The South-west Marine Bioregional Plan

Bioregional Profile

A Description of the Ecosystems, Conservation Values and Uses of the South-west Marine Region

Australian Government
Department of the Environment, Water, Heritage and the Arts

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Short-headed seahorse. Photo: Michael Morris, Marine Life Society of South Australia.

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Australian sea lion. Photo: David Muirhead, Marine Life Society of South Australia.

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 contributes to an ecosystem approach to the management of 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 South-west Marine Region. It establishes the information-base upon which the South-west Marine Bioregional Plan will be developed. In particular, it focuses on the natural assets of the South-west 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 South-west Marine Atlas for example, available at <www.environment.gov.au/coasts/mbp/south-west>, is an interactive mapping tool that displays information about the biodiversity and physical characteristics of the Region and the human activities they support. Our information-base will be periodically updated as new information becomes available.

The Bioregional Profile summarises information detailed in a number of reports produced for marine bioregional planning in this Region. These are available on the internet at <www.environment.gov.au/coasts/mbp/south-west> and include:

The South-west Marine Region: Ecosystems and Key Species Groups – a literature review prepared in 2006 by a consortium of scientists led by the South Australian Research and Development Institute and the University of Western Australia.

Characterisation of the Marine Environment of the South-west Marine Region – reports the discussions and outcomes of a two-day science workshop convened in Perth, Western Australia, on 27-28 September 2006.

Geomorphology and Sedimentology of the South Western Planning Area of Australia – prepared by Geoscience Australia in 2005 (with a supplement in 2006) to summarise all available information on the geology and sedimentology of the Region.

A Socio-economic Analysis and Description of the Marine Industries of Australia's South-west Marine Region – conducted by the Institute for Regional Development, University of Western Australia.

Sea Countries of the South: Indigenous Interests and Connections within the South-west Marine Region of Australia – prepared by the Australian Institute of Aboriginal and Torres Strait Islander Studies. This report is available at <www.environment.gov.au/indigenous>.

While this Bioregional Profile and the associated reports attempt to provide a comprehensive picture of the Marine Region, and care has been taken to ensure accuracy (for example, all reports were subject to a peer review process), there may be gaps in information that can be filled during 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 South-west Marine Region.

Please email any additional information, as well as any questions or comments you might have concerning this document, to:
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A school of small fish swim around a basket star with arms extended to feed. Central Western Province, 174 m deep. Photo: CSIRO.

Executive Summary

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

- describing each Region's conservation values, including mapping sites of importance for protected species and communities, and ecological processes;
- 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 to consider whether their action might result in a significant impact on matters of national environmental significance.

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 (MPAs). The guidelines the Government is using to develop the National Representative System of MPAs have been agreed with the States and the Northern Territory. See <www.environment.gov.au/coasts/mpa>. The Bioregional Profile describes the environmental and socio-economic characteristics of the South-west Marine Region. The Region comprises Commonwealth waters from the eastern end of Kangaroo Island, South Australia, to waters off Shark Bay, Western Australia (see Figure 1.1). It covers some 1.3 million km² and includes both subtropical and temperate waters. Australia's deepest areas of ocean, reaching depths of approximately 5900 m, are found in the Region, in the Diamantina Fracture Zone south of Cape Leeuwin.

A Glossary has been developed to assist with technical terminology used in the Bioregional Profile. The glossary is located on page 193.

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

The Region's environment and its conservation values

By global standards, the South-west Marine Region has high biodiversity and is home to many species that occur nowhere else (endemic species). The biological productivity of the Region is relatively low, compared to other marine regions of the world, mainly because of the interactions of the Leeuwin Current with other currents, which result in the absence of large seasonal upwellings of nutrient-rich water from the deeper parts of the Region. There are, however, small seasonal upwellings that are ecologically important because they enhance biological productivity in specific areas of the Region.

The *Integrated Marine and Coastal Regionalisation of Australia Version 4.0* divides the South-west Marine Region into seven bioregions[1]:

The Southwest Shelf Transition

(Area: 32 809 km²; max depth: 200 m)

This bioregion covers the continental shelf extending seaward from Kalbarri to Perth. Its ecology is heavily influenced by the Leeuwin Current, which carries sub-tropical and tropical species southward. Here they mix with temperate species to form diverse and unique biological communities, such as those surrounding the Houtman Abrolhos Islands. Adjoining one of the most populated coastal areas of the south-west, this bioregion is critical to a number of industries and other activities, including fishing (particularly for western rock lobster), defence and, more recently, petroleum production.

The Central Western Province

(Area: 268 460 km²; max depth: 5795 m)

This offshore bioregion extends from the Southwest Shelf Transition to the limit of the Australian Exclusive Economic Zone (EEZ). The continental slope is cut by numerous canyons, including the Perth Canyon, the largest of Australia's submarine canyons. The bioregion is characterised by numerous eddies (circulating bodies of water, about 200-300 kilometres in diameter) that detach from the Leeuwin Current, trapping shallow water biological communities and nutrients and transporting them offshore. The Perth Canyon appears to be an important ecological feature attracting krill and

1 For the purpose of this document, 'bioregion' means provincial bioregion as defined in the *Integrated Marine and Coastal Regionalisation of Australia Version 4.0*.

fish aggregations that in turn attract larger species such as predatory fish and pygmy blue whales. This bioregion is of high value for recreational and commercial fishers and is important for shipping and defence training.

The Southwest Shelf Province

(Area: 73 772 km²; max depth: 200 m)

This bioregion extends over a long stretch of continental shelf from Fremantle in the north around to Point Dempster, east of Esperance, in the south. Marine life in the bioregion is very diverse and clearly influenced by the warm waters of the Leeuwin Current. It includes globally important biodiversity hotspots, such as the waters off Geographe Bay and those surrounding the Recherche Archipelago. This bioregion is important to the petroleum industry, shipping, marine tourism, and charter, recreational and commercial fishing.

The Southwest Transition

(Area: 101 055 km²; max depth: 5190 m)

This is one of the South-west Marine Region's least researched bioregions. It is dominated by the Naturaliste Plateau, a large extension of the continental plate, which adjoins the continental slope through the Naturaliste Trough. Little biological sampling has been conducted here due to its remoteness and rough waters, but based on its characteristics and data from elsewhere in the world, scientists believe that the Plateau hosts rich and diverse biological communities. Recently, a number of exploratory surveys of the seafloor have been undertaken to test the petroleum prospectivity.

The Great Australian Bight Shelf Transition

(Area: 146 547 km²; max depth: 200 m)

This is a vast and shallow bioregion. It includes the only existing Commonwealth marine reserve in the south-west, the Great Australian Bight Marine Park, which was established in 1998 and is jointly-managed by the Australian and South Australian Governments. The Benthic Protection Zone of the Great Australian Bight Marine Park projects offshore into the neighbouring Southern Province. The Great Australian Bight Shelf Transition extends from Point Dempster to Ceduna. The invertebrate communities that inhabit the seafloor are among the most diverse in the world. The inshore areas of the bioregion are globally important for the threatened southern right whale and the Australian sea lion. The coast adjacent to this bioregion is the least populated in the south-west. A range of commercial fisheries are active within this bioregion including the Southern Bluefin Tuna Fishery and other State and Australian Government-managed fisheries.

The Spencer Gulf Shelf Province

(Area: 133 160 km²; max depth: 200 m)

This bioregion straddles Australia's South-west and South-east Marine Regions, extending east from Ceduna. Seasonal winds and ocean currents interact with seafloor features to produce a number of small seasonal upwellings that are important for biological productivity. This enhanced productivity appears to support the commercial and recreational fisheries of the bioregion. Commercial fishers are active in the bioregion, targeting species including sardines and other scalefish. Charter and recreational fishers also fish in this bioregion. The adjacent coastline is complex with shallow gulfs and numerous islands. The bioregion is noted for its very diverse seafloor communities, productivity hotspots and aggregations of marine life associated with small seasonal upwellings. New Zealand fur seals, Australian sea lions, dolphins, penguins, blue whales and seabirds inhabit or visit the area.

The Southern Province

(Area: 770 270 km²; max depth: 5900 m)

This bioregion covers almost half the Region and extends offshore from the south-west corner of the Australian mainland across to the eastern boundary of the South-west Marine Region. Submarine canyons and the Diamantina Fracture Zone are key ecological features of the Southern Province. Some of these canyons are important aggregation areas for a range of species, including commercially fished species, deep-diving toothed whales, dolphins and New Zealand fur seals. There are a number of prospective areas for oil and gas in the bioregion.

Conservation values of the South-west Marine Region

Conservation values[1] of the South-west Marine 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 105 species that are known to live in the Region are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), either as threatened, migratory, listed marine or cetacean species. Of these, 26 species are listed as threatened, including five endangered species, 20 vulnerable and one listed as conservation dependent.

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

- a species, group of species or a community with a regionally important ecological role;
- 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 productivity;
  b) aggregations of marine life;
  c) biodiversity and endemism; or
- a unique seafloor feature with known or presumed ecological properties of regional significance.

Key ecological features of the South-west Marine Region that have conservation value are:

- the West Coast Canyons and adjacent shelf break (enhanced productivity; feeding aggregations; unique seafloor feature);
- the Diamantina Fracture Zone (unique seafloor feature);
- the Albany Canyons Group and adjacent shelf break (enhanced productivity; feeding aggregations; unique seafloor feature);
- the Kangaroo Island canyons and the adjacent shelf break (enhanced productivity; feeding and breeding aggregations; unique seafloor feature);
- the 'Kangaroo Island Pool' and Eyre Peninsula upwellings (enhanced productivity; feeding aggregations);
- meso-scale (hundreds of kilometre) eddies in predictable locations – south-west of Shark Bay, offshore of the Houtman Abrolhos Islands, south-west of Jurien Bay, south-west of Cape Naturaliste and Cape Leeuwin and south of Albany, Esperance and the Eyre Peninsula (enhanced productivity; feeding aggregations);
- the Naturaliste Plateau (unique seafloor feature);
- Commonwealth waters within and adjacent to the west coast inshore lagoons – extending from south of Mandurah to Kalbarri (enhanced productivity (benthic); breeding and nursery aggregations);
- Commonwealth waters surrounding the Houtman Abrolhos Islands (high biodiversity);
- Commonwealth waters within and adjacent to Geographe Bay (enhanced productivity (benthic); high biodiversity; feeding, resting, breeding and nursery aggregations);
- Commonwealth waters surrounding the Recherche Archipelago (high biodiversity; breeding and resting aggregations);
- the Cape Mentelle upwelling (enhanced pelagic productivity; feeding aggregations);

1 Marine conservation values are defined for the purpose of marine bioregional planning, as including:

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.

