development of a National Representative System of Marine Protected Areas with the primary goal to establish and manage a comprehensive, adequate and representative system of Marine Protected Areas to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems, and to protect Australia's biological diversity at all levels. In summary:

- each distinct provincial bioregion in Australian waters will be represented in a Marine Protected Area network;
- the design of the network should be sufficient to achieve the conservation of all major ecosystem functions and features; and
- the network should properly represent the identified habitats and biota (the range of plants and animals and the places where they live) characteristic of each provincial bioregion.

The Marine Protected Area network, established through the marine bioregional planning process, will include highly protected zones equivalent to IUCN Categories I and II and large areas initially assigned to IUCN Category VI (see box 4.1). This precautionary approach recognises that in many areas, the Marine Protected Area network will be developed in the absence of detailed biological information. Using this staged and adaptive approach to zoning is consistent with the principles of ecological sustainable development. A staged approach also allows for continued gathering of information about specific ecological, economic and social values in an area, and the threats to those values. Where a staged approach is taken, the Government will identify the information gaps and the strategy for addressing these gaps over time.

The National Representative System of Marine Protected Areas is being developed using the national *Guidelines for Establishing the National Representative System of Marine Protected Areas* agreed between the Australian Government, the States and the Northern Territory in 1998.

Since 1998, there have been many decisions that have helped formulate the Australian Government's approach to establishing a Marine Protected Area network. These include developing a clearer understanding of how the *Guidelines for Establishing the National Representative System of Marine Protected Areas* will be applied by the Australian Government, drawing on the best available scientific information. The Department of the Environment, Water, Heritage and the Arts, in consultation with other Australian Government agencies, has set out this approach in the *Goals and Principles for the Establishment of the National Representative System of Marine Protected Areas in Commonwealth Waters*.

The goals and principles are derived from the nationally agreed guidelines and from the Australian Government's implementation experience to date, to ensure proper consideration of ecological and socio-economic requirements. These goals and principles are set out in section 4.1 of this chapter.

The Australian Government considers that measures other than Marine Protected Areas also play a critical role in biodiversity conservation and that the existence and effectiveness of those measures should be taken into account in assessing the adequacy of any Marine Protected Area network.

In addition to Marine Protected Areas, the Government supports the use of spatial measures in fisheries management. While the two spatial management mechanisms are designed and used for different purposes, they can have mutually beneficial outcomes. Fisheries-specific measures, including both temporary and permanent area closures, are developed according to the particular goals and circumstances of each fishery. Marine Protected Areas are developed in Commonwealth waters for the purpose of general biodiversity conservation or to address threats to particular species or habitats – not to manage fisheries. Marine Protected Areas may lead to improved fisheries performance and fisheries closures may achieve biodiversity benefits. The Government seeks to ensure that the design of Marine Protected Areas takes into account the potential for beneficial impacts on fishery resources and that Marine Protected Areas are selected and zoned to enhance or conserve fisheries wherever possible.

Marine Protected Areas have long-term benefits for the environment and the economy, but even where impacts can be minimised, they may affect some businesses in the short- to medium-term. The Government recognises that a new Marine Protected Area network may transfer some marine resources from current production to biodiversity conservation. Therefore, before any new Marine Protected Areas are declared, it will assess the financial and economic costs and benefits of each proposed regional Marine Protected Area network and decide on the provision of any adjustment assistance to affected businesses.

4.1 Goals and principles

The Australian Government is committed to develop a National Representative System of Marine Protected Areas by 2012. The development of Marine Bioregional Plans for each of Australia's five large-scale Marine Regions provides an opportunity to make substantial progress towards this goal. Areas suitable for inclusion in the National Representative System of Marine Protected Areas will be identified during the planning process.

The network will be representative of the 41 provincial-scale bioregions recognised in Commonwealth waters, as identified by the *Integrated Marine and Coastal Regionalisation of Australia Version 4.1* (IMCRA v4.0). The focus is to ensure that Marine Protected Areas are developed for those provincial bioregions that are currently not represented, or are under-represented, in Marine Protected Areas.

The management of Marine Protected Areas may require conditions to be put on the nature and extent of activities that can occur within them. This means the identification of areas suitable for inclusion in the National Representative System of Marine Protected Areas needs to be based upon clear goals and principles. These goals and principles recognise both the scientific information available and the interests of ocean users whose activities may be impacted upon by new Marine Protected Areas.

This approach seeks to draw on available science while recognising from the outset that the information base is poor for some areas. Much of each Marine Region is far offshore, composed of very deep water, and has not been the subject of detailed study or data gathering. In these circumstances, existing detailed and peer-reviewed data will be supplemented with information drawn from known linkages between biodiversity and the physical environment; that is, where detailed species and habitat data is lacking, surrogates for diversity (such as water depth, substrate and geomorphology) will be used.

Key inputs to the process will include:

- existing scientific information underlying IMCRA v4.0 (e.g. bathymetry, geomorphic features, distribution of endemic biota);
- additional regional information on habitats, species distribution and ecology gathered during the marine bioregional planning process;
- data on the location and distribution of human activities in the Region;
- views of ocean users and stakeholders in each Marine Region;
- consideration of the contribution that existing spatial management measures can make to the National Representative System of Marine Protected Areas; and
- consideration of potential management effectiveness (e.g. feasibility of compliance).

4.1.1 The goals

Four goals to help maximise conservation outcomes will guide the identification of areas suitable to be included in the National Representative System of Marine Protected Areas. These goals apply nationally, and they will be used to guide identification of representative Marine Protected Areas in all the Marine Regions (except the South-east Marine Region, where the process has been completed). Additionally, a number of supporting principles will assist in determining the location, selection (when more than one option is available to meet the goals), design and zoning of suitable areas.

Goal 1 – each **provincial bioregion** occurring in the Region should be represented at least once in the Marine Protected Area network. Priority will be given to provincial bioregions not already represented in the National Representative System.

Goal 2 – the Marine Protected Area network should cover all **depth ranges** occurring in the Region or other gradients in light penetration in waters over the continental shelf.

Goal 3 – the Marine Protected Area network should seek to include examples of **benthic/demersal biological** features (e.g. habitats, communities, sub-regional ecosystems, particularly those with high biodiversity value, species richness and endemism) known to occur in the Region at a broad sub-provincial (hundreds of kilometres) scale.

Goal 4 – the Marine Protected Area network should include all **types of seafloor** features. There are 21 seafloor types across the entire Exclusive Economic Zone. Some provincial bioregions will be characterised by the presence of a certain subset of features, such as continental slope or seamounts.

4.1.2 Guiding principles

Location of Marine Protected Areas

1. Marine Protected Areas will be located taking into account the occurrence and location of existing spatial management arrangements (e.g. existing protected areas and sectoral measures) that contribute to the goals.

Humpback whale. Photo: Dave Paton.

2. The goals should be met with the least number of separate Marine Protected Areas (i.e. a smaller number of larger Marine Protected Areas rather than many small Marine Protected Areas) to maximise conservation outcomes.

Selection

3. The capacity of a Marine Protected Area to mitigate identified threats to conservation values.
4. The occurrence of spatially defined habitats for and/or aggregations of threatened and/or migratory species.
5. The occurrence of ecologically important pelagic features which have a consistent and definable spatial distribution.
6. The occurrence of known small-scale (tens of kilometres) ecosystems associated with the benthic/demersal environment.
7. Relevant available information about small-scale distribution of sediment types and sizes and other geo-oceanographic variables.
8. Occurrence of listed heritage sites (where inclusion in the Marine Protected Area network would improve administration of protection regimes).
9. Socio-economic costs should be minimised.

Design

Once the broad location of Marine Protected Areas has been determined, the following **design principles** should be applied to further refine the size and shape of individual Marine Protected Areas:

10. Individual areas should, as far as practicable, include continuous depth transects (e.g. from the shelf to the abyss).
11. Whole seafloor features (such as geomorphic features) should be included.
12. Features should be replicated wherever possible within the system of Marine Protected Areas (i.e. included more than once).
13. Size and shape orientation should account for inclusion of connectivity corridors and biological dispersal patterns within and across Marine Protected Areas.
14. Boundary lines should be simple, as much as possible following straight latitudinal/ longitudinal lines.
15. Boundary lines should be easily identifiable, where possible coinciding with existing regulatory boundaries.
16. The size and shape of each area should be set to minimise socio-economic costs.

For each area identified as a candidate Marine Protected Area, specific conservation objectives will be set. Area-specific conservation objectives will reflect the four goals. For example, they may relate to the integrity of bioregional characteristics (Goal 1) or of specific large-scale biological features (Goal 3) that the area aims to represent. They

Lord Howe Island Group. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

may also relate to other relevant principles, such as the integrity of habitat important for a threatened species (Principle 4).

To accommodate climate change as far as practicable, design principles and zoning that promote resilience and adaptation will be incorporated, in particular, accommodating latitudinal or longitudinal movement in ecosystem or species distributions and changes in oceanographic features and currents anticipated in response to climate change.

Zoning

Because zoning of Marine Protected Areas (i.e. the allocation of appropriate management regimes to different areas) has the potential to affect the socio-economic costs associated with the establishment of any protected area, the Australian Government recognises the importance of addressing zoning considerations as early as possible in the process. The following **zoning principles** will be applied in developing the regional systems of Marine Protected Areas:

17. Zoning will be based on the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)/the World Conservation Union (IUCN) categories of protection (see box 4.1).
18. The regional Marine Protected Area network will aim to include some highly protected areas (IUCN Categories I and II) in each provincial bioregion.
19. Zoning will be based on the consideration of the threat that specific activities pose to the conservation objectives of each Marine Protected Area.
20. Zoning of Marine Protected Areas will seek to ensure that the conservation objectives of the area are protected, taking into account a precautionary approach to threats as well as the relative costs and benefits (economic, social and environmental) of different zoning arrangements.

Box 4.1 Categories assigned under the EPBC Act for Marine Protected Areas

Under the EPBC Act marine reserves must be assigned to an IUCN category. These IUCN categories are:

- Strict nature reserve (IUCN Ia): Managed primarily for scientific research or environmental monitoring;
- Wilderness area (IUCN Ib): Protected and managed to preserve its unmodified condition;
- National Park (IUCN II): Protected and managed to preserve its natural condition;
- Natural Monument (IUCN III): Protected and managed to preserve its natural or cultural features;
- Habitat/species management area (IUCN IV): Managed primarily, including (if necessary) through active intervention, to ensure maintenance of habitats or to meet the requirements of specific species;
- Protected landscape/seascape (IUCN V): Managed to safeguard the integrity of the traditional interactions between people and nature; and
- Managed resource protected area (IUCN VI): Managed to ensure long-term protection and maintenance of biological diversity with a sustainable flow of natural products and services to meet community needs.

See <www.iucn.org/themes/wcpa/pubs/guidelines.htm>

4.2 Regional specifications for identifying representative Marine Protected Areas in the East Marine Region

4.2.1 Meeting the national goals in the East Marine Region

To achieve the four national goals for the establishment of the National Representative System of Marine Protected Areas in the Region, the following set of regional specifications have been developed, drawing on available biophysical information. Much of this information is available in more detail in this Bioregional Profile or in the associated web-based products.

Specifying Goal 1 – provincial bioregions

The network of representative Marine Protected Areas in the East Marine Region will represent each of the fourteen provincial bioregions (figure 2.4). Each provincial bioregion has been identified because it reflects broad-scale patterns of biodiversity and evolution. In identifying new areas for inclusion in the National Representative System of Marine Protected Areas, priority will be given to areas representative of provincial bioregions with no, or very low levels, of current representation.

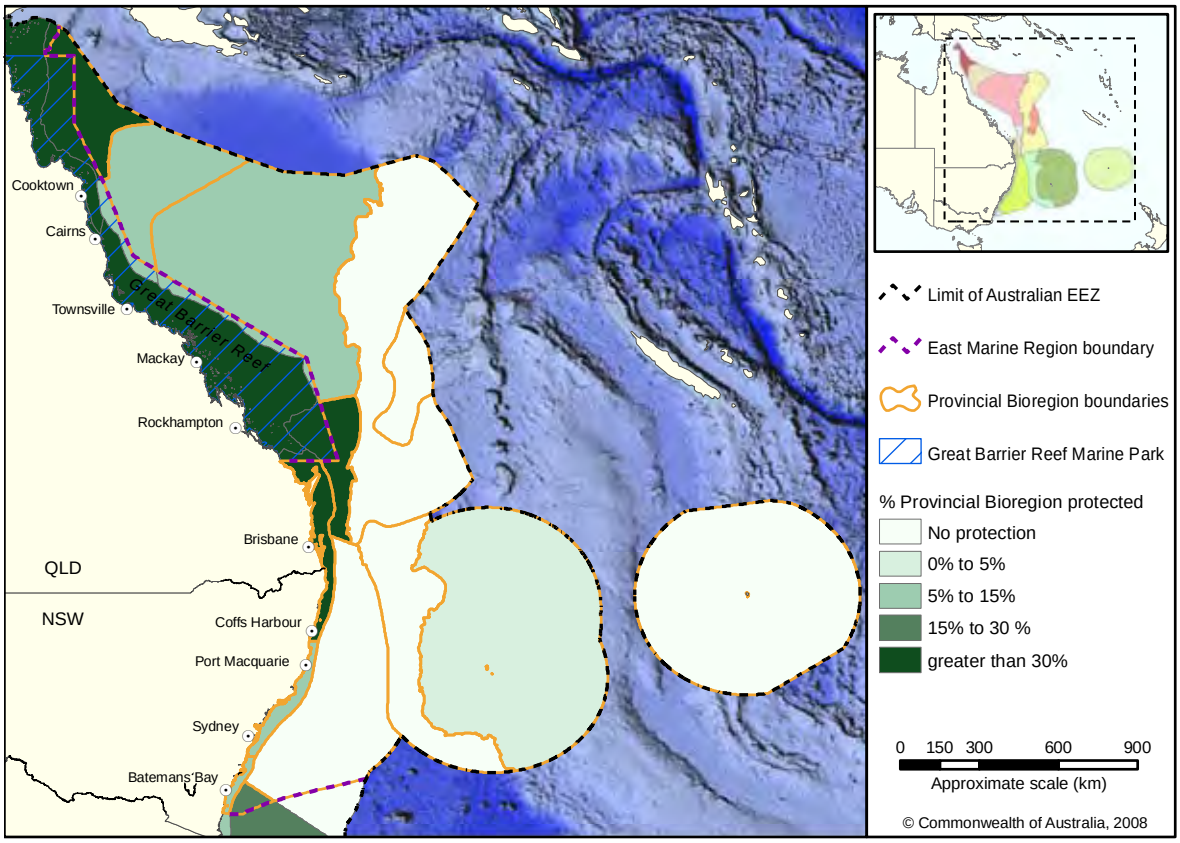
The Region has existing Marine Protected Areas within nine of the fourteen provincial bioregions represented. A number of protected areas have been designated in coastal waters and there are a range of spatial management measures in place, as outlined in the next section of this chapter. See figure 4.1 for information on existing Marine Protected Area coverage in each provincial bioregion.

All of these reserves contribute to the National Representative System of Marine Protected Areas, and several were established primarily to protect specific features or sites and are not necessarily broadly representative of provincial bioregions. The Great Barrier Reef Marine Park includes only the edges of several provincial bioregions in the Coral Sea.

In identifying new areas in the Region suitable for inclusion in the National Representative System of Marine Protected Areas, priority will be given to areas representative of the following provincial bioregions:

- Northeast Transition
- Northeast Province
- Kenn Transition
- Kenn Province
- Central Eastern Province

Figure 4.1 Proportion of provincial bioregions in the East Marine Region protected by existing Marine Protected Areas and other spatial measures for marine or coastal conservation



- Tasman Basin Province
- Lord Howe Province
- Norfolk Island Province

Specifying Goal 2 – depth ranges

Depth is one of the main factors determining distribution of benthic and demersal biological communities. Depth reflects certain basic physical variables – such as light penetration and pressure – that determine what types of animals and plants are found in particular locations.

The Region includes an extensive expanse of abyssal plain, a narrow continental shelf, and chains of seamounts that run north-south, rising up from the abyssal plain. In these deep water systems, water depth is the primary determinant of light penetration. There is a high level of certainty that different types of biological communities will be associated with different depths or with different levels of light penetration.

The range of depths that occur in the East Marine Region will be represented in the network of representative Marine Protected Areas. Water depths in the Region range from 0 – 5 000 m, but the majority of the Region is represented within depths of 1000 – 5000 m (figure 4.2). The Region's provincial bioregions occur mainly in deep waters off the shelf and display significant variation in depth (see depth transects at figure 4.3). The biota (plants and animals) and habitats vary with the significant changes in depth across the Region. More detail on the depth ranges observed for each provincial bioregion is provided in table 4.1.

Specifying Goal 3 – large-scale biological features

The network of Marine Protected Areas will seek to include examples of known large-scale (greater than hundreds of kilometres) key ecological features. This will supplement the habitats and biota included through representing each of the provincial bioregions in the network.

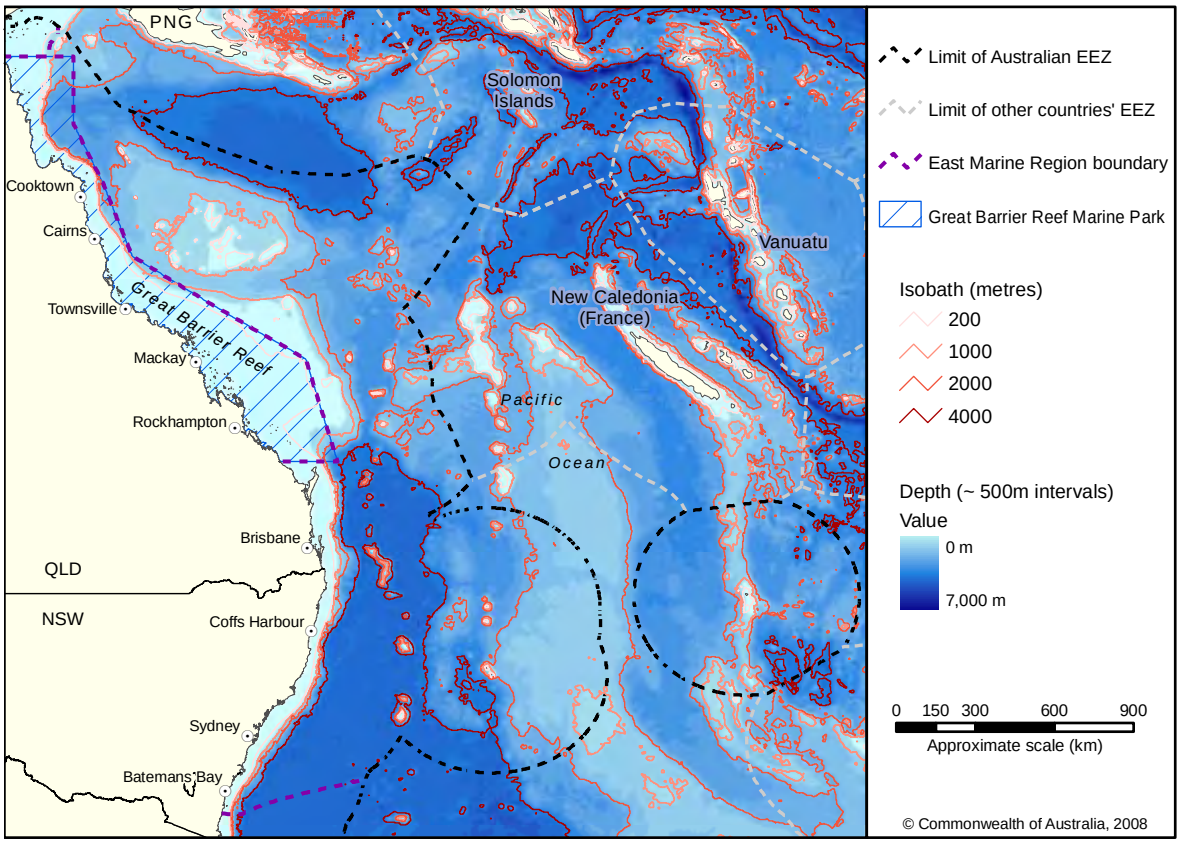
Some examples of the key ecological features that characterise the Region include: temperate (reef) corals and sponges; pelagic squid; large pelagic predators; the east coast humpback whale population; herbivorous fish of coral reefs; the offshore chains of seamounts and rises (including the Tasmantid Seamount Chain, Lord Howe Seamount Chain and Norfolk Ridge); the assemblages of scattered and diverse reefs and cays of the Coral Sea; and canyons of the eastern continental slope and shelf edge rocky reefs. More information about the key ecological features can be found in table 3.1.

The East Australian Current is an important oceanographic feature of the Region. It is characterised by a surface flow of warm nutrient-poor water running from the Coral Sea southwards along the full length of Australia's east coast.

Table 4.1 Provincial bioregion depth information

Provincial bioregion (National Marine Bioregionalisation number)	Total area (km^2)	Percentage of bioregion occurring within the Region	Depth range within the Region (m)	Mean depth within the Region
Cape Province (20)	109 340	57.2	0–4200	2520
Northeast Transition (19)	148 700	89.1	0–4600	2270
Northeast Province (18)	442 870	95.4	0–4700	1750
Kenn Transition (16)	377 130	100	0–4800	3130
Kenn Province (17)	57 420	100	0–2500	1890
Central Eastern Transition (15)	67 150	66.8	180–4800	2100
Central Eastern Shelf Transition (39)	43 030	61.2	1–240	80
Central Eastern Province (12)	266 590	87.7	170–5100	4190
Central Eastern Shelf Province (38)	18 220	79.4	20–240	120
Norfolk Island Province (21)	430 790	100	0–4300	2770
Lord Howe Province (14)	485 350	99.9	0–4500	2340
Tasman Basin Province (13)	156 420	100	120–5100	4420
Southeast Shelf Transition (37)	59 610	7.2	20–240	120
Southeast Transition (11)	241 910	3.6	130–5200	3480

Figure 4.2 Range of water depths across the Region



Typically the current is 100 km wide and 500 m deep travelling at up to 5 knots, and it is the interactions between the East Australian Current, other currents and seafloor features that are largely responsible for the existence of identifiable areas of biological richness. Large scale warm-core eddies, current disruptions around seamounts and reefs, the interfaces between cooler and warmer waters and the action of the current running parallel to the steep continental slope in the southern part of the region are all features that exist at a provincial, or larger, scale.

The high variability in geomorphic features and depths of the Region strongly influence the biological communities that occur on or near the seafloor. There is relatively good biological information on the distribution and extent of communities on the narrow continental shelf, for example the marked transition between tropical and temperate benthic species between Fraser Island and Coffs Harbour. There is less information about the distribution and extent of communities in the deep water systems further offshore and the abyssal plain. The bioregional planning process will provide further opportunities to identify other key ecological features that may be suitable for inclusion within this representative system.

Specifying Goal 4 – seafloor features

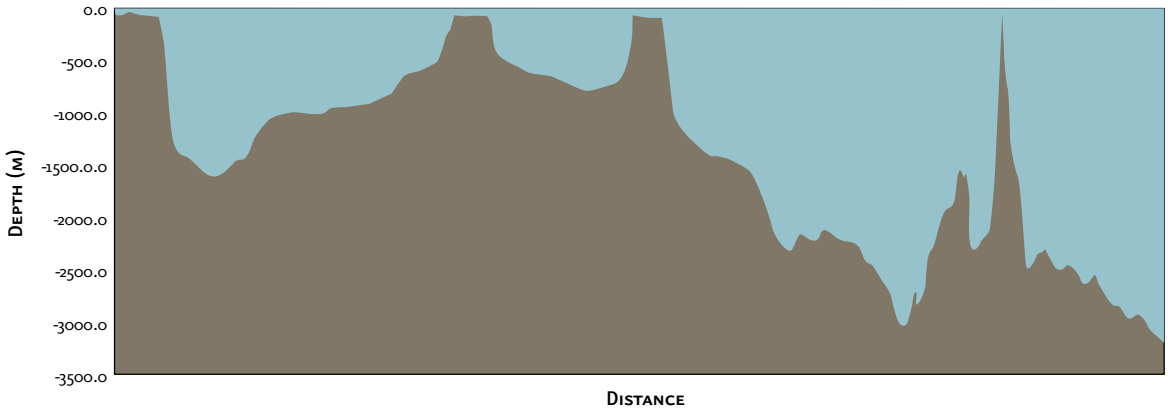
The Region is dominated by very deep expanses of abyssal plain and raised offshore blocks of continental crust. A number of regionally significant seafloor features (geomorphic features), including the offshore chains of seamounts and rises of the Tasman Sea, and the assemblages of scattered and diverse reefs and cays of the Coral Sea, are found in these areas. More information about the regionally significant geomorphic features can be found in table 3.1.

Different biological communities are often associated with different types of seafloor geomorphology. Ensuring that the characteristic features of each provincial bioregion are represented is important in achieving a comprehensive and representative sample of biodiversity within the Marine Protected Area network. 'Seafloor features' here refer specifically to the geomorphic features as defined by IMCRA v.4.0.

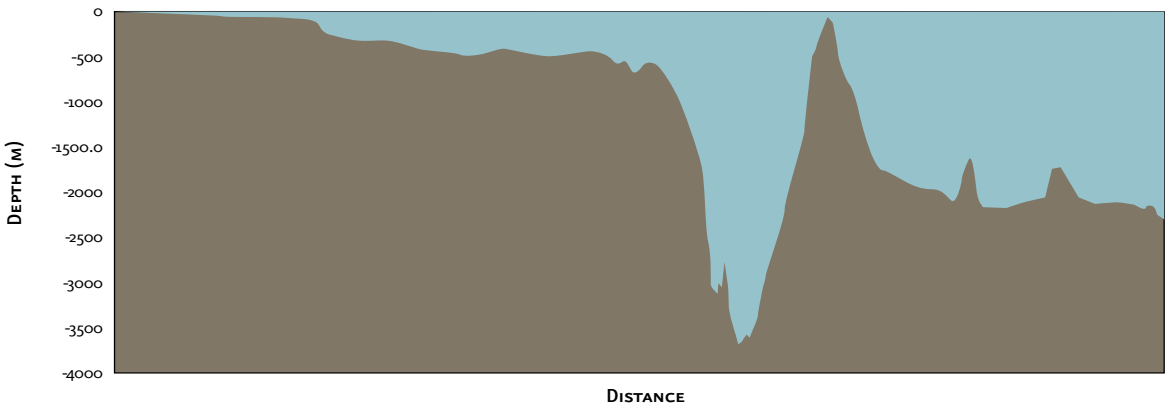
The network of Marine Protected Areas in the Region will include representative examples of the 18 seafloor features identified in the Region. Table 4.2 provides detail on those seafloor features that only occur in one provincial bioregion or at one site within the Region. Table 4.3 provides information on the occurrence and extent of all 18 seafloor features within each provincial bioregion.

Figure 4.3 Depth and elevation transects in the Region

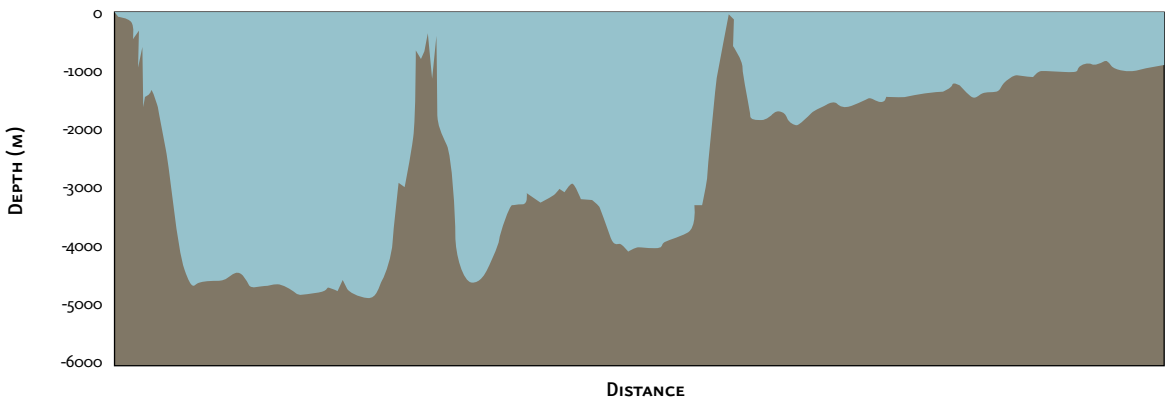
Depth Profile – Cairns through Melish Reef to EEZ boundary



Depth Profile – Coast off Rockhampton through Cato Island to EEZ boundary



Depth Profile – North Solitary Island through Derwent Hunter Seamount and Lord Howe Island to EEZ



Elevation Profile from Bendigo through Mt Kosciusko, through (just south of) Narooma to 100km offshore

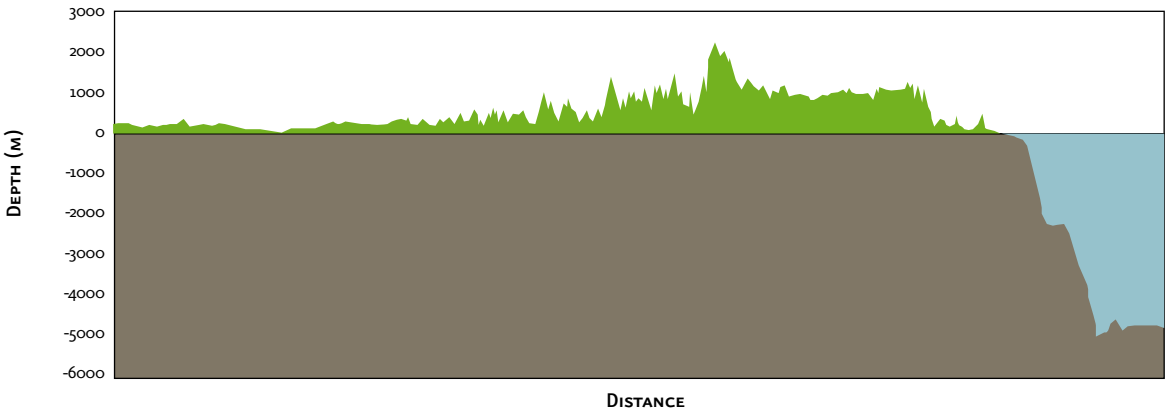


Table 4.2 Seafloor feature with a single occurrence within the Region

Seafloor feature	Provincial Bioregion
Slope, Deep, Escarpment	Cape Province
Trench, Saddle	Northeast Transition
Seamount, Deep, Escarpment	Northeast Province
Shelf, Abyssal Plain, Slope, Canyon, Apron	Kenn transition
Basin, Terrace, Plateau	Kenn Province
Continental Rise, Canyon	Central Eastern Transition
Shelf, Abyssal Plain	Central Eastern Shelf Transition
Shelf, Abyssal Plain, Basin, Terrace, Plateau	Central Eastern Province
Shelf, Abyssal Plain	Central Eastern Shelf Province
Shelf, Abyssal Plain, Ridge, Sill, Bank, Sandbank, Deep, Escarpment	Norfolk Island Province
Ridge, Sill, Trench, Saddle, Basin, Terrace, Plateau	Lord Howe Province
Shelf, Abyssal Plain	Tasman Basin Province
Ridge, Sill, Deep, Escarpment	Southeast Shelf Transition
Shelf, Abyssal Plain	Southeast Transition

Table 4.3 Provincial bioregion seafloor features

Provincial bioregion (National Marine Bioregionalisation number)	Seafloor features	Total area of seafloor feature in provincial bioregion (km²)	Per cent area of seafloor feature occurring in the Region
Cape Province (20)	slope	39 120	17.64
	basin	2090	0.57
	canyon	10	0.10
	deep/hole/valley	4890	26.31
	plateau	6450	0.63
	reef	950	5.14
	ridge	170	15.20
	saddle	580	0.61
	terrace	180	0.31
	trench/trough	7930	9.65
		62 370	
Northeast Transition (19)	slope	11 970	0.17
	rise	10 600	41.03
	trench/trough	15 580	18.96
	basin	19 680	5.37
	reef	570	2.87
	canyon	750	7.65
	ridge	440	39.67
	pinnacle	50	2.38
	plateau	82 260	8.00
	apron/fan	790	29.71
		142 690	

Table 4.3 Provincial bioregion seafloor features

Provincial bioregion (National Marine Bioregionalisation number)	Seafloor features	Total area of seafloor feature in provincial bioregion (km²)	Per cent area of seafloor feature occurring in the Region
Northeast Province (18)	slope	63 060	33.68
	rise	2200	7.52
	deep/hole/valley	480	2.53
	trench/trough	48 840	59.44
	basin	68 230	18.63
	reef	18 410	91.98
	canyon	2580	26.22
	knoll/abyssal hills/ mountains/peak	310	3.14
	seamount/guyot	1310	3.11
	pinnacle	370	14.76
	plateau	176 100	17.13
	saddle	8660	9.15
	apron/fan	1500	56.53
	terrace	39 110	67.04
		431 160	
Kenn Province (17)	basin	60	0.02
	pinnacle	20	0.67
	plateau	55 580	5.41
	seamount/guyot	1730	4.14
		57 390	
Kenn Transition (16)	slope	3320	1.49
	rise	5380	18.43
	abyssal plain/deep ocean floor	60 380	16.31
	deep/hole/valley	13 010	68.93
	basin	43 580	11.90
	canyon	110	1.08
	knoll/abyssal hills/hills/ mountains/peak	600	6.12
	seamount/guyot	10 570	25.08
	pinnacle	170	6.75
	plateau	169 110	13.62
	saddle	32 110	33.94
	apron/fan	370	13.76
	terrace	2730	4.69
	no data	64 740	
		406 180	
Central Eastern Transition (15)	slope	35 210	11.65
	rise	9630	33.01
	canyon	600	6.08
	terrace	8780	15.04
		54 220	
Central Eastern Shelf Transition (39)	shelf	18 960	<0.01
	slope	4090	0.35
	canyon	30	5.56
	terrace	3250	<0.01
		26 330	

Table 4.3 Provincial bioregion seafloor features

Provincial bioregion (National Marine Bioregionalisation number)	Seafloor features	Total area of seafloor feature in provincial bioregion (km²)	Per cent area of seafloor feature occurring in the Region
Central Eastern Shelf Province (38)	no data	11 250	
	terrace	2060	3.84
		13 310	
Central Eastern Province (12)	slope	60 260	25.87
	abyssal plain/deep ocean floor	169 540	45.81
	canyon	3820	0.43
	knoll/abyssal hills/ mountains/peak	60	39.41
	pinnacle	860	0.64
	terrace	1140	34.96
		235 680	3.52
Tasman Basin Province (13)	abyssal plain/deep ocean floor	136 610	36.91
	knoll/abyssal hills/hills/ mountains/peak	1120	11.53
	seamount/guyot	18 480	43.86
	pinnacle	210	8.41
		156 420	
Lord Howe Province (14)	deep/hole/valley	410	2.18
	basin	65 100	17.77
	knoll/abyssal hills/ mountains/peak	800	8.21
	ridge	220	20.25
	seamount/guyot	5450	12.95
	plateau	389 390	37.88
	saddle	23 470	24.80
		484 840	
Norfolk Island Province (21)	shelf	650	1.87
	slope	31 300	14.11
	banks/shoals	710	99.57
	deep/hole/valley	10	0.05
	trench/trough	9830	11.96
	basin	167 450	45.73
	canyon	630	6.34
	knoll/abyssal hills/hills/ mountains/peak	6790	70.04
	ridge	280	24.88
	seamount/guyot	4580	10.86
	pinnacle	790	32.05
	plateau	178 030	17.32
	saddle	29 800	31.49
		430 850	
Southeast Shelf Transition (37)	shelf	3930	
	slope	340	
		4270	
Southeast Transition (11)	slope	3910	1.76
	abyssal plain/deep ocean floor	3600	0.97
	canyon	1260	12.76
	knoll/abyssal hills/hills/ mountains/peak	30	0.31
		8800	

4.2.2 Applying the national principles in the East Marine Region

This section outlines considerations relevant to the regional application of the location, selection, design and zoning principles as listed in section 4.1. In any given Marine Region, there may be different options for Marine Protected Areas that meet the four goals for the establishment of a representative network.

Note that only Principles 1-9 that require a regional specification (or input of regionally specific data) are considered below.

Location of Marine Protected Areas
In developing options that meet the four goals, the following principles will be applied.

Principle 1 – existing spatial management measures
In any given Marine Region, there may be a number of areas that meet the four goals for the establishment of a representative network. Consistent with the goals, the first step in determining the approximate location of suitable Marine Protected Areas will be to identify the occurrence, extent and purpose of existing spatial management arrangements (existing protected areas, sectoral measures etc.) and assess their capacity to contribute to or compliment a representative network in the Region.

Spatial management arrangements in the Region and adjacent coastal areas include mechanisms that may contribute to the development of a Marine Protected Area network. Examples of these existing arrangements are provided in table 4.4.

Catchment processes have previously been identified as important ecosystem drivers within the Region. Land-based spatial management arrangements including National Parks, Indigenous Protected Areas, Ramsar-listed and nationally important wetlands may therefore also contribute to biodiversity conservation and need to be considered during the development of a Marine Protected Area network. These spatial management arrangements may seek to protect fish breeding habitat such as mangroves or marine turtle nesting beaches.

Some of the above arrangements have access restrictions, while others are multiple use areas with restrictions on take of wildlife, disturbance of habitat, or the type of fishing gear that can be used.

There are a number of spatial considerations which do not contribute to biodiversity conservation, but may also be taken into account when considering Marine Protected Areas. These include designated sea-dumping sites, shipping arrangements, oil and gas arrangements, and gas pipelines and cables. Some of these such as chemical dump sites may be inconsistent with Marine Protected Area placement; others may only be inconsistent with certain categories of Marine Protected Areas.

Principle 2 – small number of large marine parks
While small Marine Protected Areas can sometimes be justified to protect particular species, habitat or heritage sites, representative Marine Protected Areas are designed to include examples of multiple different environments and ecological processes. While no area of ocean, however large, can be said to be truly self-sustaining, larger areas have greater resilience to changes.

Selection
Where different options that meet the goals exist, the following selection principles should be applied in selecting areas suitable for inclusion in the National Representative System of Marine Protected Areas.

Principle 3 – threats to the Region's conservation values
Current and future activities may pose a threat to the Region's marine environment and conservation values. A key function of Marine Bioregional Plans is the identification of potential threats, so that decision-makers are aware of long-term implications for management.

An analysis of the threats to the key ecological features and protected species identified for the Region (see chapters 2 and 3, and appendices C and D) will take place during the next stage of the planning process. Those key ecological features and places of particular importance to protected species that are subject to threats, and for which spatial protection is thought to provide the best option, will be considered for inclusion in the proposed network of Marine Protected Areas.

Principle 4 – habitat and aggregation areas for threatened/migratory species
While there are no habitats listed in the Register of Critical Habitats under the EPBC Act, the Region includes and abuts coastal breeding, feeding, nursery and aggregation sites of national and international significance for birds, marine turtles, sharks, seals and whales. Table 3.3 lists known areas in or adjacent to the Region that are of importance to threatened or migratory species. Further details on habitats and sites used by the protected species known to occur in the Region are included in the table of Nationally Protected Species of the Region (appendix C) and Protected Species Group Report Cards (appendix D).

Table 4.4 Existing spatial management arrangements in the Region and adjacent coastal areas

Description	Location	Management
Protected Areas		
Coringa-Herald National Nature Reserve, and Ramsar listed wetlands	Located within the Coral Sea Islands Territory, 400 km east of Cairns, covering an area 8852 km².	Managed by the Commonwealth Government to maintain the ecological processes and systems and to protect the habitats and biodiversity of the Reserves from the pressures associated with human use.
Lihou National Nature Reserve	Located within the Coral Sea Islands Territory, 400 km east of Cairns, covering an area 8428 km².	Managed by the Commonwealth Government to maintain the ecological processes and systems and to protect the habitats and biodiversity of the reserves from the pressures associated with human use.
Solitary Islands Marine Park and Reserve	Located 600 km north of Sydney between Coffs Harbour and Plover Island, covering an area 870 km².	Managed jointly by the NSW and Commonwealth Governments to maintain ecological processes and systems and to protect the habitats and biodiversity of the Solitary Islands region.
Elizabeth and Middleton Reefs Marine National Nature Reserve, and Ramsar listed wetlands	Located within the Coral Sea Islands Territory, 600 km east of Coffs Harbour, covering an area 1877 km².	Managed by the Commonwealth Government to maintain ecological processes and systems and to protect the habitats and biodiversity of the Reserve.
Lord Howe Island Marine Park, and World and National Heritage listed sites	Located in the Tasman Sea, 700 km north-east of Sydney, covering an area 3005 km².	Managed jointly by the NSW and Commonwealth Governments to protect the seamount system and its conservation values associated with marine biodiversity, habitats and ecological processes.
Cod Grounds Commonwealth Marine Reserve	Located 7 km off Laurieton in NSW, covering 3 km².	Managed by the Commonwealth Government to protect the grey nurse shark and its habitat.
Great Barrier Reef Marine Park, and World and National Heritage listed sites	Located along the QLD coastline from the tip of Cape York peninsula to near Bundaberg, covering almost 350 000 km².	Managed jointly by the Commonwealth and QLD Governments for the long-term protection, ecologically sustainable use, understanding and enjoyment of the Marine Park.
Norfolk Island National Heritage listed sites	Located in the Territory of Norfolk Island 1700 km east of Sydney in the South Pacific Ocean, covering 6.5 km².	Managed by the Commonwealth Government for the protection and conservation of the Reserve.
Great Sandy Marine Park, including the Fraser Island World and National Heritage listed sites (QLD)	Located in coastal waters of QLD from Baffle Creek in the north to Double Island Point in the south, including Fraser Island and covering 8400 km².	Managed by the QLD Government for the conservation and reasonable use of significant marine natural resources.
Moreton Bay Marine Park (QLD)	Located in coastal waters of QLD from Caloundra to the southern tip of South Stradbroke Island, covering 3400 km².	Managed by the QLD Government for the conservation and reasonable use of significant marine natural resources.
Batemans Marine Park (NSW)	Located in coastal waters of NSW from Brush Island in the north to Wallaga Lake in the south, covering 850 km².	Managed by the NSW Government to conserve marine biodiversity while allowing sustainable recreational and commercial activities in the Park.
Cape Byron Marine Park (NSW)	Located in coastal waters of NSW from Brunswick Heads in the north to Lennox Head in the south, covering 220 km².	Managed by the NSW Government to conserve marine biodiversity while allowing sustainable recreational and commercial activities in the Park.

Table 4.4 Existing spatial management arrangements in the Region and adjacent coastal areas

Description	Location	Management
Jervis Bay Marine Park (NSW)	Located in coastal waters of NSW from Kinghorn Point in the north to the northern side of Sussex Inlet in the south, covering 214.5 km².	Managed by the NSW Government to conserve marine biodiversity while allowing sustainable recreational and commercial activities in the Park.
Port Stephens–Great Lakes Marine Park (NSW)	Located in coastal waters of NSW from near Forster in the north to the northern end of Stockton Beach in the south, covering 980 km².	Managed by the NSW Government to conserve marine biodiversity while allowing sustainable recreational and commercial activities in the Park.
Fisheries Management Areas		
Fish Habitat Areas (QLD) Various	There are 73 declared Fish Habitat Areas along the Queensland coast adjoining the Region, covering 8530 km².	The Queensland Department of Primary Industries and Fisheries manage Fish Habitat Areas. The areas are designated 'multiple use' and aim to protect fish habitat from disturbance, whilst allowing for fishing and boating.
Other Management Areas		
Aquatic Reserves (NSW) Various	There are 12 declared aquatic reserves along the NSW coast adjoining the Region.	Managed by the NSW Government to protect marine biodiversity.

Principle 5 – ecologically important pelagic features
Seven of the nine key ecological features of the Region (table 3.1) encompass pelagic environments (i.e. open waters) and have a consistent and definable spatial distribution. These include the East Australian Current; offshore chains of seamounts and rises (Tasmantid seamount chain, Lord Howe seamount chain, Norfolk ridge); canyons of the eastern continental slope and shelf edge rocky reefs; herbivorous fish of the coral reefs; pelagic squid; large pelagic predators (marlin, sharks, tuna, billfish); and the east coast humpback whale population. In accordance with Principle 5, these will be considered in selecting Marine Protected Areas in those instances where multiple options exist that meet the four national goals.

Principle 6 – small-scale (tens of kilometres) benthic/demersal ecosystems
Ecosystem structure and functioning have been considered and described in chapters 2 and 3 at broad regional and bioregional scales. Finer-scale data and information, such as information on meso-scale bioregions and the distribution and extent of biological communities and habitats, will be considered to explore options that meet the four national goals.

The distribution and extent of some common and important communities has been relatively well described, for example: coral reefs and cays in the Coral Sea; benthic communities on Elizabeth and Middleton seamounts, and Lord Howe and Norfolk Islands; and continental shelf communities throughout the Region.

Principle 7 – small-scale distribution of sediment types and sizes
Scientists have found that sediment type and size strongly influence the species and communities that are found on and near the seafloor within the Region. In the deeper parts of the Region, the marine organisms associated with different sediments are to a large extent unknown.

It is reasonable to expect that by including multiple and diverse sediment types within a Marine Protected Area, a larger variety of organisms will be protected. In those instances where different options to meet the four national goals exist, sedimentology maps and data will be used during the selection of candidate Marine Protected Areas, aiming to include areas that cover a broader range of sediment types.

Principle 8 – listed heritage sites
Sites of particularly high conservation or heritage value should be incorporated into, and managed as part of, the representative network to avoid complex and overlapping measures applying to particular places.

Table 4.5 Active native title determination claimant applications as per Schedule (Federal Court) as at 27 August 2008

Native title determination claimant applications that intersect the East Marine Region		
Federal Court No	**NNTT No**	**Name**
QUD6040/01	QC01/42	Torres Strait Regional Sea Claim
QUD16/06	QC06/4	Butchulla Land and Sea Claim
NSD6034/98	NC96/16	Bandjalang People 1
Native title determination claimant applications that include the sea adjacent to the East Marine Region		
Federal Court No	**NNTT No**	**Name**
QUD6010/98	QC95/2	Quandamooka
QUD6131/98	QC97/21	Darumbal People
QUD6140/98	QC97/30	Butchulla People
QUD6155/98	QC97/48	Kalpowar Holdings
QUD6223/98	QC98/37	Yuibera People
QUD6023/99	QC99/24	Gia People
QUD6016/98	QC99/38	Kuuku Yau 1
QUD6011/01	QC01/13	Barada Barna Kabalbara and Yetimarla People 3
QUD6023/01	QC01/25	Barad Barna Kabalbara and Yetimarla People 4
QUD6026/01	QC01/29	Port Curtis Coral Coast
QUD6003/03	QC03/3	Djiru People 2
QUD6014/03	QC03/15	Jagera People 2
QUD97/05	QC05/9	Gurambilbarra People
QUD169/05	QC05/10	Wondunna Clan Badtjala People
QUD346/06	QC06/10	Gold Coast Native Title Group
NSD6010/98	NC95/1	Byron Bay Bundjalung People 1
NSD6013/98	NC95/4	Kattang People – Traditional Owners of Saltwater 1
NSD6014/98	NC95/5	Kattang People – Traditional Owners of Saltwater 2
NSD6034/98	NC96/16	Bandjalang People 1
NSD6052/98	NC96/38	The Yaegl People
NSD6054/98	NC96/41	Gumbaynggirr People
NSD6061/98	NC97/8	Darug Tribal Aboriginal Corporation
NSD6104/98	NC98/15	Gumbaynggirr People
NSD6107/98	NC98/19	Bandjalang People 2
NSD6020/01	NC01/8	Byron Bay Bundjalung People 3

The Lord Howe Island National Park and Norfolk Island are heritage listed sites that occurs in the Region, and the Great Barrier Reef Marine Park and Fraser Island National Park are heritage listed sites that occur adjacent to the Region.

Principle 9 – socio-economic factors

The Australian Government is seeking to minimise any socio-economic costs associated with the displacement of activities and resource access that might result from the establishment of Marine Protected Areas. The potential impacts on current users will be considered throughout the process, and particularly during the selection stage and at the design stage. This Bioregional Profile provides a snapshot of information about the key commercial and recreational activities that take place in the Region. Further detailed data on distribution, intensity and value of marine uses and resources will be gathered in consultation with State Government agencies and relevant stakeholders throughout the process.

Socio-economic aspects of establishing new Marine Protected Areas will need to include consideration of any native title rights and interests (see Section 227 of the *Native Title Act 1993*). Coastal Indigenous peoples of the Region consider their sea country to encompass waters from the coastline to the horizon and sometimes beyond

Gorgonian fan and diver, Coral Sea. Photo: Mike Ball.

(see appendix B for a description of the native title regime in Australia). There are 27 active native title determination claimant applications as per the Schedule (Federal Court), 24 of which have been entered onto the Register of Native Title Claims. Three of the registered native title determination claimant applications include Commonwealth waters of the East Marine Region, and the other registered and active native title determination claimant applications include sea[9] that is adjacent to the East Marine Region.

4.3 Process for establishing new Commonwealth Marine Reserves in the East Marine Region

The identification of new Marine Protected Areas in the Region will occur during the next stages of the marine bioregional planning process (see chapter 6).

Step 1 – A proposed Marine Protected Area network will be developed by the Department of the Environment, Water, Heritage and the Arts in accordance with the national goals and principles and regional specifications outlined in section 4.2. During development, stakeholders will be consulted by the Department in order to ensure the Department has accurate and comprehensive details of the current uses and to help ensure that the impact of proposed Marine Protected Areas on current users will be minimised. The Department will also seek expert scientific advice to ensure the proposed network is underpinned by all relevant data and best available knowledge.