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.

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.

- Commonwealth waters adjacent to the Head of Bight (enhanced productivity (pelagic); high biodiversity; feeding and resting aggregations);
- western rock lobster (species with an important ecological role);
- small pelagic fish (species group with important ecological role);
- demersal slope fish communities of the Central Western Province (communities with high species diversity); and
- benthic invertebrate communities of the eastern Great Australian Bight (communities with high species diversity).

A description of these key ecological features of regional conservation value is given in Chapter 3.

There are no listed heritage sites in the South-west Marine Region. However, there are five known historic shipwrecks found within the Region that are considered of regional conservation value (most historic shipwrecks are found within State waters). These are the:

- *SS Cambewarra*, a steam powered transport vessel wrecked in 1914 near Fisherman's Island, 80 km south of Dongara, Western Australia;
- *Red Rover*, a fishing boat wrecked in 1887 near Coffin Bay, South Australia;
- *Lord Roberts*, wrecked in 1902 in the Gulf St Vincent region, South Australia;
- *HMAS Sydney II*, wrecked in 1941 while engaged in battle with the *HSK Kormoran*, approximately 250 km off the mid-west coast of Western Australia; and
- *HSK Kormoran*, wrecked in 1941 while engaged in battle with the *HMAS Sydney II*, approximately 250 km off the mid-west coast of Western Australia.

These are protected under the *Historic Shipwrecks Act* 1976, which safeguards shipwrecks and associated relics from damage, interference, removal or destruction.

Marine protected areas in the South-west Marine Region

One of the largest marine reserves in Australia, the Great Australian Bight Marine Park, is already established in the South-west Marine Region. This park is comprised of adjoining Australian and South Australian Government protected areas, with both governments managing the Park cooperatively. The Commonwealth waters component of the Park was the first to include an area especially designed to be 'representative' – that is, to have as its main objective the protection of examples of the type of ecosystems that occur within the bioregion. When the South-west Marine Bioregional Plan is complete, this Marine Park will be complemented by new marine reserves to form a regional network of marine protected areas (MPAs) as part of the developing National Representative System of MPAs.

The new MPAs 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 MPA network are described in Chapter 4 of this Bioregional Profile, along with their application to the South-west Marine Region and an outline of the principles that will guide the location, selection, design and zoning of representative MPAs. Consideration of the socio-economic implications of potential MPAs will inform the Government's decision about a final regional MPA network.

Human activities and the marine environment

The marine environment has played a central role for coastal communities since before European settlement. Aboriginal people have lived adjacent to the Region for many thousands of years. Following European settlement, the Region became an important area for the then thriving sealing and whaling industries. The last whaling station in Australia, near Albany, was active up to 1978.

Today the major marine industries associated with the Region include commercial fishing, marine-based tourism, shipping, petroleum exploration and production, defence activities and aquaculture. Twenty ports adjacent to the Region provide vital services to the Western Australian and South Australian communities. Petroleum production in the Region commenced in 2006 and exploration continues in the Perth Basin, the Mentelle Basin and the Bight Basin.

Australian Government-managed fisheries in the Region target southern bluefin tuna, yellowfin and bigeye tuna, blue-eye trevalla, ling, shark and other species. There are also commercially important State-managed fisheries

predominantly adjacent to the Region including the Western Australian rock lobster and South Australian southern rock lobster fisheries, and abalone, scallop, shark, King George whiting and prawn fisheries. The Region is also important for the recreational and charter fishing it supports.

Next steps

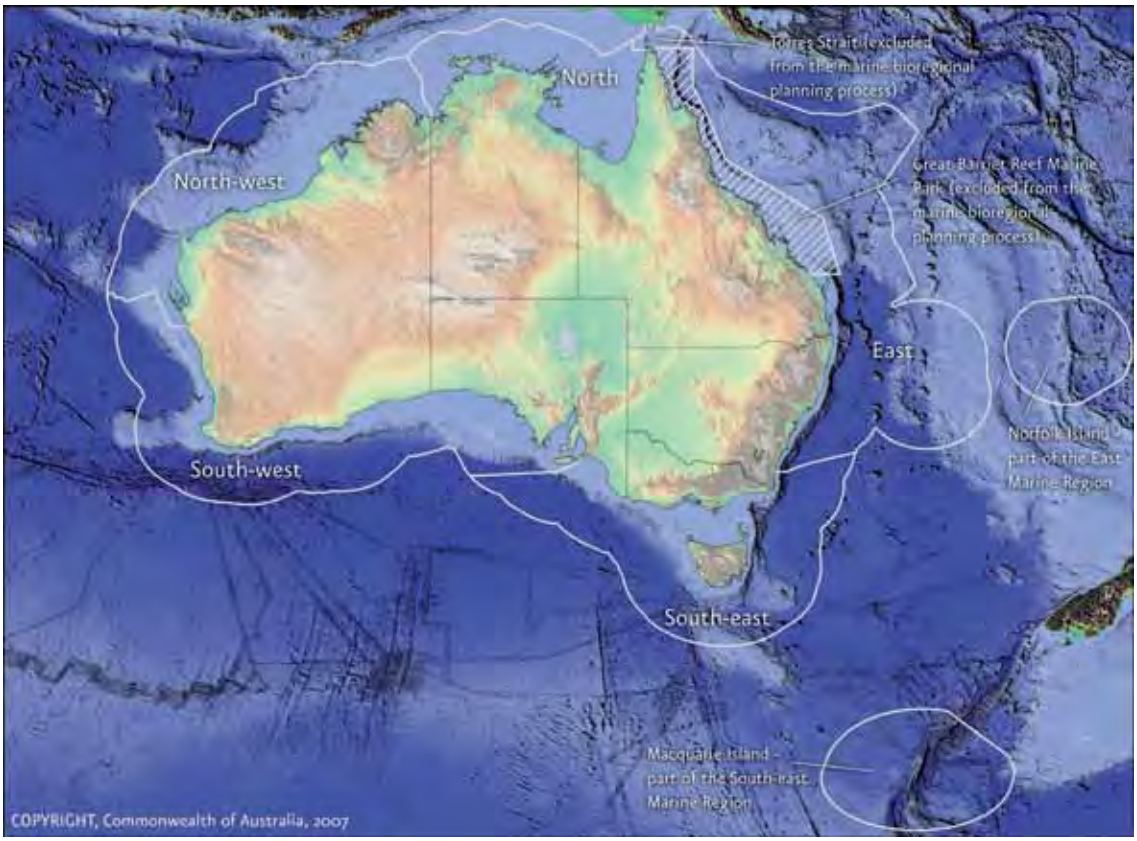
This Bioregional Profile and associated web-based information will guide development of a Draft Marine Bioregional Plan for the South-west Marine Region. The Draft Plan will be released for a period of formal public comment, as required under the EPBC Act. Conservation measures and potential implications for people and industries will be considered and resolved through a process involving stakeholder and wider public consultation. 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 for the Environment, Heritage and the Arts 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 programme undertaken under Commonwealth legislation, the planning process occurs in consultation with State Governments. This is important because the Governments of Western Australia and South Australia are also undertaking marine planning and processes to establish MPAs in State waters.

Map Data

Figure 1.1 Australia's Marine Regions
Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2005): Australian Bathymetry and Topography
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts. COPYRIGHT Commonwealth of Australia, 2007.

Figure 1.1 Australia's Marine Regions



Temperate reef with swallowtail nannygai, close to Rottnest Island. Photo: Glen Cowans.

Chapter 1 Introduction

Marine bioregional planning is being undertaken to better protect marine environments, conserve biodiversity and deliver greater certainty for industry, the wider community and decision makers about the marine conservation priorities of the Australian Government. Section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires that, where relevant the Minister for the Environment, Heritage and the Arts must have regard to a Marine Bioregional Plan when making decisions under the EPBC Act.

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 (MPAs). The guidelines the Government is using to develop the National Representative System of MPAs have been agreed with the States and the Northern Territory. See <www.environment.gov.au/coasts/mpa>.

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

- describing each Region's conservation values, including mapping sites of importance for protected species and communities, and ecological processes;
- 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, providing proponents with a regional context to national guidelines will enable them to better consider whether their action might result in a significant impact (see Appendix B). Plans may also include guidance on the type of information that should be included with referrals under the EPBC Act or the monitoring requirements that may be required for certain activities or locations within a Region.

Each Marine Region is divided into bioregions based on ecological similarities, species distribution and oceanographic and seafloor characteristics[1]. The South-west Marine Region has seven bioregions, which are described in Chapter 2. These bioregions reflect our understanding of the Region's ecology and underpin the planning process.

1 For the purpose of this document, 'bioregion' means provincial bioregion as defined in the *Integrated Marine and Coastal Regionalisation of Australia Version 4.0*.

Seawhips (octocorals) extending from fine sands, Central Western Province, 418 m deep. Photo: CSIRO.

1.1 The Bioregional Profile of the South-west Marine Region

The South-west Marine Region encompasses Commonwealth waters from the eastern end of Kangaroo Island, South Australia, to offshore of Shark Bay in Western Australia (Figure 1.1). It covers 1.3 million km^2 of ocean and also includes the airspace above the water and the seabed below. The Region is described in more detail in Chapter 2. In this Bioregional Profile, the terms the Region, and the South-west Marine Region are used interchangeably to refer to the Commonwealth waters defined above.

The objectives of the South-west Bioregional Profile are to describe:

1. the conservation values of the Region – including marine species, communities and places already specifically protected under legislation, and those identified through the planning process as key ecological features;
2. the considerations and information that will guide the identification of MPAs; and
3. ecosystems and human activities.

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

Chapter 2 – *The marine environment of the South-west Marine Region* describes the biophysical and ecological characteristics of the Region, with particular focus on ecosystem structure and functioning.

Chapter 3 – *Conservation values of the South-west Marine Region* summarises and describes the biodiversity and heritage features that are considered of conservation value in the South-west Marine Region.

Chapter 4 – *Establishing new marine protected areas in the South-west Marine Region* introduces the goals and principles of the Australian Government for the establishment of the Commonwealth component of the National Representative System of MPAs and explains their application to the South-west Marine Region.

Chapter 5 – *Human activities and the South-west 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 South Australian and Western Australian economies adjacent to the Region.

Chapter 6 – *Developing a South-west 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 South-west 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 – *South-west 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.

A decapod crustacean swimming over fine sediments. Central Western Province, 411 m deep. Photo: CSIRO.

Dolphin. Photo: Kevin Smith, Marine Life Society of South Australia.

1.2 Supporting information

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

Marine bioregional planning has a strong focus on understanding the natural environment. A scientific workshop was held in September 2006 to bring together marine scientists with specific experience and expertise in the Region. The aim was to take stock of current knowledge and theory about the way marine ecosystems function in the Region. It also helped to ensure that the Bioregional Profile and subsequent Marine Bioregional Plan are based on the most comprehensive understanding possible, with an explicit recognition of the uncertainties due to gaps in the information base. The outcomes of the workshop are also available online at <www.environment.gov.au/coasts/mbp/south-west>.

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

Key references and further readings

Australian and New Zealand Environment and Conservation Council, Task Force on Marine Protected Areas (ANZECC TFMPA), 1998, *Guidelines for Establishing the National Representative System of Marine Protected Areas*, Environment Australia, Canberra, <www.environment.gov.au/coasts/mpa>, accessed 07/05/07.

Department of the Environment and Heritage (DEH), 2006, *A Guide to the Integrated Marine and Coastal Regionalisation of Australia Version 4.0*, DEH, Canberra, <www.environment.gov.au/coasts/mbp/publications/imcra-4>, accessed 07/05/07.

Department of the Environment and Water Resources (DEW), 2006, *Characterisation of the Marine Environment of the South-west Marine Region: Perth Workshop Report*, DEW, Canberra, <www.environment.gov.au/coasts/mbp/south-west>.

Legislation

Environment Protection and Biodiversity Conservation Act 1999 (Cth), <www.environment.gov.au/epbc/about>, accessed 07/05/07.

Southern rock lobster. Photo: Marine Life Society of South Australia.

Chapter 2 The Marine Environment of the South-west Marine Region

The South-west Marine Region comprises Commonwealth waters and seabed from the eastern end of Kangaroo Island, South Australia, to 70 km offshore from Shark Bay, Western Australia, and covers an area of some 1.3 million km² (Figure 2.5). The Region is bounded inshore by the outer limit of the State waters jurisdictional boundary, (which generally extends out to three nautical miles from the territorial sea baseline[1]) and offshore by the outer limit of the Australian Exclusive Economic Zone (EEZ), 200 nautical miles from the low water mark (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 South Australia and Western Australia. This chapter is primarily focused on describing features and ecological processes in the Commonwealth waters. However, in some instances features and ecological processes occurring in State waters are identified because:

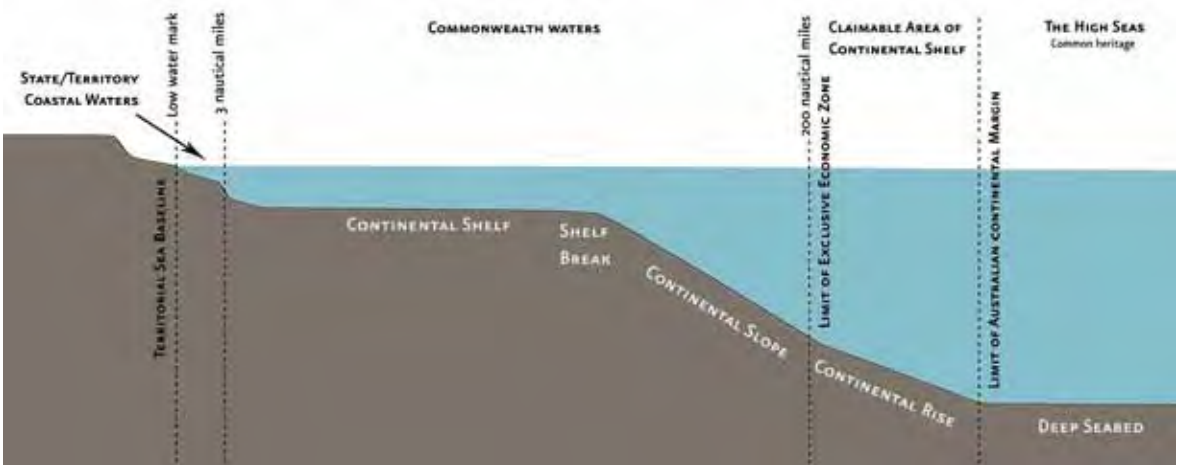
- they are important to species listed as threatened or migratory under the EPBC Act, which are protected as matters of national environmental significance (see Chapter 3 and Appendix B for further information on matters of national environmental significance); and
- there is connectivity between features and ecological processes that link State waters and the Commonwealth marine area of the South-west Marine Region.

The Region encompasses waters over the continental shelf, the continental slope, the continental rise and the abyssal plains. It also includes the Diamantina Fracture Zone, which reaches depths of approximately 5900 m (see separate map in the envelope inside the back cover). The shallower waters of the Region are found on the continental shelf where depths range from appropximately 10-200 m. The meeting point of the shelf and slope is often referred to as the 'shelf break'. The continental slope of the Region is incised by a large number of submarine canyons, more than anywhere else in Australia.

From a global perspective, the South-west Marine Region is generally characterised by low levels of nutrients and high species biodiversity, including a large number of species found nowhere else in the world. The biological communities comprise species of temperate origin, which, in the north of the Region, mix with tropical and subtropical species. Broadly, these characteristics are caused by the influence of the Leeuwin Current, the low level of run-off from the land and the relatively stable recent geological history. How these factors influence the ecosystems in the Region are discussed in the following sub-sections.

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

Figure 2.1 Australia's maritime zones



For a more detailed description of Australia's Maritime zones see Australia's Ocean's Policy, Appendix 2 <www.environment.gov.au/coasts/mbp/south-west>.

The Geomorphology of the Region

The Region has been relatively stable throughout its recent geological past. This has shaped a continental shelf that has high wave exposure and is punctuated with coastal features such as island groups and fringing coastal reefs providing sheltered habitats for marine communities.

The continental slope of the Region comprises some of Australia's most complex networks of submarine canyons. The Region also contains some of the largest areas of abyssal plains within Australia's Exclusive Economic Zone and thus contains some of the most extensive deep-water benthic environments. The Naturaliste Plateau is Australia's deepest temperate-water marginal plateau and is separated from the shelf by the Naturaliste Trough. It forms an extensive area (the entire feature is approximately 90 000 km^2) of deep-water habitat between 2000-5000 m deep. Similarly, the Diamantina Fracture Zone, a very deep area of complex topography featuring troughs with depths of approximately 5900 m and ridges that rise up from the seafloor to approximately 4000 m deep, provides unique and varied deep-water habitats.

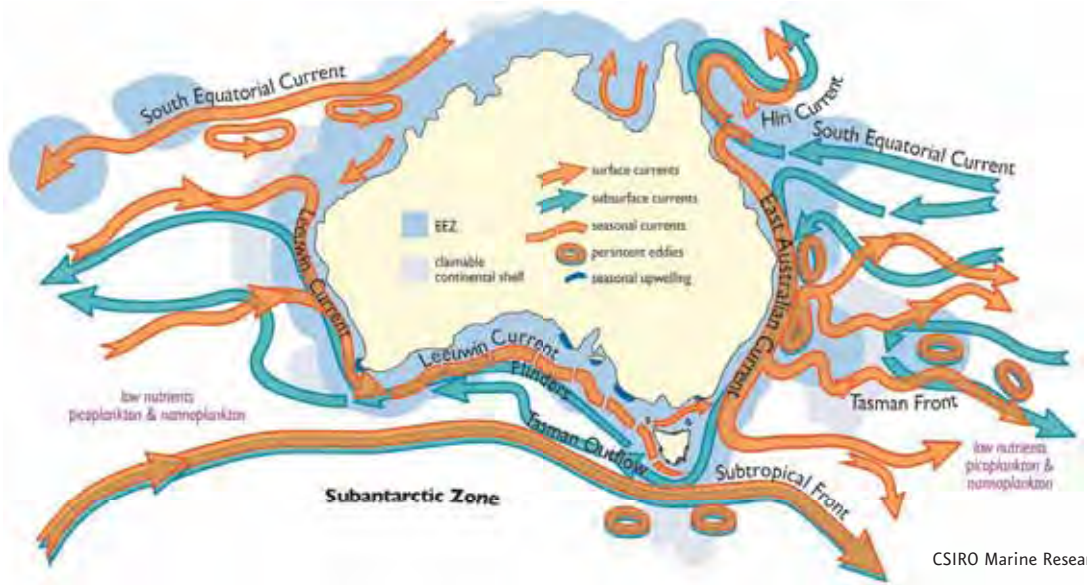
Oceanography and other ecological drivers

There are a number of ocean currents in the Region, including the Leeuwin Current, the deeper subsurface Leeuwin Undercurrent on the west coast, the Flinders Current on the south coast, and the seasonal, coastal Capes Current and Cresswell Current (Figures 2.2, 2.3). The Leeuwin Current is the 'signature current' of the Region because of its extent and significant impact on the biological productivity of ecosystems and biodiversity. The Leeuwin Current is a shallow and narrow current (less than 300 m deep and 100 km wide) that transports warm, nutrient-depleted water from the tropics southward along the shelf break and outer parts of the shelf of the entire Region and south-east to Tasmania's North-west Cape. Although the Leeuwin Current flows all year round, the strength of its flow shows a marked seasonal variation with the strongest flows occurring during winter. During summer, the Leeuwin Current weakens to the point that its inflow to the Great Australian Bight is largely absent.

The Leeuwin Current originates in the tropical waters of the Indian Ocean as the result of a large-scale difference in water density between the warmer, lower salinity waters flowing through the Indonesian Archipelago and the cooler, more saline ocean waters off south-western Australia. The difference in water density causes a change in sea level of approximately 0.5 m between the waters off the northern and southern coasts of Western Australia. The sea level difference, combined with the Earth's rotation, gives origin to the Leeuwin Current, which accelerates as it runs southward.