Step 2 – The proposed Marine Protected Area network will be agreed by Government and released in a Draft Plan for a three-month period of statutory public consultation. During this time, the Department will make available all relevant data and will facilitate information sessions to assist members of the public who wish to make a representation to the Government in relation to the proposed Marine Protected Area network or other aspects of the Draft East Marine Bioregional Plan.

Step 3 – After consideration of public submissions, advice from the Department, and agreement by the Government, the Final Plan will be released. It will contain a network of candidate Marine Protected Areas to be declared as Commonwealth marine reserves in accordance with the relevant sections of Part 15 of the EPBC Act.

Chapter 6 provides further information about how the marine bioregional planning process (including identification of protected areas) will unfold in the Region following the release of this Bioregional Profile.

[9] Sea includes any waters beyond the Australian coastline (mean high water mark).

Key references and further reading

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Map data

Figures 4.1 and 4.2

Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts
COPYRIGHT Commonwealth of Australia, 2008.
Projection: Geographics, Datum: GDA94.
Data sources:
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Ships bow – about 3,000 ship movements occur every year at the Port of Newcastle. Image courtesy of Newcastle Port Corporation.

Chapter 5 Human Activities in the East Marine Region

Planning for long term ecologically sustainable use in the East Marine Region requires an understanding of human interactions with the marine environment. Chapter 5 provides a broad overview of the nature and extent of human activities that take place within and adjacent to the Region. It provides background material that will assist in the next stage of the planning process. It is not intended to provide a detailed information base for assessing the socio-economic costs and benefits of conservation measures that may be proposed in developing the East Marine Bioregional Plan. In addition to finer scale information, the assessment will also require consultation with stakeholders. More information on how the East Marine Bioregional Plan will be developed is provided in chapter 6.

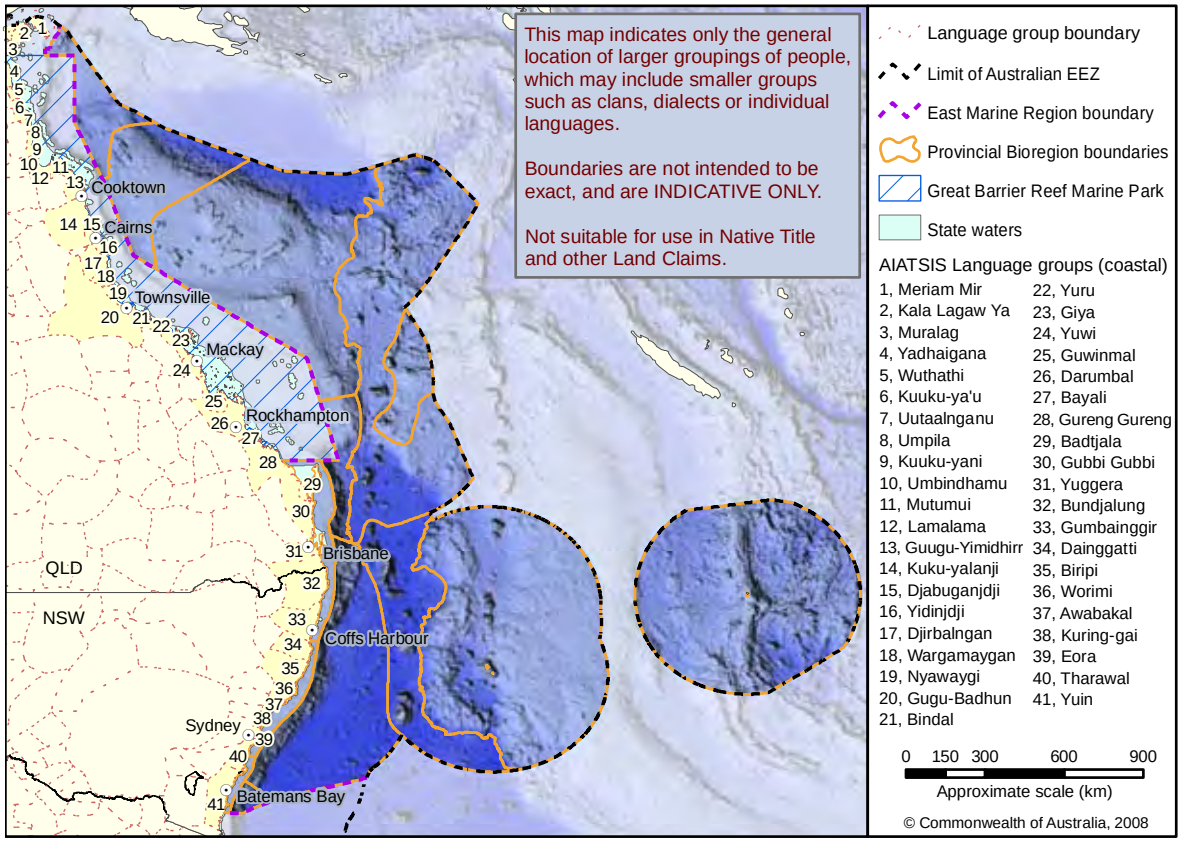
Encompassing some 2.4 million square kilometres, the East Marine Region is the largest in Australia and is adjacent to the most heavily populated coastline in Australia. Human settlement in and adjacent to the Region ranges from a tiny four-person scientific outpost on the remote Willis Island in the Coral Sea through to the large metropolises of Brisbane and Sydney with resident populations in the millions.

Cities like Wollongong, Newcastle, the Gold Coast, Mackay and Cairns are regional hubs for numerous coastal towns and villages. On Cape York Peninsula in far north Queensland there are a number of small remote communities, and far from the mainland shore, Norfolk Island and Lord Howe Island have their own small townships.

The pattern of human use in the Region is shaped by many factors including the extreme isolation of much of the Region, the presence of major population centres on the adjacent coastline and the varied physical and biological characteristics of the Region. The majority of human activity in the Region occurs closest to the major population centres in New South Wales and south-east Queensland. The most extensive human activities that occur in the offshore environment are commercial fishing and shipping. Closer to shore, commercial fishing and shipping activity increases and tourism and recreational use of the Region becomes more significant.

Further more detailed information on the Region is contained in the reports and other web-based resources that are available on the Department's website at www.environment.gov.au/coasts/mbp/east/.

Figure 5.1 Indigenous language groups adjacent to the East Marine Region



Boats moored in a marina on the south coast of New South Wales. Photo: Arthur Mostead and the Department of the Environment, Water, Heritage and the Arts.

5.1 The human dimension: an overview

The Indigenous People – The First Settlers in the Region

Dreamtime stories of the Indigenous people tell of their ancestors' arrival into the Region from across the sea between 20,000 and 40,000 years ago. Physical evidence found at cultural heritage sites on the coastline support this, with radio-carbon dating demonstrating that areas around Newcastle and Wollongong were occupied by the Indigenous people at least 20,000 years ago (Barnett and Ceccarelli 2007).

Over 60 Indigenous tribal groups have been identified along the coastline adjacent to the Region. These people have a spiritual connection to the Region through cultural traditions, ancient sites of cultural importance and enduring relationships with marine species such as whales, turtles and dolphins.

The Indigenous people have a long history of utilising natural marine resources in and adjacent to the Region, particularly as a source of food. Natural resource use and management is a part of the traditional culture of the Indigenous people and is closely intertwined with their spirituality.

The long history of the Indigenous people has seen the passing of ice ages and the rise and fall of the sea. During the last ice age (approximately 10 000-18 000 years ago), sea level was significantly lower than it is today. The Great Barrier Reef lagoon was exposed land, as were other sections of the continental shelf along the coastline. According to Indigenous oral tradition, sacred sites that were once on dry land were flooded as the ice age ended and sea levels rose about 6000 years ago. These flooded sites remain important to the Indigenous people (Barnett and Ceccarelli 2007).

Further discussion of Indigenous resource use in the Region and the Indigenous people's connection to the marine environment follows in section 5.3.

European Settlement in the Region

Lieutenant James Cook arrived on the east coast of Australia aboard *HMS Endeavour* in 1770 and named the land New South Wales. The first European settlement on the coastline was at Port Jackson on Sydney Cove, settled by Captain Arthur Phillip and the First Fleet in 1788 (Culture and Recreation Portal 2008).

After establishing the colony, Arthur Phillip immediately dispatched *HMS Supply* to start a new penal colony on Norfolk Island (discovered by James Cook in 1774). En route to the island the commander of the *Supply*, Lieutenant Henry Lidgbird Ball, discovered Lord Howe Island. The *Supply* carried convicts and free men under the command of Lieutenant Phillip Gidley King who established the first penal colony on Norfolk Island in March, 1788. It was not

Table 5.1 Major population centres adjacent to the East Marine Region

New South Wales		Queensland	
City	**Population**	**City**	**Population**
Sydney	4 284 379	Brisbane	1 820 400
Newcastle	288 732	Gold Coast	472 279
Wollongong	234 482	Townsville	128 808
Port Macquarie	39 219	Cairns	98 349
Nowra	27 478	Mackay	66 874
Lismore	27 069	Rockhampton	60 827
Coffs Harbour	26 353	Bundaberg	46 961
Batemans Bay	10 845	Hervey Bay	41 225
Ulladulla	10 298	Gladstone	28 808

Source (Australian Bureau of Statistics 2008a)

until 1834 that a permanent settlement was established on Lord Howe Island (Lord Howe Island Tourism Association 2008, Norfolk Island Tourism 2008).

The colony of Queensland separated from the colony of New South Wales in 1859. Moreton Bay Settlement had been established as a penal colony in 1824, and was later moved to the future site of Brisbane. Free settlers first moved into the area in 1838 (Culture and Recreation Portal 2008).

The East Marine Region today

Today, the waters in and around the Region have a complex pattern of use that has formed around our history of trade and settlement and the unique marine environment of the Region. The uses and activities that have been examined in this report include:

- commercial fishing
- recreational and charter fishing
- tourism
- ports and shipping
- border protection
- offshore oil and gas
- offshore mineral exploration
- aquaculture
- sea dumping
- submarine cables
- emerging industries such as biodiscovery and renewable energy
- Indigenous activities

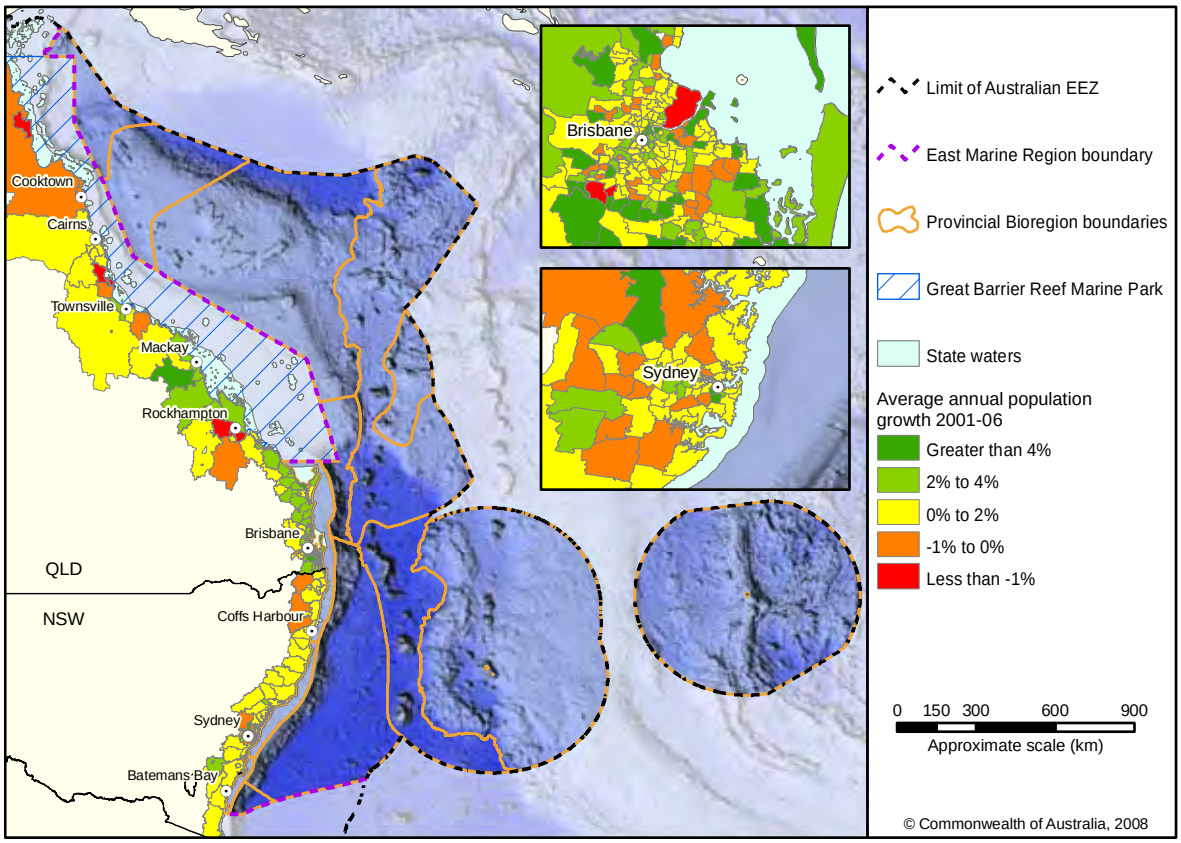
These activities directly affect the socio-economic character of the Region, are activities of national interest, or are uses that may be of significance in the future.

Population in the coastal areas adjacent to the Region is concentrated around the capital cities of Sydney and Brisbane with Sydney being home to 4.3 million people and Brisbane to 1.8 million. Other major population centres include the Shoalhaven (including Batemans Bay, Ulladulla and Nowra), Wollongong, Newcastle, Port Macquarie, Coffs Harbour and Lismore in New South Wales and the Gold Coast, Hervey Bay, Bundaberg, Gladstone, Rockhampton, Mackay, Townsville and Cairns in Queensland (Australian Bureau of Statistics 2008b).

These cities have generally formed around industry and tourism. Many regional cities such as Gladstone and Mackay were established to support the mining and agricultural industries inland and function as ports for the export of resources, particularly coal. Other cities, such as Newcastle and Wollongong, support industries such as steel works and foundries that process raw materials and export finished products. Many of these ports have a history of commercial fishing and others, such as Cairns and the Gold Coast, are centres for tourism.

In the period 2001–2006 the most significant areas of national population growth outside of the capital cities were along the coasts of Australia. Queensland in particular has experienced a large growth in coastal population most notably in the areas around the Gold Coast, Maroochy, Caloundra, Cairns and Rockhampton. In New South Wales, substantial coastal growth was experienced in the Tweed, Newcastle, Hastings and Nowra regions (see figure 5.2) (Australian Bureau of Statistics 2008b).

Figure 5.2 Average annual population growth 2001- 2006



Trawling in the Southern and Eastern Scalefish and Shark Fishery, off Bermagui. Image courtesy of the Australian Fisheries Management Authority.

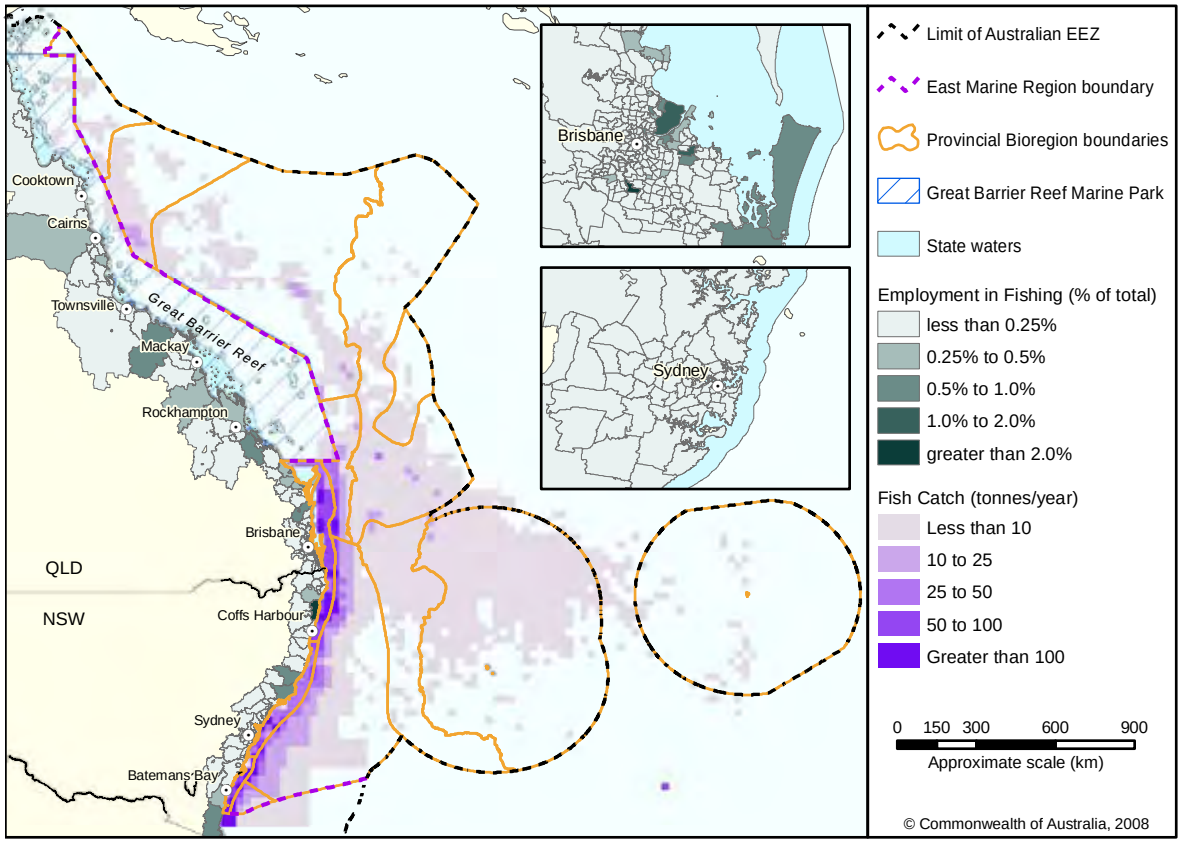
In 2006 more than half of Australia's Indigenous population resided in Queensland and New South Wales with an estimated 28.3% (146,400 people) living in Queensland and 28.7% (148,200 people) living in New South Wales. Indigenous people formed an estimated 3.6% of Queensland's total population and 2.2% of New South Wales' population, but in far north Queensland an estimated 14% of the population were of Indigenous descent. Over a third of Australia's Indigenous total population lives in major coastal cities (Australian Bureau of Statistics 2007c, Australian Bureau of Statistics 2007b, Australian Bureau of Statistics 2007a).

5.2 Marine activities

5.2.1 Commercial fishing

The East Marine Region includes 18 commercial fisheries – nine managed by the Australian Government, six managed by the Queensland Government and three by the New South Wales Government (Moore et al. 2007). Given that the location of a fishery is determined by the presence of the target stock rather than by the location of political boundaries, many fisheries cross the borders of several jurisdictions. Under the terms of the Offshore Constitutional Settlement (OCS) the governments of Australia have

Figure 5.3 Annual fish catch tonnage in the East Marine Region and commercial fishing industry employment in adjacent communities



agreed to a sharing of fisheries management responsibilities which has resulted in the Queensland and New South Wales governments managing fisheries that are partly within Commonwealth waters (Department of Agriculture Fisheries and Forestry 2006).

In Queensland, commercial fishing is managed by the Department of Primary Industries and Fisheries under the *Fisheries Act 1994*. In New South Wales it is managed by the Department of Primary Industries under the *Fisheries Management Act 1994*. Commonwealth fisheries are managed by the Australian Fisheries Management Authority under the *Fisheries Management Act 1991*.

The *Environment Protection and Biodiversity Conservation Act 1999* strengthens the role of the Australian Government in promoting ecologically sustainable management of fisheries and assessing their environmental performance, including:

- the strategic assessment of fisheries under Part 10 of the Act (note that only Commonwealth fisheries require a Part 10 assessment);
- assessments relating to impacts on protected marine species under Part 13 of the Act; and
- assessments for the purpose of export approval under Part 13A of the Act (Commonwealth of Australia 2007b).

Commercial fishing effort in the Region is heavily concentrated along the New South Wales and southern Queensland coastlines. Activity in the deeper waters of the Region is widespread although much less intensive than in areas closer to shore. Figure 5.3 shows the distribution of catch tonnage throughout the Region.

In 2006, fisheries of the Region landed more than 32 000 tonnes of seafood estimated to have a Gross Value of Production (GVP) of approximately $130 million (Moore et al. 2007)[10]. GVP is a measure of the annual value of harvested seafood at the point of landing and is generally used as the primary economic indicator for the industry (ABARE 2007b). Table 5.2 compares the GVP of the Region's fisheries against some other primary industries in Australia.

It should be noted that although GVP is used as an economic indicator for many primary industries, it does

[10] Most jurisdictions are required to guarantee the confidentiality of log book data supplied by fishermen. This is known as the "Five Boat Rule". In cases where less than five boats contribute to any given statistic, that figure can not be reported in the public domain to ensure that it can not be attributed to specific fishing boats and their operators. The consequence of this requirement is that some quoted fisheries statistics are under-represented. As a result, all Australian fisheries statistics should be considered as approximations unless specifically stated otherwise.

Fishing boat. Image courtesy of the Department of Fisheries.

Table 5.2 Gross Value of Production – Primary Industry Comparison

East Marine Region Commercial Fisheries (combined)	Western Australian Rock Lobster Fishery	Sugar Cane	Salt	Bananas	Capsicums and chillies (Queensland)	Zinc
$130m	$292m	$1.02 b	$237m	$270m	$80m	$3.8b

Source: (ABARE 2007a, Australian Banana Growers Council Inc 2008)

not represent the overall contribution of these industries to the Australian economy. Although current and accurate figures are not available, based on 2002–03 data, the Allen Consulting Group (2004) estimated that the direct and indirect contribution of the commercial fishing industry to the national economy was approximately $4 billion. This figure includes contributions through the purchase of fuel and equipment and supporting onshore industries such as fish markets and canneries and other related businesses.

Data on the costs and net returns of the Region's fisheries is patchy and incomplete and is subject to a number of external influences such as world seafood market prices and fluctuations in the value of the Australian dollar against major currencies. However, available data, the high level of latency and low GVP, suggest that fisheries in the Region generally appear to have either a low or negative return on investment (ABARE 2007b, Moore et al. 2007, Newton et al. 2007).

Over the past decade, the commercial fishing industry in the Region has been characterised by an overall decline in catch tonnage and value and a high rate of latency (permitted effort or allocated catch that is not being used). Recent Government licence buy-back and structural adjustment schemes have reduced fishing effort and/or latency in many of the Region's fisheries with the objective of increasing the profitability of remaining fishing businesses (Moore et al. 2007).

The Region's decline in GVP and catch tonnage since 2000 has been due to a number of factors including reduced fish stocks, decreased catch quotas, increased overheads, greater fuel and maintenance costs and a significant increase in the value of the Australian dollar. Some sectors

Table 5.3 Number of commercial fishing related businesses and proportion of workforce employed in the commercial fishing industry in ports adjacent to the East Marine Region

Port	Commercial fishing (no.)	Fish wholesaling (no.)	Seafood Processing (no.)	Consolidated fishing industry (CFI) (no.)	Fishing employment (% of total employment)
Cairns	228a	161a	21a	410a	< 1a 0.5b
Innisfail	42a	3a	3a	48a	1.4b
Townsville	29a	9a	3a	41a	1.3b
Mackay	61a	36a	5a	102a	0.3b
Gladstone	77a	57a	20a	154a	0.6b
Bundaberg	72a	40a	16a	128a	0.8b
Mooloolaba	-	-	-	-	< 1a 0.4b
Brisbane	-	-	-	-	0.2b
Southport	-	-	-	-	0.1b
Coffs Harbour	71a	22a	3a	96a	< 1a 1.1b
Sydney	-	-	-	-	0.1b
Ulladulla	-	-	-	-	0.5b
Bermagui	-	-	-	-	2.3b

Source: a – Larcombe et al. 2006, b – Australian Bureau of Statistics 2001

of the industry appear to have stabilised over recent years, however it is an industry that is susceptible to rapid change in response to environmental and socio-economic factors such as variable fish stock abundance and fluctuations in market prices (Moore et al. 2007).

The decline in the Region's fisheries is consistent with industry trends at the national level. Australia's fisheries have been steadily declining since 2000 with a 25 per cent drop in GVP and a 36 per cent drop in exports over that period. In the 2005–06 financial year the GVP of all Australian fisheries dropped by 13 per cent. A key factor behind this national trend has been the strength of the Australian dollar over that period (Newton et al. 2007). It should be noted that the full effect of the recent Government licence buy-out and structural adjustment efforts have not been felt yet: they may go some way to reducing the current negative trend.

The key ports for fishing within the Region include Cairns, Innisfail, Townville, Mackay, Gladstone, Bundaberg, Mooloolaba, Brisbane, Southport, Coffs Harbour, Sydney, Ulladulla and Bermagui. With over 1300 fishing-related businesses, these ports are all important centres for the commercial fishing industry (Moore et al. 2007).

Including both direct and indirect employment, the Region's fisheries are believed to employ about 3600 people. However, commercial fishing is traditionally a family-oriented industry and businesses are often managed by extended family groups. Employment statistics for the fishing industry do not account for a significant number of unpaid family members who work in fishing companies in a casual or temporary capacity (Moore et al. 2007).

By examining what proportion of each port's workforce is employed in the industry (see table 5.3), we can infer which ports are most reliant on commercial fishing. According to 2001 Census data, Bermagui is the most reliant with 2.3 per cent of the town's workforce employed in the commercial fishing industry, followed by Innisfail, Townsville, Coffs Harbour and Bundaberg, each with less than 2 percent (Moore et al. 2007).

Commercial fishing activities are known to have an impact on the marine environment. There are many different types of fishing gear that are used by commercial fishers, each designed to target particular species and to operate in particular environments and each with a different set of impacts associated with its use. A more detailed description of some of the equipment used by commercial fishers in Australia is available at appendix E.

Generally speaking, the impacts associated with the commercial fishing industry include the removal of target species, by-catch, entanglement in discarded fishing gear

and physical damage to seafloor habitats. The scale of these impacts will vary depending on the type of fishing gear used, the species targeted, the degree and location of fishing effort, and the effectiveness of fisheries management practices.

There are a variety of tools used by fisheries management agencies to promote the sustainable use of fisheries resources including catch quotas, fisheries closures, industry guidelines and by-catch reduction devices. For example, the Australian Fisheries Management Authority is putting in place an ecological risk management framework to identify a list of key species in Commonwealth fisheries requiring management attention. Management initiatives can then be focussed on reducing threats to these species.

The appropriate use of environmental conservation tools such as marine reserves, species protection regulations, strategic environmental impact assessments and fisheries export accreditations can reduce fisheries-related impacts.

Australian Government Fisheries

Australian Government fisheries are managed by the Australian Fisheries Management Authority (AFMA). There are currently nine Commonwealth fisheries that occur wholly or partly within the East Marine Region:

- Coral Sea Fishery
- Eastern Skipjack Fishery
- Eastern Tuna and Billfish Fishery
- Small Pelagics Fishery
- Southern Bluefin Tuna Fishery
- South East Scalefish and Shark Fishery (includes Commonwealth Trawl Sector; Commonwealth Gillnet, Hook and Trap Sectors; and East Coast Deepwater Trawl Sector)
- Norfolk Island Fishery (includes inshore shelf/upper slope fishery and an exploratory offshore deepwater fishery)
- Southern Squid Jig Fishery
- Torres Strait Turtle Fishery[11]

11 This is a Commonwealth fishery managed by the Protected Zone Joint Authority (PZJA). The Australian Fisheries Management Authority provides management services for the PZJA.

The Coral Sea Fishery and the Norfolk Island Inshore and Offshore Fisheries are located entirely within the Region. Part of the Torres Strait Turtle Fishery is located in the north of the Region. The Eastern Tuna and Billfish Fishery and Skipjack Fishery includes all of the Region's waters and extends southwards, however, the majority of effort in these fisheries occurs outside of the Region. The Southern Bluefin Tuna Fishery includes all Australian waters although very little activity occurs in the Region. The remaining fisheries occur in the southern half of the Region and extend around the southern coastline of Australia (Larcombe et al. 2006, Moore et al. 2007).

In 2006 the Region's Commonwealth Fisheries landed a catch of approximately 19,800 tonnes valued at about $35 million of which more than 80 per cent was accounted for by the Eastern Tuna and Billfish Fishery. Despite being the most economically significant Commonwealth fishery in the Region, the Eastern Tuna and Billfish Fishery has suffered a sharp decline in recent years with a 50 per cent drop in GVP since the early 2000's. Until recently, the fishery had a high level of latent (or unused) fishing capacity. However, in response to recent structural adjustments, 100 of the more than 200 available longlining permits for this fishery were surrendered (Moore et al. 2007). Table 5.4 outlines the area of operation, catch tonnage and GVP for Commonwealth Fisheries.

The main home ports for fishing vessels working in the Region's Commonwealth fisheries include Cairns, Mooloolaba, Sydney, Ulladulla and Bermagui. The key landed ports (those ports in which catch is actually taken ashore) include Cairns, Mooloolaba, Brisbane, Southport, Wollongong, Greenwell Point, Ulladulla and Bermagui.

There is an overall trend to decreasing fishing effort in the Region's Commonwealth fisheries associated with reduced fish abundance, low quotas and increasing costs. Overall catch in the Region has declined in recent seasons and most of the capacity for the expansion of fishing effort is confined to isolated, less profitable fisheries such as the small pelagic and southern squid jig fisheries which are unlikely to be exploited in the near future. There is potential for a significant expansion in the skipjack tuna fishery depending on the outcome of a decision to allow new fishing vessels to enter this fishery. The recent reduction in fishing effort resulting from structural adjustment in the Region may improve the sustainability and profitability of existing fisheries (Moore et al. 2007).

Table 5.4 Commonwealth Fisheries in the East Marine Region

Fishery	Management area	Species	Fishing method	Catch within Region (value)	Concession holders/owners within Region*	Status #
Coral Sea Fishery.	Extends from the east of Fraser Island to the east of Cape York. The fishery commences east of the Great Barrier Reef Marine Park and extends to the edge of the Australian Fishing Zone.	A wide range of finfish species are taken as well as sharks, lobsters, trochus, sea cucumbers and live rock. Rosy jobfish, alfonsino and red emperor are the three most common species taken for seafood. The aquarium sector is highly selective and the species targeted vary in response to market demand.	• Demersal Longlines • Trotlines • Droplines • Setlines • Handlines • Demersal Finfish Trap • Otter Board Trawl Gear for fish and for crustaceans • Hand collection	In 2006: 105 t ($0.503 m)	18 permits	All fisheries uncertain
Eastern Tuna and Billfish Fishery.	Extends from Cape York to the South Australia–Victoria border, out to AFZ boundary including Lord Howe and Norfolk Islands and adjacent high seas	Principle species include yellowfin tuna, bigeye tuna, albacore tuna, broadbill swordfish and striped marlin.	• Pelagic longline • Minor line	In 2006: 6380 t ($28.7 m)	115 longline permits and 50 minor-line permits	Bigeye and yellowfin (overfishing, but not overfished). Striped marlin and broadbill swordfish (overfished status uncertain and overfishing status uncertain); Albacore (not overfished, no overfishing)
Norfolk Island Inshore and Offshore Fisheries (includes inshore shelf/upper slope fishery and an exploratory offshore deepwater fishery).	Norfolk Island is located 1500 km east of Brisbane. Australia exercises territorial control over the surrounding 200 n. miles EEZ	Inshore fishery: trumpeter kingfish cod snapper salmon trevally (Offshore not currently active)	Inshore: • Demersal line Offshore: (not currently active): • Demersal line • Demersal trawl	In 2005: Inshore 5 t (value confidential) Offshore (no current fishing activity)	Inshore - no permits Offshore - no current permits as exploratory fishery ceased in 2003	Inshore (uncertain), offshore (uncertain)
Eastern Skipjack Fishery.	Southern New South Wales to north-eastern Tasmania between November and June each year	Skipjack tuna	• Purse seine • Pole • Line	In 2005: confidential (less than 5 boats)	21 permits	(Not overfished and not subject to overfishing)

Table 5.4 Commonwealth Fisheries in the East Marine Region

Fishery	Management area	Species	Fishing method	Catch within Region (value)	Concession holders/owners within Region*	Status #
Small Pelagic Fishery.	Extends from Queensland/ New South Wales border (around southern Australia, to north of Perth. Typically occurs outside 3 nautical miles.	Jack mackerel yellowtail scad blue mackerel red bait	• Purse seine • Mid-water trawling	In 2006: 11060 t GVP is confidential	74 permits	Blue mackerel (not overfished and not subject to overfishing). Jack mackerel, yellowtail scad and redbait (uncertain)
Southern Bluefin Tuna Fishery.	Includes all of the Australian Fishing Zone – most effort occurs outside Region	Southern bluefin tuna	• Purse seine • Longline • Pole • Line • Trolling	In 2006: Estimated 105 t ($2.8m)	98 SFR holders nationally	(Overfished and subject to overfishing)
Southern Squid Jig Fishery.	Primarily offshore of Lakes Entrance, Queenscliff and Portland in Victoria, although fishery area does extend into southern half of Region	Arrow squid	• Squid jigging	In 2006: No catch in Region	N/A	(Uncertain)
South East Scalefish and Shark Fishery (Commonwealth trawl, scalefish-hook and deepwater trawl sectors).	Trawl sector from Sydney southwards around Tasmania to Cape Jervis in SA; adjoins east coast deep-water sector that extends to 24°30´S off Queensland. Scalefish-hook sector from the same boundary off Queensland to SA/WA border. Within the Region, the main effort is on seamounts from Sydney to Brisbane. Deepwater to 4000 m	Blue warehou, deepwater sharks, eastern gemfish, orange roughy, redfish, silver trevally, dories, blue-eye trevalla, blue grenadier, flathead and alfonsino	• Mid-water trawl • Demersal otter trawl • Pair trawl • Demersal longline • Dropline	In 2006: 1483 t ($3.1m)	59 trawl SFRs, and 56 scalefish hook boat SFRs; 10 for deepwater trawl (1 active)	(Eight stocks overfished; nine stocks n ot overfished; overfishing status of seven stocks uncertain; no stocks classified as overfishing; 15 stocks not subject to overfishing; overfishing status of nine stocks is uncertain)
Torres Strait Turtle Fishery.	Torres Strait Protected Zone	Green turtle hawksbill turtle	• Traditional Spear (wap) • Hand collection	As a traditional fishery there is no catch monitoring in place	Traditional fishery	No monitoring in place

* Note that not all concession holders/owners are actively fishing in the Region, although all concessions listed do give access to all or part of the Region

\# Note that Commonwealth Fisheries use the following classification to indicate the status of fisheries: not overfished; overfished (or overfishing); or uncertain.

Source: <www.afma.gov.au>; ABARE 2007b; Moore et al. 2007

The bow of a fishing boat. Image courtesy of CSIRO.

New South Wales Fisheries

The New South Wales Government manages three fisheries that extend into the Region:

- Ocean Trap and Line
- Ocean Trawl (including both the Fish Trawl and Prawn Trawl sectors)
- Rock Lobster

The New South Wales fisheries operating in the Region extend from the coastline out to the 4000 m isobath, or roughly 80 nautical miles from land. New South Wales managed trawling activity only occurs in the Region north of Barrenjoey Head (near Sydney). Trawling in the Region south of this point is managed by the Australian Government.

In 2006, the New South Wales fisheries in the Region landed a catch of approximately 3500 tonnes valued at about $30 million. The Ocean Trawl fishery is the most economically significant, followed closely by the Ocean Trap and Line Fishery. Table 5.5 outlines the area of operation, catch tonnage and GVP for New South Wales Fisheries.

Key home ports for New South Wales fisheries include the Tweed Heads, Richmond, Clarence, Coffs Harbour, Hastings, Manning, Wallis Lake, Port Stephens, Hunter, Central Coast, Greater Sydney, Illawarra, Bateman's Bay and Far South Coast districts.

Key landed ports include Richmond, Clarence, Coffs Harbour, Hastings, Wallis Lake, Port Stephens, Hunter, North and South Sydney, Illawarra, Ulladulla and Bermagui.

In general, New South Wales' fisheries have reduced their total catch over recent years as quotas have been reduced to conserve stocks. The Ocean Trap and Line Fishery has seen a decrease in the number of fishers but has experienced a recent increase in the landed tonnage and GVP.

The Ocean Trawl Fishery has experienced an overall decline over recent years, although it has now stabilised and remains the most profitable of the New South Wales fisheries in the Region (Moore et al. 2007).

A collection of nets and buoys. Image courtesy of CSIRO.

Table 5.5 New South Wales Fisheries in the East Marine Region

Fishery	Management area	Species	Fishing method	Catch within bioregion (value)	Operators/ businesses	Status *
Rock Lobster Fishery	NSW coast offshore to the 4000m isobath (approx. 60 to 80 nm offshore).	Eastern rock lobster	Trap/pot Hand collection (SCUBA or hookah prohibited)	In 2006: 52.2 t (A$2.4m)	122 shareholders	Fully fished
Ocean Trap and Line Fishery	NSW coast offshore to the 4000 metre isobath (approx. 60 to 80 nm offshore).	Australian bonito, snapper, leatherjackets, yellowtail kingfish, grey morwong, blue-eye trevalla, spanner crabs, silver trevally, yellowfin bream, banded rock cod, gummy shark	Fish trap, spanner crab net, setline, trotline, driftline, poling, handline, jigging, dropline, trolling	In 2006: 1350 t (A$11.5m)	478 fishing businesses	Of the 11 primary target species, 3 are considered to be growth over-fished, 4 fully fished, 2 moderately fished and 2 undefined. Of the 14 secondary target species 10 are considered undefined, 1 recruitment overfished, 2 fully fished.
Ocean Trawl Fishery	NSW coast offshore to the 4,000 metre isobath between Barrenjoey Head and the Queensland border. From Barrenjoey Head to the Victorian border, the Commonwealth retains jurisdiction beyond 3 nm.	Eastern king prawn, school prawn, Royal red prawn, Balmain bugs, octopus, silver trevally, tiger flathead, sand flathead, southern calamari, school whiting, fiddler shark	Otter trawl (prawns & fish) and Danish seine	In 2006: 2100 t (A$16.2 m)	271 fishing businesses	Of the 12 primary species (3 are considered growth over-fished, fully fished, 3 undefined, 2 uncertain and 1 lightly fished). Of the 16 secondary species (9 are considered undefined, 5 fully fished, 1 growth overfished and 1 moderately fished)

* Note that New South Wales fisheries use the following classification to indicate the status of fisheries: recruitment overfished; overfished; growth overfished; fully fished; moderately fished; lightly fished; uncertain; or undefined.

Source: (Moore et al. 2007)

The Rock Lobster fishery has gone through a period of fluctuation. Following a decline in stocks in the early 2000's catch quotas were reduced to allow stock recovery. In recent years the stock appears to be recovering so catch quotas have been increased. Despite an overall decrease in effort, there has been an increase in landed tonnage and GVP in recent years. An increase in the price of lobster has had a role in improving profits for this fishery (Moore et al. 2007).

Queensland Fisheries

The Queensland Government manages six fisheries that extend into the Region:

- East Coast Otter Trawl Fishery
- East Coast Stout Whiting Fishery
- East Coast Inshore Fin Fish Fishery
- Line Fishery
- Blue Swimmer Crab Fishery
- Spanner Crab Fishery

The Queensland fisheries operating in the Region are concentrated in coastal waters; however, the East Coast Otter Trawl extends beyond the Great Barrier Reef and out into the Coral Sea.

In 2006 the Queensland fisheries in the Region landed a catch of approximately 8863 tonnes valued at about $65 million. The East Coast Otter Trawl fishery is the most significant Queensland fishery in the Region followed by the East Coast Inshore Fin Fish Fishery. Table 5.6 outlines the area of operation, catch tonnage and GVP for Queensland Fisheries

Key home and landed ports in Queensland include Cairns, Innisfail, Townsville, Mackay, Gladstone, Bundaberg, Moolooaba, Brisbane and Southport.

The Queensland fisheries in the Region are generally characterised by a high level of latency and a declining number of boats actively fishing. Although there has been an overall decline in landed tonnage and GVP over the past ten years, the fisheries appear to have stabilised at present levels and further expansion in unlikely in the near future due to rising operational costs (Moore et al. 2007).

Table 5.6 Queensland Fisheries in the East Marine Region

Fishery	Management area	Species	Fishing method	Catch within bioregion (value)	Operators/ businesses	Status *
Blue Swimmer Crab Fishery.	The fishery area extends along the entire Qld coastline. Most catch is taken in inshore and continental shelf waters up to approximately 50 m depth, mainly in southern Qld, south of the Great Barrier Reef Marine Park	Blue swimmer crabs	Crab pots and collapsible traps	In 2006 875 t (A$5.9 m) combined value for both crab fisheries	190 commercial boats accessing the fishery	N/A
Spanner Crab Fishery.	The fishery area covers inshore and offshore (>3 nm) waters off the Qld coast, from the NSW border to the NT border. Catch is concentrated in coastal waters up to 80 m depth between Yeppoon and the Qld–NSW border	Spanner crab	Crab pots, collapsible traps and dillies	In 2006 875 t (A$5.9 m) combined value for both crab fisheries	504 licences	N/A

Table 5.6 Queensland Fisheries in the East Marine Region

Fishery	Management area	Species	Fishing method	Catch within bioregion (value)	Operators/ businesses	Status *
East Coast Inshore Fin Fish Fishery.	The ECIFF area includes all tidal waters along QLDs east coast eastward of 142°09' E, near Crab Island (approximately 11° S), to the Qld —NSW border	Barramundi, king salmon, blue threadfin, grey mackerel and various sharks	A variety of net methods and hook and line	In 2005 5,437 t (A$23 m)	499 net fishery and 1649 line fishery licenses	N/A
Line Fishery.	Includes all QLD waters out to limit of the QLD Offshore Constitutional Settlement boundary (approx 1540 30' E)	Flame snapper, ruby snapper, snapper, pearl perch, tragalin jew, coral trout, red throat emperor, spanish mackerel	A variety of hook & line methods	In 2006: 366 (t) (A$3.6m)	3342 boats (includes commercial boats, endorsed tenders and charter boats)	N/A
East coast otter trawl.	The ECOTF is Queensland's largest commercial fishery, extending from the tip of Cape York to the QLD/NSW border. The majority of the fishery occurs in Commonwealth waters though the fishery is managed by QLD under OCS agreements with the Commonwealth	Tiger prawns, Endeavour prawns, red spot king prawns, banana prawns, and scallops	Otter Trawl and Beam Trawl	In 2006: 2185 t (A$32 m) combined weight/value with East Coast Stout Whiting Fishery Stout Whiting Fishery for 2005 1,130t $2.5 million	501 licences	N/A
East Coast Stout Whiting Fishery.	The fishery area, known as the T4 fishery region. It is defined in legislation as the area between the 20 and 50 fathom (36 and 90 m) depth contours. It operates from Sandy Cape to Caloundra	Stout whiting	Demersal otter trawl	In 2006: 2185 t (A$32 m) combined weight/value with East Coast Otter Fishery Stout Whiting Fishery for 2005 1,130 t (A$2.5 m)	5 licences	N/A

* Queensland fisheries do not use a classification scale to describe the status of fisheries.

Source: (Moore et al. 2007)

5.2.2 Recreational and charter fishing

Recreational fishing and charter fishing is a popular outdoor activity in Australia with more than 3 million Australians believed to be participating in the sport annually contributing more than $1 billion to the economy, which includes all direct and indirect expenditure by fishers on fishing equipment, licence fees, accommodation and travel costs associated with the activity. Although the majority of recreational fishing effort takes place from shore, as much as 4 per cent of recreational fishing is estimated to take place in Commonwealth waters (Henry and Lyle 2003).

According to the National Recreational and Indigenous Fishing Survey (2003) New South Wales (999 000) and Queensland (785 000) had the largest numbers of recreational fishers of all Australian states and territories. At the time of the survey, recreational fishing in New South Wales contributed about $554 million to the economy and in Queensland, $320 million (Henry and Lyle 2003). Figure 5.5 shows amount and location of fish caught by recreation fishermen in the Region and adjacent waters in 2001.

Although there are fewer fishers in the offshore environment of the Region, it is likely that offshore fishing contributes more per fisher to the economy than inshore fishing given the higher equipment and charter costs associated with fishing in the open ocean (Henry and Lyle 2003).

Charter fishing operators can provide vessels large enough to operate safely in the offshore environment of the Region and are commonly hired by recreational fishers who wish to take their pastime into deeper waters. Charter fishing is regulated in Queensland by the Department of Primary Industries and Fisheries and in New South Wales by the Department of Primary Industries. The charter fishing industry abides by industry codes of practice promoting the sustainable use of the marine environment.

Charter fishing activities can range from simple day trips out of port to weeks on a live-aboard vessel. A few enthusiastic recreational fishers have been known to use seaplanes to rendezvous with vessels far offshore and return to port after only a few days at sea.

Given the steady increase in boat registration numbers in both Queensland and New South Wales, it is reasonable to assume that there has been a proportional increase in the number of private boat owners entering the Region for recreational fishing close to the shore. In the 2006–07 financial year New South Wales recorded a 2% increase in recreational boat registrations with 213 387 vessels registered (NSW Maritime 2007). In Queensland, a 10% rise in recreational boat registrations was recorded in the 2003–06 period with the number of vessels surpassing 200 000 (Maritime Safety Queensland 2007).

Figure 5.4 Number of fish caught by recreational fishermen in the East Marine Region and adjacent state waters in 2001

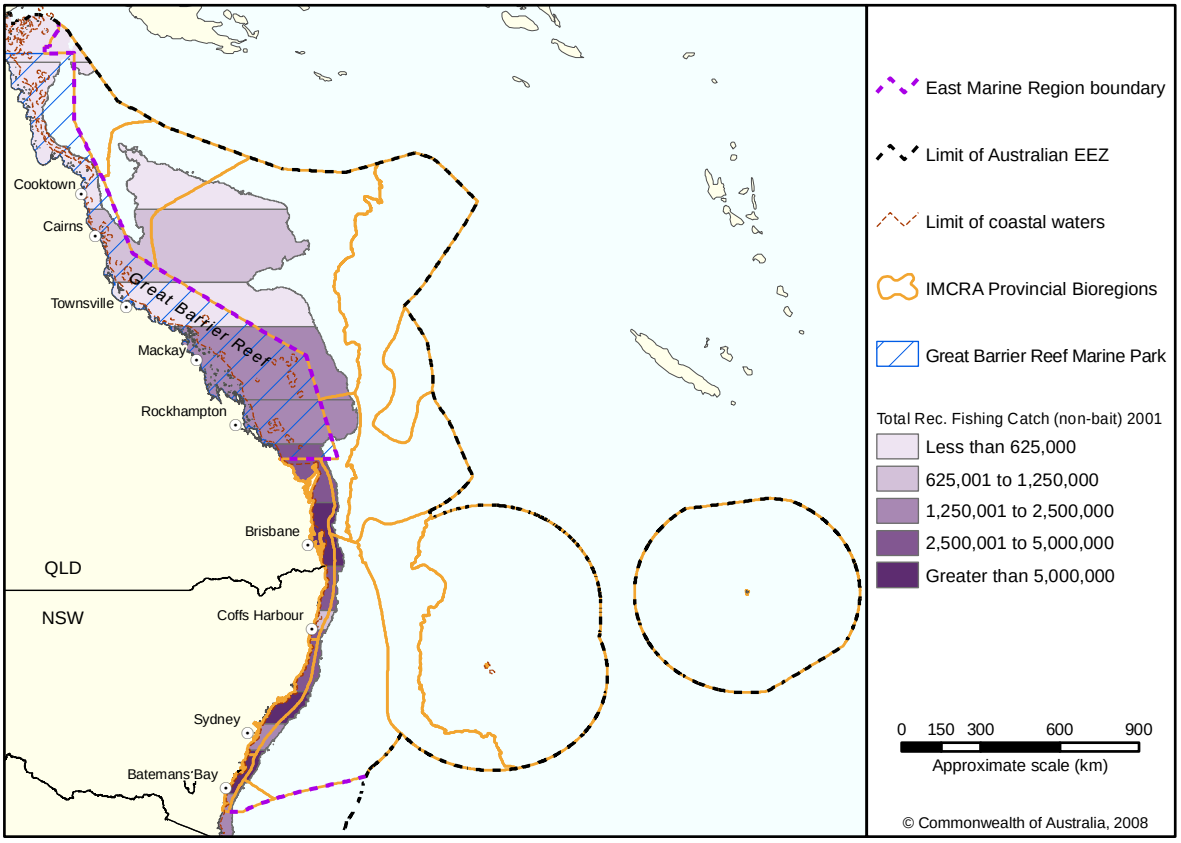


Table 5.7 Common Offshore Recreational and Game Fish Target Species

Albacore (*Thunnus alalunga*)	Nannygai (*Centroberyx affinis*)
Bar cod bass (*Epinephelus ergastularius*)	Ocean jacket (*Nelusetta ayraudi*)
Bass groper (*Polyprion americanus*)	Pearl perch (*Glaucosoma scapulare*)
Black marlin (*Makaira indica*)	Porbeagle shark (*Lamna nasus*)
Blue mackerel (*Scomber australasicus*)	Sailfish (*Istiophorus platypterus*)
Blue marlin (*Makaira nigricans*)	Samson fish (*Seriola hippos*)
Blue-eye trevalla (*Hyperoglyphe antarctica*)	Skipjack tuna (*Katsuwonus pelamis*)
Broadbill swordfish (*Xiphias gladius*)	Snapper (*Pagrus auratus*)
Cobia (*Rachycentron canadum*)	Spanish and spotted mackerel (*Scomberomorus* spp.)
Flathead (*Platycephalus* spp.)	Striped marlin (*Tetrapturus audax*)
Hammerhead shark (*Sphyrna* spp.)	Teraglin (*Atractoscion aequidens*)
Hapuka (*Polyprion oxygeneios*)	Tiger shark (*Galeocerdo cuvier*)
John dory (*Zeus faber*)	Striped trumpeter (*Latris lineata*)
Mahi mahi (*Coryphaena hippurus*)	Wahoo (*Acanthocybium solandri*)
Mako shark (*Isurus* spp.)	Yellowfin tuna (*Thunnus albacares*)
Mirror dory (*Zenopsis nebulosus*)	Yellowtail kingfish (*Seriola lalandi*)
Morwong (*Nemadactylus* and *Cheilodactylus* spp.)	

Source: (Moore et al. 2007)

In New South Wales the key ports for game and recreational fishing are Sydney, Port Stephens, Coffs Harbour, Wollongong, Batemans Bay, Bermagui, Tweed Heads and Narooma. In Queensland the key ports for game and recreational fishing include the Gold Coast, Brisbane, Mooloolaba, Cairns, Port Douglas, Cooktown, Townsville, Rockhampton, the Whitsundays and Gladstone. These ports are home to a number of major game fishing tournaments (Moore et al. 2007).

Recreational fishing can impact on the environment through the direct removal of marine biomass. Although individual recreational fishers do not remove a significant number of fish, the combined impact of many fishers can result in localised depletions, particularly in popular fishing spots. Given there are so few fishers in the offshore environment of the Region, recreational fishing is unlikely to remove a significant amount of biodiversity from these waters. However, the incidental catch or injury of endangered species remains as a potential impact associated with this activity. Disturbance of cetaceans by boat users unfamiliar with guidelines for interacting with these animals may occur, but is unlikely in the deeper waters of the Region or in the case of professional charter boat operators. Table 5.7 lists species commonly targeted by recreational and game fishers.

Recreational fishing – Spanish mackerel. Image courtesy of the Great Barrier Reef Marine Park Authority for and on behalf of the Commonwealth of Australia.

Humpback whale and tourists, Hervey Bay. Photo: Mark Farrell.

5.2.3 Marine-based tourism

Although marine-based tourism is a significant industry in the Region, quantifying its economic contribution is exceptionally difficult. Tourism industry figures are typically drawn from the Tourism Satellite Account prepared by the Australian Bureau of Statistics. Unfortunately, these figures do not make a distinction between land-based and marine-based tourism activities so it is difficult to extract figures for only the marine component of the industry. It is even more difficult to separate out those activities that occur in the Region from those that occur in adjacent state waters or in the neighbouring Great Barrier Reef Marine Park.

There is debate about methodology used to derive the Tourism Satellite Account. Some experts believe that it does not reflect the nature of Australia's tourism industry and significantly overestimates its economic contribution (Productivity Commission 2005).

The Allen Consulting Group (2004) attempted to determine the value of marine-based tourism as part of a 2004 study of maritime industries. That report estimated that in 2002–03 marine-based tourism contributed $11.3 billion to the Australian economy, that in New South Wales the industry was worth $4.5 billion and that in Queensland the industry was worth $2.2 billion.

By contrast the Great Barrier Reef Marine Park Authority (2007) reported that in 2006–07 marine tourism on the Great Barrier Reef alone contributed about $6 billion to the economy.

Although it is not possible to derive accurate tourism figures for the Region, some broad observations can be made. Tourism is a significant industry in the waters off New South Wales and Queensland, contributing billions of dollars to the national economy. The majority of this contribution comes from activities in the Great Barrier Reef Marine Park or in state waters. Nevertheless, marine tourism activities do occur in the Region and are likely to make a significant contribution to the economy.

Some non-fishing tourism activities that occur in the Region include:

- snorkelling and scuba diving;
- whale watching; and
- cruising

Snorkelling and Scuba Diving

In 2005 approximately 393 000 snorkellers and 95 000 scuba divers visited Queensland and 159 000 snorkellers and 40 000 scuba divers visited New South Wales. The vast majority would be participating in these activities in state waters or in the Great Barrier Reef Marine Park,

however, these activities do occur in the Region also (Sinclair Knight Merz 2007).

Scuba diving and snorkelling are predominantly eco-tourism or heritage-based tourism activities with participants preferring locations that offer near pristine marine environments or interesting plane or boat wrecks. Some commercial and educational organisations have offered science-based tourism opportunities where divers and snorkellers participate in experiments or surveys.

Known scuba diving hotspots in the Coral Sea include the Osprey and Shark reefs. These activities also occur in Commonwealth Marine Reserves at the Solitary Islands, the Cod Grounds and Lord Howe Island. There is also diving in the more remote reserves of Coringa–Herald, Lihou and the Elizabeth–Middleton Reefs; however, the extreme isolation of these locations ensures that they are not often visited. Scuba diving and snorkelling occur in waters around Norfolk Island and it is likely that they also take place off other islands and shallow water seafloor features in the Coral Sea and in locations closer to the mainland.

Impacts associated with these activities include damage to fragile environments such as coral reefs (by accidental collision of divers and by vessels anchoring) and stress and avoidance behaviour of species coming into contact with humans. Removal of animals by spearing or by hand is considered to be recreational fishing and is discussed in section 5.2.2.

Whale and Dolphin Watching

Whale and dolphin watching activities occur in many locations along the New South Wales and Queensland coastlines. Although the majority of whale watching activities occur in state waters, it is not uncommon for whale watching vessels to follow animals into the waters of the Region. It is difficult to determine how much whale watching occurs in the Region itself, as the location of whale watching sites varies from season to season.

The International Fund for Animal Welfare conducted a study of commercial whale watching activities in 2003 (IFAW 2004) in which it identified a total of 43 operators in Queensland and 28 in New South Wales. Despite there being fewer operators, 319 706 people went on whale watching in New South Wales compared with 140 133 people in Queensland.

The study estimated that the total direct expenditure on whale watching activities in Queensland and New South Wales was $21.4 million in 2003.

The impacts of whale and dolphin watching include the disturbance of animals by the noisy presence of people and passing boats and aircraft. Extreme cases of disturbance can result in behavioural changes, displacement from normal habitat areas and reduced breeding success. To minimise any distress to the animals, the *Australian National Guidelines for Whale and Dolphin Watching* (Department of the Environment and Heritage 2005) were developed by the Commonwealth and agreed to by all Australian state and territory governments. The Guidelines form the basis of appropriate laws and regulations relating to whale and dolphin watching in each relevant jurisdiction.

For more information on the guidelines see <www.environment.gov.au/coasts/publications/whale-watching-guidelines-2005.html>

Cruising

The cruise ship industry has been experiencing a period of growth over the past decade and has been recognised as the fastest-growing segment of Australia's tourism industry for much of that period. The general trend has been for cruise ships to visit an increasing number of ports and for cruise ships visiting Australia to be bigger.

In the 2006–07 financial year, the total direct and indirect national economic impact of the cruise shipping industry was $376 million. Economic impact is defined as the expenses, employment, income and value-adding to other industries generated by crew and passenger expenditure. This represents a decrease of 7.8% compared to the previous year despite the general upwards trend in the industry. The total economic impact in waters off New South Wales was $94.7 million and for waters off Queensland it was $69.9 million (Cruise Down Under 2007).

Willis Island, a small island in the middle of the Coral Sea, is of particular interest to the cruise shipping industry in the Region. Willis Island has a meteorological research station with a staff of scientists and is the only permanently populated island in the Coral Seas Islands Territory. Under Australian law, Willis Island is considered to be outside of Australia for the purposes of the *Customs Act 1901*. This special status means that cruise ships visiting Willis Island can consider the voyage as an international journey, and crew and passengers are therefore entitled to claim duty-free and GST free concessions. The cruise ship company can also purchase supplies for the voyage, including fuel, free of duty or GST (Commonwealth of Australia 2007a).

As a result of these concessions cruise companies will often include Willis Island as a destination on domestic Australian cruises, allowing Australian passengers to take

advantage of duty-free provisions. In practice, cruise ships anchor offshore of Willis Island for just a few hours before continuing with the voyage: passengers do not generally disembark.

Impacts specific to cruise shipping include the potential discharge of very large quantities of untreated sewage from vessels although modern vessels now have sophisticated effluent treatment equipment. Although most cruise ship destinations are in coastal waters outside of the Region, vessels do anchor off some of the Coral Sea islands and Norfolk Island, and passengers do sometimes go ashore. Passenger activities may have an impact on fragile environments (Sinclair Knight Merz 2007).

In addition to these industry-specific impacts, cruise ships also have the same impacts on the environment as any other large vessel, as discussed in more detail in the section 5.2.4.

5.2.4 Ports and shipping

Shipping is a vital industry and is the primary form of transport for international freight to and from Australia and around the world. In the 2006–07 financial year the total sea freight trade (the value of imports added to exports) for Australia was over $275 billion. Ports adjacent to the Region handled almost 45% of Australia's trade or about $123 billion. Sydney was the largest trading port adjacent to the Region (also the largest in Australia) with more than $54 billion in trade, followed by Brisbane (third largest in Australia) with more than $30 billion (Bureau of Infrastructure Transport and Regional Economics 2007b).

Approximately 38 million tonnes of cargo were imported through ports adjacent to the Region and about 271 million tonnes were exported. The largest importing port adjacent to the Region by weight was Sydney with more than 15 million tonnes of cargo, followed by Brisbane with 12 million tonnes. In terms of exported weight, the largest ports adjacent to the Region are Hay Point (86 million tonnes), Newcastle (82 million tonnes), Gladstone (55 million tonnes), Port Kembla (14 million tonnes) and Abbot Point (11 million tonnes). These ports are all industrial ports that export high volumes of raw minerals, most notably coal (Bureau of Infrastructure Transport and Regional Economics 2007b).

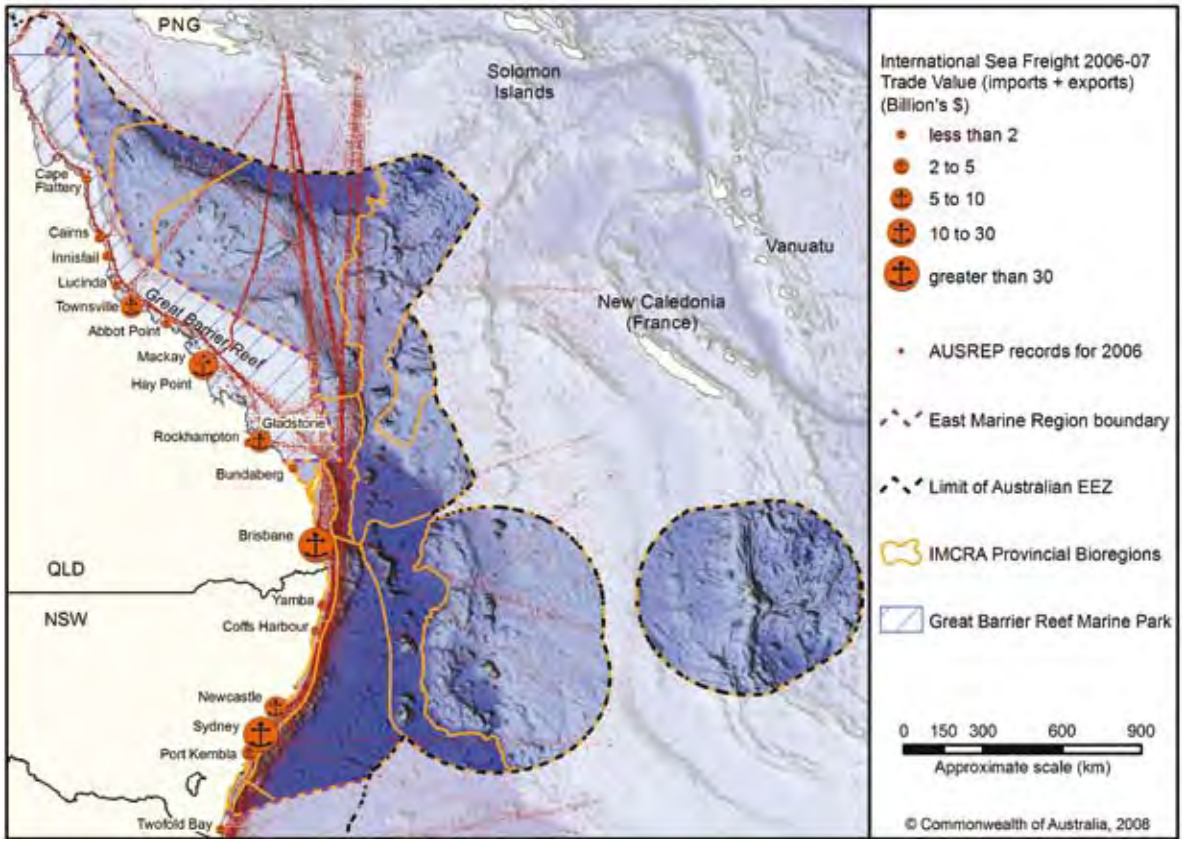
The most commonly imported cargoes into Australia included machinery, cars and petroleum products. Commonly exported cargoes included coal, iron ore, petroleum, meat

Table 5.8 The value and weight of imports and exports from ports adjacent to the East Marine Region

Port	Value Import ($ 000's)	Value Export ($ 000's)	Total Trade ($ 000's)	Tonnes Import	Tonnes Export
Queensland					
Brisbane	20 373 322	10 368 789	30 742 111	12 025 169	9 236 437
Hay Point	-	10 422 866	10 422 866	-	86 371 140
Gladstone	588 767	6 685 612	7 274 379	25	26
Townsville	1 093 761	1 093 761	2 187 522	4 064 398	3 562 012
Cairns	344 891	492 610	837 501	349 847	331 895
Abbot Point	-	789 138	789 138	-	11 155 370
Mackay	305 382	455 213	760 595	472 003	1 181 969
Lucinda	-	246 707	246 707	-	591 750
Innisfail	-	207 238	207 238	-	504 950
Bundaberg	5 827	55 994	61 821	851	139 419
Other Ports Qld	319	34 339	34 658	63	1 791 102
New South Wales					
Sydney	42 916 202	11 255 703	54 171 905	15 687 719	4 731 959
Newcastle	606 919	6 577 014	7 183 933	1 144 133	82 482 288
Port Kembla	384 862	3 872 485	4 257 347	2 103 394	13 927 745
Coffs Harbour	342	1 234	1 576	25	26
Other Ports NSW	241	7 836	8 077	248	4 535

Source: (Bureau of Infrastructure Transport and Regional Economics 2007b)

Figure 5.5 Shipping lanes in the East Marine Region and the International Sea Freight Trade Value of ports in state waters adjacent to the Region



and aluminium (Bureau of Infrastructure Transport and Regional Economics 2007a).

The Region includes some major shipping routes that are an important link in the global shipping lanes between Europe and Asia. The major shipping lane in the Region follows the eastern coast of Australia from the south before splitting into two directions near Fraser Island. One arm continues directly North through the Coral Sea, and on towards south-east Asia. The other travels the inner route of the Great Barrier Reef, a path that follows the narrow strip of water between the coastline and the reef itself. Vessels sailing this passage are required under the *Great Barrier Reef Marine Park Act 1975* to take on board a Commonwealth licensed pilot for the leg of the journey between Hydrographers Passage and Cape York (Australian Reef Pilots Pty Ltd 2007).

The Australian Maritime Safety Authority maintains the Australian Ship Reporting System (AUSREP) and requires certain commercial vessels within the Australian Search and Rescue Region to report their location at least once every 24 hours to improve the safety of life at sea. By plotting the reported location of vessels over the period of a year it is possible to determine which areas of the East Marine Region have the high levels of shipping activity associated with shipping lanes (see figure 5.5).

There are a number of environmental impacts or potential impacts associated with all shipping in the Region. Shipping traffic is rising in all Australian waters increasing the chances of collisions, running aground and other accidents such as the loss of cargo at sea. Oil spills and other toxic chemicals lost overboard in such incidents can have serious consequences for the environment depending on the nature of the cargo and the location of the incident. Chemically inert cargoes lost overboard, such as shipping containers or garbage, contribute to marine debris pollution and in some cases can cause navigation hazards (Sinclair Knight Merz 2007). The discharge of sewage (treated or otherwise) can also have implications for environmental quality.

Increasing traffic also increases the possibility of accidental collision with marine animals such as turtles, dugongs and cetaceans. Figures are not available for the number of such strikes that occur in the Region, however there are numerous reports in adjacent waters of small boats colliding with animals and some animals have been observed with scarring consistent with propeller strike. Given the size of some of the larger ships navigating the sea lanes of the Region, it is unlikely that a collision with wildlife would be noticed or reported (Sinclair Knight Merz 2007).

Customs boat. Image courtesy of Australian Customs.

Shipping is also a potential vector for the introduction of marine pests into Australian waters, either through biofouling or the exchange of ballast water. Biofouling occurs when a pest attaches itself to the hull of a vessel and is carried to another port. Ballast water taken on by empty cargo ships in a port may draw pest species into the ballast tanks which are then expelled with the ballast water when the ship arrives at its destination port (Sinclair Knight Merz 2007).

Management of the risks associated with shipping is governed by a number of national and international agreements and industry codes of conduct. Australia's commitments under the international *Convention for the prevention of Pollution from Ships 1983* (MARPOL) are met by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1973* and the *Navigation Act 1912*. Oil and chemical spill response in the Region is implemented by the Australian Maritime Safety Authority using the *National Plan to Combat Pollution to the Sea by Oil and Other Noxious and Hazardous Substances*. There is a high level of national collaboration between jurisdictions and the shipping and ports industry on marine pollution and oil spill response matters in Australia. Australia is currently working with the International Maritime Organization (IMO) to address the issue of ship strikes on cetaceans.

5.2.5 Border protection activities

Both the Australian Customs Service (ACS) and the Australian Defence Force (ADF) make widespread use of the East Marine Region while undertaking their duties. The range of activities includes national security, surveillance, interception and legal action (Forbes 2002) as well as supporting environmental management and research initiatives in places like Commonwealth marine reserves.

The ADF also undertakes other tasks such as:

- preparedness and contingency planning;
- fisheries and (where applicable) environmental law enforcement;
- search and rescue;
- hydrographic assessments; and
- oceanographic data management.

Border Protection Command

In order to address security threats in Australia's maritime environment the Federal Government, in March 2005, directed the establishment of the Joint Offshore Protection Command (JOPC). In 2006 JOPC, in line with an expanded mandate from Government, was re-named as Border

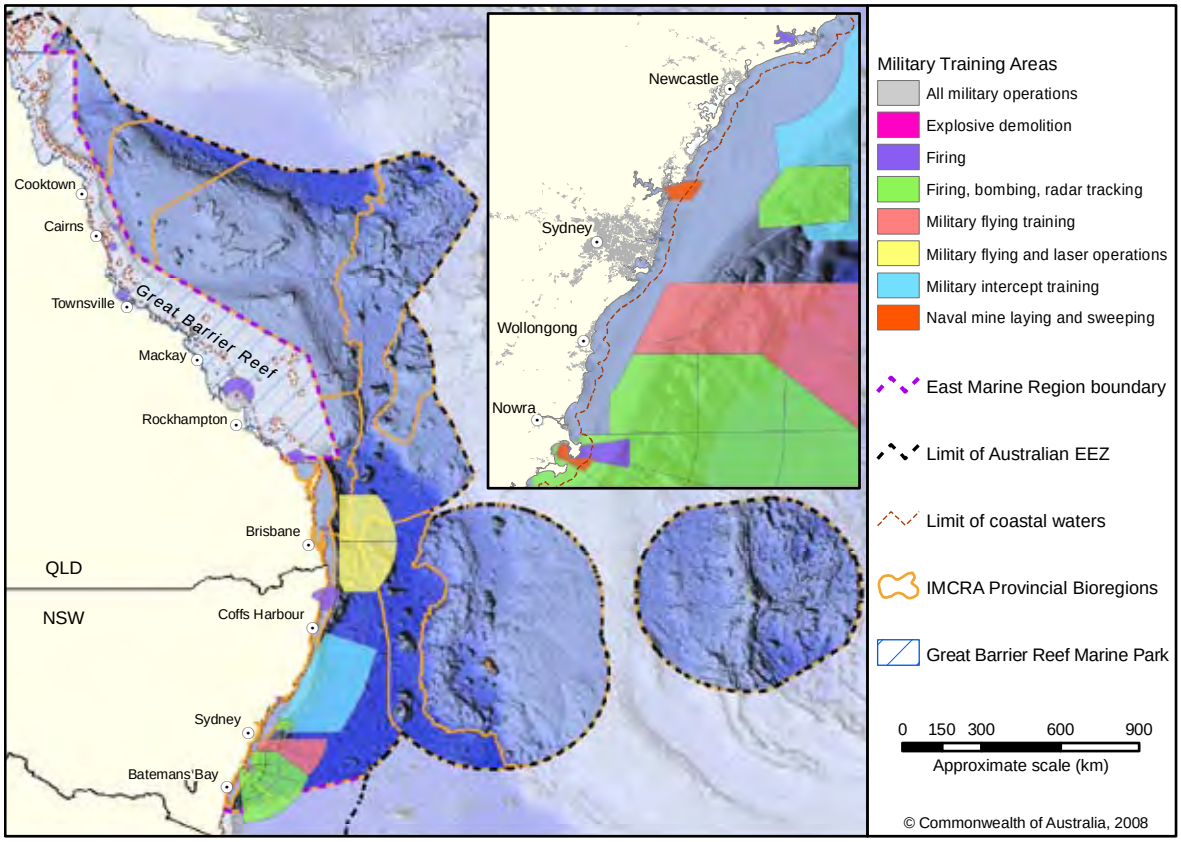
Protection Command (BPC). BPC is a multi-agency organisation staffed with officers from the Australian Customs Service, the Australian Defence Force, the Australian Fisheries Management Authority, and the Australian Quarantine Inspection Service. BPC uses assets assigned to it by the ACS and ADF to counter security threats in Australia's maritime domain. The eight security threats, identified by Government, are illegal activity in protected areas, illegal exploitation of natural resources, marine pollution, prohibited imports and exports, unauthorised maritime arrivals, compromise to bio-security, piracy, robbery or violence at sea, and maritime terrorism.

Regional Defence Activities

The Australian Defence Force (ADF) conducts a range of training, research activities, and preparatory operations in the East Marine Region in support of ships and aircraft stationed at bases in various locations along the east coast of Australia. Major home port bases for east coast Royal Australian Navy (RAN) ships and aircraft include Fleet Base East (destroyers and support ships) and HMAS Waterhen (minehunting vessels) in Sydney, HMAS Albatross in Nowra (aircraft) and HMAS Cairns in Cairns (Hydrographic, maritime patrol and support vessels). Training and support establishments are located in Sydney, Wollongong and Jervis Bay. Royal Australian Air Force (RAAF) establishments at Richmond, Williamstown and Amberley support flying operations and crew training activities in the Region.

Primary training locations include the East Australia Exercise Area off the south coast of New South Wales, RAAF flying training areas and air-to-air ranges off the north coast of New South Wales, and the Shoalwater Bay Defence Training Area, on the central Queensland coast. Additionally, there are a number of smaller practice areas in the Region that cater to specific training requirements. Defence activities in these training areas include general ship and aircraft training, including seamanship, flight training, demolition, use of explosives, weapons firings, use of radar, sonar, sonobuoys, flares, sensors and other equipment. All Defence activities in the Region are subject to assessment under the ADF Maritime Activities Environmental Management Plan, supported by planning guides and procedural tools, including threat assessments for prospective activities, and notification of relevant marine bodies and ocean users about impending activities. In addition, Defence activities that are considered likely to impact upon matters of national environmental significance are assessed and considered for referral under the EPBC Act.

Figure 5.6 Defence training areas in the East Marine Region



Major exercises are conducted infrequently in the Region. These exercises are subjected to additional environmental assessment. Exercise Talisman Saber is held biennially off eastern Australia in the Coral Sea, involving Australian and United States armed forces. The exercises focus on operational level warfare with fictional scenarios including ground, air and marine activities, and typically involve around 30 ships, 100 aircraft and 20 000 personnel. Effective environmental management is a major consideration involving a rigorous environmental risk assessment process (Sinclair Knight Merz 2007). On occasions, RAAF aircraft from other bases train in the Region and regular larger scale air exercises potentially with international participants are held in the Region.

In addition, the ADF may conduct hydrographic survey operations, search and rescue, surveillance, and interdiction activities at any time in the East Region in support of Government priorities. For example, Operation Resolute involves ocean patrols and law enforcement activities targeting illegal activity in the Region.

5.2.6 Offshore oil and gas exploration and production

At the time this report was written, no major offshore oil and gas activity occurred in the Region. Offshore areas within the Region are largely under-explored although locations exist where reserves may occur (see table 5.9). Data are available for the Nambour Basin and the Sydney Basin, however there is no current activity in either of these locations (Quinn et al. 2005).

Australian oil and gas resources include crude oil, condensate, liquefied petroleum gas and natural gas. Exploration and production can be an expensive process

Table 5.9 Offshore basins with potential oil and gas reserves in and adjacent to the East Marine Region

Basin	Offshore Area (km²)	Details/Prospectivity
Capricorn Basin	45 000	Mostly within the Great Barrier Reef Marine Park where exploration is prohibited. The offshore basin is poorly explored with three wells having been drilled (all dry) and no exploration since 1968.
Clarence Moreton Basin	1 000+ (offshore extent poorly known)	A possible offshore extension of the onshore basin. The Solitary Islands Marine National Park and Reserve nearby. Offshore basin lies under a whale migration path. One offshore survey conducted, 2 of 30 onshore wells flowed sub-economic gas, basin has abundant oil-prone organic matter. No offshore wells.
Eastern Plateau	31 000	Midway between Queensland and Papua New Guinea. The plateau is surrounded by troughs and is free of terrigenous sediments.
Lord Howe Rise	1 500 000	Recognised as having long term hydrocarbon potential. Potentially prospective sedimentary basins underlie much of western half and eastern flank.
Lorne Basin	?	Unknown if extends offshore and if so, based on onshore information, prospectivity is probably very low.
Maryborough Basin	15 500	Basin offshore and onshore. Five onshore wells (all dry except for gas shows in one). None offshore. The offshore Maryborough Basin underlies whale migration paths for several months of the year and includes the Fraser Island National Park.
Nambour Basin	2500 (poorly known)	Offshore and onshore. The offshore basin lies under a whale migration path for several months of the year. One petroleum well on an offshore island. Unlikely to contain commercial quantities of hydrocarbons.
Papuan Basin	7000 (only partly within Region)	One exploration well within Australia. The Queensland extension lies mostly within Torres Strait and the Great Barrier Reef Marine Park, so is considered to be within a very sensitive area.
Sydney Basin	28 000	Offshore and onshore. The offshore basin lies under a whale migration route for several months of the year. 115 onshore wells and zero offshore.
Townsville Basin	13 000	The western part of the Townsville Basin lies within the Great Barrier Reef Marine Park, in which petroleum exploration activity is prohibited. The rest of the basin is also in a sensitive area due to the proximity of the Park. No wells have been drilled.

Source: (Geoscience Australia 2003)

Figure 5.7 Oil and gas exploration permits in the East Marine Region

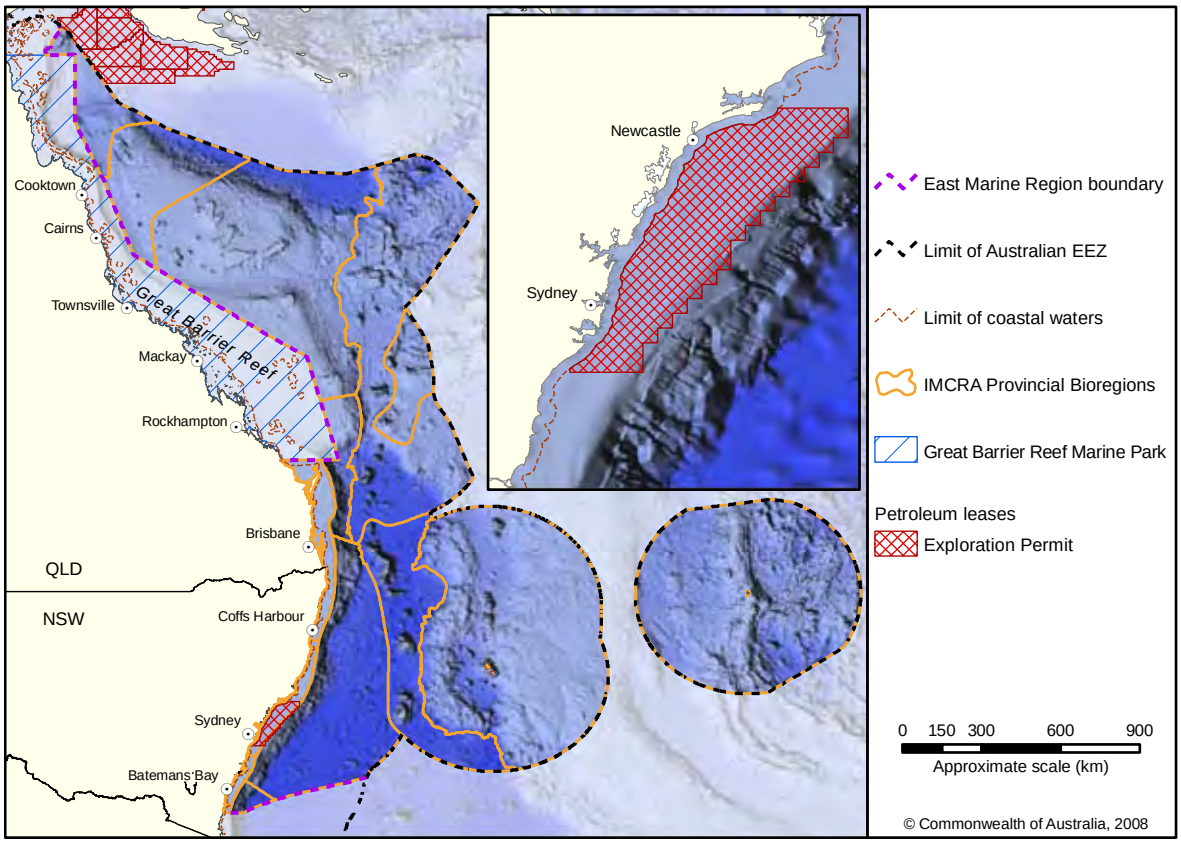


Table 5.10 Possible impacts of oil and gas exploration and extraction on the environment

Issue	Possible Impacts
Ship movements	May cause sedimentation at coastal facilities from propeller disturbance, introduction of invasive species from ballast water release, disposal of produced and process waters that may have raised salinity and hydrocarbons, collisions at sea, potential to alter animal movements and oil spills.
Seismic surveys	Sound waves might cause mortality, sublethal injuries or modify feeding or mating activity of marine mammals, fish and other organisms. Evidence suggests the seismic sound waves do alter the behaviour of some species and may cause damage to the hearing organs. Whales have also been known to avoid noise associated with surveys even at a distance of 7–12 km (Australian State of the Environment Committee 2001, McCauley et al 2000).
Drilling rig placement	Possible localised damage from the placement of rig.
Drilling	Modifications to the benthic faunal communities even up to 11 months after drilling (Currie and Isaacs 2005), drill cuttings discharged overboard, increased suspended sediments in the water column, drilling fluids containing harmful constituents potentially released into environment.
Anchoring	Localised physical damage.
Platform placement	Habitat disturbance, however platforms may act as artificial reef attracting marine and bird life. The decommissioning of the equipment may involve only the partial removal of platform which may be left to act as an artificial reef.
Emissions and discharges	Formation water with hydrocarbon traces at an elevated temperature released into environment, cumulative effects on organisms from long exposure to low levels of particular hydrocarbons, greenhouse gas emissions (mostly carbon dioxide and methane) are released but exploration and production combined contribute only 3% to Australia's emissions.
Sewage	Elevated water column nutrients may increase the numbers of some organisms.
Oil spills	Smothering and toxic effects for organisms and cascading impacts along the food chain.

Source: (Sinclair Knight Merz 2007)

because petroleum resources are extremely difficult to find and exploit (Australian Institute of Petroleum 2002). Nonetheless, identification of more resources is essential to the growth of the industry. Exploration in offshore waters is very important considering offshore drilling contributes approximately 85% of Australia's approximately $15 billion petroleum production industry (Ward and Butler 2006).

Economic contributions from the oil and gas industry within the Region will depend largely on the outcome of the recent exploration of the Lord Howe Rise and the success of drilling by the company Bounty Oil and Gas NL off the coast of Sydney. Seismic investigations indicate that there are potential recoverable gas reserves in excess of 1.2 trillion cubic feet offshore in the Sydney area. If successful, this well is expected to provide enough gas to meet Sydney's needs for the next decade (MEC Resources 2006).

Historically, petroleum exploration and production activities have had very little environmental impact but there are risks of future impacts if exploration and production activities are not managed carefully (Australian State of the Environment Committee 2001). With respect to East Marine Region, the risk of environmental impacts is low due to the lack of production and minimal exploration activities. Table 5.10 summarises the potential hazards and impacts associated with petroleum exploration and recovery.

5.2.7 Offshore mineral exploration

No major offshore mining or exploration is currently taking place within the Region but two major offshore extraction operations are currently taking place in Australian waters. One is a sand dredging operation in Moreton Bay directly adjacent to the Region, the other is a lime-sand dredging operation off Fremantle, Western Australia (McKay et al. 2005).

Seafloor mining was pioneered in the 1970s, primarily to access manganese nodules and the nickel, copper and cobalt they contain (McDonald 2005). Due to the difficulty and expense of operating in the offshore environment, the feasibility of seafloor mining depends largely on the discovery of minerals that have a high value.

Data on the location and productivity of mineral deposits in Australia have been obtained primarily by private companies, and through reconnaissance surveys undertaken by federal and state geoscience agencies (McKay et al. 2005). The main focus of these explorations and mining activities has been the extraction of construction material, heavy mineral sands and high value deposits of gold and diamonds (McKay et al. 2005). Minerals potentially available for extraction from the sea bed include carbonate sands, sulphides rich in copper, gold and zinc located around hydrothermal vents, and phosphate and manganese nodules. Many of these minerals are located in the Region and adjacent State waters. However as the bioregion has not been subjected to systematic mineral exploration, little is known of the full extent of mineral occurrences, and mineral potential is virtually unknown.

In the past, the cost of extracting and treating the resources has outweighed their commercial value, but this situation is changing as new technologies are discovered and developed. Recently, minerals obtained from hydrothermal fields have shown economic prospects equal to or even higher than terrestrial mines (McDonald 2005) and Nautilus Minerals Inc will commence seabed mining of seabed base metals in Papua New Guinea waters near the Region in 2009.

As the only mineral extraction operation in the vicinity of the Region occurs in Queensland state waters, there are no direct impacts on the Region itself.

5.2.8 Aquaculture

With the majority of commercially fished species in the Region being classified as fully or over exploited by fisheries management authorities, there is increasing pressure on wild fisheries to deliver profitable catches. It has become apparent that commercial fishing alone cannot provide for the increased worldwide demand for seafood. Globally, Australia ranks around 55th in seafood production, despite having the third largest fishing zone in the world.

Australia's fisheries are not as productive or as abundant compared with many other parts of the world. With ever-increasing population, demand for seafood is outstripping supply. Aquaculture has been suggested as a sustainable method of commercial production of fish, molluscs, crustaceans and marine plants although there is no consensus as to whether this is achievable.

There are no major aquaculture operations currently within the Region. The major aquaculture industries in waters adjacent to the Region include the farming of scallops, prawns, edible oysters and silver perch. The economic contribution of marine-based aquaculture in Queensland and New South Wales is difficult to distinguish as figures for both land-based and marine-based aquaculture are amalgamated in industry reports. Queensland aquaculture production generally has a higher value than New South Wales production, although this may be attributed to the size of the prawn industry. The value of prawn production

was highest for the period 2003–04 with a value in excess of $53 million.

Aquaculture is a rapidly developing industry in Australia and worldwide, representing approximately 35 per cent of the total value of Australian fisheries production of $2.13 billion (ABARE 2007b). Aquaculture worldwide has a growth rate of 11 per cent per year and is worth an estimated $US56.5 billion dollars (Department of Primary Industries 2005).

Comprehensive research programs are currently being conducted with the view to increasing the contribution of aquaculture to the fishing industry in Australia (Department of Primary Industries 2005). Specific research programs include:

- hatchery and breeding technologies for oysters and molluscs;
- technologies and systems for finfish breeding and farming; and
- fish feeds and feeding.

5.2.9 Sea dumping

Dumping at sea has been a common practice as it was perceived to minimise the impacts of land-based waste disposal on population centres in a time when there was not much awareness of potential environmental impacts. Additionally, waste disposal at sea may have also been a cheaper and less regulated alternative to land-based waste management.

The *Beaches, Fishing Grounds and Sea Routes Protection Act 1932* was enacted in response to pollution of beaches in major coastal cities and uncontrolled dumping resulting in obstruction of shipping passages. Under the Act, the Federal Government designated fourteen dumping grounds isolated from major shipping routes. Permits were required for the dumping of vessels and permission was required from the Director of Quarantine for the dumping of organic waste or garbage (Plunkett 2003).

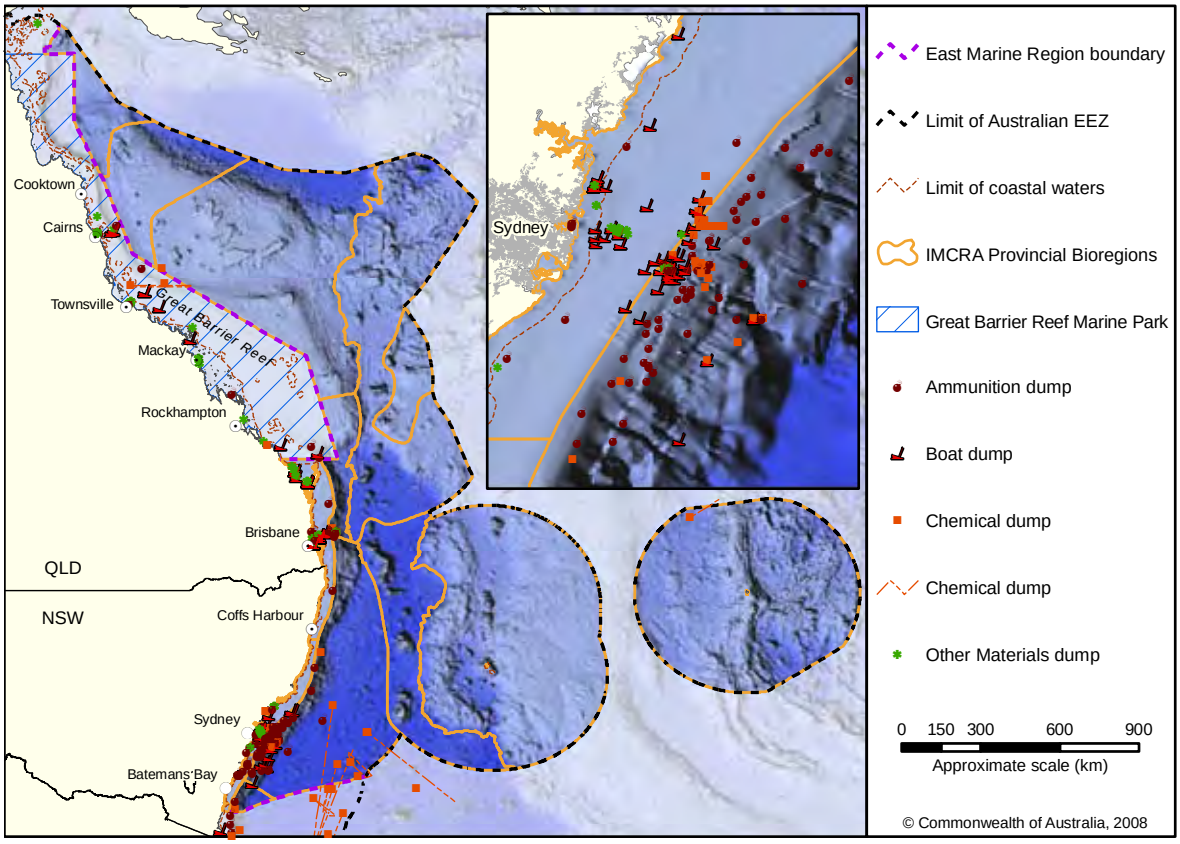
In recent years, the practice of dumping at sea has been further regulated by the Australian Government to minimise environmental degradation and protect human health. As a signatory of the international *Convention on the Prevention of Sea Dumping of Wastes and Other Matter 1972* (The London Convention) the Australian Government introduced the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) to increase regulation of sea dumping in Australian waters, including those surrounding Australia's seven external territories (Plunkett 2003).

Table 5.11 Materials dumped in the East Marine Region

Description	Sites in the East Marine Region
Arsenic Solution	1
Black Liquor	1
Carbonate/Cyanide	1
Caustic Soda	1
Chemical Warfare Agent	3
Chlorinated Hydrocarbons	14
Contaminated Hydrocarbons	2
Cyanide	6
Cyanide Residue	4
Cyanogen Bromide	1
Electric Plating Vats	1
Exhaust Valves	4
Hydrocarbons	21
Medical Stores	1
Medical Stores/ Sulphur Drugs	1
Methyl Parathion	1
Mustard Gas	3
Mustard Gas Cylinders	1
Phosphorous Trichloride	2
Phosphorous Oxychloride	1
Polymerised Ethylene Oxide	1
Pyrotechnics	1
Rapidech Crystallised Chemicals	1
Sheep Dip	1
Sodium	1
Sodium Exhaust Valves	2
Solvents	1
Spent Caustic Soda	12
Spent Sulphuric Akulation Acid	3
Sulphonamides & Antihistamines	1
Toxic Sludge	1
Unknown	4
White Spirit/ Perchloroethylene	1

Source: (Sinclair Knight Merz 2007)

Figure 5.8 Sea dumping sites in the East Marine Region



The London Convention (1972) was updated by the 1996 Protocol which is much more restrictive and lists materials permitted to be dumped under Annex 1 (International Maritime Organization 2002). Permissible materials include:

- dredge material;
- sewage sludge;
- fish waste, or material resulting from industrial fish processing operations;
- vessels and platforms other than structures made at sea;
- inert, inorganic geological material;
- organic material of natural origin; and
- bulky items, primarily comprising iron, steel, concrete and other similar chemically-harmless materials for which the concern is the physical impact – generally limited to circumstances where there is no other practical disposal option, e.g. for small islands having isolated communities.

Permits for the disposal of any of the above-listed materials must be obtained before dumping takes place. Permits are most commonly issued for dumping of uncontaminated dredge spoil (Plunkett 2003). Table 5.11 lists some of the materials that have been dumped in the East Marine Region.

Regulations apply to the two broad waste disposal solutions: land-based disposal and dumping at sea. Marine pollution can result from land-based disposal including sewage outflows, flows of industrial by-products, and stormwater runoff, which can potentially affect the water quality of coastal and marine environments, especially sensitive reef systems in the tropical waters off Queensland. Dumping of waste at sea can also have significant localised environmental implications depending on the nature of the material being dumped, the location and depth in which it is dumped and oceanic conditions (Plunkett 2003).

Sea dumping sites in the Region can be categorised into four broad groups:

- ammunitions sites;
- boat dumping sites;
- chemical dumping sites; and
- miscellaneous waste sites.

There are a total of 471 ocean waste disposal sites in the 14 provincial bioregions that comprise the Region. Most of these sites are concentrated in the shelf provinces (see figure 5.8). The Central Eastern Province has the highest number of ocean disposal sites including the highest number of ammunition, boat and chemical dumping areas,

Sydney Deepwater Sewage Outfalls

As Australia's most populated city, Sydney generates massive volumes of effluent putting significant pressure on the aging infrastructure of the city. Each day, approximately 1.2 billion litres of wastewater passes through a system of 30 sewage treatment plants. About 1 billion litres a day, or the equivalent of 1000 Olympic swimming pools, passes through three deepwater outfalls off the coast from North Head, Bondi and Malabar (Sydney Water 2007).

Wastewater discharged from these outfalls has been subject to 'high rate primary' treatment. Ordinary primary treatment of sewage involves the removal of solid debris using filter screens and settling tanks. High rate primary treatment removes fewer solids because of the faster than normal treatment process. The effluent passing through the deepwater outfalls contains a relative high level of sewage because treatment processes remove only about half of the suspended solid material entering the treatment plants. This sewage is dispersed in an effluent plume between 1.7 and 3.7 km from shore in water between 60 and 80 m deep (Pritchard et al. 1996).

Effluent plumes leaving the outfalls are rapidly diluted and are subject to a number of oceanographic variables. The prevailing winds and currents drive effluent plumes in a south or south-westerly direction, following the coast toward the Illawarra region. Although heavily diluted, traces of effluent have been found as far as 40 km south of the outfalls (offshore of Stanwell Park) (Wilson et al. 1995).

The waters off the coast of Sydney are also subject to stratification, a process where the water column settles into distinct layers of different temperature waters. When there is a large difference in temperature between the surface and deeper waters, the effluent plume becomes trapped about 30 metres below the surface. It is estimated that those plumes will surface between 15 and 19 per cent of the time (Wilson et al. 1995).

After the outfalls became operational, the Sydney Deepwater Outfalls Environmental Monitoring Program conducted an extensive analysis on the behaviour and impact of effluent discharged from the outfalls. Although there was some decline in the populations of some marine species, overall there appeared to be little impact on the environment around the outfalls (Scanes et al. 1996). This has been supported by the ongoing monitoring program conducted by the Sydney Water Corporation (Sydney Water 2007).

According to the National Pollution Inventory, in the financial year ending 30 June 2006, the Malabar Sewage Treatment Plant was recorded as the facility emitting the largest volume of ammonia (5 300 000 kg), nitrogen (6 500 000 kg) and phosphorus (1 300 000 kg) into the Australian marine environment (National Pollutant Inventory 2007)

The volume of wastewater passing through Sydney's deepwater outfalls is comparable with other global population centres in North America and Europe (Phillip 1995).

The Sydney sewerage system is managed by the Sydney Water Corporation. Sydney Water is licensed to run and maintain this infrastructure by the NSW Department of the Environment and Climate Change (DEC) under the *Protection of the Environment Operations Act 1997*. The licences set conditions for how the sewerage system is to be managed and determines what penalties will be applied in the event that there is a breach of the Act (Department of Environment and Climate Change 2008). Sydney Water reports any breaches of the Act in its annual report.

Despite the outfalls having a good environmental record the fact remains that the outfalls are a major source of pollution. The community remains concerned about the possible impacts of the outfalls and as a result they are subject to a strict monitoring and licensing program. Considerable investment has been made in upgrading the city's wastewater infrastructure with the aim of reducing impacts on the environment.

Although it is extremely rare for effluent to pass into the waters of the East Marine Region itself, the close proximity of the outfalls and the high volume of effluent passing through them make the outfalls a matter of interest for the Regional Profile.

Cruise ship – a luxury cruise ship enters the Port of Newcastle for day excursions by passengers to the nearby Hunter Valley. Image courtesy of the Newcastle Port Corporation.

while the Central Eastern Shelf Province has the highest number of miscellaneous dump sites in the Region. There are no registered sites in the Cape Province, Kenn Province, Kenn Transition, Tasman Basin Province or Lord Howe Province. There is one chemical dump site in the Norfolk Island Province, however sea dumping defined under the *Environment Protection (Sea Dumping) Act 1983* is not permitted off Norfolk Island (Plunkett 2003). Management of waste generated on the island generally involves incineration.

Potential impacts of ocean waste disposal on the marine environment include localised effects on water quality and destruction of habitat. Impacts of ocean waste disposal also extend to humans who may ingest contaminated seafood or snag dumped material through trawling. Another impact which mostly occurred before sea dumping sites were charted was ship collisions with dumped material (Plunkett 2003).

To combat the issues that arise from land-based pollution, the Federal Government developed *Australia's National Programme of Action for the Protection of the Marine Environment from Land Based Activities* (Department of the Environment and Heritage 2006). The program builds upon the *National Cooperative Approach to Integrated Coastal Zone Management* (Natural Resource Management Ministerial Council 2006). Management of impacts arising from waste dumped at sea is more difficult due to the limited data available about dumping events in the past and their locations. The Australian Government now keeps a database of dump sites and permits issued (Plunkett 2003).