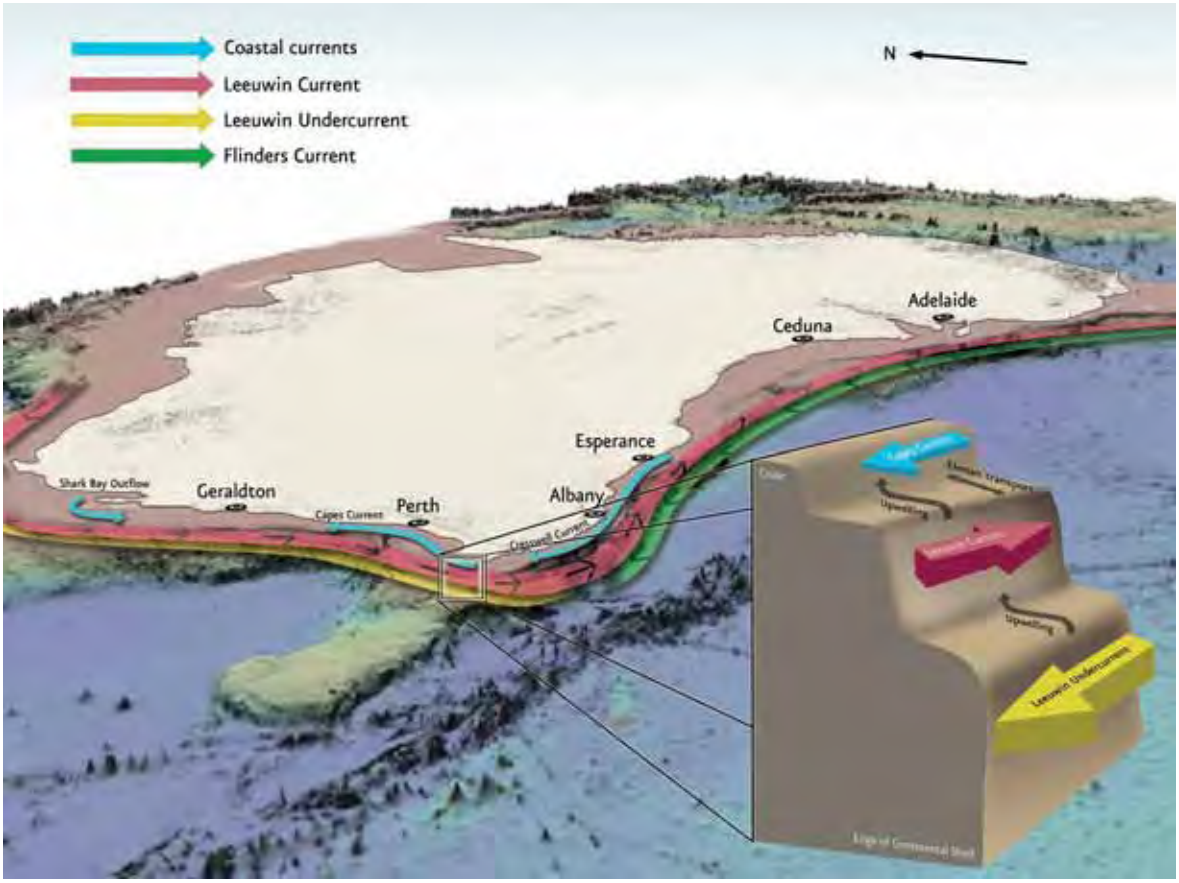
The Leeuwin Current strongly affects the ecology of the Region in a number of ways. In nutrient-poor waters, production hinges on the import of nutrients from deeper waters into surface waters through upwelling and meso-scale cyclonic eddies (50-200 km diameter eddies that spin clockwise and in some cases lift deeper water toward the surface). The Leeuwin Current suppresses predictable large-scale upwellings on the west coast. In some areas it interacts with seafloor features and other currents to generate relatively small, periodic upwellings that locally enhance nutrient levels (Figures 2.3 and 2.4). As

Figure 2.2 Major ocean currents in Australian waters



CSIRO Marine Research

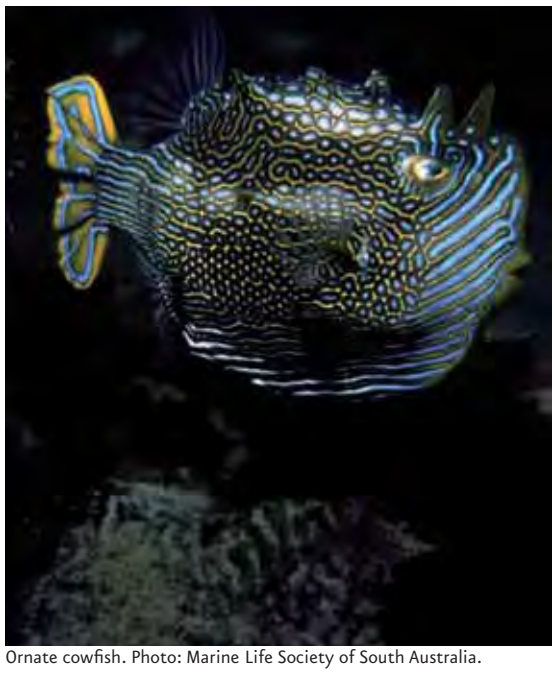
Figure 2.3 Schematic of major ocean currents flowing through the South-west Marine Region
Inset: major currents contributing to the Cape Mentelle upwelling



Bathymetric image Geoscience Australia, current schematic after McClatchie *et al.* 2006.

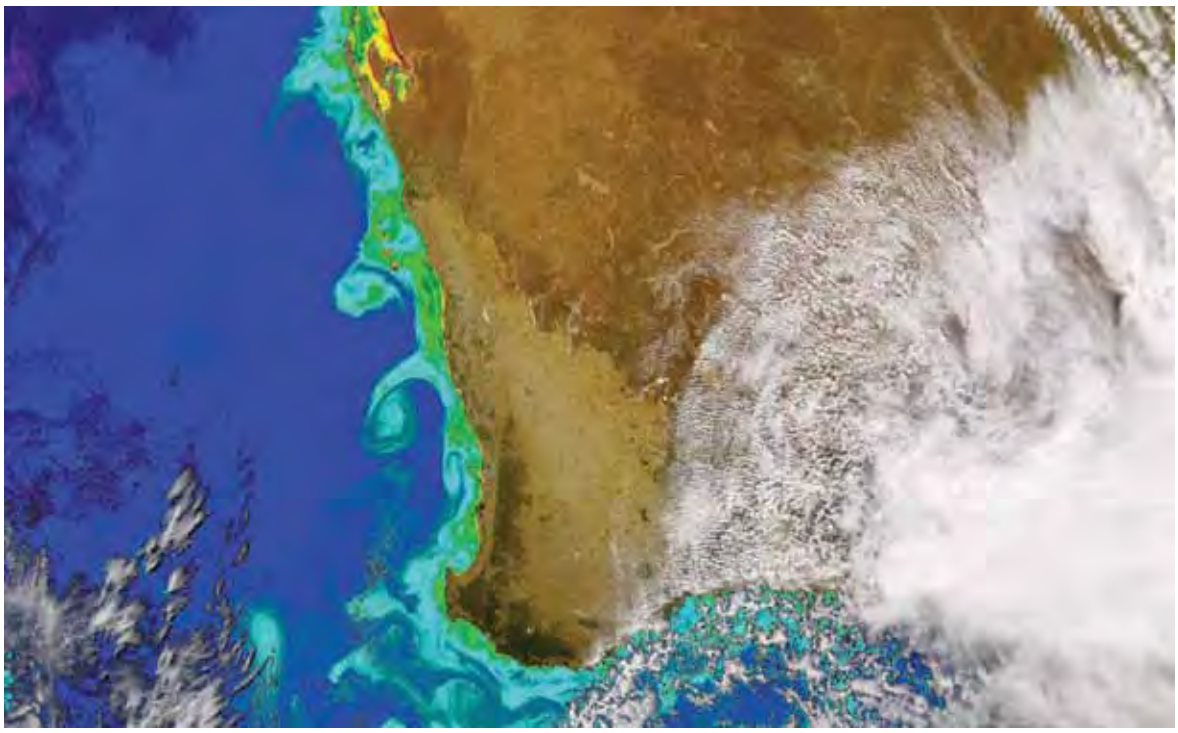
a result, the Leeuwin Current plays an important role in maintaining low levels of productivity on the west coast. Consequently, Australia's west coast is an area that can only support relatively small fisheries compared with all other areas with eastern boundary currents in the world, such as the Humboldt Current off Peru and the Benguela Current off Africa.

The interactions of the Leeuwin Current with seafloor features at the shelf break also leads to the formation of meso-scale eddies. Such eddies are known to occur in predictable locations; off Shark Bay, the western edge of the Houtman Abrolhos Islands, south-west of Jurien Bay, the Perth Canyon, south-west of Cape Naturaliste and Cape Leeuwin, south of Albany, Esperance and Eyre Peninsula (Figure 2.4). Scientists think that eddy systems may have a profound effect on pelagic production in the Region, driving offshore production by transporting nutrients and entire pelagic communities offshore and also generating upwellings of deeper water that are higher in nutrients. However, these processes have not yet been studied in detail. A major challenge to understanding their importance in the Region is the complexity and variability of eddy systems. For example, there are both clockwise and anti-clockwise eddies that form on both the south and west coasts and they may have different physical characteristics – eddies can have cool water or warm water in their core or they may be associated with ascending or descending water.



Ornate cowfish. Photo: Marine Life Society of South Australia.

Figure 2.4 Ocean colour image showing the eddy structure of the Leeuwin Current off the west coast



Ocean colour image NASA/GSFC Orbimage SeaWiFS Project. Water higher in chlorophyll (shown light green) is located on the shelf, and is swept into the Leeuwin Current, spiralling off to form eddies.

The Leeuwin Current plays a crucial role in the distribution of species in the Region. Its warm water transports tropical and sub-tropical species, which become established in areas further south than they otherwise would. For instance, it is because of the Leeuwin Current that a number of tropical fish and hard coral species are found as far south as Rottnest Island (latitude 32°S). The Leeuwin Current and the deeper Flinders Current are also likely to aid the large-scale movements of a number of migratory species.

The ecology is also greatly influenced by the lack of river discharge into the Region. The few significant rivers adjacent to the Region flow intermittently, and their overall discharge is low. Consequently, there is a limited amount of terrigenous (originating from the land) nutrient inputs. When combined with the suppression of large-scale upwelling, discussed above, limited nutrient input from the land reinforces the Region's relatively nutrient-poor status compared with many other marine environments.

The low discharge of rivers and the generally low rate of biological productivity also results in low turbidity (suspended sediments), making the waters of the Region relatively clear. This means that light can penetrate to greater depths allowing a number of light-dependent species and associated communities to be found in waters deeper than those in which they live in other parts of Australia. For instance, macro-algae and seagrass are found at depths of up to 120 m in some parts of the Region.

Biodiversity in the South-west Marine Region

The flora and fauna of the Region are a blend of tropical, subtropical and temperate species. Temperate species dominate the southern and eastern parts of the Region while tropical species become progressively more common in the north.

The South-west Marine Region is known for its high species diversity and high numbers of endemic species (species that are found nowhere else in the world), and there are many more species yet to be discovered. Of the known species, more than 1000 species of macro-algae, between 17 and 22 species of seagrass, 600 species of fish, 110 species of echinoderm and 189 species of ascidians have been recorded in the Region. In the nearshore area of southern parts of the Region approximately 85 per cent of fish species, 95 per cent of molluscs and 90 per cent of echinoderms are thought to be endemic. By comparison, it has been estimated that only 13 per cent of fish, 10 per cent of molluscs and 13 per cent of echinoderms are endemic to tropical regions of Australia. The Region also contains a number of endemic species that are commercially fished, such as

the western rock lobster and dhufish. A global study of coral reef biodiversity hotspots has also found that while the west coast of Western Australia from Ningaloo reef (outside the Region) to Rottnest Island has moderate to high species richness, it is also one of the global hotspots for endemism. Similarly, recent studies of demersal fish communities on the continental slope of the west coast revealed high species richness compared with the North Atlantic and northern Pacific Oceans.