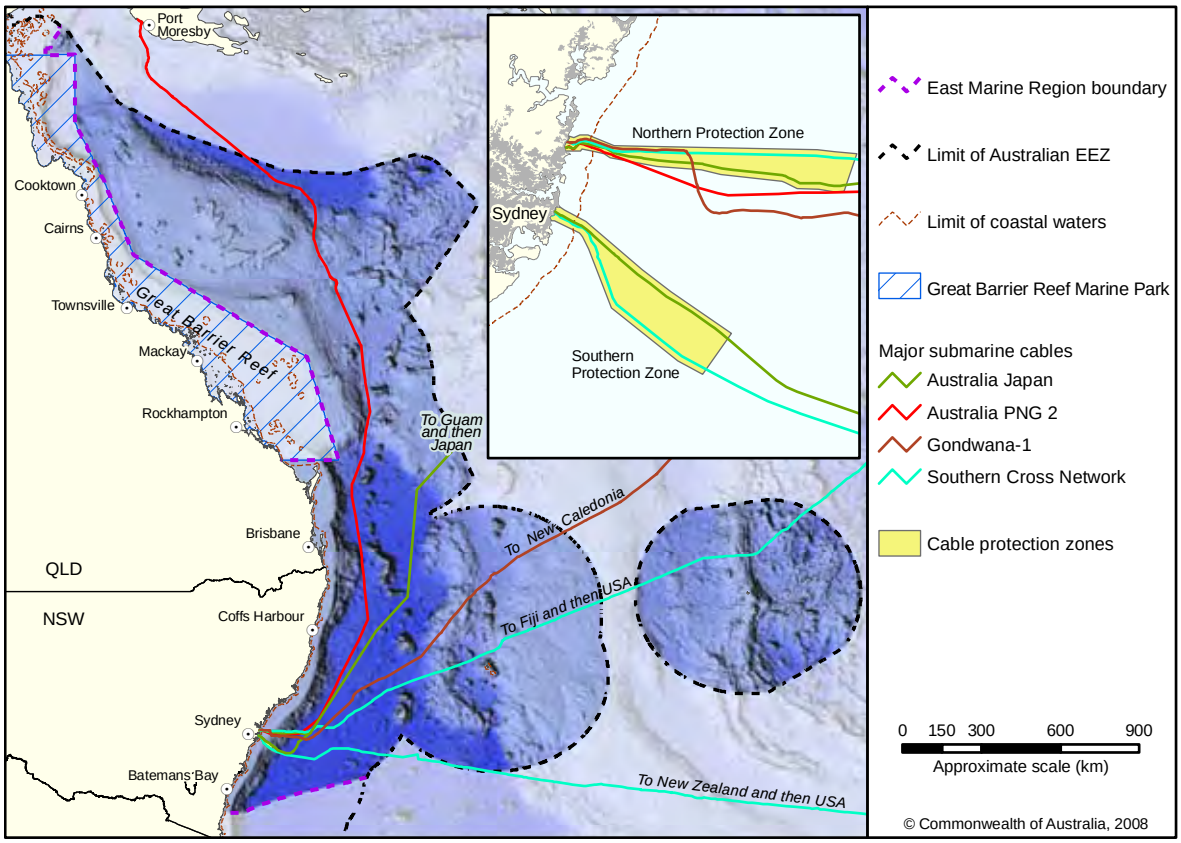
Dumping sites are now all charted to minimise incidence of snagging by trawlers and ship collisions. In addition, the 1996 Protocol to the London Convention (1972) provides further regulation on the nature of materials allowed to be dumped at sea, so helping to minimise the environmental impacts of ocean waste disposal.

5.2.10 Submarine cables

Communications cables are the only form of submarine cable within the Region. They include cables of national significance and several out-of-service cables.

Three operational cables dissect the East Marine Planning Region, being the Australia–Japan Cable, the Southern Cross Cable and the Tasman 2 Cable. The first two support most of the voice and data traffic and are vital to Australia's national infrastructure. Because submarine cables are vulnerable to damage by commercial fishing activities such as trawling by large vessels, potentially leading to significant data and financial losses and serious delays in the flow of information to and from Australia, the government introduced the *Telecommunications and Other Legislation Amendment (Protection of Submarine Cables and Other Measures) Act 2005*. This has allowed the Australian Communications and Media Authority (ACMA) to propose protection zones over those

Figure 5.9 Major submarine cables in the East Marine Region



cables of national significance, effectively prohibiting or restricting activities that may cause damage to cables one nautical mile either side of the cable.

All three operational cables within the East Marine Planning Region are linked to Sydney (see figure 5.9). The Australia– Japan Cable links Sydney to Guam and Japan and has been in service since December 2001. It divides into two about 150 km off the NSW coast with branches landing on the southern and northern sides of Sydney. The Southern Cross Cable consists of two cable routes, one linking Sydney to USA via New Zealand and the other linking Sydney to the USA via Fiji.

The Australia–Japan Cable and the Southern Cross Cable are cables of national significance leading to ACMA proposing protection zones above them (ACMA 2006). The Tasman 2 cable is a 2195 km-long communications cable that has been operational between Sydney and Auckland since March 1992. It is not considered a cable of national significance. Sixteen other cables are located within the Region, none of which are in service.

Australia's submarine communications cables carry approximately 99% of the international voice and data traffic and are estimated to be worth more than $5 billion yearly to the national economy (ACMA 2006). Australia's bandwidth use tripled in the period between 2004 and 2006 to 157 gigabytes per second (GB/s).

The Australia–Japan Cable and the Southern Cross Cable network are considered to be of particularly high economic value due to the linkages with Japan, the United States and New Zealand, some of Australia's most significant trading partners (ACMA 2006).

While there is limited information on the effect of laying and maintaining submarine cables, evidence suggests some installation methods could potentially cause adverse effects on the near shore environment including geomorphic alterations and seagrass loss (Austin et al. 2004). However, it is envisaged that with the introduction of cable protection zones, a secondary benefit would include the protection of marine organisms through the exclusion of fishing and other activities that impact on habitats. In addition, older, obsolete and unburied submarine cables attract a variety of species through the provision of habitat and may be utilised in artificial reef construction (Wagner 1994).

Submarine telecommunication cables are typically 69 mm in width and weigh about 10 000 kg per kilometre (Johnson 2008). Optical fibres are sealed inside a copper sleeve that is resistant to deepwater environmental effects and cables are typically dual-armoured with layers of protective steel

Scientists work on the deployment of the towed stereo video camera array, which is capable of working at depths of over 1500m, from the RV Southern Surveyor. Image courtesy of CSIRO.

wires. A negative-buoyancy material is often added to the cables to ensure that they will rest on the seabed (Alwayn 2004).

5.2.11 Emerging industries and research

Australia's marine resources provide a number of opportunities for emerging industries due to the vastness of the ocean and its high biodiversity, including biodiscovery and renewable energy.

Marine biodiscovery

Biodiscovery is the investigation of biological resources such as plants and animals, for properties or characteristics that have a commercial value or some other wider application. Products such as drugs, agrichemicals and industrial enzymes may be created from biological resources and used in a number of applications (Prime Minister's Science Engineering and Innovation Council 2005).

Marine organisms have few physical defence mechanisms and therefore protect themselves by chemical means. As such, many organisms produce venoms, antifouling agents and other biochemical agents that may be utilised for commercial and biomedical applications (Volkman 1999). Their discovery may result in better vaccines, faster diagnosis of diseases, better quality foods and more environmentally friendly products. Sea sponges and other invertebrates, as well as marine algae, have been some of the most common sources for extracts used in pharmaceuticals.

Renewable Energy

Australia relies heavily upon non-renewable energy sources to provide electrical power to the population. As the consumption of fossil fuels including oil, gas and coal continues, the availability of hydrocarbons required for power generation is reduced and the emission of greenhouse gases increases. Consequently government and industry are investing in energy from renewable sources for future generations. Renewable energies such as wind, solar, wave, tidal, biomass and hydro energy have also become increasingly popular due to concerns about greenhouse gas emissions that are linked with causing climate change.

Marine-based renewable energy in and around the East Marine Region is currently limited to the coastal environment within state waters of New South Wales. Australia's first wave energy system has been installed at the breakwater wall at Port Kembla near Wollongong. The Port Kembla Wave Energy Plant, incorporating a wave energy generator developed by Energetech Australia Pty Ltd (now Oceanlinx Limited), has proved highly successful, with connection to the main power system forecast for the near future. Trials have shown the turbine system capable of producing 1 GWh of electricity per year.

5.3 Indigenous activities

Traditionally, the Indigenous people managed the marine environment through rights and responsibilities granted to them by their laws and customs and through an intimate knowledge of the ocean environment. This knowledge protected marine ecosystems from over-exploitation and ensured the sustainable use of marine resources.

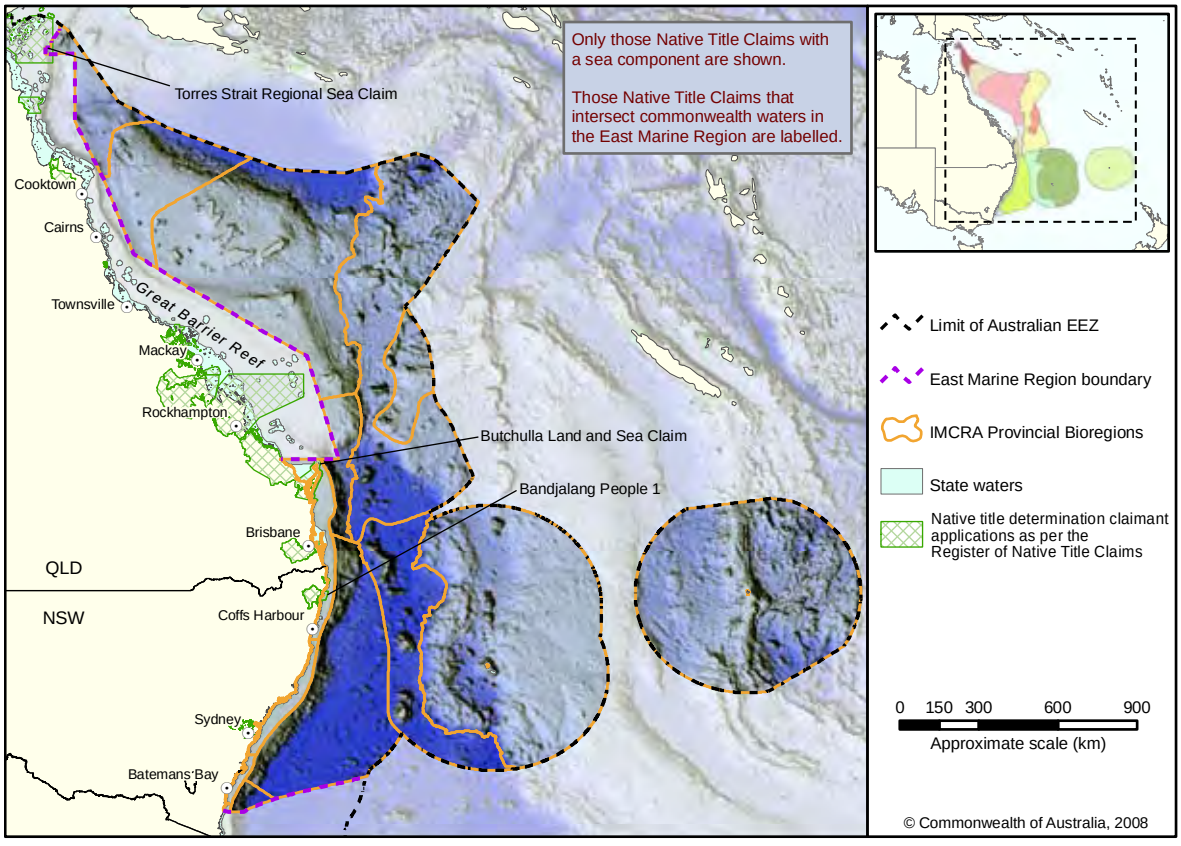
The Indigenous people approached the management of oceans resources in a very different manner to the European settlers. The subsistence economy of the Indigenous people involved taking only enough from the environment to provide for the needs of the family and community, rather than the industrial scale removal of fish for commerce and trade. Although current fisheries management practice has impacted on the ability of the Indigenous people to access traditional foods in this manner, fish remains a major source of protein for coastal Indigenous communities (Barnett and Ceccarelli 2007).

The primary Indigenous resource use in the offshore environment of the Region is fishing. There are few comprehensive surveys of Indigenous fishing activities available. The National Recreational and Indigenous Fishing Survey 2003, and another survey have been conducted in the vicinity of the Region. This other survey in far north Queensland found that 93.3 per cent of the local Indigenous community participated in fishing activities. About five per cent of that activity took place more than five kilometres offshore in the Great Barrier Reef Marine Park. Although none of this activity took place within the Region, it does demonstrate that the Indigenous people use and access resources in offshore environments (Barnett and Ceccarelli 2007).

Other important species that are traditionally collected in and around the Region and are used by the Indigenous people for cultural or subsistence purposes include shellfish, crabs, lobsters, prawns, turtles, seals, dugongs and mutton birds (Barnett and Ceccarelli 2007).

Aside from utilising the resources of the sea, Indigenous people have a strong cultural connection to the marine environment. Traditional stories and oral histories relating to the waters in and around the Region have been documented and speak of a strong spiritual connection with the sea, describing ancestral origins from sea animals, flooded ancestral sites and the totemic relationship with species such as whales, dolphins and turtles. The exact nature of such traditions vary between different Indigenous communities of the east coast of Australia, however it is clear that the waters of the Region are culturally important to Indigenous people (Barnett and Ceccarelli 2007).

Figure 5.10 Native title claims in waters adjacent to the East Marine Region



Coastal Indigenous peoples of the Region consider their sea country to encompass waters from the coastline to the horizon and sometimes beyond (see appendix B for a description of the native title regime in Australia). There are 27 active native title determination claimant applications as per the Schedule (Federal Court), 24 of which have been entered onto the Register of Native Title Claims. Three of the registered native title determination claimant applications include Commonwealth waters of the East Marine Region, and the other registered and active native title determination claimant applications include sea[12] adjacent to the East Marine Region.

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Map data

Figures 5.1 and 5.10

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Lord Howe Island Group. Photo: Ian Hutton and the Department of the Environment, Water, Heritage and the Arts.

Chapter 6 Developing an East Marine Bioregional Plan: Next Steps

This Bioregional Profile describes the characteristics and conservation values of the East Marine Region and the adjacent coastal waters and land. This information will guide development of a Draft Marine Bioregional Plan for the Region.

The Region encompasses a vast area of ocean spanning 2.4 million km², crossing tropical and temperate waters and extending many hundreds of kilometres from the mainland to include the seas around Norfolk and Lord Howe Islands. The Region is characterised by high variability in habitats, species, climate, oceanography and geomorphology.

The tropical north of the Region is dominated by the warm, shallow waters of the Coral Sea. Corals and other autotrophic species dominate the shallow Queensland Plateau and the many scattered and diverse reefs and atolls of the Coral Sea. These waters are home to sharks, tuna, billfish, turtles, parrotfish and a range of other ecologically important species.

The temperate south of the Region is characterised by a short continental shelf sloping sharply down to large, deep abyssal plains stretching across the floor of the Tasman Sea. Three parallel ranges of seamounts cross the deep sea plains in north-south lines: the Tasmantids, Lord Howe Rise and the Norfolk Ridge. The seamounts of this area are biological islands – home to corals, sponges and brittle stars, and supporting many other species. Whales, turtles and large predator fish, such as tuna and billfish, pass through the area feeding on squid and other prey.

The primary ecological driver of the Region is the East Australian Current (EAC). The EAC begins in the tropical north of the Region and carries warm water south throughout the length of the Region. Off the northern New South Wales coast, an arm of the current spirals out into the Tasman Sea, spawning a series of eddies and gyres and extending past Lord Howe Island and out into the Pacific Ocean around Norfolk Island. The East Australian Current provides ecological connectivity throughout the Region and is a major force for the tropical and temperate climate of the east Australian coastline.

One hundred and eight species that are known to occur in the Region are protected under the *Environment Protection and Biodiversity Conservation Act 1999*, as either threatened, migratory, cetacean or listed marine species. Of these, 38 species are listed as threatened, including two critically endangered, eight endangered, 27 vulnerable species and three conservation-dependant species. Nine key ecological features have been identified as playing a significant role in the marine environment of the Region.

The Region shares international borders with Papua New Guinea, the Solomon Islands, New Caledonia (a self-governing territory of France) and New Zealand. The Region also includes a major global shipping lane carrying most of Australia's international trade with Asia, and critical submarine telecommunications cables linking Australia with North America and Asia.

The Region supports a range of human uses and activities including commercial and recreational fishing, tourism, shipping and border protection activities. The Region is also culturally and spiritually important to the Indigenous communities of eastern Australia who have lived in the area for many thousands of years.

The ecosystems of the East Marine Region have been under pressure from human activities longer than any other Region in Australian waters. The Australian economy has been steadily growing over recent decades, based largely on the extraction and utilisation of natural resources. Increased activity in, and increased pressure on, the marine environment of the Region has followed.

Shipping and commercial fishing are the two most economically significant offshore activities occurring in the Region. Although shipping activity in the Region is increasing, it is focussed in narrow shipping lanes, and commercial fishing is declining as a result of reduced catches and rising costs. Human use of the Region is heavily concentrated in a narrow band along the western boundary of the Region adjoining New South Wales and Queensland state waters and the Great Barrier Reef Marine Park. Large, ecologically important areas, such as the Coral Sea and the areas around Lord Howe and Norfolk Islands have been less visited and are believed to remain in much the same condition they were in prior to European settlement of Australia.

Next steps in the planning process

This Marine Bioregional Profile is the first product in the marine bioregional planning process. It forms the information base for development of the Draft Marine Bioregional Plan, the next major product in the process. The development of the Draft Marine Bioregional Plan compromises two major activities:

Pink anemonefish. Photo: Photolibrary.

- the EPBC assessment, which examines the conservation values of the region, analyses the threats to those values, and identifies the most appropriate existing and new measures required to conserve the values to meet the requirements of the EPBC Act; and
- Marine Protected Area development, which identifies representative areas to include in a Marine Protected Area network for the East Marine Region.

The Draft Marine Bioregional Plan will include guidelines for meeting the requirements of the EPBC Act, conservation and protection measures and new actions proposed, including the Marine Protected Area network. The Draft Plan will be released for a period of formal public comment, as required under the EPBC Act. A final Marine Bioregional Plan will then be developed for consideration and approval by the Minister for the Environment, Heritage and the Arts.

Once finalised, the Minister will be guided by the final Marine Bioregional Plan in all decisions made under the EPBC Act for which the Plan has relevance. The release of the final Plan will also trigger a further formal consultation process for declaration of the Marine Protected Area network.

Linkages with state and territory planning

Although marine bioregional planning is an Australian Government program undertaken under Commonwealth legislation, the planning process occurs in consultation with State and Territory governments. This consultation is important because the governments of Queensland and New South Wales are also undertaking planning and Marine Protected Area development processes in state waters.

Consultation during the planning process

Consultation with stakeholders will focus on issues and activities relevant to the East Marine Region. Workshops will be held early, mid-way and late in the process of developing the Draft Marine Bioregional Plan to provide an update on progress and to discuss and seek feedback on planning approaches. In addition to these workshops, the Department of the Environment, Water, Heritage and the Arts will also undertake consultation with stakeholders or sectors on specific aspects of the planning process.

As the Draft Plan is being prepared under the EPBC Act, consultations with stakeholders will be undertaken in accordance with the requirements of the Act and its Regulations. The consultation phase will last at least 60 days, during which the Department will contact stakeholders and hold public meetings where needed to facilitate and discuss feedback on the Draft Plan.

Views expressed by stakeholders during this time will be considered by the Government before the Bioregional Plan is finalised and adopted for the Region.

At a national scale, information sessions will be organised for key national stakeholder groups as necessary. At these sessions, the Department will provide a general briefing on the progress of the marine bioregional planning process across Australian waters. If required, the Department will also meet with national stakeholder groups to address specific national issues relevant to the marine bioregional planning process.

Statutory consultation on the candidate Marine Protected Area network

Once the Minister has adopted the final Marine Bioregional Plan, the declaration process for the proposed Marine Protected Area network will commence. The consultation process will include:

- a 60 day period inviting public submissions on the proposed declaration;

Yacht in the Rolex Sydney to Hobart Yacht Race 2005. Photo: Carlo Borlenghi / Rolex.

- preparation of a report by the Director of National Parks for the Minister for the Environment, Heritage and the Arts that includes each submission received and the Director's views on each;
- preparation of a Regulation Impact Statement approved by the Office of Best Practice Regulation; and
- development of interim management arrangements in discussion with key stakeholder groups.

Following declaration of the Marine Protected Area network, the process for determining how the new Marine Protected Areas will be managed begins. Two rounds of consultation will occur as the management plan for each Marine Protected Area is developed. The first round of consultation will be a public invitation to comment on a proposal to prepare a draft management plan for a particular Marine Protected Area, and the second round will involve a public invitation to comment on the draft management plan prepared for a particular Marine Protected Area.

More information and feedback

Further information and updates on the marine bioregional planning process for the East Marine Region can be found on the website <www.environment.gov.au/coasts/mbp/east>.

The Department welcomes comments on the Bioregional Profile and any additional information that may assist in developing the East Marine Bioregional Plan. Comments and additional information can be sent by email to eastmarineplan@environment.gov.au or by post to:

The Director
Temperate East Marine Conservation
Department of the Environment, Water,
Heritage and the Arts
Edgar Waite Building
203 Channel Highway
Kingston Tasmania 7050

Hermit crabs, Lihou Reef, Coral Sea. Image courtesy of the Australian Institute of Marine Science.

Appendix A International conventions and agreements on the marine environment

Australia's use and management of its oceans and their resources are subject to a range of international treaties to which Australia is a party. These can be broadly divided into three categories: those concerned with regulating activities to protect the marine environment; those relating specifically to conservation of biodiversity; and those relating to the management of shipping. The following sections outline the main international agreements that influence Australia's management.

Australia has also signed a number of international agreements that are not yet in force. They are:

- *International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004;*
- *International Convention for the Control and Management of Harmful Anti-fouling System on Ships 2001*; and
- *The International Convention on Civil Liability for Bunker Oil Pollution Damage 2001*.

International agreements regulating maritime activities including those to protect the marine environment

The convention establishing the International Maritime Organization (IMO) was adopted in Geneva in 1948 and IMO first met in 1959. Australia has been a signatory to the convention since its inception. IMO's main task has been to develop and maintain a comprehensive regulatory framework for shipping and its remit today includes safety, environmental concerns, legal matters, technical co-operation, maritime security and the efficiency of shipping.

IMO, a specialised agency of the United Nations with 167 Member States and three Associate Members, is based in the United Kingdom with around 300 international staff. IMO's specialised committees and sub-committees work to update existing legislation or develop and adopt new regulations, with meetings attended by maritime experts from Member Governments and those from interested intergovernmental and non-governmental organisations.

The result is a comprehensive body of international conventions, supported by hundreds of recommendations governing every facet of shipping. There are, firstly, measures aimed at the prevention of accidents, including standards for ship design, construction, equipment, operation and manning – key treaties include Safety of Life At Sea (SOLAS) – and, secondly, the MARPOL convention for the prevention of pollution by ships (discussed below).

United Nations Convention on the Law of the Sea 1982

The Australian Government has rights and responsibilities under the *United Nations Convention on the Law of the Sea 1982* (UNCLOS) to manage seas adjacent to its coastline. Under UNCLOS, coastal states are able to claim rights and responsibilities for seas out to 200 nautical miles from the coast, and to the edge of the continental shelf. Within this area coastal nations can exploit, develop, manage and conserve all resources associated with the water column, seabed or subsoil. Under UNCLOS all Parties have an obligation to conserve the marine environment, including on the high seas (*inter alia* articles 61-65 inclusive and article 119).

Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks 1995 (Fish Stocks Agreement)

This implementing agreement to UNCLOS provides additional and enhanced rules on the conservation and management of highly migratory and straddling fish stocks that occur on the high seas and within areas of national jurisdiction. The Fish Stocks Agreement promotes cooperation with other States Parties, particularly through the establishment of regional fisheries management bodies. The Fish Stocks Agreement also includes application of the precautionary approach and requires consideration of impacts on the broader ecosystem.

Convention relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 and the 1973 Protocol to the Convention.

This convention affirms the right of coastal States to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate danger to their coastline

or related interests from pollution by oil, or the threat thereof, following upon a maritime casualty. The 1973 Protocol extended the convention to cover substances other than oil.

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) 1972 and the 1996 Protocol to the Convention

Under this convention, dumping is defined as deliberate disposal of wastes or other matter in the sea that does not constitute normal operations. The convention has been updated by the *1996 Protocol to the Convention* (the London Protocol), which Australia ratified in 2000, and which entered into force internationally in 2006. The convention is implemented in Australia under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Environment Protection (Sea Dumping) Act 1981*, which have been amended to reflect the London Protocol. These Acts require permits to be issued for the dumping of materials at sea.

Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention) 1972

This convention, which came into force in 1975, provides for the protection of the world's cultural and natural heritage places. The convention is administered by the World Heritage Committee whose functions are to:

- identify nominated cultural and natural properties of outstanding universal value, which are to be protected under the convention and to list them on the World Heritage List;
- decide if properties on the list should be inscribed on the List of World Heritage in Danger; and
- determine how and under what conditions the World Heritage Fund can be used to assist countries in the protection of their World Heritage property.

Under the EPBC Act, the Commonwealth of Australia has the power to submit properties for inclusion on the World Heritage List. This power may be exercised if the Minister for the Environment, Heritage and the Arts is satisfied that the Commonwealth has endeavoured to reach agreement on the listing and management arrangements for the property with the owner or occupier of the property as well as the State or Territory Government in which the property is located.

International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL)

Under the terms of this convention regulatory controls were placed on operational waste from ships. The convention has six Annexes that specifically address different types of pollution from shipping by prohibitions and/or controlling the discharge through:

- Annex I that addresses the discharge of oil and oil mixtures;
- Annex II that addresses the discharge or escape of noxious liquid substances (i.e. chemicals);
- Annex III that addresses harmful substances carried in packaged forms (i.e. freight containers);
- Annex IV that addresses the discharge of sewage;
- Annex V that addresses the discharge of garbage; and
- Annex VI that addresses air emissions.

International Convention on Oil Pollution Preparedness, Response and Cooperation 1990

This convention facilitates international cooperation to prepare for and respond to major oil pollution incidents and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. In Australia the provisions of the convention are given effect through administrative arrangements of the Australian Maritime Safety Authority and other Government agencies.

International Convention on Civil Liability for Oil Pollution Damage 1992

This convention requires oil tankers to have compulsory insurance against pollution damage liabilities. The convention applies to an oil spill occurring in the territory, including the territorial sea and the Exclusive Economic Zone (EEZ), of Australia, and sets the upper limits of liability, which depend on the size of the vessel.

International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992

This convention applies if the cost for a clean-up of an oil spill exceeds the upper limit of liability set under the *International Convention on Civil Liability for Oil Pollution Damage 1969*. Under the convention, oil importing companies in member states are invoiced to pay damages and to cover the clean-up costs of oil spills.

The International Convention for the Control and Management of Harmful Anti-Fouling Systems on Ships 2001

This convention requires parties to the convention to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a party.

Regional Fisheries Management Organisations

The Australian Government Department of Agriculture, Fisheries and Forestry develops policies and programs to address Australia's international rights and obligations, and represents Australia's interests in a number of international fora. Chief amongst these are Regional Fisheries Management Organisations, which have been established to govern the management of fish stocks.

Commission for the Conservation of Southern Bluefin Tuna 1994

The *Convention for the Conservation of Southern Bluefin Tuna* formalised the management arrangements between Australia, Japan and New Zealand that had been established on a voluntary basis. The convention created the *Commission for the Conservation of Southern Bluefin Tuna* (CCSBT). The Republic of Korea, Indonesia and the Fishing Entity of Taiwan have since joined the Commission. Cooperating Non-Members participate fully in the business of the CCSBT but cannot vote. Since 2003 the Philippines, South Africa and the European Community have been formally accepted as Cooperating Non-Members. The Commission establishes binding conservation and management measures for the southern bluefin tuna fishery, including a total allowable catch and national allocations. A range of monitoring, control and surveillance measures are being developed by the Commission. The Commission also considers issues related to the impact of the fishery on ecologically related species.

Other fisheries arrangements

Australia also participates in a number of fora that aim to promote regional development through sustainable fisheries management. These include:

- the Food and Agriculture Organization of the United Nations (FAO), through its **Committee on Fisheries**;
- the **Asia–Pacific Economic Cooperation (APEC) Fisheries Working Group**; and

Japanese southern bluefin tuna market. Image courtesy of CSIRO.

- **Pacific Fisheries Fora**, including Australia's involvement in the Pacific Island Countries–US Treaty.

To promote regional fisheries cooperation, Australia maintains a strong and productive dialogue with its close neighbours. Australia conducts bilateral meetings with its neighbours to tackle issues such as shared and highly migratory fish stock management, illegal, unreported and unregulated fishing, and aquaculture development. There are also a number of bilateral agreements or arrangements between Australia and neighbouring countries to ensure the sustainable use of shared resources. The neighbouring countries with which Australia shares cooperative ties include Indonesia, East Timor, Papua New Guinea (including Torres Strait issues), and New Zealand.

There are also several overarching multilateral agreements and arrangements to which Australia is a signatory or a party. These include:

- *United Nations Convention on the Law of the Sea 1982* (UNCLOS);
- *Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea* of 10 December 1982 relating to the *Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks* (UN Fish Stock Agreement);

- *FAO's Code of Conduct for Responsible Fisheries*; and
- *Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas* (Compliance Agreement).

International Agreements for the conservation of biodiversity

International Convention for the Regulation of Whaling 1946

This convention was signed on 2 December 1946 to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry. Over the decades, most member countries have abandoned whaling, but have continued to view the International Whaling Commission (IWC) as the best forum to focus on the conservation of whales. For over 26 years the Australian Government has pursued, through the IWC, a permanent international ban on commercial whaling and worldwide protection for all cetaceans.

Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES)

This convention aims to ensure that international trade in specimens of wild animal and plant species does not threaten their survival. CITES works by providing a legalling binding framework whereby Parties adopt their own legislation to implement CITES measures at the national level. The convention also allows Parties to adopt national legislation that is stricter than CITES measures.

All international trade – imports, exports, re-exports and introduction – of species listed under the convention is controlled through a licensing system. The species covered by CITES are listed in three appendices, according to the degree of protection they require. Appendix I includes species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled to avoid exploitation that could threaten their survival. Appendix III lists species that are protected in at least one country, which have asked other CITES Parties for assistance in controlling the trade.

Bilateral Migratory Bird Agreements

For nearly 30 years, Australia has played an important role in international cooperation to conserve migratory birds in the East Asian–Australasian Flyway, which stretches from Alaska and the east of Russia, through the countries of East and South East Asia, to Australia and New Zealand. Australia has negotiated and entered into bilateral agreements with Japan, China and Korea to protect migratory birds. These agreements are:

- *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA);
- *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA); and
- *Republic of Korea–Australia Migratory Bird Agreement 2007* (ROKAMBA).

The Partnership for the Conservation of Migratory Waterbirds and the Sustainable Use of their Habitats in the East Asian – Australasian Flyway

Launched in Bogor, Indonesia on 6 November 2006, this partnership represents an important new step in international efforts to conserve migratory waterbirds and their habitats in the flyway. Established as a Type II partnership initiative of the 2002 World Summit on Sustainable Development, the partnership is the major international framework for the conservation of migratory waterbirds in the East Asian–Australasian Flyway, promoting dialogue, cooperation and collaboration between stakeholders. To date, the partnership has been endorsed by 17 governments and organisations.

Convention on Wetlands of International Importance 1971

This convention was the first modern inter-governmental treaty aiming to conserve natural resources. The signing of the convention took place in 1971 in the small Iranian town of Ramsar. Since then, the convention has been known as the Ramsar Convention.

Australia was one of the first nations to become a Contracting Party to the Ramsar Convention. There are now more than 150 Contracting Parties to the convention who have designated more than 1650 wetland sites throughout the world to the Ramsar List of Wetlands of International Importance.

Australia currently has 65 Wetlands of International Importance listed under the Ramsar Convention covering approximately 7.5 million hectares. In the East Marine Region RAMSAR-designated areas include the Coringa-Herald and Lihou Reefs and the Elizabeth and MiddletonReefs (both Commonwealth Reserves) and the Elizabeth and Middleton Reefs Marine National Nature Reserve.

Agreement on the Conservation of Albatross and Petrels (ACAP)

This is a multilateral agreement which seeks to conserve albatrosses and petrels throughout the Southern Hemisphere by co-ordinating international activity to mitigate known threats populations, both at sea and on land. ACAP, which was developed under the auspices of the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS) came into force on 1 February 2004.

Albatrosses and petrels are amongst the most endangered species in the world. Presently, there are 19 albatross and 7 petrel species protected under ACAP. Of these, five albatross and three petrel species breed in Australia and another 14 species are either known to occur, or potentially occur, in Australian waters. Many of these species regularly range through the southern half of the East Marine Region and have an established history of vulnerability to mortality arising from interactions with fishing activities in Australian waters. Seabird bycatch mitigation measures are mandatory south of 25° South for longline fisheries in the East Marine Region managed by the Australian Government.

The Convention on the Conservation of Migratory Species of Wild Animals 1979 (CMS or the Bonn Convention)

This Convention aims to conserve terrestrial, marine and avian migratory species throughout their range. The convention has two Appendices: Appendix I lists migratory species that have been categorised as being in danger of extinction throughout all or a significant portion of their range; Appendix II is for migratory species that have an unfavourable conservation status and would benefit significantly from international cooperation. For species listed under Appendix I, signatory nations strive to take action to protect these animals, conserve or restore the places where they live, mitigate obstacles to migration and control other factors that might endanger them. For species listed under Appendix II, the Convention encourages the development of regional conservation instruments.

Since becoming a party to the CMS in 1991, Australia has been an active participant in implementing the Convention through the development of regional conservation instruments under the CMS. Australia played a key role in the development of the *Agreement for the Conservation of Albatross and Petrels* (ACAP) and the *Indian Ocean and South-East Asian Memorandum of Understanding for Sea Turtles* (IOSEA-Turtles), and has supported implementation of measures in the agreements since they were finalised. For instance, the Australian Government hosted and provided the interim Secretariat of ACAP from its inception until 2007; since then the interim Secretariat has been funded by ACAP Parties and it is expected that the permanent Secretariat and headquarters will be established in Australia in due course. Australia has also taken the lead in the development of new regional conservation arrangements for marine mammals in the South Pacific. All species listed under the CMS that naturally occur in Australia are listed under the EPBC Act and thereby protected.

Convention on Biological Diversity 1992

Australia is a signatory to this convention, which was formulated at the 1992 Earth Summit in Rio de Janeiro. The convention has three main goals: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits from the use of genetic resources. A significant provision of the convention is the requirement that environmental impact assessments be performed for proposed activities likely to have significant adverse impacts on the environment. The EPBC Act is the mechanism by which the Australian Government undertakes this provision of the convention.

Convention on Conservation of Nature in the South Pacific 1976 (Apia Convention)

The Apia Convention establishes a broad framework for nature conservation in the South Pacific region, particularly in relation to migratory and endangered species and the preservation and management of wildlife habitat and terrestrial ecosystems. The convention entered into force on 26 June 1990.

Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP) 1986 and related protocols (two)

This convention is a comprehensive, umbrella agreement for protection, management and development of the marine and coastal environments of the South Pacific region. It lists sources of pollution that require control

and identifies environmental management issues requiring regional cooperation. It came into force generally on 22 August 1990.

SPREP Protocol concerning Cooperation in Combating Pollution Emergencies in the South Pacific Region 1986

This protocol is designed to enhance cooperation among Parties in order to protect the South Pacific region from threats and effects of pollution incidents. It came into force generally on 22 August 1990.

SPREP Protocol for the Prevention of Pollution of the South Pacific Region by Dumping 1986

The SREP Protocol is designed to prevent, reduce and control pollution by dumped wastes and other matter in the South Pacific. It came into force generally on 22 August 1990.

Other Bilateral or Multilateral Arrangements

The UNFCCC and *Bilateral Climate Change Partnership Programme* are specifically relevant to the East Marine Region as some of the network of climate monitoring stations that contribute to international climate reporting, are located within the Region. Coral reef research within the Coral Sea Islands Territory and the Great Barrier Reef also contributes to global knowledge on the impact of climate change on tropical marine systems.

The United Nations Framework Convention on Climate Change (UNFCCC)

The *UNFCCC* provides the basis for global action 'to protect the climate system for present and future generations'. Negotiated between 1990 and 1992, the UNFCCC was adopted in May 1992 and opened for signatures a month later at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil.

Australia ratified the convention in December 1992 – one of the first countries to do so. The convention came into force in 1994 after the requisite 50 countries had ratified it. There are now 186 Parties to the UNFCCC – almost all of the members of the United Nations. Parties to the convention have agreed to work towards achieving the convention's ultimate aim of stabilising 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'.

Bilateral Climate Change Partnership Programme

Australia aims to achieve or facilitate emission reductions through this program. Arrangements for bilateral cooperation are currently in place with the United States, China, New Zealand, the European Union, Japan and South Africa. Specific actions include:

- build support for an effective global response to climate change;
- improve scientific understanding of climate change;
- build capacity to enable implementation of mitigation and adaptation programs;
- facilitate market opportunities for greenhouse technologies, products and expertise from Australia and partner countries, thereby expanding the capacity for climate change action; and
- foster direct involvement by industry, business, scientists and communities in bilateral projects to broaden participation in climate change action.

Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) 1980

The CCAMLR is part of the Antarctic Treaty system. It was established to prevent over-exploitation of a key Southern Ocean prey species, Antarctic krill, in part to ensure that exploitation of krill did not inhibit the recovery of whale and seal populations that were onto the brink of extinction. The objective of the CCAMLR is the conservation of Antarctic marine living resources and, for the purposes of the convention, the term "conservation" includes rational use. The convention outlines three principles of conservation which must be achieved when harvesting is considered. These principles seek to ensure that ecological relationships are maintained and that any changes in the marine ecosystem are not irreversible, and prevented or minimised.

Convention for the Conservation of Antarctic Seals (CCAS) 1972

Like the CCAMLR, CCAS is part of the Antarctic Treaty system. It was established to provide a means to regulate commercial sealing in the Southern Ocean should such an industry ever be resumed, as Southern elephant seals and Antarctic fur seals had been reduced to near extinction previously. Although there have been no sealing activities since CCAS came into force, the convention provides for such activities to be undertaken sustainably.

Key References and Further Readings

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Yacht in the Rolex Sydney to Hobart Yacht Race 2005. Photo: Carlo Borlenghi / Rolex.

Appendix B An overview of the legislative framework for environmental protection and biodiversity conservation in Commonwealth waters

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), streamlines national environmental assessment and approvals processes, protects Australian biodiversity and integrates the management of important natural and cultural places. Alongside the EPBC Act, the *Environment Protection (Sea Dumping) Act 1981* (Sea Dumping Act) and the *Historic Shipwrecks Act 1976* are the main pieces of legislation that give effect to the Australian Government's responsibilities to protect and conserve the environmental and heritage assets that exist in Commonwealth waters. Like the EPBC Act, these Acts are also the responsibility of the Minister for the Environment, Heritage and the Arts.

Other key pieces of legislation and regulations that include provisions for the protection of the environment are the *Petroleum (Submerged Lands) (Management of Environment) Regulations 1999*, made under the *Petroleum (Submerged Lands) Act 1967*, the *Fisheries Management Act* 1992, the *Great Barrier Reef Marine Park Act 1975*, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and the *Sea Installations Act 1987*. In addition, the *Native Title Act 1993* interacts with the EPBC Act in areas of environmental protection.

Appendix B summarises the legislative context in which marine bioregional planning takes place.

The EPBC Act

Marine Bioregional Planning

Marine Bioregional Plans are being developed for the Commonwealth marine area under section 176 of the EPBC Act. The Commonwealth marine area generally stretches from three nautical miles to 200 nautical miles from the coast, see Box B1.

The States and the Northern Territory are responsible for managing the marine environment in State and Northern Territory coastal waters. Coastal waters are a belt of water between the territorial sea baseline (normally the low water mark along the coast), and a line three nautical miles seaward of the territorial sea baseline. As many ecological processes occur across both State and Commonwealth waters, the Australian Government aims to work cooperatively with the States and the Northern Territory in developing and implementing Marine Bioregional Plans.

Box B1: The Commonwealth marine area

The Commonwealth marine area is defined in the EPBC Act as any part of the sea, including the waters, seabed and airspace, within Australia's EEZ and/or over the continental shelf of Australia, excluding State and Northern Territory coastal waters. Generally, the Commonwealth marine area stretches from three nautical miles from the territorial sea baseline (normally the low water mark) to the outer limit of the EEZ, 200 nautical miles from the baseline. It may extend further than 200 nautical miles, to the edge of the continental shelf if this extends beyond the outer limits of the EEZ.

A person must not take an action within the Commonwealth marine area that has, will have, or is likely to have, a significant impact on the environment without approval from the Commonwealth Minister for the Environment, Heritage and the Arts. A person must not take an action outside the Commonwealth marine area that has, will have, or is likely to have, a significant impact on the Commonwealth marine area without approval.

Marine Bioregional Plans will bring together comprehensive information and provide guidance to sectoral managers and industry in relation to decisions made under the EPBC Act about key conservation issues and priorities in each marine region. The EPBC Act requires the Minister for the Environment, Heritage and the Arts where relevant, to have regard to Bioregional Plans when making any decision under the Act. Marine Bioregional Plans also aim to streamline conservation and environmental management and to create Marine Protected Areas in Commonwealth waters that will further the development of the National Representative System of Marine Protected Areas.

The marine bioregional planning program is being undertaken by the Department of the Environment, Water, Heritage and the Arts in consultation with all Commonwealth agencies responsible for marine-based activities, with input from other stakeholders.

Referral, Assessment and Approval

Central to the EPBC Act is the concept of *matters of national environmental significance*. Matters of national environment significance 'trigger' the referral, assessment and approval of activities under the EPBC Act. The EPBC Act requires proposals for actions that have, will have, or are likely to have, a significant impact on a matter of national environmental significance to be referred to the Minister for the Environment, Heritage and the Arts for assessment and approval. This occurs unless some other provision of the EPBC Act allows the action to be taken without this assessment and approval.

The EPBC Act identifies seven matters of national environmental significance:

- World Heritage properties;
- National Heritage places (from 1 January 2004);
- Ramsar wetlands of international significance;
- listed threatened species and ecological communities (excluding species listed as extinct or conservation-dependant);
- listed migratory species;
- the Commonwealth marine environment; and
- nuclear actions (including uranium mining).

Of these, three are particularly relevant to marine bioregional planning: listed threatened species, listed migratory species and the Commonwealth marine environment. Further information on the Commonwealth marine area and its status as a matter of national environmental significance is provided in box B1.

A number of EPBC Act Policy Statements have been developed to provide guidance on when actions should be referred to the Minister for the Environment, Heritage and the Arts. The following EPBC Act Policy Statements provide guidance about the types of actions that should be referred for assessment and approval:

- *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance* (May 2006). These provide proponents of activities in Commonwealth Marine Areas with guidance about whether or not the actions they propose to take will require assessment and approval under the EPBC Act;
- *EPBC Act Policy Statement 1.2 Significant Impact Guidelines – Actions on, or impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (May 2006). These provide guidance on land-based actions which should be referred for approval under the EPBC Act and should be read in conjunction with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance*;
- *Draft EPBC Act Policy Statement 2.1 – Interactions between offshore seismic exploration and whales* (March 2007). This Draft EPBC Act policy statement updates the previous cetacean interaction guidelines, produced in 2001. The policy will be implemented immediately subject to refinement based on operational experience and public and expert comments. The policy statement has been prepared to:
  - provide practical standards to minimise the risk of acoustic injuries to whales in the vicinity of seismic survey operations;
  - provide a framework that minimises the risk of biological consequences to whales from seismic surveys in biologically important habitat areas or during critical behaviour; and
  - provide advice to proponents of offshore seismic operations on their legal responsibilities under the EPBC Act; and
- *EPBC Act Policy Statement 2.2 Industry – Offshore Aquaculture* (August 2006) This provides guidance to proponents of marine aquaculture activities as to whether or not the actions they propose will require assessment and approval under the EPBC Act. These guidelines should be read in conjunction with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance*;

Nationally threatened species and ecological community guidelines have been prepared for a number of land-based threatened species and ecological communities. To date no nationally threatened marine species or ecological community guidelines have been developed.

Copies of the EPBC Act Policy Statements and Guidelines are available at <www.environment.gov.au/epbc/policy>.

Protecting Marine Biodiversity

A number of instruments, measures and programs are in place under the EPBC Act for the protection, conservation and recovery of marine biodiversity. The EPBC Act contains provisions that protect listed threatened species, listed migratory species and listed marine species and cetaceans. Commonly, species listed under the Act are referred to as protected species as it is an offence to kill, injure, take, trade, keep or move a listed species without authorisation. These provisions apply generally in the Commonwealth

marine area (as well as other Commonwealth areas), and to members of species taken in the Commonwealth marine area (as well as other Commonwealth areas) and subsequently moved from the area.

Species listed as threatened under the EPBC Act are those identified as facing serious risk of extinction in the wild (as determined in accordance with criteria specified in the regulations). Under the EPBC Act, listed threatened species must be classified into one of the following six categories: extinct; extinct in the wild; critically endangered; endangered; vulnerable; and conservation-dependent. The EPBC Act also allows for the listing of threatened ecological communities. To date, no ecological communities in the marine environment have been listed under the EPBC Act. The Commonwealth Minister for the Environment, Heritage and the Arts can also identify and list habitat critical to the survival of a listed threatened species or ecological communities, on the Register of Critical Habitat. In relation to threatened species and communities, the EPBC Act also provides for the identification and listing of key threatening processes, the preparation of threat abatement plans and species recovery plans.

All whales, dolphins and porpoises are protected as cetaceans under the EPBC Act, as the Australian Government recognises these species require protection to ensure their conservation. The EPBC Act also established the Australian Whale Sanctuary, which encompasses all Commonwealth waters. Within the Australian Whale Sanctuary, and in waters beyond the outer limits of the Sanctuary, it is an offence to kill, injure or interfere with cetaceans. They are also protected in State and Territory waters.

Migratory species listed under the EPBC Act are species already listed under international agreements to which Australia is a signatory. They are species that require, or would significantly benefit from, international cooperation. Such agreements are discussed in appendix A.

Marine species listed under the EPBC Act are species occurring naturally in the Commonwealth marine area that the Australian Government recognises require protection to ensure their long-term conservation. Species listed as marine species are identified in Section 3.3 of the Act.

In Australia, the EPBC Act controls the international movement of wildlife, wildlife specimens and products made or derived from wildlife. These controls apply to all transactions undertaken by commercial and non-commercial organisations and individuals. In addition, controls under the *Quarantine Act 1908* may apply. Under the EPBC Act a permit is required to:

- import or export CITES-listed specimens. CITES is the *Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973*;
- export specimens derived from native species not included in the list of exempt native specimens; or
- import live plants or animals included in part two of the list of plants and animals suitable for live import. See <www.environment.gov.au/biodiversity/trade-use/permits>.

Commonwealth Marine Reserves

Part 15 of the EPBC Act provides for the declaration of Commonwealth reserves over areas occurring in Commonwealth waters. It sets out the legal requirements for establishing and managing Commonwealth reserves, which include Marine Protected Areas. The EPBC Act also provides for the preparation and enforcement of reserve management plans. Many activities are illegal in Commonwealth reserves unless carried out in accordance with relevant management plans, permits and determinations. Division 12 of the *Environment Protection and Biodiversity Conservation Regulations 2000* details the prohibitions or restrictions on many activities in Commonwealth reserves.

Fisheries Assessments

Under the EPBC Act, the environmental performance of all fisheries managed under Commonwealth legislation, and State-managed fisheries that have an export component, must be assessed. The purpose of the assessment is to ensure that, over time, fisheries are managed in an ecologically sustainable way. *Guidelines for the Ecologically Sustainable Management of Fisheries* outline specific principles and objectives that are used to assess fisheries management arrangements.

Historic Shipwrecks Act 1976

Australia's historic shipwrecks are an invaluable and irreplaceable heritage resource. The *Historic Shipwrecks Act 1976* protects historic wrecks and relics in the territorial sea, including State and Territory coastal waters, and waters above the continental shelf. The Act does not apply to wrecks and relics in internal waters, such as rivers, lakes, bays, harbours of a State. Each of the States has complementary legislation that protects historic shipwrecks in internal waters.

The Historic Shipwrecks Acts 1976 aims to ensure that historic shipwrecks are protected for their heritage values and maintained for recreational and educational purposes. It

also seeks to regulate activities that may result in damage, interference, removal or destruction of an historic shipwreck or associated relic. Divers can use historic shipwreck sites for recreational purposes but relics must not be removed from the wreck site and the physical fabric of the wreck must not be disturbed, unless a permit has been obtained.

Under a declaration made under the *Historic Shipwrecks Act 1976*, all wrecks, known and unknown that are more than 75 years old are protected, together with their associated relics. The Minister for the Environment, Heritage and the Arts can also make a declaration to protect any historically significant wrecks or articles and relics that are less than 75 years old.

The Act requires anyone who finds the remains of a ship, or articles associated with a ship, to give notification of the location as soon as practicable to the Minister for the Environment, Heritage and the Arts.

Some historic shipwrecks lie within protected or no-entry zones. The protected zone can apply to an area of sea and land not exceeding 200 hectares. These zones may cover an area up to a radius of 500 m around a wreck site, and may be declared where circumstances place it at particular risk of interference. This declaration prohibits all entry into this zone without a permit. Permits are also required to undertake any activities otherwise prohibited or restricted by the Act.

The Act is administered by the Australian Government in conjunction with delegates in each of the States, the Northern Territory and on Norfolk Island.

Environment Protection (Sea Dumping) Act 1981

The Environment Protection (Sea Dumping) Act 1981 was enacted to fulfil Australia's international responsibilities under the London Convention of 1972 and has been amended to implement the *1996 Protocol to the London Convention* (London Protocol) that came into force internationally in 2006. The objective of the London Protocol is to prevent and reduce marine pollution resulting from dumping of wastes and other matter.

Under the Sea Dumping Act, Australia prohibits ocean disposal of waste materials considered harmful to the marine environment, and regulates the deliberate loading and dumping of wastes at sea to ensure the environmental impact is minimised. In deciding whether to grant a permit, consideration is given to the type of material proposed to be dumped, the disposal site and the potential impacts on the marine environment.

If the sea dumping activity is likely to have a significant impact on the environment, the Department will also refer the proposal for assessment under the EPBC Act, in accordance with Part 11 of the Act. In such cases the Department will seek to undertake both assessments concurrently.

Permits are required for all sea dumping operations. Currently, about 30 permits are issued in Australia each year, mainly for the dumping of uncontaminated dredged material, disposal of vessels and for burials at sea. A relatively uncommon activity also requiring a permit under the Act is the creation of artificial reefs. The *National Ocean Disposal Guidelines for Dredged Material* (2002) has been prepared to assist applicants for a sea dumping permit with the assessment and management of dredged material.

The Sea Dumping Act, which is administered by the Minister for the Environment, Heritage and the Arts, applies to all Australian waters other than waters within the limits of a State or the Northern Territory such as harbours and river estuaries, from the low water mark out to the edge of the EEZ.

The Act applies to all vessels, aircraft or platforms in Australian waters, other than vessels or aircrafts belonging to the naval, military or air forces of a foreign country, and to all Australian vessels or aircraft in any part of the sea. The Act does not cover operational discharges from ships, such as sewage and galley scraps. Those are regulated by the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, and the *Navigation Act 1912*.

Fisheries Management Act 1991

The *Fisheries Management Act 1991* establishes the Australian Fishing Zone (AFZ) and underpins the domestic compliance and enforcement powers that enable Australia to protect its valuable fishery resources. Under the *Fisheries Management Act 1991* and *Fisheries Administration Act 1991* the Australian Fisheries Management Authority (AFMA) has an obligation to develop plans and implement policy to manage fisheries in the AFZ (waters within the limits of the EEZ, except for State and Territory coastal waters and waters within the limits of a State or Territory). The *Fisheries Management Act 1991* also sets out the legislative basis for statutory fishing rights, licences, and permits.

The *Fisheries Management Act 1991* requires that management plans are prepared for all fisheries unless AFMA has determined that a management plan for a particular fishery is not warranted. Each management plan sets out objectives, measures by which the objectives are to be attained, and criteria against which the success of measures taken may

be assessed. These plans are prepared in consultation with participants in the fishery and made available for public comment before they are finalised.

Section 3(1)(b) of the *Fisheries Management Act 1991* sets out the Australian Government's responsibilities regarding the pursuit of ecologically sustainable development (ESD). The Act thus requires fisheries be managed for the long-term sustainability of fisheries resources, for the benefit of all users and interest groups both now and in the future. This requires that stocks be maintained at a sustainable level and, where necessary, rebuilt to ensure maximum inter-generational equity. It also requires that fisheries management minimise the impact of fishing on biological diversity and ecosystem habitat. The *Fisheries Management Act 1991* interacts with the EPBC Act through the independent assessments required under the EPBC Act.

Petroleum (Submerged Lands) Act 1967

The *Petroleum (Submerged Lands) Act 1967* (PSLA) regulates the exploration and exploitation of offshore petroleum resources in Commonwealth waters.

These activities in State and Northern Territory coastal waters are regulated by relevant State and Territory legislation. Responsibility for petroleum operations in Australia's offshore areas, beyond coastal waters, rests with the Australian Government. The Australian Government and the governments of the States and the Northern Territory jointly administer and supervise industry activities in this area through Joint Authority arrangements.

Sea Installations Act 1987

The Sea Installations Act 1987 provides the legislative basis for the Commonwealth to:

- ensure that sea installations are operated with regard to the safety of the people using them, and the people, vessels and aircraft near them;
- apply appropriate laws in relation to such sea installations; and
- ensure that such sea installations are operated in a manner that is consistent with the protection of the environment.

A sea installation refers to any man-made structure that when in contact, or brought into physical contact with the seabed, or when floating, can be used for an environment-related activity.

An environment-related activity is defined as: any activity relating to tourism or recreation; the carrying on of a business; exploring, exploiting or using the living resources of the sea, sea bed or subsoil of the sea bed; marine archaeology; or any other prescribed activity. Examples of structures that are defined as sea installations include floating hotels, tourism pontoons, artificial islands, oil or gas platforms and submarine power cables. There are also a number of exclusions that are set out under the Act.

The *Sea Installations Act 1987* applies to waters within the limits of the EEZ, or the continental shelf where this extends beyond the EEZ excluding State and Territory coastal waters. It applies from the coast outwards in the case of external Territories.

Proponents wishing to install and/or operate a sea installation must apply for a permit or exemption certificate to the Department of the Environment, Water, Heritage and the Arts, or the Great Barrier Reef Marine Park Authority (GBRMPA).

Applications for permits and exemption certificates will be assessed for environmental implications and safety. If the installation or operation of the installation is likely to have a significant impact on the environment, the Department of the Environment, Water, Heritage and the Arts or the Great Barrier Reef Marine Park Authority will refer the proposal for assessment under the EPBC Act, in accordance with Division 4 of Part 11 of that Act. In such cases the Department seeks to undertake both assessments concurrently.

Native Title Act 1993

The *Native Title Act 1993* (NTA) provides a framework for recognising and protecting native title in Australia. Native title rights and interests are the communal, group, or individual rights and interests of Aboriginal people or Torres Strait Islanders in relation to land or waters. The NTA seeks to regulate acts that have an impact on the native title rights of Indigenous Australians.

The NTA and the EPBC Act

The EPBC Act does not affect the operation of the NTA.

The Department of the Environment, Water, Heritage and the Arts, in administering the EPBC Act, has responsibilities to promote the involvement of Indigenous people and their knowledge of biodiversity in developing strategies for ecologically sustainable development and biodiversity conservation, including through Marine Bioregional Plans

and their associated conservation measures. The Department also has responsibilities under the heritage provisions of the EPBC Act to assess and manage listed Indigenous heritage values, including in the marine environment.

The Application of Native Title Legislation to the Offshore Area

'Offshore' is defined under the NTA as any land or waters other than those lands and waters within the limits of a State or Territory. Section 6 of the Act extends the operation of the NTA to each external Territory, to the coastal sea of Australia and each external Territory, and to any waters over which Australia asserts sovereign rights under the *Seas and Submerged Lands Act 1973*. Under the NTA, coastal sea is defined in accordance with section 15B of the *Acts Interpretation Act 1901*.

The recognition of native title offshore was confirmed in the High Court case of Yarmirr (The Commonwealth v Yarmirr; Yarmirr v Northern Territory [2001] HCA 56 11 October 2001). In this case, the majority of the High Court concluded that non-exclusive native title could exist in offshore areas. **The native rights over areas of water may include the right to use and enjoy the reefs and associated water; the right to hunt and gather, including for dugongs and turtles; and the right to use resources for food, trapping fish, religious, cultural and ceremonial purposes.** Exclusive native title (which would allow the native title holders to control access to the area) was not found to exist because exclusivity of title would be inconsistent with the right of innocent passage under international law, and the common law rights to navigate and fish.

Preservation of Indigenous Fishing Rights

The NTA recognises that there may be Commonwealth, State or Territory laws that could prohibit or restrict native title holders from hunting, fishing, gathering or carrying out cultural and spiritual activities offshore. Under section 211 of the Act, native title holders are not prohibited or restricted from carrying on such activities, or gaining access for those purposes, so long as they are carrying out these activities as an exercise of their native title rights and only for the purpose of satisfying their personal, domestic or non-commercial communal needs. As a result, the relevant law's validity is unimpaired but its operation will be suspended in relation to the exercise of native title rights and interests. This exemption does not apply in relation to legislation aimed at environmental protection, research or public health or safety.

Lord Howe Island Act 1953

Although some 700 km off the mid north coast, Lord Howe Island is part of the State of New South Wales, Australia. Due to its isolation, unique environment and social situation, it is administered by the Lord Howe Island Board.

Unlike the rest of NSW, there is no freehold title, and the island is entirely NSW Crown Land. The island is predominantly forested, has a population of about 350 people, and enjoys a thriving tourism industry. The Lord Howe Island Board is a NSW Statutory Authority established under the *Lord Howe Island Act 1953*, which gives a high level of autonomy to this community.

The Board reports directly to the NSW Minister for Climate Change, Environment and Water, and is charged with the care, control and management of the island. Its responsibilities include:

- protection of World Heritage values;
- development control;
- administration of all Crown Land including the island's protected area;
- managing the Permanent Park Preserve;
- the provision of community services and infrastructure; and
- the delivery of sustainable tourism.

The Board is comprised of seven members, four of whom are elected from the Islander community. The remaining three members are appointed by the Minister to represent the interests of business, tourism and conservation. The full Board meets on the island every three months and, on a day-to-day basis, the affairs of the island are managed by the Board's administration.

Norfolk Island Act 1979

Norfolk Island is a self-governing Australian Territory situated in the South Pacific approximately 1600km north-east of Sydney, 900 km north-east of Lord Howe Island and 1100km north-west of Auckland. It is about 8 km long and 5 km wide with an area of 3455 hectares.

Norfolk Island is an integral part of the Commonwealth of Australia and has been since 1914 when it was accepted into the Federation as an Australian Territory under section 122 of the Australian National Constitution.

The Federal Parliament enacted the Norfolk Island Act 1979 allowing a considerable degree of self-government for the Island's 2000 residents. The Act provides for:

- an Administrator to act as the nominal head of the Norfolk Island Government;
- a Norfolk Island Legislative Assembly able to make laws for the peace, order and good government of the Territory including laws to raise taxes and impose charges;
- an Executive Council or Ministry to be drawn from the Legislative Assembly and appointed by the Administrator on the recommendation of the Assembly;
- the Administrator to act on ministerial advice;
- the Norfolk Island Supreme Court and Norfolk Island's system of laws; and
- a Norfolk Island public service.

The Norfolk Island Legislative Assembly has the power to legislate for all things except coinage, the raising of defence forces, the acquisition of property on other than just terms, and euthanasia.

This means that the Assembly can enact laws on virtually any topic that it chooses, including on matters that are the preserve of the Commonwealth Government elsewhere (such as customs and immigration). Once the Assembly enacts a law, the Norfolk Island Government is equipped with broad executive powers and responsibilities to administer and enforce that law. The Norfolk Island Government is also primarily responsible for the delivery of government services on the Island.

In the preamble to the Act, the Federal Parliament and Government acknowledged the special relationship between Norfolk Island and Norfolk Islanders of Pitcairn Island descent and their desire to maintain their traditions and culture.

The *Norfolk Island Act* establishes the broad framework for Norfolk Island's self-government. The Act itself contains very little by way of specific machinery of government provisions. The intention was that the laws that spell out in detail how the Norfolk Island system of governance will work would generally be laws enacted by the Norfolk Island Legislative Assembly.

Norfolk Island's self-governing status is similar to that of Australia's mainland Territories – the Australian Capital Territory (ACT) and the Northern Territory (NT). The major difference is that the Norfolk Island Government and Legislative Assembly have greater legislative and executive powers and responsibilities - such as in respect of immigration, customs and quarantine.

Coral Sea Islands Act 1969

The Coral Sea Islands Territory was established as a Territory of the Commonwealth in 1969 under the *Coral Sea Islands Act 1969*. The Coral Sea Islands Territory is made up of the islands situated in an area of approximately 780 000 sq km of the Coral Sea extending from the outer edge of the Great Barrier Reef. The coral and sand islands are quite small with some grass and low vegetation cover. There is no fresh water.

The Act was amended in 1997 to extend the boundaries of the Coral Sea Islands Territory around Elizabeth and Middleton Reefs. Elizabeth and Middleton Reefs are 150 km north of Lord Howe Island in the Tasman Sea.

Currently, Commonwealth interest in the Coral Sea Islands Territory is mainly through the Bureau of Meteorology, the Department of the Environment, Water, Heritage and the Arts and the Australian Fisheries Management Authority.

The only permanently inhabited island in the Coral Sea is Willis Island. Willis Island is a Bureau of Meteorology observation station with four staff. Unmanned weather stations beacons and a lighthouse are located on some of the other islands and reefs.

In 1982 Lihou Reef and Coringa-Herald National Nature Reserves were established and are currently managed under the EPBC Act. Elizabeth and Middleton Reefs were declared a Marine National Nature Reserve in 1987 and are also administered under the EPBC Act by the Department of Environment, Water, Heritage and the Arts.

Requests for permission to undertake commercial fishing in areas outside Commonwealth Reserves are referred to the Australian Fisheries Management Authority. Officers of the Department make regular visits to the Coral Sea Islands.

The Royal Australian Navy and the Australian Customs Service also conduct regular sea and aerial surveillance of the area.

Great Barrier Reef Marine Park Authority Act 1975

Both the Great Barrier Reef Marine Park and the Torres Strait (discussed below) are adjacent to the East Marine Region. The associated legislation for these areas, the *Great Barrier Reef Marine Park Act 1975* and the *Torres Strait Fisheries Act 1984*, are included in this appendix because of the interaction within and between the fishing industry and many marine species, across the East Marine Region's boundaries.

The Great Barrier Reef Marine Park is very extensive, covering approximately 345 000 square kilometres, and extending more than 2 300km along the Queensland coast. It is the largest Marine Protected Area in the world (equivalent to the area of Japan). The Great Barrier Reef World Heritage Area extends to the low water mark on the mainland coast, and includes all islands and all waters within the outer boundaries of the Marine Park. In 1975 the Australian Government enacted the *Great Barrier Reef Marine Park Act* that established the Great Barrier Reef Marine Park Authority (GBRMPA) and the Marine Park.

The Great Barrier Reef was declared a World Heritage Area in 1981, internationally recognised for its outstanding natural values, and one of only a few ever nominated for all four natural criteria. It was the first time a listing went beyond the bounds of individual sites and embraced a whole region. The GBRMPA has now been managing the Great Barrier Reef for thirty years.

Torres Strait fisheries

When the management arrangements for Torres Strait Protected Zone Joint Authority (PZJA) fisheries first came into effect in 1985 under the *Torres Strait Fisheries Act 1984*, transferable licences were issued to persons if they could demonstrate the required history of commitment to fishing in Torres Strait.

Since 1985, new licences have only been issued to traditional inhabitants. In different fisheries a number of provisions have also reduced the number of licenses held by non-traditional inhabitants over time.

People who are not traditional inhabitants and wish to obtain a licence for a fishery in Torres Strait must buy one of the transferable licences from an existing operator. These licences are subject to strict boat replacement regulations limiting vessel size. Traditional inhabitants can enter any commercial fishery by obtaining a Traditional Inhabitant Boat (TIB) fishing licence. All licences are issued by the Queensland Department of Primary Industries and Fisheries as delegates of the PZJA.

Until 1999, the PZJA managed those fisheries that Australia and Papua New Guinea (PNG) agreed to jointly manage in the TSPZ, including the prawn, Spanish mackerel, pearl shell, tropical rock lobster, dugong and turtle fisheries and the barramundi fishery in accordance with Commonwealth law in the Australian component of the TSPZ.

In October 1996 the PZJA agreed that all commercial fishing in the Torres Strait should come under PZJA management. The new arrangements were introduced in April 1999 for the following fisheries:

- finfish
- crabs
- trochus
- bêche-de-mer

Recreational fishing, including charter fishing, and marketing are still managed by the Queensland Department of Primary Industries and Fisheries.

Key References and Further Readings

Legislation (Available from the Commonwealth of Australia Law website <www.comlaw.gov.au>

Acts Interpretation Act 1901
Coral Sea Islands Act 1969
Environment Protection and Biodiversity Conservation Act 1999
Environment Protection and Biodiversity Conservation Regulations 2000
Environment Protection (Sea Dumping) Act 1981
Fisheries Administration Act 1991
Fisheries Management Act 1992
Great Barrier Reef Marine Park Act 1975
Historic Shipwrecks Act 1976
Lord Howe Island Act 1953
Native Title Act 1993
Navigation Act 1912
Norfolk Island Act 1979
Petroleum (Submerged Lands) Act 1967
Petroleum (Submerged Lands) (Management of Environment) Regulations 1999
Protection of the Sea (Prevention of Pollution from Ships) Act 1983
Quarantine Act 1908
Sea Installations Act 1987
Seas and Submerged Lands Act 1973
Torres Strait Fisheries Act 1984

Policies and Guidelines

The following EPBC Act policy statements are available from www.environment.gov.au/epbc/policy

Department of the Environment and Heritage, 2001, *EPBC Act Policy Statement 2.1 Significant Impact Guidelines – Interactions Between Offshore Seismic Operations and Larger Cetaceans*, DEH, Canberra.

Department of Environment and Heritage, 2006, *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance*, DEH, Canberra.

Department of the Environment and Heritage, 2006, *EPBC Act Policy Statement 1.2 Significant Impact Guidelines – Actions on, or impacting upon, Commonwealth Land and Actions by Commonwealth Agencies*, DEH, Canberra.

Department of the Environment and Heritage, 2006, *EPBC Act Policy Statement 2.2 Industry Guidelines – Offshore Aquaculture*, DEH, Canberra.

Environment Australia, 2001, *Guidelines for the Ecologically Sustainable Management of Fisheries*, EA, Canberra <www.environment.gov.au/coasts/fisheries/guidelines.html> accessed 10/05/07.

Environment Australia, 2002, National Ocean Disposal Guidelines for Dredged Material, EA, Canberra, <www.environment.gov.au/coasts/pollution/dumping/guidelines/index.htm> accessed 10/05/07.

International agreements:

Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES), <www.cites.org>, accessed 10/05/07.

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention), www.imo.org, accessed 10/7/07.

Wandering albatross. Photo: Dr Michael Double.

Appendix C Nationally protected species in the East Marine Region

Current at March 2008. For updates see <www.environment.gov.au/coasts/mbp/east>.

Species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are commonly referred to as protected species because it is an offence to kill, injure, take, trade, keep or move a listed species without authorisation. Under the EPBC Act, species can be listed as threatened, migratory, cetaceans, or as marine species:

- *Threatened species* are those species that have been identified as being in danger of becoming extinct. Threatened species can be listed as being Extinct; Extinct in the Wild; Critically Endangered; Endangered; Vulnerable; or Conservation Dependant.
- *Migratory species* are those species that are listed under:
  - the Convention on the Conservation of Migratory Species of Wild Animals 1979 (CMS or the Bonn Convention);
  - the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA);
  - the *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA); or
  - the *Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds, 2007* (ROKAMBA); and
  - any other international agreement, or instrument made under other international agreements approved by the Minister for the Environment, Heritage and the Arts.

Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided in appendix A.

- *Cetaceans* – whales, dolphins and porpoises – are protected under the EPBC Act to ensure their long-term conservation.
- *Listed marine species* are those species that the Australian Government recognises as requiring protection to ensure their long-term conservation (in accordance with Section 248 of the EPBC Act). Listed marine species occurring in the East Marine Region include species of:
  - dugongs (Family Dugongidae);
  - seasnakes (Families Hydrophiidae and Laticaudidae);
  - marine turtles (Families Cheloniidae and Dermochelyidae);
  - seahorses, pipehorses, pipefish and seadragons (Families Syngnathidae and Solenostomidae); and
  - birds (seabirds, shorebirds, waterbirds and a number of other coastal or migratory birds that occur naturally in marine environments).

In addition, the EPBC Act regulates the international movement of wildlife and wildlife products, including:

- export of Australian native species other than those identified as exempt;
- export and import of species included in the appendices to the *Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973* (CITES); and
- import of live plants and animals that (if they became established in Australia) could adversely affect native species or their habitats.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Sharks and Rays	White shark (*Carcharodon carcharias*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix I)	Global species found in temperate and sub-tropical seas. Primarily found in the Region south of Moreton Bay.	Known to feed in the Region and may also breed in the Region.	Feeding areas near seal colonies. Coastal areas of NSW and southern Qld appear important for juveniles.
Sharks and Rays	Grey nurse shark East coast population (*Carcharias taurus*)	Critically endangered	Subtropical to warm- temperate inshore waters of the Region.	Known to feed in the Region and believed to breed in the Region.	Inshore rocky reefs. Known aggregation sites inshore NSW and southern Qld coast. 19 areas of critical habitat identified.
Sharks and Rays	Whale shark (*Rhincodon typus*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix II)	Wide ranging species found in tropical of warm temperate waters between 300 N and 350 S. Found in oceanic and inshore waters.	Data deficient.	None identified.
Bony fish	Orange roughy (*Hoplostethus atlanticus*)	Conservation dependent	Orange roughy are found in cold, deep waters in the Atlantic, Pacific and Indian Oceans. Most common at depths of 800-1000 m. Found south of central NSW to southern WA. They occur on the Lord Howe Rise.	Known to aggregate and spawn in the Region.	Aggregate on seamounts and similar large features. Known spawning ground off central NSW coast near Port Stephens. Known to occur on Lord Howe Rise.
Bony fish	SYNGNATHIDAE and SOLENOSTOMI-DAE (seahorses, pipehorses, ghost pipefish and seadragons)	Marine, all seahorses CITES Appendix II	There is a paucity of knowledge on the distribution of species of syngnathids in the Region, although they are known to occur throughout.	Resident in the Region.	Commonly found in shallow and inshore areas including seagrass beds and macro-algae dominated reefs. Some pipehorses are found in deeper waters on the shelf.
Reptiles	Leatherback turtle, Leathery turtle (*Dermochelys coriacea*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Global species found in tropical and subtropical oceans and range can extend into sub polar waters. Found throughout the Region.	Nests and forages in the Region.	East coast nesting sites historically concentrated in the GBR, with some smaller sites in southern Qld and northern NSW. Nesting population declining rapidly and approaching extinction in the Region.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Reptiles	Loggerhead turtle (*Caretta caretta*)	Endangered, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Global species found throughout tropical and warm-temperate seas. Occasionally ventures south into temperate waters.	Nests and forages in the Region. Post-hatchlings travel south on the EAC to northern NSW, then leave the Region to the east. Re-enter the Region in the Coral Sea an immature adults.	This species nests on northern NSW and southern Qld beaches.
Reptiles	Green turtle (*Chelonia mydas*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Global species found throughout tropical and warm-temperate seas. Occasionally ventures south into temperate waters.	Nests and forages in the Region. Post-hatchlings travel south on the EAC to northern NSW, then leave the Region to the east. Re-enter the Region in the Coral Sea an immature adults.	High density nesting sites in the Coringa Herald Islets in the Coral Sea. Smaller breeding areas in southern GBR.
Reptiles	Olive ridley (*Lepidochelys olivacea*)	Endangered, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Global species found throughout tropical and warm-temperate seas. Occasionally ventures south into temperate waters.	Forages in the Region. No substantial breeding occurs in the Region.	Data deficient.
Reptiles	Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Global species found in tropical, sub-tropical and temperate waters. Concentrated in and around the GBR in the Region.	Forages and nests in the Region. Little data available about migration routes through the Region.	Large nesting population in the GBR. Some occasional nesting in the Coringa Herald Islets, Coral Sea.
Reptiles	Flatback turtle (*Natator depressus*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Found only in tropical waters around northern Aust, PNG and Irian Jaya.	Resides and nests in the northern half of the Region.	Large nesting population in GBR, a few small nesting populations on southern Qld coast. Foraging areas within GBR.
Reptiles	SEASNAKES (COLUBRIDAE, ACROCHORDIDAE, and ELAPIDAE families)	Marine	Up to 25 species of seasnake are believed to occur in or around the Region.	Resident in the Region.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Birds	Little tern (*Sterna albifrons*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA & CMS (Appendix II)	Migrates into the Region from the Northern Hemisphere.	Regular visitor during annual migration – forages, does not breed in the Region.	None identified.
Birds	Lesser frigatebird (*Fregata ariel*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA	Found in tropical waters in northern half of Region.	Populations nest and forage in the Region.	Nesting occurs on islands of the Coral Sea and in the GBR.
Birds	Great frigatebird (*Fregata minor*)	Migratory, Marine Listed under CAMBA & JAMBA	Found in tropical waters in northern half of Region.	Populations nest and forage in the Region.	Nesting occurs on islands of the Coral Sea and in the GBR.
Birds	Red-footed booby (*Sula sula*)	Migratory, Marine Listed under CAMBA & JAMBA	Found in tropical waters in northern half of Region.	Populations nest and forage in the Region.	Nesting occurs on islands of the Coral Sea and in the GBR.
Birds	Brown booby (*Sula leucogaster*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA	Found in tropical waters in northern half of Region.	Populations nest and forage in the Region.	Nesting occurs on islands of the Coral Sea and in the GB.R
Birds	Sooty shearwater (*Puffinus griseus*)	Migratory, Marine Listed under CAMBA & JAMBA	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Petrel and Shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.
Birds	Little Shearwater (*Puffinus assimilis*)	Marine	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Breeds on Lord Howe and Norfolk Islands.
Birds	Common noddy (*Anous stolidus*)	Migratory, Marine Listed under CAMBA & JAMBA	Global species found in tropical waters.	Breeds and forages in the Region.	Breeding sites in the GBR and the Coral Sea Islands.
Birds	Grey ternlet (*Procelsterna cerulean*)	Marine	Pacific species found in open, shallow seas in tropical and sub-tropical climates.	Breeds and forages in the Region.	Breeding sites on Lord Howe and Norfolk Islands.
Birds	Bridled tern (*Sterna anaetheta*)	Migratory, Marine Listed under CAMBA & JAMBA	Migratory species found globally in tropical waters. Found in the GBR and the Coral Sea.	Regular visitor during annual migration – forages, does not breed in the Region.	None identified.
Birds	Black-naped tern (*Sterna sumatrana*)	Migratory, Marine Listed under CAMBA & JAMBA	Migratory species found globally in tropical waters. Found in the GBR and the Coral Sea.	Regular visitor during annual migration – forages, does not breed in the Region.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Birds	Common tern (*Sterna hirundo*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA	Migrates into the Region from the Northern Hemisphere.	Regular visitor during annual migration – forages, does not breed in the Region.	None identified.
Birds	Lesser crested tern (*Sterna bengalensis*)	Migratory, Marine Listed under CAMBA	Migratory species found in tropical and subtropical waters. Found in GBR and Coral Sea.	Breeds and forages in the Region.	None identified.
Birds	Wilson's storm-petrel (*Oceanites oceanicus*)	Migratory, Marine Listed under JAMBA	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Petrel and Shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.
Birds	Masked booby (*Sula dactylatra*)	Migratory, Marine Listed under ROKAMBA & JAMBA	Found in tropical waters in northern half of Region.	Populations nest and forage in the Region.	Nesting occurs on islands of the Coral Sea and in the GBR.
Birds	Osprey pandion (*Pandion haliaetus*)	Migratory, Marine, CITES (Appendix II), CMS (Appendix II)	Global species found in temperate and tropical islands and coastlines, including all of those adjacent to the Region.	Nests in adjacent coastal areas but may pass into the Region for food.	None identified.
Birds	White-tailed tropicbird (*Phaethon lepturus*)	Migratory, Marine Listed under JAMBA	Found throughout the northern half of the Region.	Forages in the Region but does not breed in the vicinity.	None identified.
Birds	Red-tailed tropicbird (*Phaethon rubricauda*)	Listed Marine	Found on oceanic islands throughout the Pacific and Indian oceans, including the Coral Sea islands, Norfolk and Lord Howe Islands.	Nests on islands but disperses widely after breeding.	Prefers coral atolls with low shrub cover for nesting sites.
Birds	Wedge-tailed shearwater (*Puffinus pacificus*)	Migratory, Marine Listed under JAMBA	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Petrel and shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Birds	Flesh-footed shearwater (*Puffinus carneipes*)	Migratory, Marine Listed under ROKAMBA & JAMBA	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Petrel and shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.
Birds	Short-tailed shearwater (*Puffinus tenuirostris*)	Migratory, Marine Listed under ROKAMBA & JAMBA	Petrels and shearwaters are found throughout the Region.	Petrels and shearwaters are found throughout the Region.	Petrel and shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.
Birds	Gould's petrel (*Pterodroma leucoptera leucoptera*)	Endangered, Migratory listed under JAMBA	Petrels and shearwaters are found throughout the Region.	Petrels and shearwaters are found throughout the Region.	This endangered subspecies breeds and forages off the coast of NSW.
Birds	White necked petrel (*Pterodroma cervicalis*)	Listed Marine Species	Petrels and shearwaters are found throughout the Region.	Petrels and shearwaters are found throughout the Region.	This species has a breeding population on Norfolk Island.
Birds	Crested tern (*Sterna bergii*)	Migratory, Marine Listed under JAMBA	Global species found in tropical, sub-tropical and warm temperate waters. Found throughout Australian coastal waters.	Breeds and forages in the Region.	None identified.
Birds	Herald petrel (*Pterodroma heraldica*)	Critically Endangered	Petrels and shearwaters are found throughout the Region.	Populations breed and forage in the Region.	Petrel and shearwater populations concentrated on the mainland coast, the GBR, the Coral Sea, Norfolk and Lord Howe Islands.
Birds	Light-mantled sooty albatross (*Phoebetria palpebrata*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	Occasional sightings in temperate waters of the Region in non-breeding periods. Nesting mainly occurs on sub-Antarctic islands.	Forages but does not breed in the Region.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Seals and dugong	Australian fur-seal (*Arctocephalus pusillus*)	Listed Marine	Species is found in temperate waters off SA, Vic, Tas and NSW.	Forages in the Region but does not breed.	Found in large numbers around Montague Island.
Seals and dugong	New Zealand fur-seal (*Arctocephalus forsteri*)	Listed Marine	Species found in temperate waters off WA, SA, Vic, Tas and NSW.	Forages in the Region but does not breed.	Found in large numbers around Montague Island.
Whales and dolphins	Killer whale (*Orcinus orca*)	Cetacean Migratory CITES Appendix II CMS Appendix II	Global species found in all oceans and seas ranging from polar to tropical.	Known to feed in the Region.	No specific areas.
Whales and dolphins	Long-finned pilot whale (*Globicephala melas*)	Cetacean CITES Appendix II	Found in temperate waters throughout the southern hemisphere, including the southern half of the Region.	Possible resident for all or part of the year.	None identified.
Whales and dolphins	Short-finned pilot whale (*Globicephala macrorhynchus*)	Cetacean CITES Appendix II	Found in tropical and temperate waters world wide, including all waters in the Region.	Unknown.	None identified.
Whales and dolphins	Melon-headed whale (*Peponocephala electra*)	Cetacean CITES Appendix II	Found in offshore tropical and sub-tropical waters world wide, including most of the waters of the Region.	Unknown.	None identified.
Whales and dolphins	Pygmy killer whale (*Feresa attenuata*)	Cetacean CMS Appendix II	Found in tropical and sub-tropical waters world wide, including most of the waters of the Region.	Unknown.	None identified.
Whales and dolphins	False killer whale (*Pseudorca crassidens*)	Cetacean CITES Appendix II	Found globally in deep tropical and temperate waters, including all of the Region.	Possible resident.	None identified.
Whales and dolphins	Pygmy sperm whale (*Kogia breviceps*)	Cetacean CITES Appendix II	Found globally in offshore tropical and temperate waters, including the Region.	Unknown.	None identified.
Whales and dolphins	Dwarf sperm whale (*Kogia sima*)	Cetacean CITES Appendix II	Found globally in tropical and temperate waters, including the Region.	Unknown.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Whales and dolphins	Sperm whale (*Physeter macrocephalus*)	Cetacean Migratory CITES Appendix I CMS Appendix I	Global species found in deep tropical, temperate and polar oceans, including the Region.	Unknown.	None identified.
Whales and dolphins	Humpback whale (*Megaptera novaeangliae*) Oceania subpopulation	Cetacean Vulnerable Migratory NSW Vulnerable CITES Appendix I CMS Appendix I	Global species found throughout the southern hemisphere and as far north as the Arctic circle. Found throughout Australian waters including the Region.	The east Australian population migrates through the Region from Antarctic feeding grounds to tropical calving grounds in the Region's north during winter.	Calving occurs in and around the GBR. Known aggregation sites for resting include the Whitsunday Islands, Hervey Bay, Stradbroke, Cape Byron, Coffs Harbour and the south coast of NSW.
Whales and dolphins	Pygmy right whale (*Caperea marginata*)	Cetacean Migratory CITES Appendix I CMS Appendix II	Found in sub-Antarctic and temperate waters between 300 S and 500 S, including waters in the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	Dwarf minke whale (*Balaenoptera acutorostrata*)	Cetacean CITES Appendix I	Found in sub-Antarctic, temperate and tropical waters of southern hemisphere including all of the Region.	Believed to migrate north through the Region from sub-Antarctic waters to winter in tropical waters off Qld. Calving is believed to occur in tropical and temperate waters and may occur in the Region.	Ribbon Reefs (Great Barrier Reef).
Whales and dolphins	Antarctic minke whale (*Balaenoptera bonaerensis*)	Cetacean Migratory CITES Appendix I CMS Appendix II	Found in sub-Antarctic, temperate and tropical waters of southern hemisphere including all of the Region.	Unknown.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Whales and dolphins	Sei whale (*Balaenoptera borealis*)	Cetacean Vulnerable Migratory CITES Appendix I CMS Appendix I	Global species found in all oceans except the Arctic. Infrequent sightings have created a patchy known distribution in the Region with most sightings occurring in the southern half of the Region near the mainland and a few sighting in far north Coral Sea.	Unknown.	None identified.
Whales and dolphins	Bryde's whale (*Balaenoptera edeni*)	Cetacean Migratory CITES Appendix I CMS Appendix II	Global species found in tropical and temperate waters between 400 N and 400 S, including all of the waters of the Region.	Unknown.	None identified.
Whales and dolphins	Fin whale (*Balaenoptera physalus*)	Cetacean Vulnerable Migratory CITES Appendix I	Global species found in polar and temperate waters including the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	Blue whale (*Balaenoptera musculus*) Antarctic subspecies (*Balaenoptera musculus intermedia*)	Cetacean Endangered Migratory CITES Appendix I CMS Appendix I	Global species found in all oceans and throughout the Region.	Unknown.	None identified.
Whales and dolphins	Andrew's beaked whale (*Mesoplodon bowdoini*)	Cetacean CITES Appendix I	Full distribution is uncertain but is believed to be a southern hemisphere species found between 320 S and 54030'S. Found in the southern half of the Region.	Unknown.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Whales and dolphins	Blainville's beaked whale (*Mesoplodon densirostris*)	Cetacean CITES Appendix II	Global species found in tropical and warm temperate waters. Found throughout the Region.	Unknown.	None identified.
Whales and dolphins	Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*)	Cetacean CITES Appendix II	Found in the tropical and temperate waters of the Indian and Pacific Oceans, including the waters of the Region.	Unknown.	None identified.
Whales and dolphins	Strap-toothed beaked whale (*Mesoplodon layardi*)	Cetacean CITES Appendix II	Found in the Southern Ocean and adjoining temperate waters. Found in the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	True's beaked whale (*Mesoplodon mirus*)	Cetacean CITES Appendix II	Thought to occur in deep temperate waters including the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	Gray's beaked whale (*Mesoplodon grayi*)	Cetacean CITES Appendix I	Circumpolar in the southern hemisphere between 300 S and 450 S, including the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	Cuvier's beaked whale (*Ziphius cavirostris*)	Cetacean CITES Appendix I	Global distribution in all temperate and tropical waters, including all of the Region.	Unknown.	None identified.
Whales and dolphins	Arnoux's beaked whale (*Beradius arnuxii*)	Cetacean CITES Appendix I	Circumglobal in temperate and Antarctic waters in southern hemisphere including southern half of Region.	Unknown.	Primarily off the shelf.
Whales and dolphins	Southern bottlenose whale (*Hyperoodon planifrons*)	Cetacean CITES Appendix I	Circumglobal in temperate and Antarctic waters in southern hemisphere including southern half of Region.	Unknown.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Whales and dolphins	Australian snubfin dolphin (*Orcaella heinsohni*)	Cetacean CITES Appendix II IUCN Near Threatened	This species is found on the northern coastline of Australia, extending from the Kimberley in the west to the Qld border in the East.	Resident in the Region.	Unknown.
Whales and dolphins	Indo-Pacific humpback dolphin (*Sousa chinensis*)	Cetacean CITES Appendix II IUCN Near Threatened	This species is found in the Indo-Pacific region around south east Asia and northern Australia. Found along the tropical coastline of Australia including the northern half of the Region.	Resident in the Region.	None identified.
Whales and dolphins	Rough-toothed dolphin (*Steno bredanensis*)	Cetacean CITES Appendix II IUCN Least Concern	Populations have been identified in tropical and sub-tropical oceans around the world. They are known to occur in all but the southern extremity of the Region.	Resident in the Region.	None identified.
Whales and dolphins	Southern right whale dolphin (*Lissodelphis peronii*)	Cetacean CITES Appendix II IUCN Data Deficient	Circumglobal in temperate and polar waters of the southern hemisphere including the southern half of the Region.	Unknown.	None identified.
Whales and dolphins	Risso's dolphin (*Grampus griseus*)	Cetacean CITES Appendix II IUCN Least Concern	Global species found in shelf waters in tropical, temperate and sub polar waters, including all of the Region.	Unknown.	None identified.
Whales and dolphins	Fraser's dolphin (*Lagenodelphis hosei*)	Cetacean CITES Appendix II IUCN Least Concern	Global species usually found in deep tropical waters, including the northern half of the Region.	Unknown.	None identified.

Table C1 Protected species known to occur in the east marine region

	Species	Conservation Status	Distribution	Known use of the Region	Important areas in or adjacent to the Region
Whales and dolphins	Pantropical spotted dolphin (*Stenella attenuata*)	Cetacean CITES Appendix II IUCN Least Concern	Global species found in tropical and sub-tropical waters, including the northern half of the Region.	Unknown.	None identified.
Whales and dolphins	Spinner dolphin (*Stenella longirostris*)	Cetacean CITES Appendix II IUCN Data Deficient	Global species found in tropical and sub-tropical waters, including the northern half of the Region.	Unknown.	None identified.
Whales and dolphins	Striped dolphin (*Stenella coeruleoalba*)	Cetacean CITES Appendix II IUCN Least Concern	Global species found in tropical and temperate water including all but the southern extremity of the Region.	Unknown.	None identified.
Whales and dolphins	Common dolphin (*Delphinus delphis*)	Cetacean CITES Appendix II IUCN Least Concern	Global species found in tropical and temperate waters, including all of the Region.	Resident in the Region.	None identified.
Whales and dolphins	Bottlenose dolphin (*Tursiops truncatus*)	Cetacean CITES Appendix II IUCN Least Concern	Global species found in tropical and temperate waters, including all of the Region.	Resident in the Region.	None identified.
Whales and dolphins	Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	Cetacean CITES Appendix II IUCN Data Deficient	Global species found in tropical and temperate waters, including all of the Region.	Resident in the Region.	None identified.

Table C2 Protected species that may infrequently occur in the East Marine Region

	Species	EPBC Act Conservation Status
Sharks and Rays	Green Sawfish (*Pristis zijron*)	Vulnerable, CITES
Birds	Streaked shearwater (*Calonectris leucomelas*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Pacific golden plover (**Pluvialis fulva**)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Lesser sand plover (*Charadrius mongolus*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Bar-tailed godwit (*Limosa lapponica*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Whimbrel (*Numenius phaeopus*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Little whimbrel (*Numenius minutus*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Terek sandpiper (*Xenus cinereus*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Common sandpiper (*Actitis hypoleucos*)	Migratory, Marine Listed under CAMBA & JAMBA
Birds	Grey-tailed tattler (*Tringa brevipes*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Wandering tattler (*Tringa incana*)	Migratory, Marine Listed under CAMBA & JAMBA
Birds	Common greenshank (*Tringa nebularia*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Marsh sandpiper (*Tringa stagnatilis*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Ruddy turnstone (*Arenaria interpres*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Red knot (*Calidris canutus*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Sanderling (*Calidris alba*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Red-necked stint (*Calidris ruficollis*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Sharp-tailed sandpiper (*Calidris acuminate*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Curlew sandpiper (*Calidris ferruginea*)	Migratory, Marine Listed under ROKAMBA, CAMBA & JAMBA
Birds	Pomarine jaeger (*Stercorarius pomarinus*)	Migratory, Marine Listed under CAMBA & JAMBA
Birds	Brown skua (*Stercorarius antarcticus*)	Migratory, Marine Listed under JAMBA
Birds	Cattle egret (*Ardea ibis*)	Migratory, Marine Listed under JAMBA

Table C2 Protected species that may infrequently occur in the East Marine Region

	Species	EPBC Act Conservation Status
Birds	Pectoral sandpiper (*Calidris melanotos*)	Migratory, Marine Listed under ROKAMBA & JAMBA
Birds	Arctic jaeger (*Stercorarius parasiticus*)	Migratory, Marine Listed under ROKAMBA & JAMBA
Birds	Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered, Migratory, Marine Listed under CMS (Appendix I)
Birds	Chatham albatross (*Thalassarche eremita*)	Endangered, Migratory, Marine Listed under CMS (Appendix II)
Birds	Wandering (Snowy) albatross (*Diomedea exulans*)	Vulnerable, Migratory, Marine Listed under JAMBA, CMS (Appendix II)
Birds	Tristan albatross (*Diomedea dabbenena*)	Endangered, Migratory, Marine Listed under CMS (Appendix II)
Birds	Northern royal albatross (*Diomedea sanfordi*)	Endangered, Migratory, Marine Listed under CMS (Appendix II)
Birds	Black-browed albatross (*Thalassarche melanophrys*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Grey-headed albatross (*Thalassarche chrysostoma*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Northern giant-petrel (*Macronectes halli*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Southern royal albatross (*Diomedea epomophora*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Shy albatross (*Thalassarche cauta*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	White-capped albatross (*Thalassarche steadi*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Salvin's albatross (*Thalassarche salvini*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Buller's albatross (*Thalassarche bulleri*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Pacific albatross (*Thalassarche* sp. nov. (*plateni*))	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Campbell albatross (*Thalassarche impavida*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Indian yellow-nosed albatross (*Thalassarche carteri*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Sooty albatross (*Phoebetria fusca*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Birds	Southern giant-petrel (*Macronectes giganteus*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)

Table C2 Protected species that may infrequently occur in the East Marine Region

	Species	EPBC Act Conservation Status
Birds	Providence petrel (*Pterodroma solandri*)	Migratory, Marine Listed under JAMBA
Birds	Antipodean albatross (*Diomedea antipodensis*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)
Seals and Dugong	Dugong (*Dugong dugon*)	Listed Marine, Migratory
Whales and Dolphins	Southern right whale (*Eubalaena australis*)	Endangered, Migratory, CITES Appendix I, CMS Appendix I
Whales and Dolphins	Hector's beaked whale (*Mesoplodon hectori*)	CITES Appendix II
Whales and Dolphins	Shepherd's beaked whale (*Tasmacetus shepherdi*)	CITES Appendix II
Whales and Dolphins	Tropical bottlenose whale (*Indopacetus pacificus*)	CITES Appendix I

Grey nurse shark and diver, Cod Grounds. Photo: David Harasati.

Appendix D East Marine Region Protected Species Group Report Cards

These report cards summarise information on those species that occur in the East Marine Region that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The report cards present relevant information on species groups and are designed to be updated as new information becomes available. The report cards included in this appendix are current at September 2007. Updates of the report cards will be available on the web at <www.environment.gov.au/ coasts/mbp/east>. Protected species groups occurring in the East Marine Region for which report cards have been compiled include:

D1 Cartilaginous fish (including sharks, rays, skates and chimaeras)

D2 Bony fish (including seahorses, sea-dragons, pipefish, ghost pipefish and orange roughy)

D3 Reptiles (marine turtles and sea snakes)

D4 Seabirds

D5 Pinnipeds (fur seals, seals and sea lions)

D6 Cetaceans (whales, dolphins and porpoises)

The text for these protected species group report cards has been compiled from various sources including the following:

- South west Marine Bioregional Plan: Bioregional Profile (Department of the Environment and Water Resources 2007);
- Description of Key Species Groups in the East Marine Region (Australian Museum 2007);
- Australian Government species recovery plans including:
    - Whale Shark (*Rhincodon typus*) Recovery Plan 2005-2010 (Department of the Environment and Heritage 2005).
    - Recovery plan for the Grey Nurse Shark (*Carcharias taurus*) in Australia (Environment Australia 2002a).
    - White Shark (*Carcharodon carcharias*) Recovery Plan (Environment Australia 2002b).

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D.1. East Marine Region Protected Species Group Report Card – Cartilaginous Fish

General information

Sharks, rays, skates and chimaeras (or ghost sharks) are cartilaginous fish belonging to the class Chondrichthyes. Of the 297 species that occur in Australian waters, it is estimated that approximately 200 species (125 sharks, 68 rays and 7 chimaerids) occur in the East Marine Region.

Nationally protected species

Three species of sharks found in the Region are listed under the EPBC Act (table D1). Recovery Plans for each of these three species can be found at <www.environment.gov.au/coasts/species/sharks> and white and whale sharks are also listed under international instruments. School sharks are on the priority assessment list for consideration by the Threatened Species Scientific Committee for possible listing under the EPBC Act. These three dogfish species may also be considered by the Committee.

Great white shark. Photo: Mike Ball and Rodney Fox.

Table D 1 Sharks listed as threatened or migratory under the EPBC Act that are known to occur in the East Marine Region

Species	Conservation Status	Australian Government Conservation Plans or Strategies for the Species
White shark (*Carcharodon carcharias*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix I)	White Shark (Carcharodon carcharias) Recovery Plan (July 2002) Recovery Plan for the Grey Nurse Shark (Carcharias taurus) in Australia (June 2002) National Plan of Action for the Conservation and Management of Sharks (2004) Whale Shark (Rhincodon typus) Recovery Plan 2005-2010 (2005)
Grey nurse shark (east coast population) (*Carcharias taurus*)	Critically endangered	
Whale shark (*Rhincodon typus*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix II)	

Ecology of protected sharks in the East Marine Region

White shark

The white shark is widely distributed, and located throughout temperate and sub-tropical regions in both the northern and southern hemispheres. It is most frequently encountered off South Africa, southern Australia, northern California and the northeastern United States (Last and Stevens 1994). In Australia, its range extends primarily from Moreton Bay in southern Queensland around the southern coastline to North West Cape in Western Australia (Bruce 1995). There is one record of a white shark as far north as Mackay (Paterson, 1990:154)

There are areas in the East Marine Region where encounters with white sharks are frequent. These include waters in and around seal and sea lion colonies in general, and the New South Wales coastal region between Newcastle and Port Stephens (particularly juveniles). Large white sharks were also taken in the past off Cape Moreton (once a whaling station) in Queensland (D'Ombrain 1957).

Movement patterns over the longer-term are poorly known; however, the white shark is capable of swimming long distances and for extended periods. For example, offshore tracking of a large shark with sonic tags indicated that it moved 190 kilometres in 2.5 days at an average cruising speed of 3.2 kilometres per hour (Carey et al. 1982 in Bruce 1992). One tagged shark was recorded travelling 2946km over 113 days. Other research in Australian waters has recorded shark movements mainly restricted to shelf and coastal waters and swimming depths down to 94 m (Bruce et al. 2001)

White sharks eat a variety of prey including finfish, other sharks and rays, marine mammals such as seals, sea lions, dolphins and whales, as well as squid, crustaceans and seabirds. Their diet is known to change with size – juveniles less than 2.7 m feed primarily on fish and other sharks and rays while larger sharks (reaching up to 6 m in length) are known to feed on marine mammals.

Although catch estimates for white sharks are based on incomplete information, the southern half of the East Marine Region has, historically, been a relatively significant one for white shark catch including through game fishing, incidental catch by commercial fishers, and through targeted shark control activities.

Grey nurse shark

The grey nurse shark is listed as two separate populations under the EPBC Act. The west coast population is listed as vulnerable, while the east coast population is listed as critically endangered with research suggesting that the New South Wales population is less than 1000 individuals (Otway and Burke 2004). The species is thought to occur in all waters off the Australian mainland but is considered rare in the Northern Territory and throughout the southern extent of its range (Victorian, South Australian and Tasmanian waters). It has not been found in the Great Australian Bight so it is thought that the west and east coast populations are separate.

The species is found primarily in warm-temperate (from sub-tropical to cool-temperate) inshore waters around rocky reefs and islands, and is occasionally found in the surf zone and in shallow bays. It has been recorded as far north as Cairns in the east (Pogonoski et al. 2001) although its range more recently has been confined to coastal waters off southern Queensland and along the New South Wales coast.

Grey nurse sharks have been recorded at varying depths. They are commonly found between 15 m and 40 m, but have occasionally been recorded at depths of around 200 m. The diet of grey nurse sharks is likely to consist of species such as pilchards, jewfish, tailor, bonito, moray eels, wrasses, sea mullet, flatheads, yellowtail kingfish, small sharks, squid and crustaceans.

The grey nurse shark has a relatively low growth rate and takes 4 - 6 years to mature (Branstetter and Musick 1994). The average life span of this species in the wild is unknown, although it is likely that larger specimens in the wild may be much older than 13 or 16 years (Pollard et al. 1996).

Whale shark

Whale sharks are wide-ranging species with a broad distribution. They are usually observed between latitudes 30°N and 35°S in tropical and warm temperate seas, both oceanic and coastal. The species is generally encountered close to or at the surface, as single individuals or occasionally in schools or aggregations up to hundreds.