The high species diversity of the Region is largely attributed to the lack of mass extinction events associated with unfavourable environmental conditions such as glaciations over the recent geological past and the moderating influence of the Leeuwin Current over about the last 50 million years. The high species richness (for example, in hard corals, demersal fish, seagrasses and macro-algae), is also in part due to the biogeographic overlap of the ranges of temperate and tropical species. The high endemism in the Region is partly the product of the long period (the last 80 million years) during which the marine flora and fauna in the Region have been isolated from species occurring around other land masses.

The south coast has not been as well studied as the west coast. However, a growing body of research indicates that its waters support a rich diversity of organisms. The Great Australian Bight is known to have one of the world's most diverse soft sediment ecosystems: recent sampling studies have revealed assemblages that include 360 different species of sponge, 138 species of ascidians and 93 species of bryozoans, many of which were newly discovered species.

The South-west Marine Region is an area of global significance for breeding or feeding grounds for a number of threatened marine animals, including Australian sea lions, southern right whales and white sharks. Scientists have recently identified the south-western corner of Australia as an important area for beaked whales, which are the least known species group of whales. The Region also provides habitat for a large number of seabird species that nest on nearby islands and coastline.

Our understanding of species biodiversity and endemism in the deeper parts of the Region, on the continental slope, continental rise and abyssal plain is poor when compared with our knowledge of shallower coastal and shelf communities. Of all the oceanic regions under Australia's jurisdiction, the South-west Marine Region includes the deepest areas and the largest expanse of continental rise. Species unknown to science are undoubtedly yet to be discovered in these unique environments. It is expected that the biodiversity values in the Diamantina Fracture Zone, the Naturaliste Plateau, and the numerous submarine canyons that incise the continental slope are high compared with other parts of the world.

Compound ascidian. Photo: David Muirhead, Marine Life Society of South Australia.

2.1 The bioregions of the South-west Marine Region

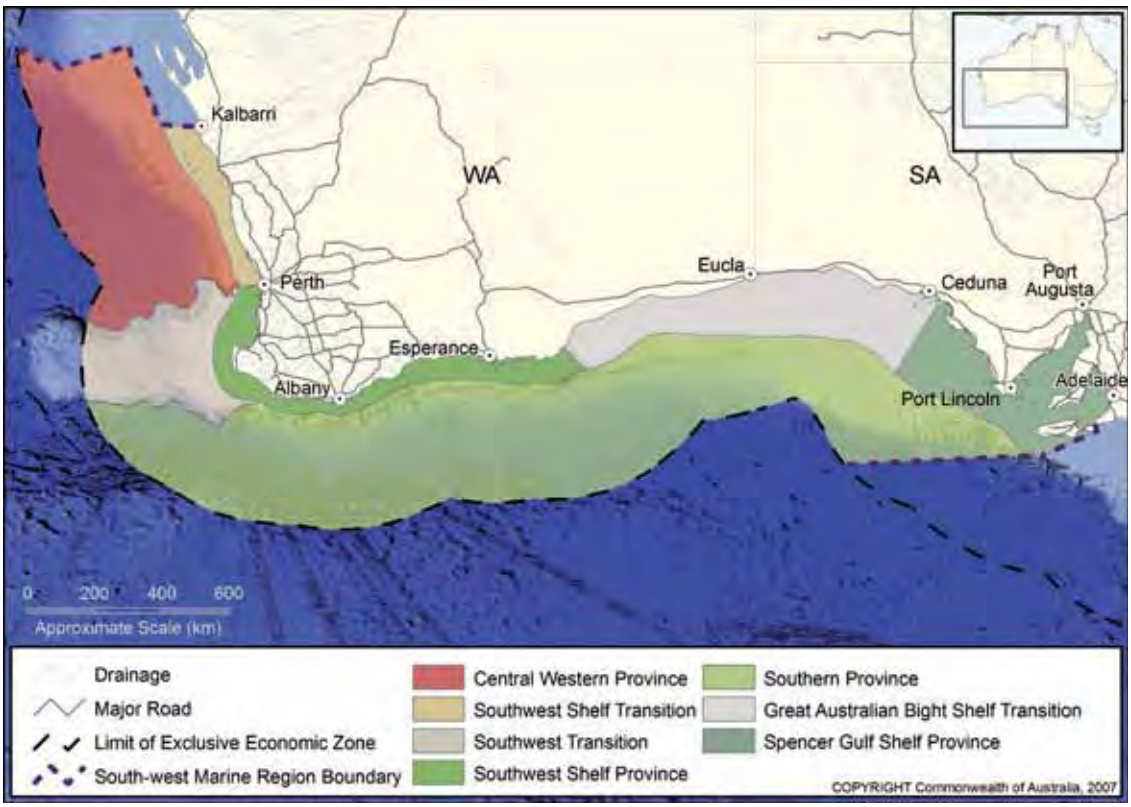
The *Integrated Marine and Coastal Regionalisation of Australia Version 4.0* (IMCRA v.4.0) identifies seven bioregions[1] in the South-west Marine Region (Figure 2.5). The Regionalisation provides a spatial framework to represent at a broad-scale the distribution patterns of marine life in the Region. IMCRA v.4.0 is the product of the combination of the 1996 Interim Marine and Coastal Regionalisation of Australia, which provided a marine regionalisation of waters on the continental shelf, with the 2005 National Marine Bioregionalisation, a regionalisation of off-shelf waters. Within IMCRA v.4.0, the nomenclature of the bioregions has used the term 'IMCRA' to identify those bioregions that lie over the continental shelf. For the purposes of this Bioregional Profile the term 'IMCRA' has been replaced with 'Shelf' to distinguish shelf bioregions from those offshore. The bioregions described in this Bioregional Profile are:

- Southwest Shelf Transition;
- Central Western Province;
- Southwest Shelf Province;
- Southwest Transition;
- Great Australian Bight Shelf Transition;
- Spencer Gulf Shelf Province; and
- Southern Province.

Each bioregion is described below in terms of the characteristics of its marine environment, including physical structure, biological communities and ecological processes. Chapter 4 discusses the bioregions in relation to the identification of areas suitable for the National System of MPAs.

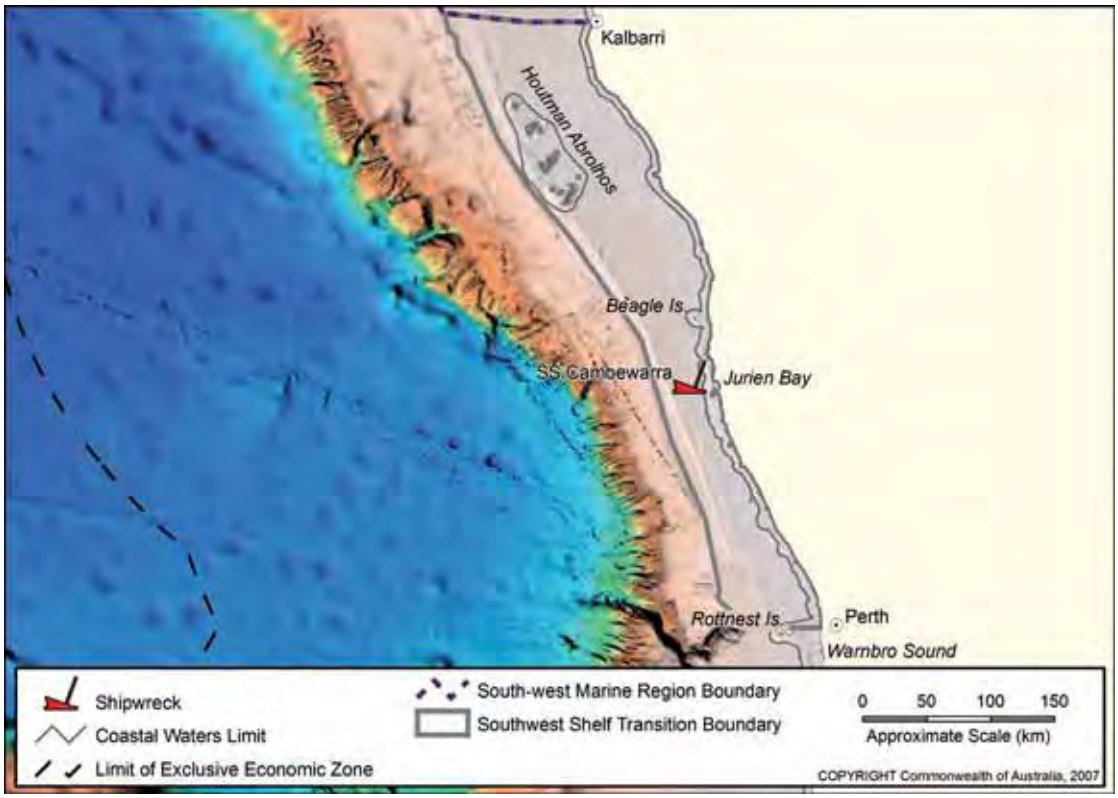
1 For the purpose of this document, 'bioregion' means provincial bioregion as defined in the *Integrated Marine and Coastal Regionalisation of Australia Version 4.0*.

Figure 2.5 Bioregions of the South-west Marine Region (IMCRA v.4.0)



2.1.1 Southwest Shelf Transition

Figure 2.6 The Southwest Shelf Transition



The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Kalbarri, and extends out to the edge of the shelf (Figure 2.6). The Commonwealth waters of this bioregion extend from the limit of Western Australian State waters to the shelf-break. Eighty-one per cent of the Southwest Shelf Transition is under the jurisdiction of the Commonwealth.

The Leeuwin Current has a significant influence on the biodiversity of this bioregion as it pushes sub-tropical water southward along the western edge of the bioregion. Ridges and inshore lagoons characterise the seafloor of the continental shelf of this area. The bioregion has high biodiversity and contains a large number of species that are found nowhere else in the world.