Although it has been suggested that this species prefers waters with temperatures between 21-25°C, the whale sharks sighted at Ningaloo Reef off Western Australia (the best consistent location in Australian waters to view them) are in waters with temperatures averaging 27°C.

No areas where whale shark aggregate have been identified in the East Marine Region and no interactions with the species, such as capture in fisheries, are known to occur in the Region. Further information on whale sharks and threats to the species is available at <www.environment.gov.au/biodiversity/threatened/publications/recovery/r-typus>.

Demersal sharks and dogfish

The group of demersal sharks known as dogfish (the Centrophorus family in particular) have been greatly depleted through trawling over the last 30 years (Graham et al. 2001) with landings now very low and less than 5 per cent of the total shark catch. In response, the Australian Fisheries Management Authority has imposed limits for Harrisson's, Endeavour and southern dogfish, and has implemented a closed area to trawling on the upper slope of the continental shelf off Sydney (Mcloughlin 2006). In addition, school shark (*Galeorhinus galeus*) is on the priority assessment list for consideration by the Threatened Species Scientific Committee for possible listing under the EPBC Act, while the 3 dogfish species may also be considered by the Committee.

Known important areas for sharks in the East Marine Region and adjacent waters

In New South Wales, aggregations of grey nurse sharks can be found at reefs off the following locations: Byron Bay, Brooms Head, Solitary Islands, South West Rocks, Laurieton, Forster, Seal Rocks, Port Stephens, Sydney,

Bateman's Bay and Narooma (Otway and Parker 2000). An aggregation is considered to be 5 or more individuals present at the same site at the same time (Otway and Parker 2000). Known key aggregation sites for grey nurse sharks in Queensland include sites off Moreton and Stradbroke Islands and Rainbow Beach. In all, 19 critical habitat locations have been identified along the east coast. These sites may play an important role in pupping and/or mating activities, as grey nurse sharks form regular aggregations at these sites (Pollard et al. 1996).

Areas off Garie beach, Wattamolla and Port Stephens–Newcastle (New South Wales), and some areas off southern Queensland, appear to be seasonally important for juvenile white sharks. (Bruce et al 2001).

The upper slope of the continental shelf off central and southern New South Wales have proven to be key fishing grounds for Harrisson's, endeavour and southern dogfish. An area off the Sydney coast has recently been closed to trawling in order to protect dogfish.

Known interactions, threats and mitigation measures

Fisheries

In general, sharks are very susceptible to over-fishing. This is because their life history is characterised by relatively slow growth, late maturity, low fecundity and low natural mortality. Most reach reproductive maturity when more than three-quarters grown and either bear live young (viviparous, ovoviviparous, or oviphagous) or produce small numbers of eggs encased in a tough horny cover (oviparous).

Numbers of offspring can range from one or two every two or more years (e.g. dogfish) to 300 at one time recently produced by a whale shark. While the biology of many sharks and rays is unstudied, some general life history patterns are evident. Many coastal and shelf species have seasonal reproductive cycles with annual breeding, whereas in the majority of deepwater demersal species reproduction is non-seasonal and asynchronous, with gestation periods up to two years or more (see Kyne and Simpendorfer 2007 for review). Chondrichthyans found in the Eastern Marine Region exhibit a full range of these reproductive modes and fecundity ranges.

In addition, the demand for shark products, including fins, is relatively high, which adds to the susceptibility of some shark species to fishing pressure.

Commercial fisheries

Several state-based fisheries, and the Commonwealth-managed Eastern Tuna and Billfish Fishery (ETBF) and South East Shark and Scalefish Fishery (SESSF) exploit sharks and rays in the Eastern Marine Region waters. The Queensland East Coast Inshore Fin Fish Fishery (ECIFFF) principally targets small whaler and hammerhead sharks, with over 90 per cent of the catch taken inshore by mesh netting (Anon 2005; DPI&F 2006). Less than 20 per cent of the annual 1500 t harvest, however, is caught in the region off southern Queensland where the main target species are not reported (Gribble et al. 1998). In a recent Queensland east coast shark fishery assessment, sustainability threats were assigned to 20 species of commercially exploited sharks and rays in the ECIFFF (Gribble et al. 1998). The New South Wales catch of pelagic sharks by participants in the Offshore Trawl and Line Fishery (OTLF) is now in excess of 150 t per annum but new management plans are being formulated to put a cap on effort (and thus catch) in the fishery.

The main impact on pelagic sharks in the region is by the ETBF, both as byproduct and bycatch. While the jurisdiction of this fishery extends from Cape York to the Victoria–South Australia border, almost all fishing is in East Marine Region waters. Effort is concentrated off the northern half of New South Wales and southern half of Queensland and spans the width of the Australian Fishing Zone including waters around Lord Howe and Norfolk Islands (DAFF 2005).

With an increasing world-wide concern over the practice of finning sharks at sea and returning the injured animal to the water alive, the Australian Fisheries Management Authority (AFMA) (with complementary State legislation) banned the practice of shark finning at sea by prohibiting the possession or landing of fins separate from the carcasses and also enforcing a limit of 20 sharks per vessel per fishing trip (DAFF 2005). This measure addresses animal welfare concerns and limits the ability of fishers to take large numbers of sharks solely for their fins.

Demersal sharks in the Region are mainly exploited by the New South Wales Ocean Trawl Fishery (OTF) and Ocean Trap and Line Fishery (OTLF) fisheries, and the New South Wales trawl sector of the SESSF. Landings from the Queensland trawl fishery are now negligible since the 1999 mandatory introduction of turtle excluder devices (TEDs) and bycatch reduction devices (BRDs) (DPI&F 2006). Over 600 t of sharks and rays were reported taken from waters off New South Wales in 2000–01 (DPI 2004; DPI 2006), although this represents less than 10 per cent of the total New South Wales fishery production.

Recreational fishing – Prior to the implementation of protective State and Commonwealth legislation, game fishing for white sharks was carried out mainly in South Australia, Queensland and New South Wales, but also in

Victoria and Western Australia. Research using game fishing data for New South Wales calculated that the ratio of white sharks to all shark species caught had changed from 1:22 in the 1960s to 1:38 in the 1970s and 1:651 in the 1980s. In the 1990s, capture of White Shark by game fishers off the coast of New South Wales was 13:2103, or 1:162 (Chan 2001).

Recreational fishers still occasionally capture white sharks (for example in gill nets in Tasmanian waters) or while fishing for other sharks off the east coast states. In some cases small white sharks are mistakenly identified as other species (for example mako sharks).

Although game fishing is a potential threat to them, grey nurse sharks, are not favoured by game-fishers as they are considered to be poor fighters compared with other sharks. The extent of the impact that incidental catch by game-fishers has on grey nurse sharks is currently unknown. Until the 1980s, grey nurse sharks were wrongly perceived by the public as man-eaters, mainly because of their fierce appearance. This perception of grey nurse sharks led to intense spear-fishing pressure in eastern Australia during the 1950s and 1960s (Environment Australia 2002).

Shark Control Activities

Meshing as a protective measure for swimmers and surfers was introduced to New South Wales beaches in 1937 and to Queensland beaches in 1962. These are the only two states in Australia that employ this shark protection measure (Krogh and Reid 1996; Paterson 1990).

In New South Wales, shark nets are usually 150 m long with a mesh size of 50 to 60 cm (Krogh 1994). The nets are set parallel to the shore in around 10 to 15 m water depth with the bottom of the net resting on the ocean floor and the top supported by a series of floats (Krogh 1994). The idea of shark nets is not to stop sharks coming in to the beaches, but to intercept and catch them on their regular feeding and territorial runs (Eckersley 1996). There are currently a total of 49 meshed beaches along approximately 200 km of coastline between Newcastle and Wollongong in New South Wales. On average, approximately 4.2km of mesh net protect the beaches on any given day. The only known aggregation site in New South Wales close to protective beach meshing nets is Maroubra in Sydney.

In New South Wales during the early 1950s, up to 34 grey nurse sharks were meshed each year (Krogh and Reid 1996, Pollard et al. 1996). By the 1980s, this number had decreased to a maximum of 3 per year (Pollard et al. 1996), and over the last decade only three grey nurse sharks have been caught in the shark nets (D. Reid. unpublished data).

In Queensland, a mixture of baited drumlines and mesh nets are used. Drumlines consist of a marker buoy and float anchored to the bottom supporting a steel chain and baited hook. There has been a similar downward trend in grey nurse shark captures as seen in New South Wales, with a decrease from 90 captured between 1962 and 1972, to 21 captured over the last decade.

White sharks caught by beach meshing programs are usually small (less than 3 metres), and in many cases, are smaller than 2 metres. This suggests that these programs operate close to pupping grounds or in juvenile nursery habitats. However, while beach meshing undoubtedly is detrimental to smaller specimens, the widespread occurrence of similar small-sized white sharks in areas where beach meshing is not undertaken suggests that nursery habitats are also probably widespread in Australia (Bruce, CSIRO, pers. comm. as cited in white shark recovery plan).

Reid and Krogh (1992) observed that there has been a steady decline in numbers of white sharks caught in New South Wales meshing since 1950. Since then, up until the 1998–99 meshing season, a total of 509 white sharks have been captured in shark mesh nets in New South Wales (Dennis Reid, New South Wales Fisheries, pers. comm.). The annual average number of white sharks caught has declined from 13 for the first 20 years of recorded meshing to 4 per year caught in the last 10 years (Dennis Reid, New South Wales Fisheries, pers. comm.). New South Wales increased the meshing effort in the early 1970s and this is also reflected in the increase in shark captures around that time (Reid and Krogh 1992).

Since 1962 a total of 670 white sharks have been caught in the Queensland Shark Control Program. During the first 20 years of beach meshing in Queensland an average of about 20 white sharks per year were caught by the nets. This rate of capture has dropped to an average of 10 white sharks per year over the last 10 years. Paterson (1990) observed that nearly 90 percent of white shark captures occurred in southern Queensland off the Gold and Sunshine Coasts. The peak in captures occurred when water temperatures were low (Paterson 1990). It is interesting to note that from 1972–73 to 1989–90 the average annual catch over three major netting areas in New South Wales was about a quarter of the 1972–73 catch. A similar trend has been detected in Queensland and South Africa (Department of Primary Industries 1992).

Tourism

White shark cage diving and shark boat tours are undertaken in South Australia. There is no evidence that this activity significantly influences white shark behaviour (Bruce et al. 2005). There is no equivalent white shark tourism in the East Marine Region.

Degradation to areas of important habitat

Nineteen locations off the New South Wales and Queensland coasts have been deemed critical habitat for the grey nurse shark and are now protected under either Commonwealth or State statute. While these areas are protected from most forms of habitat damage, and, in most cases, all forms of fishing, the potential for some habitat degradation by anchors of vessels remains. Damage to the environment of inshore waters used by white sharks as nursery areas could have an effect on breeding and/or juvenile survival. In the case of school sharks and dogfish, continual trawling on substrates that support sessile organisms (e.g. sponges and gorgonians) can destroy such assemblages in a relatively short period (Pogonoski et al. 2002). The loss of these organisms can reduce habitat diversity and consequently lower species diversity.

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D.2. East Marine Region Protected Species Group Report Card – Bony Fish (Teleosts)

Current at September 2007. For updates see <www.environment.gov.au/coasts/mbp/east>.

General information

There are approximately 4000 species of marine fish in Australian waters (Hoese et al. 2006). A high proportion of these are found in the East Marine Region with almost 400 species of teleosts being recorded from trawl surveys off the New South Wales coast. For further information see: <www.environment.gov.au/coasts/mbp/East

Nationally protected species

Only one species of bony fish, the orange roughy (*Hoplostethus atlanticus*), is listed as threatened under the EPBC Act in the Region. Orange roughy is the first commercially harvested fish to be listed under the EPBC Act. Orange roughy is listed as conservation-dependent and is being managed subject to a conservation program to be implemented by the Australian Fisheries Management Agency (See table D2).

Ecology of protected species in the East Marine Region

Orange roughy

Outside Australian waters orange roughy live in cold, deep waters in the Atlantic, Pacific and Indian Oceans. They are most common at depths of 800-1000 m, but have occasionally been found at depths as shallow as 180 m, and as deep as 1800 m. In Australia, orange roughy are found across the southern half of the continent, from central New South Wales, through to south-western Australia, including Tasmania. They also occur on seamounts and ocean ridges south of Australia, and on the South Tasman and Lord Howe rises.

Orange roughy are believed to be one of the longest living fish species. Examinations of the otoliths (ear bones) of orange roughy suggest maximum ages of between 125 and 156 years. Its longevity means that the species is very slow growing and does not reach sexual maturity for many years. Orange roughy also have relatively low fecundity. As a result of these life history characteristics, the species has very low resilience to fishing, because the likelihood of being caught before the fish has reproduced is statistically much higher than for other species.

Syngnathids and Solenostomids (seahorses, seadragons, pipefish and ghost pipefish)

The family Syngnathidae is a group of bony fish which include seahorses, pipefish, pipehorses and sea dragons. A total of about 330 species have been described worldwide. Australia has the highest recorded diversity of syngnathids with an estimated 25–37 per cent of the world's species (Pogonoski et al. 2002). Approximately 25 per cent of syngnathid genera and 20 per cent of species are endemic to Australian waters (Kuiter 2000; Pogonoski et al. 2002; Martin-Smith and Vincent 2006).

All syngnathids and solenostomids in Australia are listed as 'marine species' under Section 248 of the EPBC Act and are protected.

In 2002, all seahorses (the entire genus of *Hippocampus*) were listed on Appendix II of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973*. Permits can be granted under CITES for trade in these species, while the EPBC Act controls international trade in all wild capture and aquarium-raised Australian syngnathid and solenostomid species.

There is a paucity of knowledge on the distribution, relative abundance and habitats of species of syngnathids

Table D2 Bony fish listed as threatened under the EPBC Act that are known to occur in the East Marine Region

Species	Conservation Status	Conservation Plans and Policies
Orange roughy (*Hoplostethus atlanticus*)	Conservation dependent	Orange Roughy Conservation Programme (2006) Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes (2002)
Eastern gemfish *Rexea solandri (eastern Australian population)*	Conservation dependent	Australian Fisheries Management Authority (AFMA) (2009e). *The Eastern Gemfish Rebuilding Strategy 2008.*
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark *Galeorhinus galeus*	Conservation dependent	Australian Fisheries Management Authority (AFMA) (2009d). *The School Shark Rebuilding Strategy 2008.* Threatened Species Scientific Committee (TSSC) (2009d). *Addendum to the School Shark Rebuilding Strategy 2008.*

in the East Marine Region. They are a group with diverse characteristics, including some that are apparently rare and localised, others widely distributed and very common, and some apparently rare yet widely distributed. Many of the pipefish, seahorse and seadragon species are found in near-shore coastal environments such as seagrass beds in shallow bays, and reefs dominated by macro-algae. Some of the pipehorses are found in deeper waters of the continental shelf.

While the taxonomy of this family is contested, Australian waters appear to support the largest number of syngnathid genera in the world, and new species have been discovered in recent years. Habitats that supports syngnathid populations are generally patchy, and hence populations of syngnathid species may be dispersed and fragmented. Some groups of syngnathids, notably the seahorses, have particular microhabitat preferences, mainly occupying the edges of particular habitat types (for example, seagrass, sand or reef, or sand interfaces). Syngnathids feed in the water column, on or near the substrate. Most eat small invertebrates, such as mysids in the zooplankton and small amphipods on surfaces. A few species also eat other invertebrates (for example, shrimps), and larval fish.

Many syngnathids, particularly the seahorses, are characterised by:

- relatively low population densities;
- low mobility and small home range sizes (hence recolonisation of overexploited areas would be slow);
- possible low rates of natural mortality in adults (hence fishing may place excessive pressures on the population);
- dependency of birth and survival of offspring on the survival of the males;
- monogamous breeding (hence a 'widowed partner' may temporarily stop reproducing until another mate is found);
- small brood sizes, which limits the potential reproductive rate (although this may be offset by higher juvenile survival); and
- strong association with the preferred habitat, which can make populations vulnerable to site-specific impacts. However, some of the inshore pipefish have very high population densities and live in unstable habitats, subject to damage from storms or dramatic changes in temperature or salinity, and such species can quickly colonise even small patches of suitable habitat.

Important areas for protected bony fish in the East Marine Region

Important areas in the East Marine Region are identified for species that are listed as threatened or migratory under the EPBC Act, thus important sites are identified for the single bony fish species listed – the orange roughy.

Orange roughy are known to aggregate, particularly around underwater features such as seamounts. There are many such features in the East Marine Region although the South East Marine Region is known to contain the largest concentrations of orange roughy. In midslope depths (~800–1000 m), orange roughy aggregate at specific spawning sites; once discovered, such sites quickly become the focus of intense trawling activities e.g. St Helens Hill, a seamount off north-eastern Tasmania (Larcombe and McLoughlin 2007).

A substantial catch of spawning orange roughy was taken off Newcastle–Port Stephens in 1988 (Graham and Gorman 1988), followed by the capture of numerous orange roughy eggs in the same area in 1989 (Graham 1990). This indicates that there is also an orange roughy spawning site off central New South Wales. It is therefore likely that mature orange roughy from along much of the New South Wales coast seasonally congregate in this area for spawning as well as at the better known aggregation sites off Tasmania.

Known interactions, threats and mitigation measures

Orange roughy

Large catches of orange roughy were made during the 1980s and 1990s before stocks were given some protection. Most of the exploitation of this species occurred in the South-East Marine Region, off Tasmania.

Since the 1990s, the Australian Fisheries Management Authority, in conjunction with industry, has managed the orange roughy fishery to reduce catch levels, including the creation of management zones with associated total allowable catches set annually. In 2005, the Authority reduced several orange roughy allowable catches to negligible quantities from 2007 onwards, to enable recovery of the commercial fishery.

In addition, the *Orange Roughy Conservation Programme 2006* allowed the then Minister for the Environment and Heritage to list the orange roughy as conservation-dependent. This conservation program aims to protect orange roughy from over-fishing, in part by prohibiting targeted fishing in the management zones. The Cascade Plateau off the south-east of Tasmania (in the South-East Marine Region) is the only area where this species is currently fished with catch levels set to allow recovery of the species.

Such measures are now considered essential for long-term protection of stocks of orange roughy. In the Western Zone of the South East Fishery – an orange roughy management area adjacent to the eastern boundary of the South-west Marine Region – an important management objective of

the early 2000's was that stocks should be above 30 per cent of pre-fishing biomass by 2004. At that time, there was a 90 per cent chance that the target would not be met, and it has not been met to date. During the early 2000's, stock size was estimated to be 10–26 per cent of pre-fishing biomass (Bruce et al. 2002).

Given the long life of orange roughy, and the consequent low recruitment relative to stock size, rebuilding rates will be particularly slow, and thus the cost in foregone catch of achieving any specific rebuilding target will be high. This was evident in an assessment in 2002, which showed that even with zero fishing, rebuilding of the stocks to target biomass levels would be very slow (Caton and McLoughlin 2005, Francis and Hillborn 2002).

Although very little is known about the trophic interactions of orange roughy, it is highly likely that significant reductions in orange roughy biomass will have impacts on the species that feed on them, and on the prey of orange roughy (Bruce *et al*. 2002). For example, surveys in New Zealand have shown declines in a series of species associated with orange roughy that may be the result of orange roughy fishing, either directly through by-catch, or indirectly through trophic or habitat interactions (Clark et al. 2000).

Bottom trawling on seamounts is considered to severely affect benthic fauna by physical damage, and through by-catch. Because of the importance of seamounts to orange roughy spawning, it is considered that the damage to habitat caused by bottom trawling in such areas may also affect recruitment of orange roughy. The conservation program being implemented by the Australian Fisheries Management Authority includes a prohibition on orange roughy fishing in known aggregation areas over seamounts.

Seamount habitats can be highly productive in fishery terms, but there are growing concerns about the effects of fishing on the biodiversity and ecosystem productivity of such areas. A stark example was a description by Clark and O'Driscoll (2003) of a photographic survey in New Zealand waters that showed a reduction from almost 100 per cent coral cover on unfished seamounts to 3 per cent cover on fished seamounts. In areas adjacent to the East Marine Region, large catches of coral were reported from the Tasman Sea fisheries on the Northwest Challenger Plateau and seamounts in the South Tasman Rise (Anderson and Clark 2003). It is likely that similar habitats exist in remote areas of the Region.

Syngnathids

Syngnathids are harvested both as target species in State waters (adjacent to the Region) and as by-catch. Seahorses and pipehorses are traded in Australia and internationally for traditional medicine and for aquaria. Seahorses are currently exported for the aquarium trade, from Victoria, Queensland, South Australia, Western Australia, and the Northern Territory.

The *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes* (Environment Australia 2002) identifies over-harvesting of wild specimens for the marine aquarium fish trade and/or the traditional medicine trades as the greatest potential threat to some species of syngnathids.

Trade of seahorses is heavily regulated in Australia under international and Commonwealth law. Licences are granted under CITES II and permits are required under the EPBC Act for the export of wild capture and aquarium-raised specimens. The Department of the Environment, Water, Heritage and the Arts is the CITES management authority in Australia, relying heavily on the Australian Customs Service to implement CITES controls for the syngnathid trade at ports of exit and entry. State governments also have permit systems regulating trade in syngnathids.

The trade in dried syngnathids for traditional medicine mainly utilises tropical and sub-tropical species in Australia, which are caught as by-catch in the Queensland East Coast Otter Trawl Fishery. The by-catch and sale of syngnathids caught in this fishery is undertaken in accordance with an approved Wildlife Trade Operation issued under section 303FN of the EPBC Act.

Australia is the sole supplier of two sea dragon species, *Phycodorus eques* and *Phyllopteryx taeniolatus*, to the live aquarium trade. In a review of exports of syngnathids from Australia, Martin-Smith and Vincent (2006) conclude that trade volume is relatively low (although lucrative) and probably poses a low threat compared to habitat loss, as traders tend to capture a few brooding males and rear the young for later sale. There is no evidence of population declines for either species (Pogonoski *et al* 2002).

Seahorses are often collected for use in home aquaria but they require particular care in captivity as they usually only consume live food. Without special care many seahorses taken from the wild do not survive for very long (Kuiter 2000). A number of aquaculture organisations in Australia have developed techniques for breeding and

keeping seahorses and they are largely sold to aquarium markets in Australia, North America, Europe and Asia (Martin-Smith and Vincent 2006). Cultured specimens are not accepted in the Traditional Chinese Medicine (TCM) trade (Anna Murray pers. comm.).

More than 98 per cent of Australia's exports of dried syngnathids for use in the TCM trade are the pipehorses *Solegnathus dunckeri* and *S. hardwickii*, sourced largely from the bycatch component of the ECTF. They represent Australia's largest syngnathid export both by volume and value (Martin-Smith et al. 2003; Martin-Smith and Vincent 2006). Because *S. dunckeri* is an endemic species, Australia is the sole supplier of this pipehorse to the TCM trade (Martin-Smith and Vincent 2006).

In a recent assessment of the Queensland ECTF it was reported that over 90 per cent of the total syngnathid catch was made up of the pipehorses, *Solegnathus dunckeri* and *S. hardwickii* (Dodt 2005; Connolly et al. 2001). *Solegnathus* species have also been reported as bycatch in the New South Wales Ocean Trawl Fishery (OTF) and in trawl fishing operations off Victoria which are managed by the Australian Fisheries Management Authority (Bowles and Martin-Smith 2003). A survey of bycatch in the demersal trawl fisheries in south-eastern Australia also showed that *Solegnathus* species were the major component of the syngnathid bycatch with *Solegnathus spinosissimus* the most commonly caught species on the south coast of New South Wales and eastern Victoria, and *S. dunckeri* the most commonly caught species from the central to the far north coast of New South Wales (Bowles and Martin-Smith 2003). The volumes traded from these fisheries are largely unknown and not regulated as in the ECTF.

In an assessment of threat to bycatch species caught in the New South Wales OTF (DPI 2004) four species of syngnathids were identified as being at medium to high risk from fishing operations. These were the pipehorses *Solegnathus dunckeri*, *S. spinosissimus*, and the seahorse *Hippocampus tristis*. Many of the other species of syngnathids found along the New South Wales coast are restricted to shallow, estuarine habitats and are considered at low risk from trawling operations (DPI 2004).

Many syngnathids inhabit relatively shallow inshore areas which makes them vulnerable to human disturbance. Increasing coastal development has the potential to impact on important habitats such as seagrass, reef and soft bottom habitats through pollution, urban run-off and dredging (Vincent 1996; Kuiter 2000; Pogonoski et al. 2002; Martin-Smith unpublished manuscript).

The poaching or illegal collecting of syngnathids in southern Australia is poorly documented; however some conservation authorities and government agencies have been concerned about the potential impact of this activity on populations, particularly during the 1990s, prior to the development of syngnathid aquaculture.

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D.3. East Marine Region Protected Species Group Report Card – Reptiles

Current at September 2007. For updates see <www.environment.gov.au/coasts/mbp/east >

General information

Marine turtles and sea snakes are reptiles. Both species are distantly related to land-based reptiles. They have lungs and must surface to breathe. Marine turtles and sea snakes are typically associated with tropical seas, however, some species are known to inhabit subtropical and temperate oceanic waters.

There are two extant families of marine turtles, Cheloniidae and Dermochelyidae. There are also two families of sea snakes: Hydrophiinae – aquatic species that never leave the water; and Laticaudinae – an amphibious species that can live on land and in water.

Nationally protected species

All marine turtles are listed under the EPBC Act as endangered or threatened migratory and marine species. Both these extant families of marine turtles occur in Australia and within the Eastern Marine Region including:

Cheloniidae (hard-shelled turtle)
with five species from five genera:
Loggerhead turtle (*Caretta caretta*)
Green turtle (*Chelonia mydas*)
Hawksbill turtle (*Eretmochelys imbricata*)
Olive ridley turtle (*Lepidochelys olivacea*)
Flatback turtle (*Natator depressus*)

One genus (*Natator*) is endemic to the Australian–New Guinea continental shelf. The remainder have a global distribution in tropical and temperate waters ranging from lower estuarine and inshore continental shelf to oceanic pelagic habitats. The family is characterised by non-retractable, large, paddle-like flippers, each with one or two claws and keratinised epidermal scutes (horny, scale-like structures) on the head, flippers, carapace and plastron (the underside of a turtle's shell). The ribs are fused to the overlying pleural bones which are also fused to each other to form the shield-like bony carapace of adults. The head can be partially withdrawn beneath the carapace and there are no cusps (pointed parts) on the upper jaw sheaths (Limpus and Miller 1993.

Dermochelyidae (leatherback turtle)
with a single species, *Dermochelys coriacea*.
The family has a global distribution from tropical seas to

Table D 3 Marine turtles listed as threatened or migratory under the EPBC Act that are known to occur in the East Marine Region

Species	Conservation Status	Australian Government Conservation Plans and Policies
Leatherback turtle, Leathery turtle (*Dermochelys coriacea*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	The Action Plan for Australian Reptiles (1993) Recovery Plan for Marine Turtles in Australia (2003) Sustainable Harvest of Marine Turtles and Dugongs in Australia - National Partnership Approach (2005)
Loggerhead turtle (*Caretta caretta*)	Endangered, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	
Green turtle (*Chelonia mydas*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	
Olive Ridley Lepidochelys olivacea	Endangered, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	
Flatback turtle (*Natator depressus*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	Threat Abatement Plan for Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs. Department of the Environment and Heritage (AGDEH) (2005)

sub-Arctic and sub-Antarctic waters ranging from oceanic to coastal waters but avoiding reefs. The leatherback turtle is characterised by large paddle-like flippers lacking claws, the absence of keratinised epidermal scutes except in hatchlings, separate ribs, a mosaic of small, polygonal dermal bones covering the body, a strongly ridged carapace, and pronounced cusps on the upper jaw (Limpus 1993a). The global biology of leatherback turtles has been partly reviewed by Hamann et al. (2003).

Some 25 species of marine snakes are known, or suspected, to occur in the East Marine Region. They include members of the following four major groups of snakes:

Colubrid snakes
(Family Colubridae, subfamily Homalopsinae):
1 of 4 Australian species.
These are all inshore snakes that occur mostly in the often turbid waters of protected bays and estuaries where they feed primarily on fish and crustaceans on tidal mudflats and in the intertidal zone of mangrove forests. They possess the broad ventral (belly) scales characteristic of terrestrial snakes, and their most obvious (external) marine adaptations are upwardly-directed nostrils and eyes (to allow the snakes to breathe and to see potential predators with only the tip of the snout and the eyes above water), and valvular nostrils (to prevent water entering the air passages when the snake is submerged or feeding). Members of this group possess a pair of venom glands (Duvernoy's) which can exude venom around the enlarged, grooved rear maxillary teeth when the snake bites, the venom running down the fangs largely by capillary action into the prey.

File Snakes
(Family Acrochordidae): 1 of 2 Australian species.
These snakes are entirely aquatic. They have tiny eyes and loose flabby bodies in which the skin is covered by very small keeled scales. These scales give the snakes a rough, file-or rasp-like feel and permit them to firmly grasp fish (on which they feed) between body loops prior to ingestion. They are non-venomous and harmless to humans, with only one of the three known species entering the marine environment.

Viviparous Sea Snakes
(Family Elapidae, subfamily Hydrophiinae):
16 of 29 Australian marine species.
These snakes are closely allied to Australia's proteroglyphous (fixed front-fanged) land snakes, and contain some of the most highly venomous snakes in the world. A venom gland under the skin of each cheek sends venom along a duct to the base of a hypodermic-like enlarged fang located at the front of the upper jaw. This venom can be injected into prey or predator when the snake bites. The majority of species, with the exception of a few smaller species that frequent mud and mangrove flats, never emerge voluntarily from the water. They are, however, often washed ashore, in an exhausted condition, after heavy storms and seas. The primary adaptations to a fully-aquatic life cycle are a viviparous (live-bearing) reproductive mode; a long and highly vascularised right lung (extended in length by a well-developed tracheal lung – all snakes typically have only a single functional lung) to permit submersion for extended periods; a moderate to extreme reduction in the size of the ventral (belly) scales facilitating aquatic serpentine locomotion; a large flattened, paddle-shaped tail to propel the snake through the water; and valvular nostrils that close off the air passages when the snake is under water, including when ingesting prey. The great majority of species feed on fish, with individual species specialising in particular groups of fish (e.g. eels, scorpaenids, gobeids and their eggs).

It should be noted that three additional species – *Hydrophis laboutei*, *H. gracilis* and *H. spiralis* – have been recorded from the Chesterfield Reefs and adjacent New Caledonian waters (Minton and Dunson 1985; Ineich and Rasmussen 1997; Rasmussen and Ineich 2000) and are therefore likely to occur on reef complexes within the Region (e.g. Kenn Reef). A fourth species – *Hydrophis coggeri* – is abundant in the waters of Fiji and New Caledonia, but appears to be disjunct from the only known Australian populations occurring on reefs of the North-west Shelf. However its abundance and proximity to the eastern provinces of the East Marine Region suggest that it may well occur there.

Oviparous Sea Kraits
(Family Elapidae, subfamily Laticaudinae):
2 or 3 of 8 Asian–Pacific species.
This is a small group (eight species) of semi-aquatic marine snakes in which the majority (six species) occur in the south-west Pacific region. These are mostly reef-dwelling snakes. Members of the group are sometimes carried well away from their normal ranges by storms and currents. All Australian records appear to be of waifs, and despite substantial breeding populations of at least one species in the coastal waters of southern New Guinea, no resident populations have been located within Australian waters. Sea kraits spend a substantial part of their lives on land, usually within about 100 m of the sea, and produce clutches of parchment-shelled eggs that are laid deep in rock-crevices or above the waterline in caves and overhangs, including caves with only underwater openings. Primary adaptations to a semi-marine existence in this group are enlarged ventral (belly) scales that facilitate terrestrial

locomotion, nostrils with fleshy valves to exclude water from the air passages while underwater, and a large flattened, paddle-like tail to propel the snake when swimming.

While only two species have been recognised as occurring in Australia, the scalation of two of three specimens from Australia described in Smith (1926) suggests that there may have been a third species, *Laticauda saintgironsi*, otherwise restricted to the waters of New Caledonia (Cogger and Heatwole 2006). A fourth species, *Laticauda guinea*, is also likely to occur in the far northern waters of the Cape Province bioregion. Surveys of the marine snakes of the Coral Sea (Zimmerman et al. 1994) and of New Caledonia (Ineich and Laboute 2002) are very relevant to studies of the marine snakes of the eastern limits of the East Marine Region.

For general information on the biology and ecology of marine snakes see Dunson (1975a) and Heatwole (1999) and for Australian taxa see Cogger (2000a) (keys to all taxa), Shine and Houston, (1993) (file snakes), Ehmann (1993) (colubrid snakes), Heatwole and Guinea (1993) (oviparous sea kraits) and Heatwole and Cogger (1993 1994) (viviparous sea snakes). For regional treatments within the East Marine Region see Dunson (1975b), Limpus (1975), Cogger (2000b). The phylogeny of Australian viviparous sea snakes has been recently assessed by Lukoschek and Keogh (2006).

All sea snakes are listed under Section 248 of the EPBC Act and are protected as listed marine species. No species of sea snake has been listed as threatened or migratory under the EPBC Act.

Ecology of protected reptile species in the East Marine Region

Marine turtles

On a global scale, each species of marine turtle can be subdivided into genetically separate stocks, or management units, defined by the area where they breed. Where clusters of breeding turtles of the same species occur in close proximity, they form an interbreeding population (management unit). Widely separated breeding aggregations can be expected to be genetically different and not interbreed (Dethmers et al. 2006).

Six species of marine turtles have been recorded breeding within the East Marine Region. Miller (1985) has provided a detailed account of embryological development for these species, namely the loggerhead, green, hawksbill, olive ridley, flatback and leather back turtles.

All marine turtles migrate from their dispersed foraging areas to aggregate for breeding at traditional nesting beaches (Plotkin 2003). The breeding female does not feed, or feeds at a reduced level, while offshore from the nesting beach in the inter-nesting habitat where she prepares her eggs for laying (Limpus et al. 2001; Tucker and Read 2001). Fertilisation is internal and spherical soft-shelled eggs are buried in nests on beaches above the tidal range. There is no parental care. Eggs incubate in sun-warmed sand with incubation period, incubation success, and hatchling sex ratio being a function of nest temperature (Miller 1997; Miller and Limpus 2003; Wibbels 2003). Turtles use the earth's magnetic field for navigation and hatchlings navigate across the beach using light horizons (Lohmann et al. 1997). They disperse rapidly from inshore waters without using the waters adjacent to the nesting beach for resting or foraging. When well offshore, the hatchlings cease their swimming frenzy and are then carried by ocean currents into oceanic pelagic habitats, except for flatback turtles which remain in pelagic habitats over the continental shelf (Bolten 2003). While in the pelagic habitats, all species are carnivorous, feeding on a wide range of macro-zooplankton.

The hard-shelled turtles remain in the ocean pelagic environment for a few years (hawksbill and green turtles) or up to about 16 years (loggerhead turtles) before they return to coastal waters where they change to a benthic-feeding life phase with diet varying with the species (Bjorndal 1997; Lanyon et al. 1989; Limpus and Limpus 2000; Limpus et al. 2001, 2005).

All marine turtles are slow-growing with delayed maturity (Chaloupka 1998; Chaloupka and Musick 1997; Chaloupka and Limpus 1997; Limpus and Chaloupka 1997). Green and hawksbill turtles may take about 35 years from hatchling to first breeding, Loggerhead turtles slightly less at about 30 years. Leatherback turtles are the fastest growing, reaching maturity at less than 20 years. Analyses of population genetics indicate that widely spaced clusters of breeding aggregations are genetically discrete and that the adult returns to breed at the region birth (Bowen and Karl 1997). All species lay multiple clutches of eggs in a breeding season and typically skip years between breeding seasons (Miller 1997, Hamann et al. 2003). Animals with these life history characteristics need mortality to be low throughout all their life history phases in order to maintain stable populations (Chaloupka 2002). Marine turtles are highly vulnerable to factors which cause even small increases in mortality.

Green turtle. Photo: Robert Thorne.

Green and loggerhead turtle post-hatchlings originating from nesting beaches of the southern Great Barrier Reef and mainland south Queensland and New South Wales will be carried by the East Australian Current (EAC) southward to approximately the latitude 30 °S off Coffs Harbour in New South Wales (Limpus et al. 1994c; Walker 1994) before being carried eastward to leave the Region and pass to the north of New Zealand. Post-hatchlings from the New Caledonian rookeries (figures 7.4, 7.6) can be expected to enter this same gyre and pass through the Region.

Post-hatchling loggerheads of various genetic stock are transported throughout the entire South Pacific Ocean gyre. Approximately half-grown loggerhead, originating from Coral Sea stock, are caught regularly in the longline fisheries of Peru and Chile in the eastern South Pacific (Kelez et al. 2004; Shigueto et al. 2006) (figure 7.10). They re-enter the East Marine Region oceanic waters as large immature turtles as they return to the Coral Sea area. They will leave the oceanic pelagic post-hatchling phase for the coastal benthic foraging life history phase when they are approximately 80 cm in carapace length and around 16 years of age.

Green turtles are much smaller when they leave the oceanic pelagic post-hatchling phase as recruits to coastal seagrass and algal foraging areas (Limpus et al. 2005). They presumably spend less time in the pelagic phase than loggerhead turtles, leaving it at about 8–10 years of age. It is highly likely that the green turtle post-hatchlings do not travel as extensively as loggerheads within the South Pacific. Green turtle post-hatchlings from the Coral Sea rookeries may remain entrained within the gyre of the Coral Sea. Little is known of the distribution of the green and hawksbill turtles post-hatchlings that enter the ocean currents within the northern Coral Sea.

Leatherback turtles migrate as juveniles and adults through the pelagic environment of the Coral Sea, Tasman Sea, including Bass Strait, and therefore occur throughout the oceanic areas of the Region.

Sea snakes

With the exception of the oviparous sea kraits, all other marine snakes in Australian waters are viviparous, with all phases of the reproductive cycle (mating and fertilisation, gestation, birth) and subsequent growth and sexual maturation taking place in the sea. There appear to be few, if any, modifications of the reproductive system as found in terrestrial viviparous snakes, except that copulation in many species appears to be preceded by complex courtship rituals in which males perform in front

of the female, followed by tandem swimming and head and body contact. Once copulation occurs, the snakes typically float freely, with body contact confined to the cloacal region.

Local or regional seasonal aggregations have been reported for a number of species, but in most cases there is little evidence that such aggregations have an explicit reproductive purpose rather than being for some other purpose (e.g. prey abundance). However, Limpus (2001) recorded what he presumed to be a resident breeding aggregation of the yellow-bellied sea snake (*Pelamis platurus*) in the Gulf of Carpentaria in July 1992, where he observed 84 individuals, covering all size classes, along a 99.4 km transect.

Fry et al. (2001) found that in all 13 species that they recorded from trawl bycatch in the Gulf of Carpentaria, reproduction was annual. They further suggested that the finding by Burns (1985) that reproduction in the olive sea snake (*Aipysurus laevis*) at the southern end of the Great Barrier Reef was probably on a 2-year cycle, might have been due to lower than optimum mean water temperatures.

Most viviparous sea snakes live within a fairly narrow stratum of the water column (ca. 0–100 m), with the majority restricting their normal daily activity to the 0–50 m zone. This often results in populations with very high site-fidelity, in which exchange of individuals between reefs separated by deeper bodies of water may be very low. Species occurring at deeper levels (i.e. 50–100 m) are usually those that feed on garden eels (a specialised group within the family Congridae) found on sandy substrates at these depths.

With the exception of the yellow-bellied sea snake, whose eastern Pacific populations have been studied extensively (Kropach 1975), the most studied Australian species is probably the olive sea snake (*Aipysurus laevis)* (Burns and Heatwole 1998, 2000; Lukoschek et al. 2007; Burns 1985).

There are currently no confirmed occurrences of migration events on a large geographic scale for any marine snake. Whether the breeding aggregations cited above represent migratory or merely local events is unknown. Older reports (Heatwole 1999) of great masses of intertwined sea snakes extending over many kilometres on the surface of the open ocean have long suggested the occurrence of mass migrations of sea snakes converging on particular oceanic sites to breed, but despite the great increase in shipping over the past century such aggregations (though they may occasionally occur for reproductive or other purposes) have so rarely been reported that they are unlikely to represent regular or typical breeding behaviours.

Important areas for marine reptiles in the East Marine Region

Marine turtles

The loggerhead turtles that breed in the South Pacific Ocean basin are from one interbreeding genetic stock (Dutton et al. 2002; Bowen 2003; Limpus and Limpus 2003a; Limpus et al. 2006). These turtles come ashore to nest on beaches of eastern Australia from the southern Great Barrier Reef and along the adjacent mainland coast to as far south as northern New South Wales, and in New Caledonia. The largest of the five major nesting concentrations for this stock (several hundred females annually) occurs at Mon Repos and adjacent beaches of the Woongarra Coast near Bundaberg adjacent to the East Marine Region. Smaller and decreasing numbers of loggerheads breed on beaches south from Bundaberg. A few tens nest on the Sunshine Coast annually, mostly near Caloundra. About 10 individuals per year breed on the beaches of the islands that enclose Moreton Bay, mostly on Moreton and North Stradbroke Islands. Nesting is rare on the Gold Coast. Isolated individuals nest annually on the northern beaches to as far south as about Ballina. On rare occasions, nesting may occur as far south as Newcastle (Limpus 1985).

Breeding adults migrate through the Region to their traditional nesting beaches in eastern Australia from dispersed foraging areas scattered within a 2,500 km radius of the beaches (from Eastern Indonesia, Papua New Guinea, Solomon Islands, New Caledonia, Northern Territory, Queensland and New South Wales (Limpus et al. 1992).

There are currently eight recognised genetic stocks of the green turtle (*Chelonia mydas)* breeding in separate areas in north-eastern Australia and the adjacent western Pacific Ocean (Dethmers et al. 2006; FitzSimmons 1997). One of these, the Coral Sea stock (many hundreds to low thousands of females breeding annually) is restricted to breeding on the islets within the Coringa–Herald National Nature Reserve.

Low density rookeries at the southern extremity of the distribution of southern Great Barrier Reef stock (Bundaberg coast – low tens of females annually; Fraser Island – high tens to low hundreds annually; Sunshine Coast – less than ten females annually) also occur within the East Marine Region. The main breeding population for this latter stock occurs in the southern Great Barrier Reef with some 5 – 8 thousand females breeding annually. Nesting numbers may fluctuate across three orders of magnitude in successive years in response to El Nino Southern Oscillation climate change events (Limpus and Nicholls 2000). Isolated individuals may nest as far south as northern New South

Wales in seasons of high density nesting. Adult turtles remain in their respective foraging areas in years that they do not breed.

Hawksbill turtle nesting within the Region is a rare event, restricted to the coral cays of the Coral Sea Nature Reserve. The principal nesting areas for the species in the Coral Sea region lie outside the region in the northern Great Barrier Reef–Torres Strait and Solomon Islands. Different genetic stocks are recognised for this species as well (Broderick et al. 1994)

Breeding by the flatback turtle is restricted to Australia and occurs from the Ningaloo area off Western Australia across northern Australia to Bundaberg in eastern Australia (figure 7.8). The nesting population on the central Queensland coast from Townsville to Bundaberg (adjacent to the waters of the Region) represents a discrete genetic stock for the species (Dutton et al. 2002). This east coast breeding population nests in mid-summer in contrast to the winter peak of nesting for the northern Australia nesting population (Limpus et al. 1993). Only a few tens of flatbacks nest annually on nesting beaches of mainland south Queensland between Baffle Creek and Hervey Bay within the Region. This contrasts with approximately 1,000 females nesting annually just to the north within the Great Barrier Reef.

Breeding adults migrate to their traditional nesting beaches in eastern Australian from dispersed foraging areas scattered over a 1300 km length of the lagoonal non-reef habitats inside the Great Barrier Reef between Torres Strait and Hervey Bay.

When nesting Letherback turtles were discovered in eastern Australia in the 1970s there were less than ten females nesting annually (Limpus and McLachlan 1979 1994). Nesting occurred mainly on Wreck Rock and Rules Beaches (~24.3 °S) immediately north of Baffle Creek within the Great Barrier Reef area. However, scattered nesting occurred on most mainland beaches adjacent to the Region north from Bundaberg. Further to the south, successful nesting and incubation was reported from an isolated female at Ballina (~28.8 °S) in northern New South Wales (Tarvey 1994). In contrast, a solitary nesting was reported from Forster (~32.2 °S) in New South Wales and, although embryonic development commenced within the eggs, no hatchlings were produced because the beach temperature at nest depth was below the lethal minimum for successful incubation. Nesting has declined since that time and the last record of leatherback nesting in eastern Australia occurred at Moore Park (~24.7 °S) near Bundaberg in 1996. The Australian east coast leatherback turtle nesting population appears to be approaching extinction.

This decline in eastern Australia nesting parallels the major decline in leatherback nesting reported during the same period in the eastern Pacific and attributed to bycatch mortality in oceanic gillnet and longline fisheries (Spotilla et al. 1996).

The olive ridley turtle does not breed in eastern Australia, nor is there significant nesting by the species within the Pacific Island nations of the western Pacific. The origin of the individuals that forage along the eastern Australian continental shelf is undetermined.

Sea snakes

The regular sighting of sea snakes in the south-east waters of the East Marine Region in mid- to late-summer is most likely to reflect waif individuals being caught up in the seasonally-active East Australian Current (Cogger 2000b). Whether such summer waifs are able to return to their source populations is unknown, but there currently is no evidence that they make the reverse journey.

Known interactions, threats and mitigation measures

Marine turtles

Indigenous harvest

Under Section 211 of the *Native Title Act 1993*, Indigenous people with a native title right can legitimately hunt marine turtles in Australia for communal, non-commercial purposes. In January 2004, the Marine and Coastal Committee, a body of the Natural Resource Management Ministerial Council, established a Taskforce on Marine Turtle and Dugong Populations (MACC Taskforce). The purpose of the MACC Taskforce was to develop a national partnership approach to help Indigenous communities achieve sustainable harvests of turtles and dugongs (Australian Government 2005). In 2005 a 'National Partnership Approach' for the sustainable harvest of turtles and dugongs in Australia was endorsed by the Natural Resource Management Ministerial Council.

The 'National Partnership Approach' has five key goals, which broadly aim to ensure that Indigenous harvest of turtles and dugongs is sustainable by outlining how Governments and Indigenous communities can work more closely together to increase the effectiveness of the protection and conservation of dugongs and marine turtles. Importantly, the Approach also aims to contribute to the conservation of turtles and dugongs while ensuring that the important economic, spiritual and cultural relationships Indigenous people have with these animals are maintained for future generations.

The loggerhead, green and hawksbill turtle populations that breed in eastern Australia are derived from foraging populations spread throughout eastern Indonesia, Papua New Guinea, Solomon Islands, Vanuatu, New Caledonia and Fiji as well as in the Northern Territory, Queensland and New South Wales. Similarly, Green turtles that breed in Papua New Guinea, Solomon Islands, Vanuatu and New Caledonia have part of their dispersed populations foraging in eastern Australia. Throughout these countries, green, hawksbill and loggerhead turtles are hunted for food. Indeed, the largest collective take of green and hawksbill turtles for human consumption globally occurs in the area of eastern Indonesia, Papua New Guinea, northern Australia and the western Pacific island nations. There are serious concerns that the collective harvest of these species within this area is not sustainable. The impact of the combined harvesting of turtles within the south-western Pacific region is seen as a threat to maintaining sustainable populations of marine turtles in the Region for the above three species.

Commercial fishery interactions

Marine turtles are caught as by-catch in a range of fisheries operating in Australian waters, including trawl, longline and pot fisheries.

By catch mortality within the pelagic longline fisheries of the South Pacific has been identified as a serious threat, particularly to leatherback and loggerhead turtles (Spotila et al. 2000, Lewison et al. 2004). While the mortality of marine turtles in the longline fisheries operating within eastern Australian waters, and hence the East Marine Region, may be low (Robins et al. 2002) it is the pooled mortality from all the longline fleets operating across the entire south Pacific (for loggerheads) and within the entire Pacific Ocean (for leatherbacks) that is the issue. Even with low bycatch mortality, Australian longline fisheries are contributing to the problem.

In coastal waters, bycatch mortality in prawn trawl fisheries in eastern and northern Australia has been the major contributing factor to the decline of the loggerhead nesting population of eastern Australia since the 1970s (Limpus and Limpus 2003a). This decline has been stopped by the mandatory use of turtle exclusion devices within these prawn trawl fisheries introduced in 2001. In the past two decades there has been increasing recognition of the entanglement and mortality of green and loggerhead turtles in the floatlines of crabpots with some tens of large individuals for each species being killed annually in Hervey Bay and Moreton Bay (Greenland et al. 2004). In the broader area of Bass Strait, appreciable numbers of leatherbacks are drowned annually through entanglement in the floatlines of crayfish traps (Bone 1998). The mortality of marine turtles in coastal gillnet fisheries has been poorly documented in eastern Australia. In addition, many tens of green, loggerhead and hawksbill turtles are estimated to die annually from ingestion of hooks and ingestion or entanglement in lost/discarded fishing line (presumed to originate from recreational fishers) within Hervey Bay, Moreton Bay and the estuaries of northern New South Wales

Habitat Loss

Human alteration of catchments with the associated change in the quality of the water flowing into coastal habitats, especially with floods, is probably the most pervasive cause of habitat loss impacting marine turtles within the Region. Land clearing for agricultural and pastoral industries and for urban development can result in increased sediment outflow from rivers which can cause significant losses of marine seagrass and algal pastures (Preen et al. 1995). Associated with human activities within the catchments, a great range of chemicals find their way into our waterways and subsequently flow into coastal habitats. For example, chlorinated hydrocarbons derived from land-based activities are now widespread in the sediments of coastal estuaries and bays adjacent to the East Marine Region and are concentrated as they pass up the food web from sediments to seagrass to turtles (Gaus et al. 2001; Hermanussen et al. 2004 2006). In some cases these pollutants can be passed across generations from adult female turtles to their hatchlings via the yolk of eggs (Muusse et al. 2006). The implications of these pollutants on the food resources and health of marine turtle populations is still under investigation.

At the nesting beaches, light pollution from coastal development has the most profound impact on the use of beaches by the nesting females and the survivorship of hatchlings. In the extreme, Kelly's Beach near Bundaberg has changed from supporting the second highest nesting density of loggerhead turtles within the district prior to the mid 1970s to now supporting a trivial nesting population as a result of changed light horizons associated with motel and housing developments on the dunes. The turtle are choosing not to use this beach with its altered light horizons while they continue to nest in large numbers on dark beaches a few kilometres away.

Boatstrike and propeller cuts

In recent decades there has been an increasing incidence of turtles killed by collision with vessels and chops from propellers (Greenland et al. 2002). It is estimated that many tens of large green and loggerhead turtles are killed annually in the Hervey Bay–Moreton Bay area. With increasing numbers of vessels being used in our coastal

waters, this problem is expected to increase. There has been some success in reducing boatstrike at localised sites using "go-slow" zoning within the Moreton Bay Marine Park.

Marine debris

Plastic rubbish washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers, and solid non-biodegradable floating materials are all considered harmful marine debris. Marine debris was listed as a key threatening process under the EPBC Act in 2003 because of the threat it posed to all marine life. It is an additional threat to the survival of species already listed as threatened under the EPBC Act.

All marine turtles nesting in Australia are considered to be at risk from marine debris (Department of the Environment and Heritage 2003). Marine turtles can be harmed by marine debris in two ways: by entanglement in discarded fishing gear or by ingestion of plastics. Some species of marine turtles, particularly leatherbacks and loggerheads are known to mistake plastic bags for jellyfish.

While small numbers of turtles from the foraging populations within coastal habitats are recorded dead each year from gut blockages resulting from ingestion of synthetic debris including plastic sheeting, plastic bags, balloons and fragmented plastic containers, it appears to be a much more significant issue for the post-hatchling turtles foraging in the pelagic waters off shore. The high incidence of appreciable amounts of synthetic debris in the guts of turtles being examined from the pelagic life history phase within the Region and the difficulty in quantifying mortality from this ingestion in offshore habitats is of concern.

The majority of strandings of post-hatchling green turtles in south Queensland – identified as recently derived from pelagic habitats – have gut blockages of synthetic debris. While some of this ingested marine debris may be derived from vessel operations, a high proportion is almost certainly land-based debris, not necessarily from Australia, which has drifted into oceanic habitats.

The Australian Government is currently developing a threat abatement plan that aims to minimise the impacts of marine debris on threatened marine species. Further information is available at <www.environment.gov.au/biodiversity/threatened/publications/marine-debris.html>.

Sea snakes

Commercial fisheries

The paucity of data on marine snake numbers and species richness in the Region, including meaningful information on bycatch numbers, prevents any reliable assessment of species at risk. The greatest long-term threat to marine snakes is probably the degradation of reef systems through siltation, eutrophication (excessive input of nutrients) or pollution from agricultural run-off and from the impacts of projected climatic shifts.

The most immediate threat to marine snakes in the East Marine Region is likely to be the mortality of those snakes taken as bycatch in commercial trawl fisheries (Ward 2000, Fry et al. 2001). There is some information to show that a high proportion of sea snakes survive following release from trawl capture (Department of the Environment and Heritage 2005) so the implications of bycatch of snakes are not clear.

Another significant threat, but one with longer-term implications, is the damage wrought by trawling on the benthic ecology (involving snake feeding grounds). Clearly, the overall impacts of trawling on marine snake populations will depend on the geographic extent of trawled snake habitat. There are few data available to determine this, but with the exclusion of the Great Barrier Reef Marine Park from the East Marine Region, impacts of trawling will be largely confined to the coastal zone between Fraser Island and the border between New South Wales and Queensland.

Trade in sea snake skins

The Australian Government has not yet issued commercial export permits for Australian sea snakes, but sea snake skin goods are already sold widely in northern Australia. This trade requires careful monitoring to ensure that populations of individual species do not decline to a level that threatens their survival.

Habitat Loss

While the role of marine snakes in reef ecosystems is virtually unknown and their responses to perturbations in those systems difficult to predict, as top order predators they are integral components of tropical shallow-water reef ecosystems. It is reasonable to assume then that loss or degradation of any part of these systems will result in the decline or loss of the snakes living within them. It is known that some marine snakes are quite sensitive to subtle changes in reef ecosystems so absence of evidence of macrodegradation should not be taken to imply that snake populations are secure.

Five species of *Aipysurus* (including three endemics) are recorded from the Northwest Shelf's Ashmore Reef. Together with a further 12 species in other genera, these sea snakes were in great abundance in 1972 (Dunson 1975a) but numbers have declined dramatically in recent

years, with few species and few individuals observed in recent surveys (Guinea 2007 pers.comm.). More than 500 individuals were collected or observed by a team of biologists during one week of surveying in 1972 but Guinea (2007) recorded continuing declines in the period 1992–2007, culminating in the observation of only seven snakes in 10 survey days in March 2007. Only two of these could be accurately identified, both being the olive sea snake, *Aipysurus laevis*. The causes of these declines in what were considered pristine oceanic reef habitats are unknown, but ecosystem degradation is implicated.

Other interactions/threats – There is evidence from northern Australian waters of interactions between sea snakes and marine debris, specifically discarded trawl nets. The yellow-bellied sea snake is also vulnerable to the adverse effects of oil spills at sea.

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D.4. East Marine Region Protected Species Group Report Card – Seabirds

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/east>.

General information

The term 'seabird' is used informally for a range of birds that inhabit the marine environment to some degree, for breeding and/or feeding. The extent of such use is highly variable, with some species moving into marine, estuarine or coastal environments for short term, opportunistic periods, whereas others are obligatorily tied to these situations for all aspects of their life cycle. Taxonomically, seabirds encompass members from several avian orders.

The species considered for this report are constrained by the geographical limits that have been set. The limits of the East Marine Region exclude most of the coastal breeding islands of southeastern Australia (e.g. Five Islands, etc.) and those of the Great Barrier Reef. It also excludes birds that use estuarine environments along the coast. Islands within the Region are the Lord Howe Island group (including Ball's Pyramid, and Roach, Muttonbird and other satellite islands and rock stacks) surrounded by the Lord Howe Island Marine Park; Norfolk Island group (including Phillip and Nepean Islands); Solitary Islands (Solitary Islands Marine Reserve); and small reefs and atolls of the Coral Sea, such as Willis Reef and three national nature reserves (Coringa–Herald, Elizabeth and Middleton Reefs, and Lihou Reef). There are a number of species that breed close to the mainland but forage away from the coast and potentially move into the East Marine Region. Species generally staying within a few kilometres of the coast are of limited direct relevance for consideration here.

For the purposes of this review, the following taxa are considered further: penguins, petrels and shearwaters, albatrosses, storm-petrels, frigatebirds, tropicbirds, gannets and boobies, gulls, terns and skuas. Shorebirds and herons are addressed as a single group. These taxa include a number of species that have been recorded only as vagrants. These stragglers are not specifically addressed here, but would be affected by the same threats as related species.

There are also north-south components in the distribution of seabirds. Penguins, albatrosses, many petrels and shearwaters, and gannets are generally limited to the temperate and/or subtropical parts of the Region. Although a few nest on islands along the south-eastern coast, most breed in the New Zealand region or on sub-Antarctic islands and move into the Region to forage. Boobies, frigatebirds and several species of terns that nest on islands in the Great Barrier Reef and Coral Sea are largely restricted to the tropical northern part for their foraging. A small number of species, such as the wedge-tailed shearwater (*Puffinus pacificus*) occur widely along the entire length of eastern Australia.

Nationally protected species

Of the 130 seabirds known to occur in the Region, 64 are listed as threatened and/or migratory under the EPBC Act (table D 4). These species include: albatrosses, petrels, shearwaters, noddies and terns. The protected seabird species found within the Region are described in further detail below.

Australia is a signatory to four international agreements for the conservation of migratory birds, namely.

- the *Agreement on the Conservation of Albatrosses and Petrels* (ACAP), a multilateral agreement that seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to albatross and petrel populations. ACAP has been developed under the auspices of the *Convention on the Conservation of Migratory Species of Wild Animals (CMS) 1979*;
- the *Agreement for the Protection of Migratory Birds and their Environment between the Government of Australia and the Government of Japan 1974* (JAMBA);
- the *Agreement for the Protection of Migratory Birds and their Environment between the Government of Australia and the People's Republic of China 1986* (CAMBA); and
- the *Republic of Korea–Australia Migratory Bird Agreement 2007* (ROKAMBA).

Ecology of protected seabird species in the East Marine Region

Penguins

Although a number of penguin species have been recorded in Australian waters as stragglers or vagrants, only one species breeds here. Within the East Marine Region, the little penguin (*Eudyptula minor*) nests on islands along the coast of New South Wales and Victoria and a few mainland sites. Occurrence of this species extends northwards into subtropical waters but it is uncertain how far beyond coastal areas little penguins move.

Petrels and shearwaters

Around 30 petrels, shearwaters, prions and diving-petrels are found in the Region on a regular basis. A number of other species have been recorded as vagrants. Several species breed on islands along the coast, or in the Great Barrier Reef and Coral Sea. There are also some that nest

Table D 4. Seabirds listed as threatened or migratory under the EPBC Act that are known to occur in the Region

Common name	Species	Conservation status	Australian Government Conservation Plans and Policies
little tern	*Sterna albifrons*	Migratory, Marine Listed under CAMBA & JAMBA & CMS (Appendix II)	Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (2006) National Recovery Plan for Ten Species of Seabirds (2005) National Recovery Plan for Ten Species of Seabirds – Issues Paper (2005) Recovery Plan for Albatrosses and Giant-petrels (2001) The Action Plan for Australian Birds (2000) Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (1998)
lesser frigatebird	*Fregata ariel*	Migratory, Marine Listed under CAMBA & JAMBA	
great frigatebird	*Fregata minor*	Migratory, Marine Listed under CAMBA & JAMBA	
red-footed booby	*Sula sula*	Migratory, Marine Listed under CAMBA & JAMBA	
brown booby	*Sula leucogaster*	Migratory, Marine Listed under CAMBA & JAMBA	
sooty shearwater	*Puffinus griseus*	Migratory, Marine Listed under CAMBA & JAMBA	
streaked shearwater	*Calonectris leucomelas*	Migratory, Marine Listed under CAMBA & JAMBA	
pacific golden plover	*Pluvialis fulva*	Migratory, Marine Listed under CAMBA & JAMBA	
lesser sand plover	*Charadrius mongolus*	Migratory, Marine Listed under CAMBA & JAMBA	
bar-tailed godwit	*Limosa lapponica*	Migratory, Marine Listed under CAMBA & JAMBA	
whimbrel	*Numenius phaeopus*	Migratory, Marine Listed under CAMBA & JAMBA	
little whimbrel	*Numenius minutus*	Migratory, Marine Listed under CAMBA & JAMBA	
terek sandpiper	*Xenus cinereus*	Migratory, Marine Listed under CAMBA & JAMBA	
common sandpiper	*Actitis hypoleucos*	Migratory, Marine Listed under CAMBA & JAMBA	
grey-tailed tattler	*Tringa brevipes*	Migratory, Marine Listed under CAMBA & JAMBA	
wandering tattler	*Tringa incana*	Migratory, Marine Listed under CAMBA & JAMBA	
common greenshank	*Tringa nebularia*	Migratory, Marine Listed under CAMBA & JAMBA	
marsh sandpiper	*Tringa stagnatilis*	Migratory, Marine Listed under CAMBA & JAMBA	
ruddy turnstone	*Arenaria interpres*	Migratory, Marine Listed under CAMBA & JAMBA	
red knot	*Calidris canutus*	Migratory, Marine Listed under CAMBA & JAMBA	
sanderling	*Calidris alba*	Migratory, Marine Listed under CAMBA & JAMBA	
red-necked stint	*Calidris ruficollis*	Migratory, Marine Listed under CAMBA & JAMBA	
sharp-tailed sandpiper	*Calidris acuminata*	Migratory, Marine Listed under CAMBA & JAMBA	
curlew sandpiper	*Calidris ferruginea*	Migratory, Marine Listed under CAMBA & JAMBA	

Table D 4. Seabirds listed as threatened or migratory under the EPBC Act that are known to occur in the Region

Common name	Species	Conservation status	Australian Government Conservation Plans and Policies
pomarine jaeger	*Stercorarius pomarinus*	Migratory, Marine Listed under CAMBA & JAMBA	Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (2006) National Recovery Plan for Ten Species of Seabirds (2005) National Recovery Plan for Ten Species of Seabirds – Issues Paper (2005) Recovery Plan for Albatrosses and Giant-petrels (2001) The Action Plan for Australian Birds (2000) Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (1998)
common noddy	*Anous stolidus*	Migratory, Marine Listed under CAMBA & JAMBA	
bridled tern	*Sterna anaetheta*	Migratory, Marine Listed under CAMBA & JAMBA	
black-naped tern	*Sterna sumatrana*	Migratory, Marine Listed under CAMBA & JAMBA	
common tern	*Sterna hirundo*	Migratory, Marine Listed under CAMBA & JAMBA	
lesser crested tern	*Sterna bengalensis*	Migratory, Marine Listed under CAMBA	
Wilson's storm-petrel	*Oceanites oceanicus*	Migratory, Marine Listed under JAMBA	
brown skua	*Stercorarius antarcticus*	Migratory, Marine Listed under JAMBA	
masked booby	*Sula dactylatra*	Migratory, Marine Listed under JAMBA	
white-tailed tropicbird	*Phaethon lepturus*	Migratory, Marine Listed under JAMBA	
wedge-tailed shearwater	*Puffinus pacificus*	Migratory, Marine Listed under JAMBA	
flesh-footed shearwater	*Puffinus carneipes*	Migratory, Marine Listed under JAMBA	
short-tailed shearwater	*Puffinus tenuirostris*	Migratory, Marine Listed under JAMBA	
cattle egret	*Ardea ibis*	Migratory, Marine Listed under JAMBA	
pectoral sandpiper	*Calidris melanotos*	Migratory, Marine Listed under JAMBA	
arctic jaeger	*Stercorarius parasiticus*	Migratory, Marine Listed under JAMBA	
crested tern	*Sterna bergii*	Migratory, Marine Listed under JAMBA	
amsterdam albatross	*Diomedea amsterdamensis*	Endangered, Migratory, Marine Listed under CMS (Appendix I)	
chatham albatross	*Thalassarche eremita*	Endangered, Migratory, Marine Listed under CMS (Appendix II)	
herald petrel	*Pterodroma heraldica*	Critically Endangered	
wandering (snowy) albatross	*Diomedea exulans*	Vulnerable, Migratory, Marine Listed under JAMBA, CMS (Appendix II)	
Tristan albatross	*Diomedea dabbenena*	Endangered, Migratory, Marine Listed under CMS (Appendix II)	
northern royal albatross	*Diomedea sanfordi*	Endangered, Migratory, Marine Listed under CMS (Appendix II)	
black-browed albatross	*Thalassarche melanophrys*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
grey-headed albatross	*Thalassarche chrysostoma*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	

Table D 4. Seabirds listed as threatened or migratory under the EPBC Act that are known to occur in the Region

Common name	Species	Conservation status	Australian Government Conservation Plans and Policies
northern giant-petrel	*Macronectes halli*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (2006) National Recovery Plan for Ten Species of Seabirds (2005) National Recovery Plan for Ten Species of Seabirds – Issues Paper (2005) Recovery Plan for Albatrosses and Giant-petrels (2001) The Action Plan for Australian Birds (2000) Threat Abatement Plan for the Incidental Catch (or bycatch) of Seabirds During Oceanic Longline Fishing Operations (1998)
southern royal albatross	*Diomedea epomophora*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
shy albatross	*Thalassarche cauta*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
white-capped albatross	*Thalassarche steadi*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Salvin's albatross	*Thalassarche salvini*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Buller's albatross	*Thalassarche bulleri*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Pacific albatross	*Thalassarche sp. nov. (plateni)*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Campbell albatross	*Thalassarche impavida*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Indian yellow-nosed albatross	*Thalassarche carteri*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
sooty albatross	*Phoebetria fusca*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
southern giant-petrel	*Macronectes giganteus*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
providence petrel	*Pterodroma solandri*	Migratory, Marine Listed under JAMBA	
antipodean albatross	*Diomedea antipodensis*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
light-mantled sooty albatross	*Phoebetria palpebrata*	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	

in the Lord Howe or Norfolk Island groups. In some cases, species are extinct on the main islands and now breed only on satellite islands.

Albatrosses

No albatrosses breed in or near the Region, instead nesting mainly on islands in the sub-Antarctic and near mainland Tasmania. A number of species of albatrosses have been recorded in temperate waters along eastern Australia during non-breeding periods. The number of species recognised varies depending on the taxonomy adopted, ranging from 8 to more than 20. Albatross are long-lived, slow-breeding birds. These characteristics mean that they are unlikely to recover quickly from significant threats.

Storm-petrels

Five species of storm-petrels occur regularly in eastern Australian waters, mainly in temperate and subtropical zones. The white-faced storm-petrel (*Pelagodroma marina*) breeds on islands along the southeast coast. The white-bellied storm-petrel (*Fregetta grallaria*) formerly bred on Lord Howe Island, but is now restricted to smaller islands in that vicinity.

Frigatebirds

Two species, the great frigatebird (*Fregata minor*) and lesser frigatebird (*F. ariel*) nest on islands in the Great Barrier Reef and Coral Sea and move into the tropical sections of the Region when foraging.

Tropicbirds

The red-tailed tropicbird (*Phaethon rubricauda*) nests on islands in the Great Barrier Reef and Coral Sea, as well as on Lord Howe and Norfolk Islands. A second species, the white-tailed tropicbird (*P. lepturus*), does not breed in the vicinity but, like the other species, forages throughout the northern (tropical) part of the East Marine Region.

Gannets and boobies

Within Australia, the Australasian gannet (*Morus serrator*) breeds in a few Victorian sites adjacent to the Region, as well as having many nesting sites around New Zealand. There is extensive movement across the Tasman Sea and through the southern half of the Region. The red-footed booby (*Sula sula*) and brown booby (*S. leucogaster*) breed on islands in the Great Barrier Reef and Coral Sea, and forage widely through the tropical northern section of this Region.

Osprey

The single species of osprey, *Pandion haliaetus*, occurs around almost the entire mainland coast. It occasionally extends to the Solitary Islands.

Gulls

Australia has three breeding species of gulls. All seem confined to coastal areas, with little movement into pelagic waters.

Terns

Of the 15 species of terns that occur regularly along eastern Australia, nine breed on islands along the coast, or in the Great Barrier Reef or Coral Sea. Three breed in both the Lord Howe and Norfolk Island groups, and two widespread species are found throughout. Two species are restricted to coastal areas, while the others occur widely in the East Marine Region.

Skuas and jaegers

The four species that are found regularly in the East Marine Region do not breed near the Australian mainland, but forage widely through temperate and subtropical waters.

Shorebirds, egrets and herons

About 14 sandpiper and 3 plover species occur in small but regular numbers on the coasts of the Lord Howe and Norfolk Islands groups. Several species are non-breeding visitors, usually as migrants but occasionally as vagrants. Only the masked lapwing (*Vanellus miles*) breeds in the Region (at Lord Howe Island). The white-faced heron (*Egretta novaehollandiae*) breeds in small numbers. The cattle egret (*Ardea ibis*) is a regular, non-breeding visitor. On the Solitary Islands, two species of oystercatcher, usually confined to the mainland coast, also occur. Because all these species spend much of their time feeding along the water's edge, they are potentially at risk from oil or other pollution.

Important areas for seabirds in the East Marine Region

Breeding and roosting seabirds are an important component of the natural heritage values of areas in the Region that have been set aside for special protection. Surrounded by the Lord Howe Island Marine Park, the island itself has been recognised as a World Heritage Area in part for its biodiversity. Similarly, the Solitary Islands Marine Reserve, off New South Wales, the Coral Sea National Nature Reserves (Coringa–Herald, Lihou Reef) and Elizabeth and Middleton Reefs Marine National Park have been established because of their biodiversity, including birds.

Known interactions, threats and mitigation measures

Threats to seabirds cited in the Action Plan for Australian Birds (2000) primarily involved either mortality through longline and other fishing activities or disturbance to nesting birds and predation by feral animals. The EPBC Act specifically identifies three major threatening processes: (1) longline fishing, (2) feral cats and (3) competition with, and environmental damage caused by, rabbits. The latter two are of relevance on breeding islands, notably on sub-Antarctic Macquarie Island outside the Region.

Fishing-related impacts and disturbance/predation on breeding islands are the most relevant to seabirds within the East Marine Region. Other threats to seabirds, such as pollution, are of major concern. Discarded plastics are a global threat to both adults and chicks, and can be encountered anywhere in the Region. Some forms of pollution are more likely to be confined to areas within near proximity of coastal Australia but could occur near the Lord Howe and Norfolk Islands groups in the Region. These threats and others are discussed in detail below

Human disturbance

Historically, human impact on breeding seabirds has been substantial. Settlers on Norfolk Island harvested breeding providence petrels for food, starting in 1790. The bird was extirpated from the island within a few years. The providence petrel survived on Lord Howe Island and in recent years the species has recolonised Philip Island, off Norfolk Island. Several species of petrels once bred on the main island of those island groups, but now persist only on satellite islands (e.g. white-bellied storm petrel (*Fregata grallaria)* in the Lord Howe Island group). The sooty tern (*Sterna fuscata*) nests on Lord Howe Island and on smaller islands adjacent to Norfolk Island.

Human disturbance to sea birds on Lord Howe Island is now greatly reduced because much of the island's breeding habitat is protected. On Norfolk Island, some breeding areas are difficult to access, being on cliff faces or offshore stacks, but others rely on the protection of private landowners. Several other islands are specially protected, but a combination of difficult access and remoteness contributes as least as much to their security. Human-related disturbance to nesting

seabirds in the Great Barrier Reef has been studied, and findings are applicable to the Coral Sea also. While human intrusion does have an impact on seabirds, detrimental effects are minor if properly managed. Considerably more work is required to protect various groups of birds in different situations (e.g. burrows or surface nesting, roosting or breeding).

Introduced predators and domestic animals

Introduced species pose a considerable threat to seabird populations on the islands in the East Marine Region. For example, rats were inadvertently introduced to Lord Howe Island in 1918 by a shipwreck. Within a few years, several of the native breeding birds had become extinct. Masked owls (*Tyto novaehollandiae*), a species native to mainland Australia, were released on Lord Howe Island to control the rats but these preyed extensively on white terns (*Gygis alba*) and other native island species. Despite efforts to remove these owls, a few individuals remain. The release of predators near colonies on smaller, uninhabited Coral Sea atolls could be devastating for breeding birds.

Domestic pets, particularly cats, have caused considerable mortality in some petrel colonies on Norfolk Island.

Boats and planes

Birds become accustomed to the presence of boats and planes and associated noise, provided a minimum distance is maintained. As long as people stay within craft and collisions with birds are avoided, these are minor threats.

Mining

At present, mining activities are of minimal concern for the East Marine Region; however, these activities have been shown to have significant impact on birds elsewhere. Spillages from mainland-based mining activities could wash into feeding areas or in the vicinity of breeding sites.

Oil and pollution

Oil spills are devastating to seabirds. Oil can coat the birds, reducing insulation and waterproofing, and resulting in problems with foraging. If ingested during preening, the oil can be toxic. If not fatal to the bird, it can contaminate their young. Winds can move spilt oil towards the shore and in the vicinity of breeding areas and feeding sites. In the East Marine Region, shorelines in the Norfolk and Lord Howe island groups would be the most likely affected through oil spills, presenting a major threat to non-breeding, migrant shorebirds.

Heavy metals and organic compounds (e.g. organochlorines) also have the potential to be major threats. These can be ingested by the birds directly or bio-accumulated from further down the food chain. Contamination by organic chemicals is widespread and has been found in almost all procellariiforms tested for their presence. Individuals that are older or higher up the food chain, exhibit more elevated levels of chemicals as shown in wandering albatrosses by Hindell et al. (1999). Direct mortality may not be as pervasive as more indirect effects. For instance, higher levels of ingested contaminants can manifest themselves in faulty calcium deposition in eggshells or abnormal embryos. Effects of this nature have been documented in giant petrels by Luke et al. (1989).

Marine debris

Discarded debris at sea has been shown to be a threat to seabirds. Fish lines and nets can entangle birds, impeding their ability to forage to the point of starvation if not killing them outright. Of other substances jettisoned, plastic is by far the most hazardous. This is frequently ingested. While it can be toxic, it is more of a problem by becoming an obstruction in the digestive tract. Plastic debris has been recorded in the stomachs of a number of species and has been observed being regurgitated by adults in food for their young.

Loss of food stock

Breeding cycles of many species have evolved to exploit seasonal occurrence of food sources. Fish stocks in many areas are already known to be depleted. Combined with natural fluctuations in population densities, these decreases in available food, particularly at critical times, could cause extensive mortality in seabirds. For example, a high adult mortality and a poor breeding season for little penguins immediately followed the widespread mortality of pilchards (*Sardinops sagax*) in the autumn–winter of 1995 (Dann et al. 2000).

Commercial Fishing

Incidental bycatch of seabirds, particularly albatrosses, has been explicitly identified as a threatening process. The major fishing techniques posing threats are the use of longlines and trawling.

Longline fishing has been described as the single most pervasive threat to seabirds, and is listed in the EPBC Act as a major threatening process. Although the extent of mortality associated with longline fishing is poorly known worldwide, it is recognised that tens of thousands of birds are killed annually in licensed fisheries and even more in illegal, unreported and unregulated fishing. Longline fishing uses a weighted main line sporting side branches with baited hooks. Given that a typical single line may be up to 10 km long and have 10,000 hooks, it is not surprising that millions of hooks are set annually in the Region. Each hook is baited, and as a line is set, this remains on or near

the surface for a period before sinking. Birds attempt to take the bait while it is still on or near the surface. In doing so, they may ingest hooks and subsequently be dragged underwater and drowned as the line sinks.

There are regional differences in the effects on seabirds depending on the techniques and equipment used, as well as seasonal and geographical variations. A range of measures have been implemented to reduce seabird mortality from fishing in Australian waters. The target level is 0.05 birds killed per 1000 hooks set (Department of the Environment and Heritage 2006). However, much of the fishing occurring in the high seas adjacent to the Region, where seabirds forage, have ineffective or no seabird bycatch mitigation measures in use.

During trawl fishing, birds may be injured or killed when nets are being set or hauled. Birds can collide with trawl wires, become entangled in the nets or caught in the mechanisms withdrawing the nets as they attempt to take captured items. They have also been recorded striking ships or protruding structures when flying about awaiting an opportunity for a feeding attempt. There is growing evidence that mortality related to trawl fishing can be important, but this mostly comes from outside the review area in other Australian waters or globally. Information on domestic trawl seabird bycatch is minimal; some reports suggesting that trawl bycatch in southeastern Australian waters is low. There are probably insufficient data to make a meaningful assessment.

Seabird bycatch appears low in the longline billfish and tuna fishery, which is concentrated along the entire east coast of Australia. Monitoring of seabird mortality has increased on domestic longline boats since experience globally indicates that a dedicated observer regime during longline and trawl fishing is the only reliable method of assessing the level of seabird mortality.

Gill nets can capture and kill birds, but these are essentially used in coastal areas. Ghostfishing by discarded or lost nets is problematic; however, there are few, if any, data to assess its significance in the East Marine Region.

Birds have learnt to follow fishing boats, taking discarded fish remains. While this can have local beneficial effects if it occurs near nesting sites, by increasing food available to parents and offspring, it also increases the likelihood of mortality and injury as it brings birds into closer contact with ships, nets and lines, and is overall an undesirable situation.

Climate change

The range of impacts that climate change will have is uncertain. It is likely that warming of ocean waters will affect aspects of the food chain. For example, warming water will hold reduced levels of oxygen, which, in turn, could cause reductions in primary production and a subsequent decrease in the amount of krill. This would have ramifications up the food chain for birds that feed directly on krill or those dependent on prey species that do. Changes in water temperatures could also shift preferred feeding areas. Breeding patterns might change, with birds breeding earlier (Hobday et al. 2006). In little penguins, breeding success and chick weight can be affected by ocean temperatures at a local scale (Chambers 2004). Changes in severity of storms could affect breeding sites. Control of these factors is not amenable to direct human intervention.

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D.5. East Marine Region Protected Species Group Report Card – Pinnipeds

Current at September 2007. For updates see <www.environment.gov.au/coasts/mbp/East>

General information

There are ten species of seals recorded in Australian waters. This report focuses on the only two species breeding in continental Australia that are likely to be encountered in the East Marine Region. These are the Australian fur seal (*Arctocephalus pusillus doriferus*) and New Zealand fur seal (*Arctocephalus forsteri*).

The weight of scientific evidence suggests that although the seal population is probably still lower than before commercial hunting began, the New Zealand fur seal and Australian fur seal have been increasing their population size and range for some time (Marine and Marine Industries Council 2002; Kirkwood et al. 1992; Shaughnessy 1999). Moreover, based on current trends, seal population growth may continue into the future (Marine and Marine Industries Council 2002) with a possible trebling of the population by 2035 (Goldsworthy et al. cited in Kearney et al. 2003).

There are no known breeding colonies of either seal species in the East Marine Region; however, there are historical records of Australian fur seals breeding at Seal Rocks, near Port Stephens and Montague Island in southern New South Wales. At present Montague Island is the major haul-out site along the coast of New South Wales for both species (Shaughnessy 1999). Although there have been a number of reports of fur seal pups on Montague Island it is considered as supporting haul-out sites rather than breeding sites (Shaughnessy et al. 2001).

New Zealand fur seals can be distinguished from the Australian fur seal by their uniformly darker coat colour, high pitched call (Australian fur seals have a deep bark), and relatively long pointed nose. They also move differently on land. New Zealand fur seals "hop" with fore-flippers moving together whereas Australian fur seals "waddle" from side to side as they move one fore flipper after the other (Goldsworthy et al. 1997).

Nationally protected species

Under the EPBC Act, the Australian fur seal and New Zealand fur seal are listed marine species (see Table D5.1). It is an offence to kill, injure, take, trade, keep or move any member of either species in Commonwealth waters without a permit.

The Australian fur seal and the New Zealand fur seal are listed under Appendix II of the *Convention on International Trade in Endangered Species* (CITES). This means they are not necessarily threatened with extinction now but that may be the case unless trade is closely controlled.

Ecology of pinnipeds in the East Marine Region

The life history characteristics of the Australian and New Zealand fur seals are summarised in table D5.2.

There are no records of large seal numbers in the East Marine Region. Movements of tagged fur seals have been recorded occasionally along the New South Wales coastline which indicates that they travel large distances. Tagging studies have shown that the Australian fur seals at Montague Island come from several of the breeding colonies in Bass Strait. Tagged New Zealand fur seals from colonies in South Australia and New Zealand have been recorded on the coast of New South Wales (Shaughnessy et al. 2001).

Important areas in the East Marine Region

Although there are no breeding colonies of Australian or New Zealand fur seals in the Region and the haul-out sites for both species fall within State waters, it is likely

Table D 5.1 Pinnipeds listed as threatened under the EPBC Act that are known to occur in the Region

Species	Conservation Status	Australian Government Conservation Plans and Strategies for the Species
Australian fur seal (*Arctocephalus pusillus*)	Listed Marine	The Action Plan for Australian Seals (1999)
New Zealand fur seal (*Arctocephalus forsteri*)	Listed Marine	National Strategy to Address Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism (November 2006) National Assessment of Interactions between Humans and Seals: Fisheries, Aquaculture and Tourism (2007)

Table D5.2 Summary of life history, feeding and population information for Australian and New Zealand fur seals (sources: Shaughnessy 1999; DAFF 2007).

	Australian Fur Seal	New Zealand Fur seal
Scientific name	Arctocephalus pusillus doriferus	Arctocephalus forsteri
Abundance	92 000	57 400
Feeding	Feed primarily on fish and cephalopods, also seabirds	Feed primarily on fish and cephalopods, also seabirds (incl. little penguins)
Longevity	Male: 19 years; female: 21 years	Male: 15 years; female: 26 years
Age at sexual maturity	Females: 3–6 years; males – hold territories at 8 to 13 years	Females: 6 years; males – hold territories at about 9 years
Pupping interval	1 year	1 year
Gestation	8–9 months	8–9 months
Pupping season	late October to late December	Late November to mid-January
Mating season	November–January	Mid-November–mid-January

that they traverse both State and Commonwealth waters, and that they have feeding areas in Commonwealth waters of the Region. Montague Island and Steamers Head should be considered as key areas as they are the only haul-out sites in New South Wales, are used by many animals for resting, and are far removed from breeding grounds. There are likely to be key feeding areas nearby but further research is required to identify these areas.

The major haul-out site at Montague Island is only 8 km from the continental shelf margin, an area typically high in primary production supporting relatively high concentrations of fish and seabirds on which the seals feed (Irvine et al. 1997). These feeding grounds are mostly in Commonwealth waters.

Fur seals in the Region interact with the fishing industry and are the focus of tourist operations at Montague Island and Steamers Head (see below).

Although Australian fur seals currently breed at a small number of islands in Bass Strait, this range was previously more widespread. Adjacent to the East Marine Region Australian fur seals are reported to have bred at Seal Rocks, near Port Stephens and Montague Island, off Narooma in New South Wales (Shaughnessy 1999). Shaughnessy recommended that long-term planning for conservation should not overlook the possibility that this species may re-colonise some of its former breeding sites.

Known interactions, threats and mitigation measures

Seals may be affected by several human activities including: conflict with commercial fishing; entanglement in fishing gear and other marine debris; reduction in food supply; human disturbance, including tourism, aircraft and vessels; oil spills and chemical contaminants; and diseases.

The three most important of these occurring in the East Marine Region are considered below. To ensure the conservation of seal species, management plans put in place by State authorities need to be considered in order to protect animals traversing and feeding in Commonwealth waters of the Region.

Fishing

The main concern for fur seals in the waters of mainland Australia result from interactions with fishing operations. Australian fur seal populations are still recovering from over-exploitation during past commercial sealing operations and despite recent increases in numbers are estimated to be about half of pre-harvesting levels (Kirkwood in Shaughnessy et al. 2003a). Similarly the New Zealand fur seal is recovering from earlier harvesting (Shaughnessy et al. 1995). As fur seal numbers increase there is potential for an increase in operational interactions between these marine mammals and fisheries in Australian waters (Shaughnessy et al. 2003b).

Interactions of seals with fisheries in the East Marine Region are most likely to occur with the Ocean Trawl Fishery. This fishery is managed by the New South Wales Department of Primary Industries (DPI) which is undertaking a project to identify the broad-scale interactions that occur between fishing operations and mammals, reptiles and birds in New South Wales waters (DPI 2004). A scientific observer program is being introduced across all commercial fisheries in New South Wales. The purpose of this program is to document the interactions of fishing

operations with non-retained and threatened species (including seals), and to collect information on the use and effectiveness of bycatch reduction devices (DAFF 2007). The data collected from the observer program will be used to assess the need to introduce seal-excluder devices and other measures to minimise impacts between seals and fishing operations (DAFF 2007). Methods for decreasing bycatch of seals in the trawling sector are set out in the 'Code of Fishing Practice to Minimise Seal Bycatch' (AFMA 2001). The code also includes suggestions on how to avoid attracting seals to the fishery grounds. These are voluntary guidelines and standards of behaviour for responsible fishing practices.

There is currently limited observer data but anecdotal reports indicate that fur seals take fish from nets and interrupt fishing operations in the Ocean Trawl Fishery. The Australian fur seal may interact with the fishery in a number of ways: capture or contact with fishing gear; entanglement in discarded or lost fishing gear; competition; and illegal shooting by fishers. However, the risk to both the Australian and the New Zealand fur seal is currently considered low-medium with only a small proportion of the population affected by operations of the fishery (DPI 2004).

Seal interactions with the Ocean Trap and Line Fishery operations in the Region are also likely, particularly south of Jervis Bay (DPI 2004). As in the Ocean Trawl Fishery, there is limited observer data; however there are anecdotal reports of fur seals interacting with fishing operations (DAFF 2007). In interviews conducted in 1999 with fishers from the drop-line, trawl and hand-line fisheries on the south coast of New South Wales, between Jervis Bay and Eden, drop-liners, hand-liners and trappers reported most problems with seals. Trawlers reported fewer interactions and long-liners even less. Interactions with seals occurred more often in winter (when they were more abundant in the area) than in summer. More interactions were reported around Montague Island than north or south of it. The two main causes of interactions appeared to be seals preying on target fish in fishing operations, and seals becoming entangled in gear (Hickman 1999). The Lobster Fishery operating off the New South Wales coast has no recorded interactions with fur seals and the potential impact is currently considered low (Department of the Environment and Heritage 2006).

Seals also interact with the operations of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (SESSF). Although this fishery extends southwards from Sandy Cape in Queensland to Cape Jervis in South Australia the majority of operators fish in southern Australia—mainly off Tasmania, Victoria and South Australia. Observer programs in these regions have documented female fur seal interactions with sectors of this fishery (DAFF 2007).

A study of the seasonal overlap between the foraging areas of female Australian fur seals and fishing activity in the Commonwealth Trawl Sector found that considerable overlap occurs between the South East Trawl Fishery and the areas used by fur seals from colonies at Lady Julia Percy, The Skerries and Kanowna Island (off Victoria). This overlap does not, however, coincide with areas of the highest fishing activity.

Interactions in the Region (mainly the southern coast of New South Wales) are more likely to occur in spring when female fur seals undertake more dispersed foraging trips unencumbered by dependent pups (Arnould 2004).

Little is known of the interactions of seals and the recreational fishing sector in the Region but in a comprehensive review of marine mammal interactions with fisheries it was concluded that interactions which lead to the death and entanglement of some marine mammals and economic losses for the fishing industry are inevitable (Shaughnessy et al. 2003b).

Marine debris

Apart from direct interactions with fishing operations seals can become entangled in discarded or lost fishing equipment (classed as harmful marine debris). Marine debris is considered a Key Threatening Process under the EPBC Act 1999 (see: http://www.environment.gov.au/cgi-bin/sprat/public/publicgetkeythreats.pl). In the listing of harmful marine debris as a Key Threatening Process, six endangered species, fourteen vulnerable species, and one critically endangered population of grey nurse shark were identified as being adversely affected by harmful marine debris.

Entanglement of fur seals in discarded fishing gear usually results in death (Shaughnessy et al. 2003b). Although impacts of this mortality on Australian fur seals in the East Marine Region have not been evaluated, it is likely that fur seals in the region will become entangled based on data collected elsewhere in their range. For Australian fur seals, Pemberton et al. (1992) recorded that 1.9 per cent of animals at haul-out sites in southern Tasmania were entangled in marine debris: the highest incidence of entanglement recorded for a marine mammal. A number of juvenile Australian fur seals were observed with man-made debris around their necks at Montague Island (Shaughnessy et al. 2001) showing that fur seals are vulnerable to fishing-related marine debris throughout their foraging range.

Page et al. (2004) collated data on entanglements of Australian sea lions and New Zealand fur seals on Kangaroo Island for each year between 1988 and 2002. The incidence of entanglement for fur seals was 0.9 per cent in 2002, the fourth highest rate reported for a seal species. This rate did not decrease after government and fishing industry associations introduced guidelines in 2000 to reduce the impact of fishing on non-target species (Page et al. 2004). Loops of packing tape from the rock lobster fishery and trawl net fragments from the trawl fishery were found on seals most frequently. Page et al. (2004) estimated 295 New Zealand and 1119 Australian fur seals die as a consequence of entanglement each year in southern Australia. At present, rates of entanglement and mortality of seals in lost or discarded fishing gear in waters of the Region are not systematically assessed and are likely to be underestimated (DAFF 2007).

Tourism

In southern New South Wales there are several haul-out sites for fur seals, most of which are Australian fur seals, but some New Zealand fur seals are included. Tourist operators provide seal viewing opportunities at two of these, Montague Island, off Narooma, and Steamers Head, near Jervis Bay.

The effects of tour boat operations on fur seals at Montague Island were investigated by Shaughnessy et al. (2007). As a result a minimum approach distance to fur seal colonies of 40 m has now been gazetted as a regulation (NSW Government 2006). It has also been recommended that visitors and staff should not walk to seal colonies because the seals are likely to flee to the water when approached on shore (Shaughnessy et al. 2007).

Monitoring of the fur seal colony at Steamers Head, near Jervis Bay has shown that seals at this haul-out site are affected by a range of disturbances such as landslides, tourist boats and bombardment at a nearby weapons range. The authors recommended that researchers and tourists should remain at least 75 m from the colony when animals number less than 50 and at least 100 m when there are more than 100 seals present at the haul-out site.

In reviewing the effects of seal-focussed tourism in the southern hemisphere, Kirkwood et al. (2003) concluded that guidelines and regulations need to be implemented to ensure the protection and conservation of these animals, and the sustainability of the tourist industry.

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D.6. East Marine Region Protected Species Group Report Card – Cetaceans

Current at December 2007. For updates see <www.environment.gov.au/coasts/mbp/East>.

Dolphins/Porpoises

Description

There are 21 species of dolphins and porpoises recorded in Australian waters, with 12 of these known to occur in the East Marine Region. These are the Australian snubfin dolphin (*Orcaella heinsohni*), Indo–Pacific humpback dolphin (*Sousa chinensis*), rough-toothed dolphin (*Steno bredanensis*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), pantropical spotted dolphin (*Stenella attenuate*), spinner dolphin (*Stenella longirostris*), striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), and Indo–Pacific bottlenose dolphin (*Tursiops aduncus*) (Menkhorst and Knight 2001, and Ross 2006). The 12 species of dolphins or porpoises can be divided into near shore and oceanic species. There are two near shore species, the Australian snubfin and Indo–Pacific humpback dolphins which are primarily found in State waters. As they do not occur in the Region per se, they are not considered as key species for the purposes of this report. The significance of oceanic species in the Region is not well known.

Conservation Status

All cetaceans, which include dolphins and porpoises, are protected under the EPBC Act. This means that they are protected in Commonwealth waters and it is an offence to kill, injure, treat or interfere with them. To 'treat' a cetacean means to divide, cut-up, or extract any product from a cetacean, and to "interfere" means to harass, chase, herd, tag, mark or brand a cetacean. An approval is required for any actions that are likely to have a significant impact on these species.

The Australian snubfin and Indo–Pacific humpback dolphins are scheduled in Queensland as 'rare wildlife' under the *Nature Conservation (Wildlife) Regulation 1994* which means that their conservation status is regularly monitored and reviewed, and they are provided with protection under an assessment and approval processes for any actions that may adversely impact them. Neither species is listed in New South Wales. None of the oceanic species of dolphins or porpoises are listed in Queensland or New South Wales.

All cetacean species other than those listed in Appendix I, are listed in Appendix II of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES). Species in this list are not necessarily threatened with extinction, but trade must be controlled in order to avoid utilisation incompatible with their survival. The Indo–Pacific humpback and Australian snubfin (under the scientific name *Orcaella brevirostris*) dolphins are listed under Appendix I of CITES. This means these species are threatened with extinction and trade is permitted only in exceptional circumstances.

Habitat and Distribution

Important habitats for dolphins include those which support feeding and calving areas.

Significance of Dolphins in the East Marine Region

The bottlenose dolphin is usually found in colder, deeper waters in southern Queensland and New South Wales. The Indo-Pacific bottlenose dolphin is usually found in warmer inshore waters in northern New South Wales and Queensland. Accurate population estimates are not available for bottlenose dolphins in Australia, but they are common in inshore waters and bays such as Moreton Bay and Port Stephens. Local population numbers indicate that the total population of bottlenose dolphins is in the order of thousands rather than hundreds. Dolphins in the East Marine Region are important to a number of tourist operations and are known to interact with the fishing industry.

Known Interactions, threat and mitigation measures

Dolphins may be affected by human activities including: harassment, accidental collision, habitat loss or degradation and food stock reduction, incidental catch, capture for live display, hunting, wild feeding programs, swim programs, and strandings.

Habitat loss or degradation and food stock reduction

Indo-Pacific humpback and Australian snubfin dolphins depend on coastal and riverine habitats that may be affected by developments and pollution. Higher levels of polychlorinated biphenyls (PCBs) have been found in dolphins from the Gold Coast than anywhere else in Australia. High levels of PCBs have been linked to severely impaired reproductive capacity. Some dolphins are thought to feed regularly around sewage outlets and port facilities and could be vulnerable to contamination from poor water quality. Some studies have found significant levels of mercury in the respiratory tracts of dolphins, raising the possibility that air quality adjacent to major centres may affect dolphins. The degradation of dolphin habitat and the overfishing of dolphin prey species are potential threats to dolphins (Queensland Department of Environment 1997).

Incidental catch

The barramundi fishery and gillnet fishery for shark and mackerel may be associated with significant incidental catches of oceanic species of dolphins in the Region. Indo–Pacific humpback and Australian snubfin dolphins could be particularly at risk from barramundi and threadfin bream nets in northern Australia. Beach meshing (nets) and drum lines used in shark control programs on the east coast of Australia capture both target shark species, such as tiger sharks and bull whalers, and non-target marine species, such as turtles, rays and cetaceans (including dolphins).

Five hundred and twenty dolphins, an average of 26 a year, were caught in mesh nets along the Queensland coast from 1967 to 1987. The Australian snubfin dolphin was the most common species caught in nets north of Mackay, while the Indo–Pacific humpback dolphin was one of the main species caught in southern Queensland. From 1993 to 2003, eight Australian snubfin dolphins were caught in mesh nets, five animals dying and three animals released alive. Between 1996 and 2003, 16 Indo–Pacific humpback dolphins were caught and all died. The incidental catch of dolphins may be a significant threat due to the long lifespan, likely low breeding rate and low population densities of Indo–Pacific humpback dolphins (Queensland Department of Environment 1997). From 1996 to 2003 in Queensland, 25 bottlenose dolphins were caught in mesh nets and 19 died, while an average of 3.3 common dolphins died each year in the same way. In New South Wales, 23 common and bottlenose dolphins died in mesh nets between 1996 and 2003 (Department of the Environment and Water 2005).

Wild feeding programs

Issues associated with deliberately developed and/or maintained feeding programs for wild dolphins include the water quality at feeding areas, food quality and quantity, the risk of promoting a dependence of wild dolphins on supplied food, the possibility of dolphins seeking food from all humans, inappropriate human activities in the vicinity of feeding areas (such as boat operation and fishing), human safety issues, the risk of transmission of pathogens to dolphins, either from contaminated food or through direct contact between humans and dolphins, and the ability to control human access. The effects of feeding practices has also been associated with high calf mortalities in some dolphin populations.

There is a commercial feeding program at Tangalooma Resort on Moreton Island, 'quasi-commercial' feeding of resident Indo–Pacific humpback dolphins at Tin Can Bay, southern Queensland, and 'non-commercial' feeding of dolphins from disposal of by-catch and offal from fishing vessels (Queensland Department of Environment 1997). The Australian Government has also developed the Australian National Guidelines for Whale and Dolphin Watching. The Guidelines set standards that allow people to observe and interact with whales and dolphins in a way that ensures these animals are not harmed.

Whales

Description

There are 30 species of whales recorded in Australian waters, all of them found in the East Marine Region (Menkhorst and Knight 2001).

Humpback whales grow to a maximum length of 18 metres and can weigh 45 tonnes. They have very large, often white, pectoral fins up to 5 metres long, a prominent dorsal fin, scalloped and irregular trailing edges to flukes, and prominent knobbly protuberances on the head and pectoral fins. Southern hemisphere humpbacks usually have white undersides and male humpbacks are known for their long, complex 'songs' (Queensland Department of Environment 1997).

Dwarf minke whales are an, as yet, un-named subspecies of the Northern Hemisphere minke whales (*Balaenoptera acutorostrata*), and are only known from the Southern Hemisphere. They can grow to nearly 8 metres in length and weigh 5-6 tonnes. They have a white shoulder and flipper base, with a dark-grey tip on the flipper, and a large dark patch extending onto the throat (CRC Reef Research Centre 2002).

Humpback and dwarf minke whales are important to the whale watching and swim-with-whales industries.

Conservation Status

All cetaceans are protected by the EPBC Act. Humpback whales are listed under the EPBC Act in the Cetacean, Vulnerable, and Listed migratory species categories. These listings categorise Humpbacks as a matter of national environmental significance and ensure that their recovery is promoted through a recovery plan (describing key threats and identifying specific recovery actions) under the EPBC Act. Dwarf minke whales are listed under the EPBC Act under the category of Cetacean.