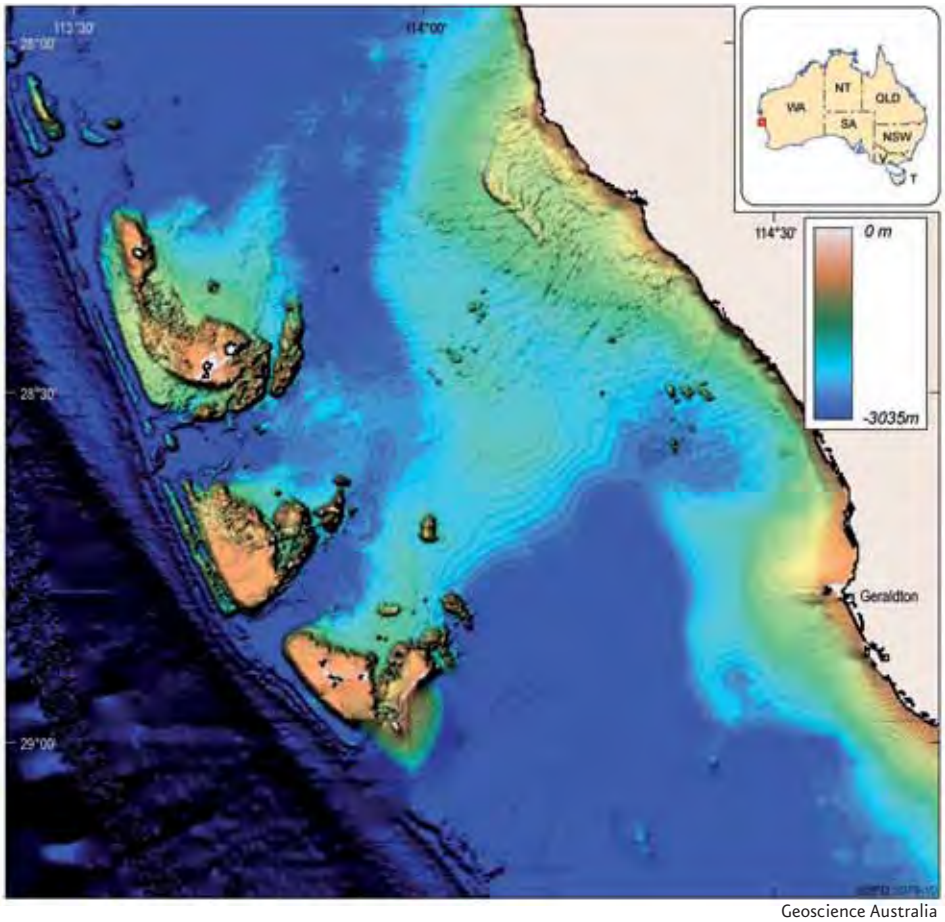
The Houtman Abrolhos Islands off Geraldton are renowned for their high species diversity, coral reefs and a unique mix of temperate and tropical species. These islands are also an important breeding site for seabirds, and are the northernmost breeding site for the Australian sea lion. The Houtman Abrolhos Islands, inshore lagoons and other islands further south, such as the Beagle Islands, provide important areas of shelter for shallow water communities in a bioregion that is otherwise exposed to ocean swells. The inshore lagoons are known for the enhanced benthic productivity of their macro-algae and seagrasses and for supporting breeding and nursery aggregations of numerous marine species.

The western rock lobster is an iconic species of the bioregion with an important trophic role for a range of inshore species that prey on juvenile lobsters.

Geomorphology

This bioregion consists of a narrow continental shelf, ranging from approximately 40-80 km wide that is noted for its physical complexity. It includes a series of near-shore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The near-shore ridges are formed by eroded limestone reefs and pinnacles that stand 10-20 m above the seafloor. The edge of the inner shelf plain is marked by a series of broken offshore ridges that extend north to the northern limits of the bioregion, where they emerge to support the tropical carbonate reef growth of the Houtman Abrolhos Islands (Figure 2.7).

Figure 2.7 ***Bathymetry of the Houtman Abrolhos Islands***



Geoscience Australia

Oceanography

The Leeuwin Current contains warm tropical waters low in nutrients and salinity, and follows a meandering path southward along the outer limit of the bioregion. It follows the shelf break and forms eddies at predictable locations: south-west of Shark Bay, adjacent to the Houtman Abrolhos Islands, Jurien Bay and Perth Canyon. The current impedes large-scale upwellings on the west coast, although weak, local upwellings may sporadically occur on the outer shelf. Eddies generate cross shelf currents that provide connectivity between the continental shelf and deeper waters. They provide nutrient-rich waters on the continental shelf that enhance biological productivity. The Capes Current, generated in the Southwest Shelf Province off Cape Mentelle by southerly winds during summer, transports cooler, saline water, together with the larvae of temperate species, northward along the inner shelf.

Biological communities

The bioregion contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. The west coast of Western Australia, from Ningaloo Reef down to Rottnest Island, is a global hotspot for endemism. Species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring.

The inner shelf of the bioregion, extending between 0-50 m deep, includes distinct ridges of limestone reef with extensive beds of macro-algae (principally *Ecklonia* spp.). These inshore lagoons are inhabited by a diverse range of coralline algae, sponges, molluscs, crustaceans and demersal and pelagic fish. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor, and Australian salmon. These small to mid-sized predators feed on smaller pelagic fish and squid, and in turn are preyed upon by larger predators, such as mulloway, snapper, samson fish, Spanish mackerel and whaler sharks. Small pelagic fish including herring, sardine, scaly mackerel, jack mackerel, yellow tail, blue mackerel, anchovy, blue sprat and sandy sprat, are considered a particularly important trophic link between plankton communities and larger fish-eating predators (Figure 2.14). Seagrass meadows occur in areas with less exposure and in the inter-reef lagoons along exposed sections of the coast. Benthic communities on the outer shelf and shelf break are dominated by adult snapper, while filter feeding sponges and bryozoans dominate the hard bottom.

The islands within the bioregion, including the Houtman Abrolhos and the Beagle Islands provide sheltered, shallow water habitats for diverse marine communities including protected species. The Houtman Abrolhos Islands are the ecological mid-point in a gradient that extends from the tropical ecosystems of Shark Bay, south along the shelf to the temperate communities at Rottnest Island. However, being offshore, these islands catch more of the flow of warm Leeuwin Current waters than the adjacent lagoons and shorelines. The coral reefs of the Houtman Abrolhos Islands are the most southern extensive coral community along the west coast. Smaller localised pockets do occur as far south as Cape Naturaliste in the Southwest Shelf Province.

The Houtman Abrolhos Islands have been relatively well studied and are noted for their high species diversity, which is attributed to the relatively equal mix of temperate and tropical species. The reefs around the islands comprise 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae. The Houtman Abrolhos group of islands are also one of the most important breeding sites for seabirds in the world, and the northernmost site of the Australian sea lion's range.

Ecosystem processes

The inshore lagoons are thought to be important areas for benthic productivity (Figure 2.8) and recruitment for a range of marine species. These shallow water, sheltered environments are located between the shore and the inner shelf ridge system and extend south well into the Southwest Shelf Province. They are characterised by extensive beds of macro-algae, interspersed with areas of seagrass which provide the primary source of benthic production inside the 50 m depth contour. Ground water enrichment may also supplement the supply of nutrients to the inshore lagoon. The inshore lagoons provide important habitat for the breeding and nursery aggregations of a number of species, including the area's iconic species, such as western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, and probably many other reef species.

Western rock lobster, the dominant large benthic invertebrate in this bioregion, is considered to be an important part of the food web of the inner shelf. Particularly when they are small, juvenile lobsters are preyed upon by a large number of species including octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod, breaksea cod and Australian sea lions (Figure 2.9). Western rock lobsters are very vulnerable to predation during their annual moults (the stage of their lifecycle when they shed their hard protective shell so they can grow a larger one), predominantly during November-December, and to a lesser degree in April-May of each year. The high biomass and vulnerability of western rock lobster to predation suggest that they are an important trophic pathway for a range of inshore species. Western rock lobster is the basis of one of Australia's most valuable commercial fisheries. The Western Rock Lobster Fishery was the first Australian fishery to be accredited with Marine Stewardship Council certification.

Figure 2.8 Simplified diagram of productivity in the marine environment

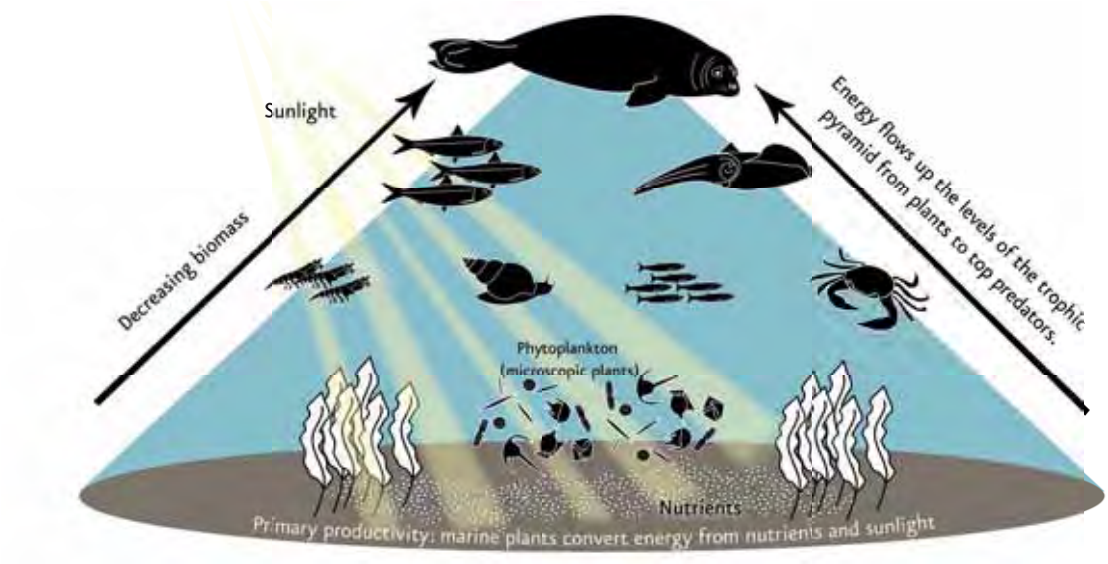


Figure 2.9 ***Simplified diagram of the life cycle of the western rock lobster including its main predators and prey***

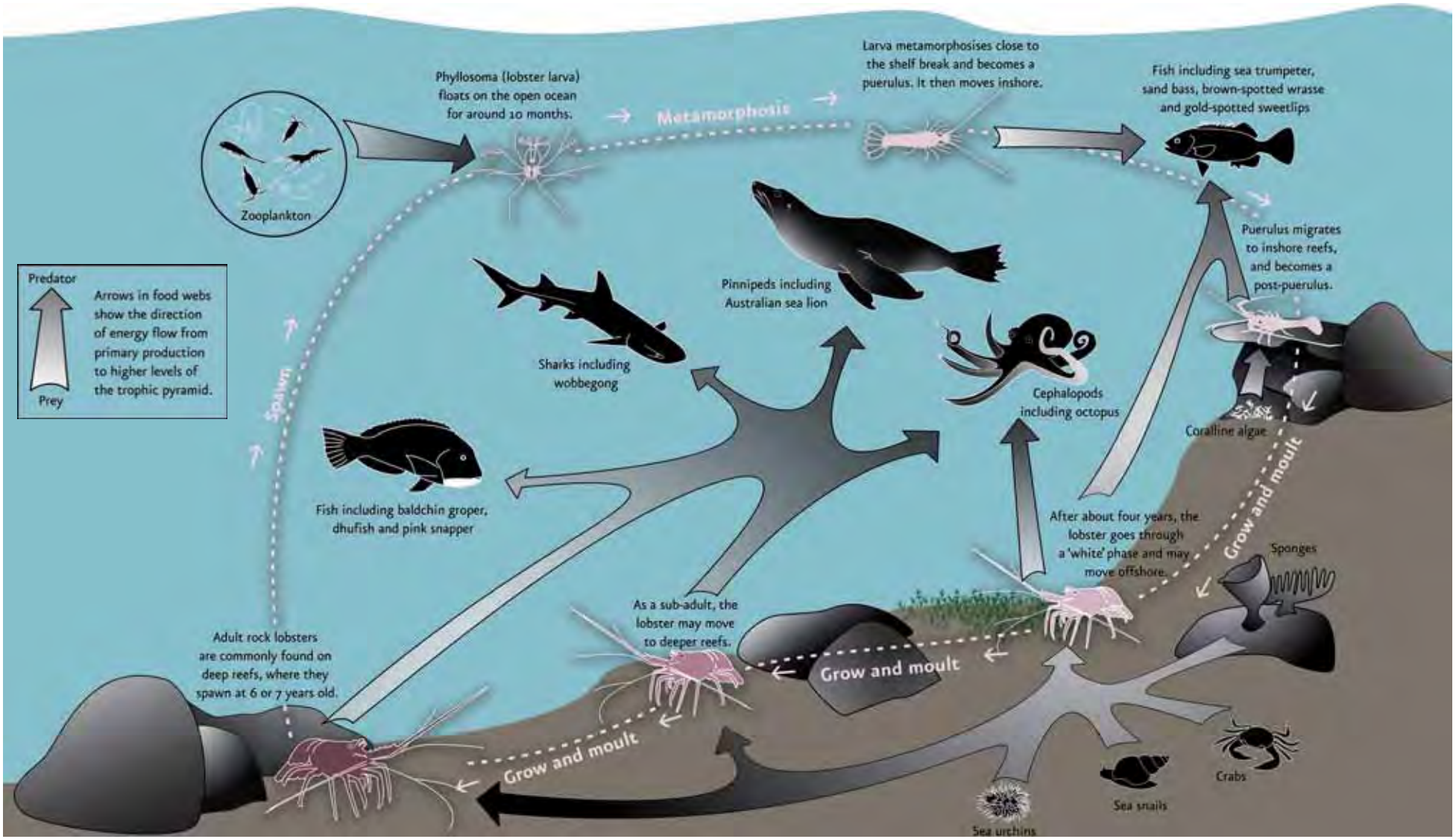


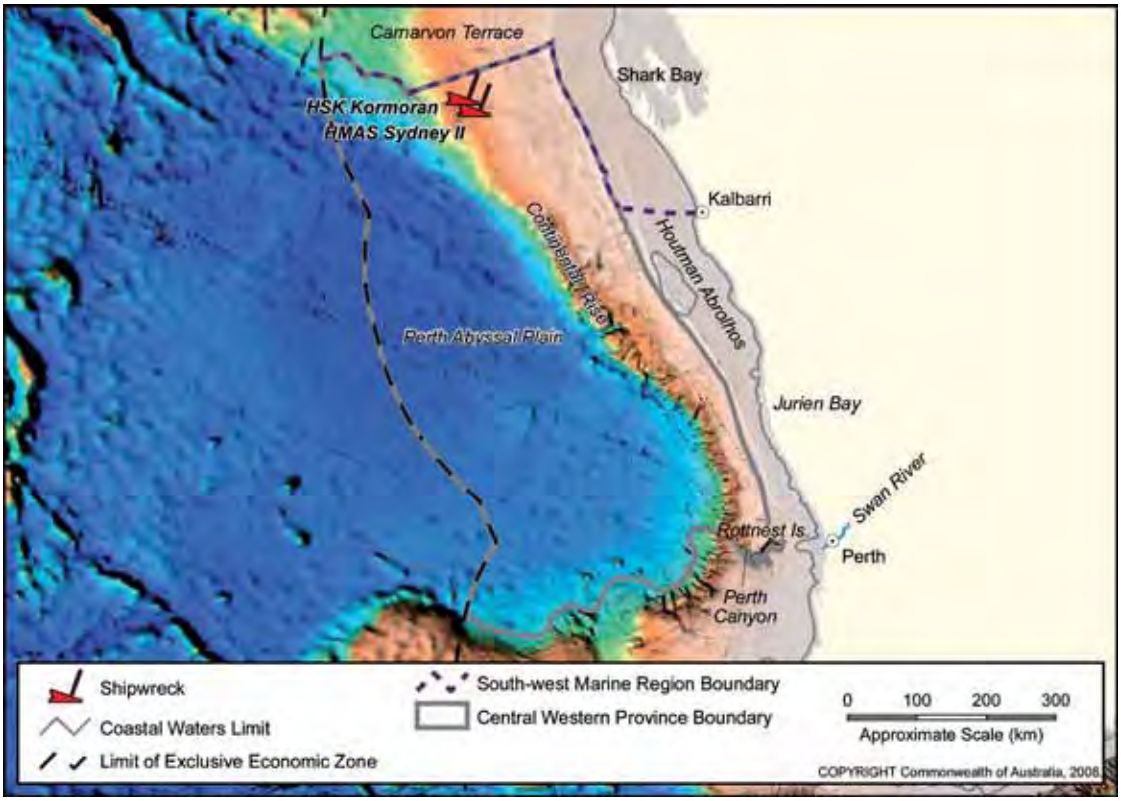
Table 2.1 Key ecological features and other important areas of the Southwest Shelf Transition

Feature or area	Rationale
Coastal reefs around Kalbarri	Important area for **protected species** (see Appendix D): • Green turtle (foraging area). Although the importance of this area to the species is not well understood, resident adult green turtles are found in this area.
Houtman Abrolhos Islands and surrounding waters	Commonwealth waters surrounding the Islands are a **key ecological feature** (see Chapter 3.1) – the islands support high species biodiversity. Regionally important area for **protected species** (see Appendix D): • Green turtle (foraging area). Although the importance of this area to the species is not well understood, resident adult green turtles are observed at the reefs of the Houtman Abrolhos Islands; • Common noddy (rookery – Pelseart Island); • Caspian tern (rookeries – Leo Island, West Wallabi Island and Pelsaert Island); • Wedge-tailed shearwaters (rookeries); • Bridled tern (rookeries – Gun Island, Leo Island, Pelsaert Island and Little North Island) • Osprey (nesting area – Pelseart Island); • White-bellied sea eagle (nesting area – West Wallabi Island); • Australian lesser noddy (feeding area and rookeries Morley Island, Wooded Island and Pelseart Island). In Australia the Australian lesser noddy is only known to breed in this area and is known to forage between the islands and the continental shelf edge; • Australian sea lion* (breeding colony – Easter Group); and • Humpback whale (resting area). Sightings of Bryde's whales also indicate this area may be important for this rarely sighted species.
Inshore lagoons	Commonwealth waters within and adjacent to the inshore lagoons are a **key ecological feature** (see Chapter 3.1) – the lagoons support enhanced benthic productivity and provide important breeding and nursery aggregation areas for marine life.
Fisherman Islands	Important area for **protected species** (see Appendix D): • Bridled tern (rookeries).
Beagle Islands	Important area for **protected species** (see Appendix D): • Bridled tern (rookeries).
Penguin Island	Important area for **protected species** (see Appendix D): • Bridled tern (rookeries).
Lancelin Island	Important area for **protected species** (see Appendix D): • Wedge-tailed shearwater (rookery); and • Bridled tern (rookery).
Waters off the mid-west coast, WA	Important area for **protected species** (see Appendix D): • Leatherback turtle (foraging area). Although the importance of this area to the species is not well understood, leatherback turtles are known to feed in pelagic waters along the mid-west coast of WA. Adult leatherback turtles have also been observed feeding in shallow inshore waters in this area.
Jurien Bay south to Rottnest Island	Important area for **protected species** (see Appendix D): • Juvenile green turtles (foraging area). Although the importance of this area to the species is not well understood, large juvenile green turtles are observed in this area.
Western rock lobster	**Key ecological feature** (see Chapter 3.1) – important trophic pathway for a range of inshore species that prey upon juvenile lobsters.
Small pelagic fish	**Key ecological feature** (see Chapter 3.1) – important trophic link between plankton communities and larger marine predators.

* Due to the closed breeding patterns of Australian sea lions (see Appendix D) and their threatened conservation status, all breeding sites for Australian sea lions are considered as regionally significant.

2.1.2 Central Western Province

Figure 2.10 The Central Western Province



The Central Western Province extends offshore from the Southwest Shelf Transition to the limit of the EEZ (Figure 2.10). The entire bioregion lies within the jurisdiction of the Commonwealth, and within the South-west Marine Region. It is characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's Marine Regions. Continental rise is the gentle slope rising from the oceanic depths towards the foot of the continental slope (see Figure 2.1). A significant feature within the bioregion are several eddies hundreds of kilometres in diameter that spin in an anti-clockwise direction that form off the Leeuwin Current at predictable locations. The eddies are ecologically important because they transport shallow water plankton communities offshore to deeper waters and under some circumstances are associated with enhanced productivity in surface waters.