The humpback whale is scheduled in Queensland as 'vulnerable wildlife' under the *Nature Conservation (Wildlife) Regulation 1994* which provides protection and requires the promotion of its recovery using a recovery plan or conservation plan and an assessment and approval process

Table D6.1 Cetaceans listed as threatened or migratory under the EPBC Act that are known to occur in the East Marine Region

Species	Conservation Status	Australian Government Conservation Plans and Policies
killer whale (*Orcinus orca*)	All cetaceans are protected under the EPBC Act Migratory CITES Appendix II CMS Appendix II	
long-finned pilot whale (*Globicephala melas*)	CITES Appendix II	
short-finned pilot whale (*Globicephala macrorhynchus*)	CITES Appendix II	
melon-headed whale (*Peponocephala electra*)	CITES Appendix II IUCN Lower Risk/Least Concern	
pygmy killer whale (*Feresa attenuate*)	CMS Appendix II	
false killer whale (*Pseudorca crassidens*)	CITES Appendix II	
pygmy sperm whale (*Kogia breviceps*)	CITES Appendix II	
dwarf sperm whale (*Kogia simus*)	CITES Appendix II	
sperm whale (*Physeter macrocephalus*)	Migratory CITES Appendix I CMS Appendix I	
humpback whale (*Megaptera novaeangliae*)	Vulnerable Migratory CITES Appendix I CMS Appendix I	Humpback Whale Recovery Plan 2005 - 2010 (Department of the Environment and Heritage 2005)
southern right whale (*Eubalaena australis*)	Endangered Migratory CITES Appendix I CMS Appendix I	Southern Right Whale National Recovery Plan 2005-2010 (Department of the Environment and Heritage 2005c)
pygmy right whale (*Caperea marginata*)	Migratory CITES Appendix I CMS Appendix II	
dwarf minke whale (*Balaenoptera acutorostrata*)	CITES Appendix I	
Antarctic minke whale (*Balaenoptera bonaerensis*)	Migratory CITES Appendix I CMS Appendix II	
sei whale (*Balaenoptera borealis*)	Vulnerable Migratory CITES Appendix I CMS Appendix I	Blue, Fin and Sei Whale Recovery Plan 2005 - 2010 (Department of the Environment and Heritage 2005)

Table D6.1 Cetaceans listed as threatened or migratory under the EPBC Act that are known to occur in the East Marine Region

Species	Conservation Status	Australian Government Conservation Plans and Policies
Bryde's whale (*Balaenoptera edeni*)	Migratory CITES Appendix I CMS Appendix II	
fin whale (*Balaenoptera physalus*)	Vulnerable Migratory CITES Appendix I	Blue, Fin and Sei Whale Recovery Plan 2005 - 2010 (Department of the Environment and Heritage 2005)
blue whale (*Balaenoptera musculus*)	Endangered Migratory CITES Appendix I CMS Appendix I	Blue, Fin and Sei Whale Whale Recovery Plan 2005 - 2010 (Department of the Environment and Heritage 2005)
Andrew's beaked whale (*Mesoplodon bowdoini*)	CITES Appendix I	
Blainville's beaked whale (*Mesoplodon densirostris*)	CITES Appendix II	
ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*)	CITES Appendix II	
strap-toothed beaked whale (*Mesoplodon layardi*)	CITES Appendix II	
True's beaked whale (*Mesoplodon mirus*)	CITES Appendix II	
Hector's beaked whale (*Mesoplodon hectori*)	CITES Appendix II	
Gray's beaked whale (*Mesoplodon grayi*)	CITES Appendix I	
goose-beaked whale (*Ziphius cavirostris*)	CITES Appendix I	
Shepherd's beaked whale (*Tasmacetus shepherdi*)	CITES Appendix II	
Arnoux's beaked whale (*Beradius arnuxii*)	CITES Appendix I	
southern bottlenose whale (*Hyperoodon planifrons*)	CITES Appendix I	
Longman's beaked whale (*Indopacetus pacificus*)	CITES Appendix I	

Humpback whale. Photo: Dave Paton.

for any actions that are likely to have an adverse impact on the whales.

The humpback whale is listed in New South Wales as "vulnerable" under the *Threatened Species Conservation Act 1995* which provides protection and requires an assessment and approval process for any actions that are likely to have an adverse impact on the whales.

The humpback and dwarf minke whales are listed under Appendix I of CITES. This means these species are threatened with extinction and trade is permitted only in exceptional circumstances.

Habitat and Distribution

Important habitats for whales include those which support resting areas, feeding areas, calving and breeding grounds.

Humpback whale

Humpback whales are found in all State and Commonwealth waters of Australia. The International Whaling Commission recognises at least six southern hemisphere populations of humpback whales based on their Antarctic feeding distribution and location of breeding grounds, but notes that the level of confidence associated with defining different populations of humpback whales varies considerably across the southern hemisphere (Bannister et al. 1996). During the southern migration of humpback whales through the East Marine Region, large numbers of whales are known to aggregate in Hervey Bay and the Whitsundays, which have been identified as resting areas. Resting areas may allow mother-calf pairs to maximise the growth of calves before swimming to Antarctic waters. Mothers with calves are often found close to shore and using sheltered bays to rest. Humpback whales are generally regarded as Antarctic krill specialists (Kawamura 1994), normally feeding in Antarctic waters south of 55° S but some opportunistic feeding has been observed off Eden in New South Wales (Stamation et al. 2007).

Calving occurs in tropical waters. Although exact locations of calving grounds are not known, breeding activity has been observed in the central Great Barrier Reef area (see the Australian Government Species and Threats Database at <www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>).

In 2004, the east population of humpback whales was estimated to be approximately 7,000 individuals increasing approximately 10 per cent per year (Noad et al. 2006). It is not known to what extent this population may mix with animals from other breeding stocks further east in the Pacific Islands.

Dwarf minke whale

Dwarf minke whales have been recorded in all state waters (except the Northern Territory) and in Commonwealth waters up to north Queensland. They spend summer in sub-Antarctic waters and are found in far north

Queensland in winter, often close inshore, and will enter bays and estuaries. They are mostly found alone or in pairs, and will approach people and ships. Dwarf minke whales feed on krill, open-ocean lantern fish and small shoaling fish, herding them into compact shoals before cruising through with open mouths (Menkhorst and Knight 2001; CRC Reef Research Centre 2002).

The size of the population in Australian waters is not known but up to 200 dwarf minke whales have been recorded over a season in Great Barrier Reef waters (CRC Reef Research Centre 2002).

Life History and Ecology

Table D6.2 Summary of life history, feeding and population information for Australian humpback and dwarf minke whales (sources: Menkhorst and Knight 2001; Australian Government Species and Threats Database 2007; GBRMPA 2007; Bannister et al. 1996; Queensland Department of Environment 1997; CRC Reef Research Centre 2002)

Movements/migration

Humpback whales migrate through the East Marine Region from June to August to northern tropical breeding grounds and return south to Southern Ocean feeding areas between September and November. Humpback whales migrating through the Region have wintering grounds in the Great Barrier Reef, New Caledonia, Tonga and other South Pacific islands. There are links between animals in these areas but these links are not well understood. Humpbacks migrate in groups segregated by sex and age (Bannister and Hedley 2001). In the Southern Ocean, humpback whales occur over a wide range of latitudes, but are mostly encountered between 62°S and 66°S (Kasamatsu et al. 1996).

Dwarf minke whales are found in sub-Antarctic waters (58°S – 60°S) to the south of Australia and New Zealand between December and March, and in the northern Great Barrier Reef between June and July. The migration of dwarf minke whales is not well understood.

Significance of Whales in the East Marine Region

Each year between April and November humpback whales can be seen migrating along the east coast of Australia. These animals undertake an annual migration of 10 000 kilometres between the waters of the Southern ocean where they feed on krill and the warmer waters of their calving grounds in the Great Barrier Reef.

The Whitsunday islands, Hervey Bay, Stradbroke Island, Cape Byron, Coffs Harbour, and the southern coast of New South Wales are key localities for humpback whales as aggregation and resting areas along their migration route. The northern Great Barrier Reef is a key locality where dwarf minke whales aggregate in winter.

Humpback whales in the East Marine Region interact with the fishing and shipping industries, and whale-watching tourist operations in the Great Barrier Reef, Whitsunday Islands, Hervey Bay, Stradbroke Island, Cape Byron, Port Stephens, Botany Bay, Jervis Bay and Eden. Dwarf minke whales interact with swim-with-whale tourist operations in the Great Barrier Reef.

Known Interactions, threat and mitigation measures

Whales may be affected by human activities including: harassment, accidental collision, habitat loss or degradation and food stock reduction, hunting, swim programs, and strandings (Department of the Environment and Heritage 2005, Queensland Department of Environment 1997).

Table D6.2 Summary of life history, feeding and population information for Humpback and Dwarf minke whales (sources: Menkhorst and Knight 2001; Australian Government Species and Threats Database 2007; GRMPA 2007; Bannister et al. 1996; Queensland Department of Environment 1997; CRC Reef Research Centre 2002)

	Humpback whale	Dwarf minke whale
Scientific name	Megaptera novaeangliae	Balaenoptera acutorostrata
Abundance	Approximately 7000 (Ei population)	Not known
Feeding	Krill	Krill and small fish
Longevity	50 years	Not known
Age at sexual maturity	4-10 years	6-8 years
Calving interval	2-3 years	1 year
Gestation	11 -11.5 months	10 months
Calving season	June – October	May – June
Calving areas	Tropical coastal waters near the Great Barrier Reef, and possibly other areas	Temperate - tropical waters
Mating season	June – October	Not known

Harassment

Unregulated recreational and commercial whale watching, and movements of general boating traffic have the potential to cause disruption to the normal behaviour or activity patterns of whales. Evidence of disrupted behaviour can include prolonged diving, evasive swimming with rapid changes in direction or speed, and interruptions to breeding or nursing activity. High levels of boating traffic have been found to cause lactating female humpback whales and calves to leave traditional inshore resting areas in favour of offshore waters. Lactation imposes the greatest energy drain on female humpback whales and they may be most vulnerable to harassment at that stage. Low aircraft operations have been found to cause extreme avoidance behaviour in humpback whales (Queensland Department of Environment 1997). Swimming, snorkelling or diving with whales has the potential to place both people and animals at risk. Direct contact with whales could transfer disease, scare away the whale or cause injury to both people and whales (CRC Reef Research Centre 2002).

Habitat loss/degradation and food stock reduction

Declining water quality along the migratory route of humpback whales may reduce occupancy and/or exclude whales from traditional inshore areas, compromise reproductive success and increase risk of mortality (Department of the Environment and Heritage 2005).

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Lord Howe Island Group. Photo: Ian Hutton and the Department ofthe Environment, Water, Heritage and the Arts.

Appendix E Technology and equipment used in commercial fishing operations

There is a wide range of gear and equipment available for commercial fishers to assist in catching target species. Technological advancements have increased the efficiency of fishing and allowed access to fishing grounds in deep and previously inaccessible waters.

Since the early 1900's trawlers have evolved from large, steam-driven vessels to relatively small, diesel engine-powered boats. In combination with hydraulic winches, the light, powerful diesel engine has allowed the use of large trawl nets on vessels that, despite their smaller size, are much more efficient than older vessels.

Studies in the fields of marine biology, animal behaviour and ecology have increased understanding of target species. Information such as when and where species breed, their ranges and habits, life cycles and physiological needs is available to help manage both species conservation and fisheries.

The use of satellites for remote-sensing and remote-imaging produce a wide range of oceanographic and biological information useful for locating schools of fish. For instance, near real-time imagery of ocean temperature is used by tuna longline fleets to identify temperature fronts associated with high catch rates of tuna.

In recent times there has been widespread use of Global Positioning System (GPS) receivers. GPS allows vessels to be positioned at any location in the world, accurate to within a few tens of metres. Prime fishing areas can now be precisely identified, and the positions of fishing spots or topographic features accurately marked on charts.

The use of sonar and sounding equipment is commonplace in many fishing vessels. Modern sonar allows fishers to locate schools of fish and to position fishing gear accurately to catch the school. Sounders and sonar, in conjunction with other equipment such as GPS and digital charts, allow an operator to build a detailed three-dimensional model of their fishing grounds.

Not all fishing technology is focussed on the removal of target species. An increasingly important aspect of fishing gear design relates to the reduction of bycatch, particularly with respect to non-target animals like cetaceans, dugongs, turtles and seabirds. Extensive research in Australia has centred on developing bycatch reduction devices (BRDs) for a range of non-target species. The technology used for developing BRDs has had other applications in allowing fishers to fish specifically for the most appropriate size range of target species. Some BRDs allow larger-sized breeding individuals to escape from nets. Others, such as Tori Lines and weighted swivels, keep fishing gear deep under water beyond the diving range of seabirds.

Given that the species caught as catch or bycatch are specific to each fishery or geographic area, the development of bycatch reducing technology is an ongoing process involving extensive experimentation and testing within different fisheries. Developing technological solutions for reducing bycatch and the effect of fishing on the marine environment will most likely remain a priority for the management of the Australian Fishing Zone in the foreseeable future (BRS 2007).

Much of the technology discussed above has been developed using recent advances in computing and engineering; consequently many of the very successful fishing gear technologies have been designed and implemented during the working life of only a single generation of fishers, and, in many cases, within a single generation of some target species. The full impact of this modern equipment on the long-term sustainability of the industry is yet to become apparent. To a large degree this will depend on the ability of target species to adapt to the technology.

In addition to new fishing technology there are numerous types of nets, traps and lines that have been in use by the fishing industry for a long time. Although refined and perfected, the more traditional pieces of equipment have been in use for many generations. Each piece has been developed to catch specific species or for operation in a particular environment.

Table E.1 details some of the different types of nets, traps and lines used by the industry in Australia. Note that not all of these gear types may be used in the East Marine Region.

Table E.1 Nets, traps and lines used in Australia

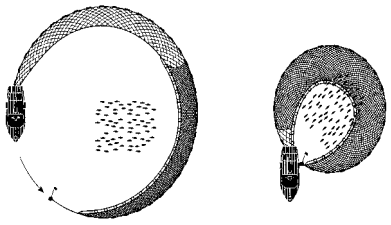
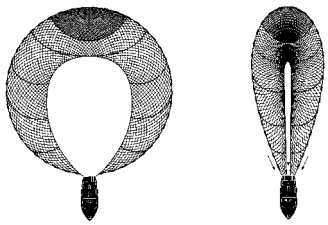
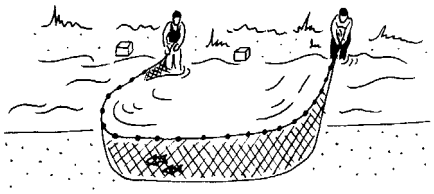
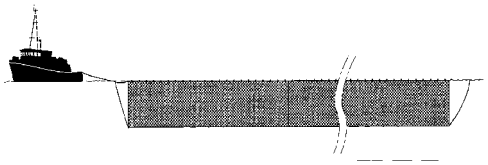
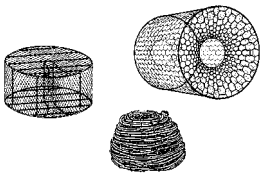
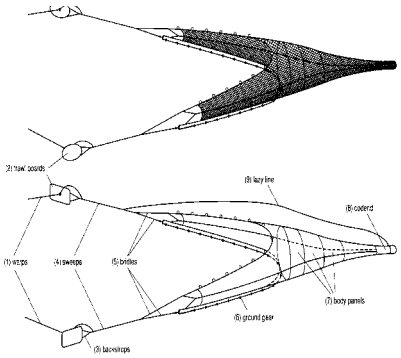
Purse seine Nets are constructed with a smaller mesh size than the size of fish being sought. A skiff or buoy anchors one end of the net while it is set around a school of fish, after which a purse line is pulled to close the bottom of the net. Used to target high volume schooling species including tuna, in coastal and oceanic waters.	 © BRS
Lampara net Similar to a purse seine, how ever the net has tapered panels to give a characteristic scoop shape rather than being flat. The net is set around a school and when both ends are retrieved the vessel tows the net forward, closing the bottom then top of the net. Used to catch pilchards and anchovy in inshore waters.	 © BRS
Beach seine The seine net is set parallel to the shoreline, some distance off the beach, usually by a dinghy. One haul line is retained on the beach while the other is returned by the dinghy and both lines are hauled until the seine net and entrapped fish are dragged onto the shore. Beach seine are used to catch many species, including mullet, Australian salmon, whiting and tailor.	 © Marina Larcombe
Gillnet Panels of net are set vertically in the water column, either at the surface or in contact with the seabed. The size of the mesh in the net determines the size range of the species caught, as smaller fish are able to swim through the mesh and fish that are too large tend to bounce off.	 © BRS
Pots and traps Traps are usually baited and set on the seabed with a line to a surface float. A wide range of designs are used to take crustaceans such as lobsters and crabs, and some species of fish. Pots and traps are set in depths from a few metres to over 200 metres.	 © BRS
Bottom otter trawl A cone-shaped net, held open across the seabed by large hydrodynamic plates called otter boards. The otter boards are usually attached to the net by lines called sweeps, which are often quite long, relative to the net width and aid in herding fish towards the net mouth. As the net is pulled along, fish accumulate in the rear section, or cod end, of the net. Depending on the vessel and gear, bottom otter trawling may occur to a depth in excess of 1,500 metres, but generally not below 1,000 metres.	 © BRS

Table E.1 Nets, traps and lines used in Australia

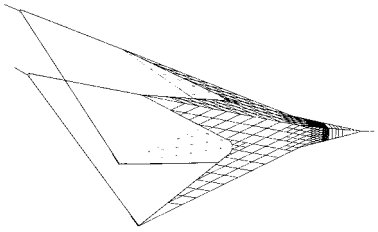
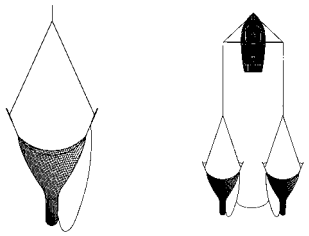
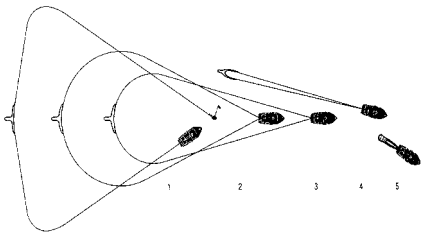
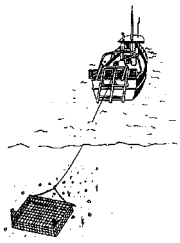
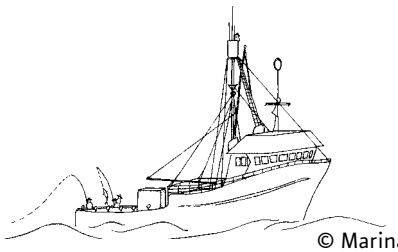
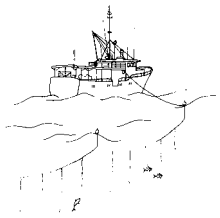
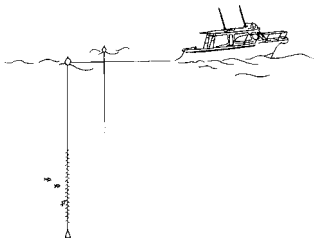
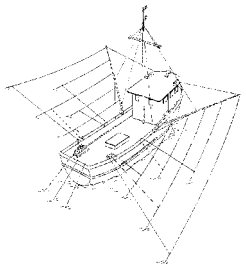
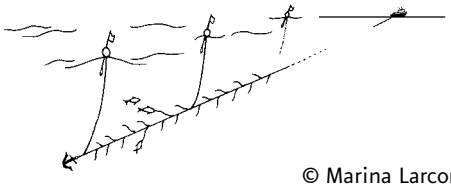
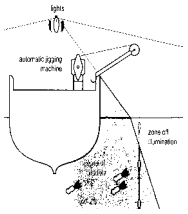
Mid-water trawl Is usually much larger than a bottom trawl and designed to fish off the seabed, in mid-water. The horizontal opening is maintained by otter boards. Floats on the headline (at the top) and weights on the groundline (at the bottom) maintain the vertical opening. Mid-water trawl gear is used to catch species such as blue grenadier (*Macruronus novaezelandiae*) off western Tasmania.	 © AFMA
Prawn trawl Nets are similar to bottom otter trawls but do not use sweep. Chains are hung below the foot rope to disturb the prawns, causing them to 'jump' into the path of the oncoming net. Arrays of two, three or even four such nets are commonly towed by a single vessel. Prawn trawling of this type is generally limited to waters shallower than about 80 metres.	 © BRS
Danish seine Nets are a cross between a trawl net and a seine net, in terms of shape. The line and net is paid out in a pear shape, and then hauled back to the stationary or slowly moving vessel in a similar fashion to a bottom trawl. The two lines act as 'sweeps', herding fish towards the net. Danish seine gear is used on the continental shelf to catch flat head, whiting and morwong.	 © BRS
Scallop dredge Mainly box-shaped mud dredges, up to 3.5 metres wide, dragged along the seabed and digging into the substrate to collect animals on and within it. Scallop dredges are used in relatively shallow continental shelf waters, to a depth of 100 metres.	 © Marina Larcombe
Pole and line (pole and live bait) Surface swimming schools of tuna are attracted to the vessel using live or dead bait. The tuna, in a frenzy of feeding, take a barbless hook and lure and are hauled aboard using a pole and short, fixed line. Pole and line may be combined with purse seining to attract and aggregate a school of fish, around which the net is set. The pole boat subsequently escapes over the top of the purse seine net.	 © Marina Larcombe
Pelagic longline (drifting longlines) Comprised of a mainline suspended horizontally by buoy lines. Branch lines, each with a single baited hook, are attached to the main line at regular intervals. The line is allowed to 'soak' for several hours before retrieval. Pelagic longlines are used to catch tuna and billfish in oceanic waters, and usually set hooks shallower than 300 metres.	 © Marina Larcombe

Table E.1 Nets, traps and lines used in Australia

Dropline A single mainline, with numerous baited hooks (usually no more than 100) attached to the bottom portion of the line via branchlines and clips. The main line is set vertically in the water column, between a large surface float and a bottom weight. Droplines are regularly set to depths in excess of 500 metres and catch blue eye trevalla (*Hyperoglyphe antarctica*), and hapuku (*Poyprion oxygeneios*) among other species.	 © Marina Larcombe
Troll Troll lines are run from the stern of the vessel and from booms on the side of the vessel. Hooked baits and lures are pulled through the water behind the moving vessel. Trolling is used to catch tuna and mackerel in coastal waters and waters off the continental shelf.	 © FAO
Bottom longline A mainline, with attached branch-lines (snoods) and hooks, that are set across the seabed. Variations may have floats incorporated to lift the baits away from the bottom (trot lines). Bottom longlines are used to catch ling (*Genypterus blacodes*) and school shark (*Galeorhinus galeus*) among other species, and may be set in depths exceeding 1 000 metres.	 © Marina Larcombe
Squid jig Occurs at night, with bright lights attracting squid to the vessel's side. Lines with several barbless lures are 'jigged' up and down and squid caught on the lures are hauled onto the vessel. Most vessels in Australia use automated, mechanical jigging machines. Squid jigging occurs mainly in coastal waters.	 © BRS

Source: (Larcombe et al. 2002)

Key References and Further Reading

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Abbreviations and Acronyms

ABS	Australian Bureau of Statistics
ACAP	The Agreement on the Conservation of Albatross and Petrels
AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
CAMBA	Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986
CBD	The Convention on Biological Diversity
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species (also known as the Convention on the Conservation of Migratory Species of Wild Animals or the Bonn Convention)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EEZ	Exclusive Economic Zone
GBRMPA	Great Barrier Reef Marine Park Authority
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IUCN	International Union for the Conservation of Nature and Natural Resources (World Conservation Union)
IWC	International Whaling Commission
JAMBA	Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974
MARPOL	International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto
NSW	New South Wales
QFJA	Queensland Fisheries Joint Management
QLD	Queensland
Ramsar	Convention on Wetlands of International Importance (Ramsar Convention 1971)
ROKAMBA	Agreement between the Government of Australia and the Government of the Republic of Korea – on the Protection of Migratory Birds, 2007
UNCLOS	United Nations Convention on the Law of the Sea

Glossary

abyssal plain

The flat, relatively featureless bottom of the deep ocean, at depths greater than 2000 m. The average depth of the abyssal floor is about 4000 m.

aggregating behaviour

Grouping of fish or other animals. This can be for reasons such as availability of food organisms, or for spawning.

ahermatypic

Pertains to corals that do not have zooxanthellae. Generally non-reef building.

alga

The common name for simple plants which do not have specialised parts such as roots or leaves. They do not have vascular systems, so most are found living in water. Singular of algae

amphipod

A small crustacean belonging to the order Amphipoda that has a laterally compressed body with no carapace.

anthropogenic

Of human origin or resulting from human activity.

anti-cyclonic

Rotation about a vertical axis that is clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

apron/fan

Sediment deposition at the base of a slope or end of a canyon.

assemblage

A collection of plants and/or animals characteristically associated with a particular environment, which can be used as an indicator of the health of that environment.

atoll

A coral island consisting of a ring of coral surrounding a central lagoon.

Australian margin

Refers to the Australian continental margin: the offshore zone consisting of the continental shelf, slope and rise that separates the dry-land portion of a continent from the deep ocean floor.

ballast water

Water carried in ships' tanks to maintain stability when a ship is lightly loaded. It is normally discharged to the sea when the ship is loaded with cargo.

barrier reef

An offshore coral reef ridge which somewhat parallels the coastline.

basin

A sunken area of the deep sea floor that can be small or large with roughly uniform dimensions.

bathymetry

The measurement of ocean depths to determine the sea floor topography.

benthos/benthic

Refers to all marine organisms living upon or in the bottom of the sea.

billfish

Pelagic fish with long, spear-like protrusions at their snouts, such as swordfish and marlin.

biodiversity

Variability among living organisms from all sources (including terrestrial, marine and other ecosystems and ecological complexes of which they are part), which includes diversity within species and between species and diversity of ecosystems.

biofouling

Biofouling (biological fouling) is the undesirable accumulation of plants, animals and micro-organisms on submerged structures such as ships' hulls, wharves and oil rigs.

biogenic

Produced by living organisms.

biogeographic

Relating to large regions with distinct fauna and flora.

biological or ecological productivity

The ability of an ecosystem to produce, grow or yield biomass – whether trees, fish or other organisms.

biomass

The quantity of organic matter within an ecosystem (usually expressed as dry weight per unit area or volume).

bioprospecting

The search for new chemicals derived from biological processes, systems or organisms.

bioregion

A large area of the ocean that is classified as having similar types of plants, animals and ocean conditions, compared to other similarly-sized areas. For the purpose of this document, bioregion means provincial bioregion as defined in the Integrated Marine and Coastal Regionalisation of Australia Version 4.0 <www.environment.gov.au/coasts/mbp/imcra/index.html>.

biota

All of the organisms at a particular locality.

bioturbation

The disturbance and mixing of sediment layers by biological activity (plants or animals).

bryozoans

Marine animals commonly known as moss animals, sea mats or lace coral. The majority of living bryozoans are encrusting (they grow in flat sheets that spread out over the substrate) but others grow upwards into the water column.

calcareous ooze

Very fine (micritic) calcareous skeletal sediments, typically dominated by nanoplankton and deposited in a deep sea environment.

canyons

A relatively narrow, deep depression with steep sides, the bottom of which generally has a continuous slope, developed characteristically on some continental slopes.

carbonate organisms

Life-forms that incorporate calcium and carbon from sea water into their skeletons or shells. They include a range of organisms such as algae, corals and bivalves, and can be microscopic.

carbonate reefs/platforms/atolls/banks

Reefs, platforms, atolls or banks whose structure primarily consists of calcium carbonate.

cay

A small, low island or bank composed of sand and coral fragments.

cetaceans

Members of the mammalian group Cetacea, including whales, dolphins and porpoises.

cold core eddy

Clockwise rotating movements of water formed on the side of a main current that causes deeper layers of cold water to dome upwards towards the centre bringing nutrient rich cold waters to the surface water layers and increasing biological productivity.

Commonwealth waters

The Commonwealth marine area, which includes 'Commonwealth waters' is defined in the EPBC Act as any part of the sea, including the waters, seabed, and airspace, within Australia's Exclusive Economic Zone (EEZ) and/or over the continental shelf of Australia, excluding State and Territory coastal waters. Generally, the Commonwealth marine area stretches from three nautical miles from the territorial sea baseline to the outer limit of the EEZ, 200 nautical miles from the baseline. It may extend further where the edge of the continental shelf extends beyond the outer limits of the EEZ. The territorial sea baseline is normally the low water mark along the coast.

conservation dependent (see also: threatened species)

The definition of a conservation dependant species in the EPBC Act (Section 179) is:

'A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:

(a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or

(b) the following subparagraphs are satisfied:

(i) the species is a species of fish;

(ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;

(iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory;

(iv) cessation of the plan of management would adversely affect the conservation status of the species.'

continental crust

The type of crust underlying the continents, including the continental shelves. The continental crust is commonly about 35 to 70 km thick.

continental rise

The gently sloping surface located at the base of a continental slope.

continental slope

The region of the outer edge of a continent between the relatively shallow continental shelf and the deep ocean.

continental shelf

The section of the seabed from the shore to the edge of the continental slope.

convergence front

An interface or zone of transition between two dissimilar water masses.

copepod

Any small, aquatic crustacean belonging to the subclass Copepoda, characterized by compound eyes and the lack of a carapace, usually having six pairs of limbs on the thorax. Can be found in marine or freshwater environments.

coral

Small, colonial, bottom-dwelling, marine animals that secrete external skeletons of calcium carbonate (calcite).

Cretaceous

Of or belonging to the geologic time, system of rocks, and sedimentary deposits of the third and last period of the Mesozoic Era, characterized by the development of flowering plants and ending with the sudden extinction of the dinosaurs and many other forms of life.

critically endangered (see also: threatened species)

The definition of a critically endangered species in the EPBC Act (Section 179) is:

'A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.'

crustacea/crustaceans

A class of arthropods that have gills and bodies covered by a hard shell (e.g. crabs, lobsters, shrimps).

cyanobacteria

A large and varied group of bacteria which possess chlorophyll a and which carry out photosynthesis in the presence of light and air, producing oxygen. They were formerly regarded as algae and were called "blue-green" algae.

cyclone

An area of low pressure where winds blow counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

decapods

An order of Crustacea comprising lobsters, crabs and shrimps that have five pairs of legs.

demersal

Living on or near the bottom of the sea.

deposit feeders

Animals such as worms, molluscs, echinoderms and crabs that feed on the particles of organic material in sediments, usually in the top layer which generally has higher levels of organic matter.

detritivores

Animals that eat detritus.

detritus

Any loose, unconsolidated debris such as finely divided rock or the finely divided remains of animal, plant or bacterial tissue.

diatom

Microscopic alga with cell walls made of silicon. Diatoms usually have two separated asymmetrical sides.

dinoflagellate

A single-celled organism found in fresh and marine waters, which combines characteristics of both plants (e.g. photosynthesis) and animals (e.g. uses external organic sources of nutrition).

doldrums

Region near the equator characterized by low pressure and light shifting winds.

downwelling

A downward current of surface water in the ocean.

East Australian Current

A current that originates in the Coral Sea and flows southward along the east coast of Australia.

echinoderms/echinoids

Exclusively marine animals distinguished from all others by an internal skeleton composed of calcite plates, and a water-vascular system to serve the needs of locomotion, respiration, nutrition, or perception. Includes starfishes, sea cucumbers, sand dollars, brittle-stars, basket stars, sea lilies, feather stars and sea

urchins. Echinoids are a group (class) of echinoderms including sea urchins, heart urchins and sand dollars. They are spiny and globular to disc-like in shape.

ecological community

The definition of an ecological community in the EPBC Act is an assemblage of native species that:

(a) inhabits a particular area in nature; and

(b) meets the additional criteria specified in the regulations (if any) made for the purposes of this definition.

More broadly, an ecological community is a grouping of species that commonly occur together in a way that is recognisably different from other groupings.

ecologically sustainable development

The principles of ecologically sustainable development are defined in the EPBC Act as:

(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;

(b) 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;

(c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generation;

(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision;

(e) improved valuation, pricing and incentive mechanisms should be promoted.

ecosystem

A dynamic complex of plant, animal and micro-organism communities and their non-living environment that interacts as a functional unit.

ecosystem approach

An approach to managing human impacts on the environment that attempts to take into account the complex relationships between organisms and physical processes in a particular ecosystem.

ecosystem services

The role played by organisms and environmental processes in creating a healthy environment for human beings, from production of oxygen to soil formation and maintenance of water quality.

eddies

Circular movements of water formed on the side of a main current.

elasmobranch

A cartilaginous fish of the subclass Elasmobranchii, which includes skates, rays and sharks.

El Niño Southern Oscillation (see also: La Niña)

The El Niño phenomenon is an abnormal warming of surface ocean waters in the eastern tropical Pacific and is one part of the Southern Oscillation, a Pacific Ocean circulation pattern. The Southern Oscillation is the pattern of reversing surface air pressure between the eastern and western tropical Pacific: when the surface pressure is high in the eastern tropical Pacific it is low in the western tropical Pacific and vice versa. El Niño is often associated with drier than normal conditions in northern and eastern Australia.

endangered species (see also: threatened species)

The definition of an endangered species in the EPBC Act (Section 179) is:

A native species is eligible to be included in the endangered category at a particular time if, at that time:

(a) it is not critically endangered; and

(b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.

endemic

Native to a particular area and found nowhere else.

Eocene

Of or belonging to the geologic time, rock series, or sedimentary deposits of the second epoch of the Tertiary Period, characterized by warm climates and the rise of most modern mammalian families.

epibenthic

Living on the top surface of the sea floor. Epibenthic organisms may be freely moving (motile) or permanently attached to a surface (sessile).

epifauna

Animals living attached to rocky reefs or on the seafloor. They include hydroids, sea-pens, small bryozoans and sponges (compare to infauna).

euphotic

The euphotic zone is the depth of the water in a lake or an ocean that is exposed to sufficient sunlight for photosynthesis to occur. It extends from the surface down to a depth where light intensity falls to one per cent of that at the surface (also called euphotic depth).

eutrophic

Refers to any environment with high levels of nutrients, usually compounds containing nitrogen or phosphorus. This may lead to an increase in the ecosystem's primary productivity (compare to oligotrophic).

exclusive economic zone

The sovereign waters of a nation, recognized internationally under the United Nations Convention on the Law of the Sea as extending out 200 nautical miles from the shoreline.

fauna

The entire group of animals found in an area.

filter feeder

Animals that feed by straining suspended particles from water (also known as suspension feeders). Animals that use this method of feeding include corals, krill, sponges and whale sharks.

finning

Removal of the fins from shark species. Shark fins are regarded as a delicacy in Chinese cooking. Because shark meat is worth very little, finless and often still-living sharks may be thrown back into the sea to make room on board ship for more of the valuable fins. If returned to the ocean, finless sharks are unable to move and die from suffocation or are eaten by other animals.

flora

The entire group of plants found in an area.

foraminifer

Members of the order Foraminifera, a large group of mainly marine single-celled organisms with calcareous shells perforated by small holes.

genus

The scientific grouping of plants and animals immediately above the species level; when combined with the species name this provides a unique identifier for a plant or animal in scientific nomenclature (plural: genera).

geomorphology

The study of landforms and the processes that shape them.

guano

Accumulation of bird (or bat) faeces and the soil it interacts with.

Gulf of Papua

A large 400 km wide delta extending out from the south shore of Papua New Guinea that receives the outflows of the Fly, Turama, Kikori, and Purari Rivers.

gyre

A gyre is any manner of swirling vortex. It is used to describe both wind and ocean currents.

habitat

The area or region where a particular type of plant or animal lives and grows.

hermatypic

Reef building corals with zooxanthellae.

Hiri Current

A current that originates in the Coral Sea and flows northward along the east coast of Australia into the Gulf of Papua.

hydroids

Small invertebrates whose colonies can take many growth forms including flower-like, tree-like or feathery. Hydroids are best represented in cool temperate southern Australian seas.

hydrography

The science of the measurement, description and mapping of the surface waters of the earth, especially in relation to navigation.

hydrology

The study of the movement, distribution, and quality of water throughout the earth.

hypersaline

Water with excessive or supersaturated salt content, well in excess of that of sea water.

infauna

Animals that inhabit the sandy or muddy surface layers of the ocean bottom, i.e. those that live buried or dig into the substrate (compare to epifauna).

invertebrates

An animal without a backbone (e.g. insects, worms, snails, mussels, prawns and cuttlefish).

isobath

A mapping line connecting points of equal depth below the sea's surface.

isotherm

A line on a map joining areas of equal temperature.

karst

An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns.

krill

Shrimp-like marine invertebrate animals, dense swarms of which occur in ocean waters. They feed mainly on phytoplankton and themselves comprise the main food of filter-feeding whales. Krill are up to 5 cm in length and are found in both surface and bottom waters.

lagoon

A shallow body of water, especially one separated from a sea by sandbars or coral reefs.

La Niña (see also: El Niño)

The La Niña phenomenon is an abnormal warming of surface ocean waters in the western tropical Pacific, north of New Guinea, accompanied by cooling in the tropical eastern Pacific Ocean, and is one part of the Southern Oscillation, a Pacific Ocean circulation pattern. La Niña is often associated with above average rainfall in eastern Australia.

living fossil

Any living species which very closely resembles fossil relatives in most anatomical details.

macroalgae

The algae are a major group of plants without a vascular or vein system, which live in fresh or marine waters. Macroalgae are the large, visible algae, such as kelps, as opposed to microalgae, the microscopic algae that form phytoplankton.

macroplankton

The component of plankton that consists of large organisms (plant or animal) 2–20 cm in size.

macrophytes

Large water plants such as seagrasses and kelps.

marginal plateau

A relatively flat shelf adjacent to a continent and similar topographically to, but deeper than, a continental shelf.

marine conservation values

Marine conservation values are defined for the purpose of marine bioregional planning, as including:

(a) Protected species and communities, including: (i) species and communities listed as threatened under the EPBC Act; (ii) species listed as migratory under the EPBC Act; (iii) species listed as cetaceans (including all whales, dolphins and porpoises) under the EPBC Act; and (iv) species listed as marine species under the EPBC Act;

(b) Key ecological features of the marine environment, including: (i) species and communities considered to play an important ecological role in the Region; and (ii) habitats or areas considered to be ecologically important at a regional scale; and

(c) Protected places, including: (i) heritage places (including World Heritage, National Heritage and Commonwealth Heritage); (ii) historic shipwrecks; (iii) Commonwealth marine reserves; and (iv) listed critical habitats.

marine protected area

Any area of intertidal or subtidal terrain, together with its overlying water and associated plants, animals, historical or cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment.

marine reserve

A marine protected area that is highly protected and is effective as a complete sanctuary; no extractive uses are permitted, and very few (or no) other human uses (including scientific research) are permitted.

marine snow

In the deep ocean, a continuous shower of mostly organic detritus falling from the upper layers of the water column. The composition of marine snow includes dead or dying animals and plants (plankton), protists, fecal matter, sand, soot and other inorganic dust. The

'snowflakes' (which are more like clumps or strings) are aggregates of smaller particles held together by a sugary mucus exuded as waste products by bacteria and phytoplankton. These aggregates grow over time and may reach several centimetres in diameter, travelling for weeks before reaching the ocean floor.

marine species (listed)

A marine species included in the list referred to in Section 248 of the EPBC Act.

The list contains the following:

(a) all species in the family Hydrophiidae (seasnakes);

(b) all species in the family Laticaudidae (seasnakes);

(c) all species in the family Otariidae (eared seals);

(d) all species in the family Phocidae (true seals);

(e) all species in the genus Crocodylus (crocodiles);

(f) all species in the genus Dugong (dugongs);

(g) all species in the family Cheloniidae (marine turtles);

(h) the species Dermochelys coriacea (leatherback turtles);

(i) all species in the family Syngnathidae (seahorses, sea-dragons and pipefish);

(j) all species in the family Solenostomidae (ghost pipefish);

(k) all species in the class Aves (birds) that occur naturally in Commonwealth marine areas.

megabenthic/megabenthos

Large invertebrates living upon or in the bottom of the sea, such as clams, sea stars, sea cucumbers, crabs and lobsters.

mesopelagic

A pelagic zone extending from 200 m down to around 1000 m below sea level (also known as the middle pelagic or twilight zone). Although some light penetrates this deep, it is insufficient for photosynthesis.

meso-scale

Of intermediate size (e.g. hundreds of kilometres).

mesotidal

Tidal ranges can be defined as the difference between mean high and mean low spring tides. Where the mean spring tide range is between 2 and 4 m it is termed mesotidal.

Mesozoic

An era of geologic time between 245 and 66 million years ago that was the major period of dinosaur dominance.

microalgae

Microscopic algae and diatoms which form the base of the ocean food chain; sometimes called microphytes.

micro-organism

A microscopic organism (animal or vegetable).

migratory species (listed)

A migratory species included in the list referred to in Section 209 of the EPBC Act. Under the Act, migratory species has the meaning given by Article 1 of the Bonn Convention: 'the entire population, or any geographically separate part of the population, of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.'

mollusc

Soft-bodied animals, including a variety of marine, fresh water and terrestrial snails; clams, oysters, mussels, scallops, squids, octopus, and nautilus.

monsoonal winds

The moist, north-westerly winds from the Indian Ocean and southern Asian ocean waters. Monsoonal winds are a seasonal reversal of the trade winds, which blow from a south-easterly direction.

morph

Local variety of a species, distinguishable from other populations of the species by morphology or behaviour.

neritic

Of or pertaining to the shallow waters near land.

nutricline

transition between low nutrient surface water layers and high nutrient deeper water layers.

oceanography

The study of the physical aspects of the ocean, the movements of the sea, and the variability of these factors in relationship to the atmosphere and the ocean bottom.

oligotrophic

Refers to any environment that offers little to sustain life. This term is usually used to describe bodies of water or soils with very low nutrient levels (compare to eutrophic).

paeleo-

Relating to the geological past.

pelagic

Associated with the surface or middle depths of the water column, e.g. fish swimming freely in the open sea.

phytobenthos

Microscopic plants that live in the surface layers of the seabed, particularly in shallow water and intertidal areas.

phytoplankton

Small plants, mostly microscopic, which are suspended in water and free-drifting; usually found near the water surface where there is sufficient light to support photosynthesis.

pinnacle

High tower or spire-shaped pillar of rock or coral that may extend above the surface of the water.

planktivores

Organisms that eat plankton.

plankton

Any small or microscopic drifting organism (plant or animal) that inhabits the water column of oceans, seas, and fresh water.

Pleistocene

A geologic period, usually thought of as the Ice Age, which began about 1.6 million years ago and ended with the melting of the large continental glaciers creating the modern climatic pattern about 11,500 years ago.

Pliocene

Epoch of geologic time 5.2 - 1.64 million years ago.

polychaetes

Members of the class Polychaetae, a group of mainly marine annelid worms, also known as bristle worms. There are more than 10,000 known species in this class.

propagule

A dispersive structure, such as a seed, fruit, eggs or sperm, released from a parent organism for reproductive purposes.

proponent

In the context of the EPBC Act, this refers to the person who is proposing an action (as designated under Division 2 of Part 7 of the Act).

province

A large-scale biogeographic unit derived from evolutionary processes in which suites of endemic species co-exist.

prospective

Referring to the expectation of finding something, e.g. commercial mineral deposits.

quaternary

Of or belonging to the geologic time, system of rocks, or sedimentary deposits of the second period of the Cenozoic Era, from the end of the Tertiary Period through the present, characterized by the appearance and development of humans and including the Pleistocene and Holocene epochs.

Ramsar-listed wetlands

The Convention on Wetlands of International Importance, known as the Ramsar Convention, was signed in 1971 in Ramsar, Iran, and is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

recruitment

The influx of new members into a population by reproduction or immigration.

reef

A rock mass (often coral) which lies at or near the water surface.

refugia

Locations of isolated or relict populations of once widespread animal or plant species (singular: refugium).

relict

i) An organism or species surviving as a remnant of an otherwise extinct flora or fauna in an environment much changed from that in which it originated;

ii) a geological feature that is a remnant of a pre-existing formation after other parts have disappeared.

saddle

A dip in a ridge or between adjoining seamounts that resembles the shape in a riding saddle.

salinity

The degree of salt in water.

seamount/guyot

An underwater mountain rising from the ocean floor and having a peaked or flat-topped summit below the surface of the sea.

sedimentology

The study of sediments and the processes that deposit them.

sea cucumber (see also trepang)

An echinoderm of the class Holothuroidea with an elongated body and leathery skin. Sea cucumbers are edible and have been harvested and traded in northern Australia and South-east Asia for hundreds of years. When processed for eating, the sea cucumber is known as bêche-de-mer or trepang.

seismic

Relating to earthquakes or other vibrations of the Earth and its crust. Also relates to geological surveying methods that involve vibrations produced artificially by explosions. A seismic source generates controlled seismic energy that is used in seismic surveys. A seismic source can be simple, such as dynamite, or it can use more sophisticated technology, such as a specialized air gun. The source provides a pulse of energy that generates seismic waves, which travel through a medium such as water or layers of rocks. Some of the waves then reflect and refract to receivers, such as geophones or hydrophones.

semidiurnal

Half daily.

sessile

Sessile animals are fixed and immobile. They are usually permanently attached to a solid substrate of some kind, such as a rock or the hull of a ship in the case of barnacles. Other sessile animals such as corals lay down their own substrate. Sessile animals typically have a free-moving (motile) phase in their development.

shelf break

The area of the seabed where the continental shelf meets the steeper slope, commonly around depths of 200 m.

socio-economic

Of or relating to both social and economic considerations.

South Equatorial Current

An equatorial current that flows west across the Pacific just south of the equator, carrying low salinity water.

spawning

A reproductive strategy where eggs and sperm are released into water.

speciation

The evolutionary differentiation of a pre-existing species into one or more distinct species.

sponge

Primitive multicellular marine animal whose porous body is supported by a fibrous skeletal framework; usually occurs in sessile colonies.

State/Territory waters

State or Territory waters are a belt of water that extends from the territorial sea baseline for three nautical miles seawards, and are under the jurisdiction of the adjacent Australian State or Territory. The normal territorial sea baseline is the low water mark measured along the coast.

stock

A group of individuals of a species, usually occupying a particular spatial range. Stocks are used as a unit for managing and assessing fisheries.

Sub-Antarctic water

Antarctic intermediate and bottom layers of water that move north from the Antarctic region.

substrate

A surface on which organisms live.

subtropical

Relating to or occurring in a region intermediate between tropical and temperate.

subtropical convergence

Interface between the cooler waters of the Tasman Sea and colder sub-Antarctic waters and runs south-eastward across the Tasman Sea around the 45° S latitude.

supratidal

Pertaining to the shore area above the high-tide level.

syngnathid

A family of fish which includes the seahorses, the pipefishes, and the weedy and leafy sea dragons.

Tasman Front

Interface between the warm waters of the Coral Sea and the cooler Tasman Sea waters and runs south-eastward across the Tasman Sea. The front moves north-south seasonally between 30° and 34° S.

taxon

Any unit used in the science of biological classification (taxonomy). The most commonly used units are genus and species (plural: taxa).

tectonic

Corresponding with the broad architecture of the outer part of the earth.

teleost

A large and extremely diverse group of ray-finned fish in the infraclass Teleostei, one of the three major subdivisions of the class Actinopterygii, the most advanced of the bony fish.

temperate

The regions in which the climate undergoes seasonal changes in temperature and moisture. Temperate regions of the earth lie primarily between 30° and 60° latitude in both hemispheres.

terraces

A relatively level bench or step-like surface breaking the continuity of a slope.

terrigenous

Sediments derived from the erosion of rocks on land, consisting of sand, mud and silt carried out to sea by rivers. Deposition of these sediments is largely limited to the continental shelf.

trade winds

Surface air from the sub-tropic latitudes (30° to 35° S) that moves back toward the equator and is deflected by the Coriolis Force, causing the winds to blow from the north-east in the northern hemisphere and from the south-east in the southern hemisphere.

threatened species

Threatened species are listed under the EPBC Act (Section 178) in six categories:

(a) extinct;

(b) extinct in the wild;

(c) critically endangered;

(d) endangered;

(e) vulnerable; and

(f) conservation dependent.

The definitions for these categories of listing are detailed in Section 179 of the EPBC Act.

trench

A very deep and narrow depression in the sea floor of non-uniform dimensions and with steep sides.

trepang (see also sea cucumber)

The Indonesian word for sea cucumber or holothurian. Trepangers were originally Moluccan fishermen who visited the north coast of Australia to collect and process sea cucumbers for eating.

trophic level

The position an organism occupies in a food chain; levels include primary producers, herbivores, primary, secondary and tertiary carnivores, and decomposers.

tropical

The area between 23.5° N and S of the equator. This region has small daily and seasonal changes in temperature, but great seasonal changes in precipitation.

trough

A long depression in the sea floor that is flat bottomed with steep sides.

turbidity

The cloudiness in water that is caused by particles, usually of fine sediment or microscopic particles of biological material.

upwelling

The phenomenon of deep ocean water rising to the surface, usually bringing nutrients that can increase biological productivity.

vulnerable species (see also: threatened species)

The definition of a vulnerable species in the EPBC Act (Section 179) is:

A native species is eligible to be included in the vulnerable category at a particular time if, at that time:

(a) it is not critically endangered or endangered; and

(b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

warm core eddy

Anti-clockwise rotating movements of water formed on the side of a main current that cause warm surface water layers to dome downwards towards the centre pushing cold water layers deeper below surface water layers.

zooplankton

Animal component of the plankton community.

zooxanthellae

Microscopic algae that live symbiotically within the cells of some marine invertebrates, especially coral.

Australian Government

Department of the Environment, Water, Heritage and the Arts