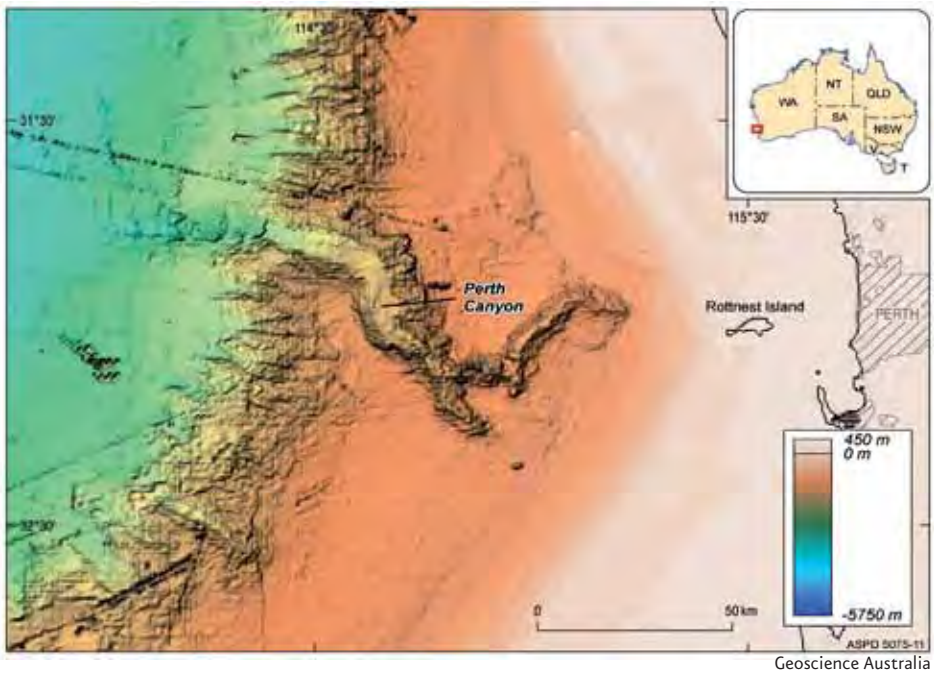
The bioregion includes the Perth Canyon, the largest of Australia's submarine canyons, which coincides with a distinct change in the distribution of marine organisms and marks the southernmost boundary for numerous tropical and sub-tropical species. Perth Canyon also appears to be an important area for blue whales and other deep-diving whales that feed around the rim of the canyon. The demersal fish communities on the continental slope of the bioregion are characterised by relatively high biodiversity and include at least 31 endemic species.

Geomorphology

This bioregion is characterised by a narrow continental slope that is heavily incised by many submarine canyons as far north as Kalbarri. The Perth Canyon, located at the southern margin of the bioregion, is an order of magnitude larger than any other canyon in the Region (Figure 2.11). The Perth Canyon, formed by erosive processes associated with the ancient Swan River, cuts into the continental shelf at approximately the 150 m depth contour, north-east of Rottnest Island. Other relatively large canyons, such as the Murchison Canyon, occur in the bioregion but little is known about them as they have not yet been studied.

The bioregion contains the most extensive area (52 185 km^2) of continental rise on the Australian margin. The continental rise is located on the edge of the Perth Abyssal Plain (103 911 km^2). There is a large terrace known as the Carnarvon Terrace on the continental slope, extending north from the Houtman Abrolhos Islands at an average of 780 m water depth.

Figure 2.11 ***Bathymetry of the Perth Canyon***



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Oceanography

As in the Southwest Shelf Transition, the Leeuwin Current is noted for its meandering pattern that generates anti-clockwise meso-scale eddies. The eddies form at predictable locations along the shelf break (south-west of Shark Bay, west of the Houtman Abrolhos Islands, south-west of Jurien Bay and at the Perth Canyon, west of Rottnest Island) and drift westward away from the coast. Mirroring the variability in strength of the Leeuwin Current, eddies tend to form predominantly in winter and are particularly frequent during La Niña events. The Leeuwin Undercurrent travels northward beneath the Leeuwin Current at between 250-450 m deep over the continental slope.

Biological communities

Our understanding of marine life in this bioregion is mostly confined to the demersal fish on the continental slope. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered to be endemic to the bioregion. In general, the density of demersal fish in this bioregion is low, especially when compared with the South-east Marine Region. Fish density is highest at the shelf break and uppermost parts of the slope (approximately 200-300 m water depth) where large adult snappers dominate. Juvenile snappers inhabit the inshore areas before migrating to offshore reefs as adults to breed and feed in deeper waters. These fish live here because it is an area of high energy, where water circulation becomes more complex relative to the continental shelf, and prey is relatively abundant compared with the shelf.

At greater depth on the slope (below 400 m water depth) demersal fish communities are dominated by many relatively small, benthic species (grenadiers, dogfish and cucumber fish). Many of these species display physical adaptations to feed on the seafloor, such as a mouth position adapted to bottom feeding, and many do not appear to undertake daily vertical migrations in their feeding habits. This is not surprising given that the abundance of suitable pelagic prey species such as Myctophids (lantern fish) is likely to be considerably lower compared with those on the south-eastern slope of Australia. This means that in this bioregion benthic prey species are likely to be relatively more important than pelagic prey species for demersal fish. The shelf break and upper parts of the slope are considered important for deep diving whales such as toothed and beaked whales that may be hunting fish and squid feeding on the slope. Deep sea crabs, such as the champagne crab and crystal crab, inhabit the seafloor of the slope.

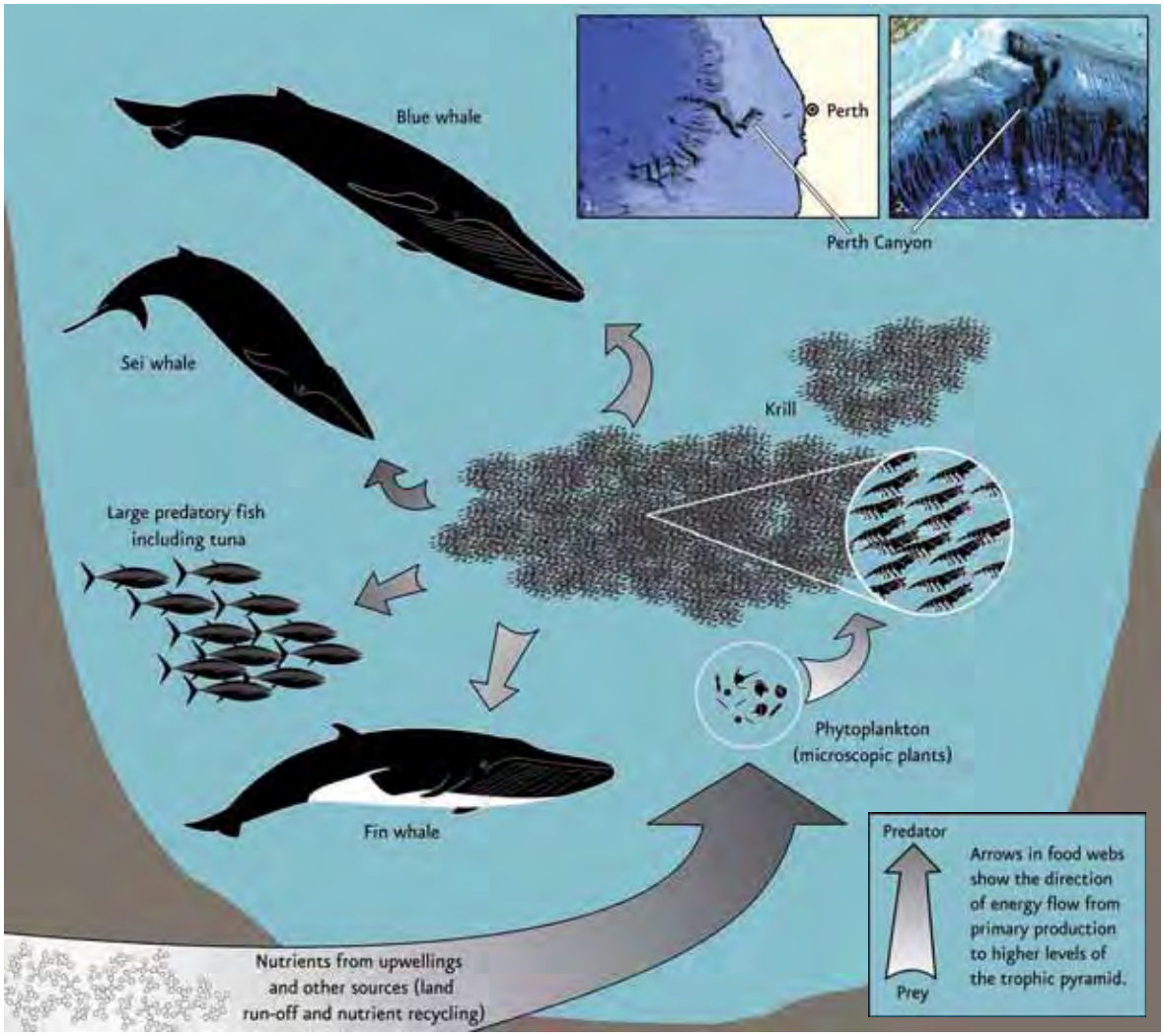
Ecosystem processes

The meso-scale eddies of this bioregion are important transporters of nutrients and plankton communities (Figure 2.4). Anti-clockwise eddies entrain water from the outer shelf along with its plankton communities, and transport these communities far offshore into the Indian Ocean, where they are consumed by oceanic communities. On the other hand, clockwise eddies may play an important role in 'lifting' deep water, which can be relatively cooler and richer in nutrients, toward the surface, where it can enhance production of plankton

communities that then attract aggregations of marine life. These are important ecosystem processes in a nutrient-poor environment. There is still much to be understood about the ecological processes associated with eddies and their importance in this bioregion.

The submarine canyons of this bioregion are key ecological features because they are thought to be linked to the localised small periodic upwellings that enhance productivity and attract aggregations of marine life (Figure 2.12). The Perth Canyon is prominent among these canyons because of its large size and ecological importance. Acting as a major constriction of the shelf, its topography is thought to contribute to frequent formation of eddies and frontal structures that occur to the north of Rottnest Island. The Perth Canyon marks the southern boundary for numerous tropical organisms on the shelf, including sponges, corals, decapods and xanthid crabs. The upwelling of deep ocean currents in the canyon creates a nutrient-rich coldwater oasis under the warm waters of the Leeuwin Current. In this setting, swarms of krill and squid seasonally 'boom and bust' attracting pygmy blue whales, toothed whales and unidentified species of beaked whales. During the day, aggregations of krill and small fish gather along the canyon's north-eastern rim, making up a deep scattering layer. Higher up, dense 'balls' of krill – up to 250 m wide and 50 m deep – have been observed at around 300 m deep just below the Leeuwin Current. By day, blue whales dive to feed on these krill 'balls' and the deep scattering layer, while at night, the krill rise to within 50 m below the surface allowing the whales to feed at shallower depths.

Figure 2.12 Simplified diagram of upwelling and aggregations of marine life in the Perth Canyon



Inset 1. Location of the Perth Canyon – Copyright Commonwealth of Australia. Inset 2. Perth Canyon bathymetry – Geoscience Australia.

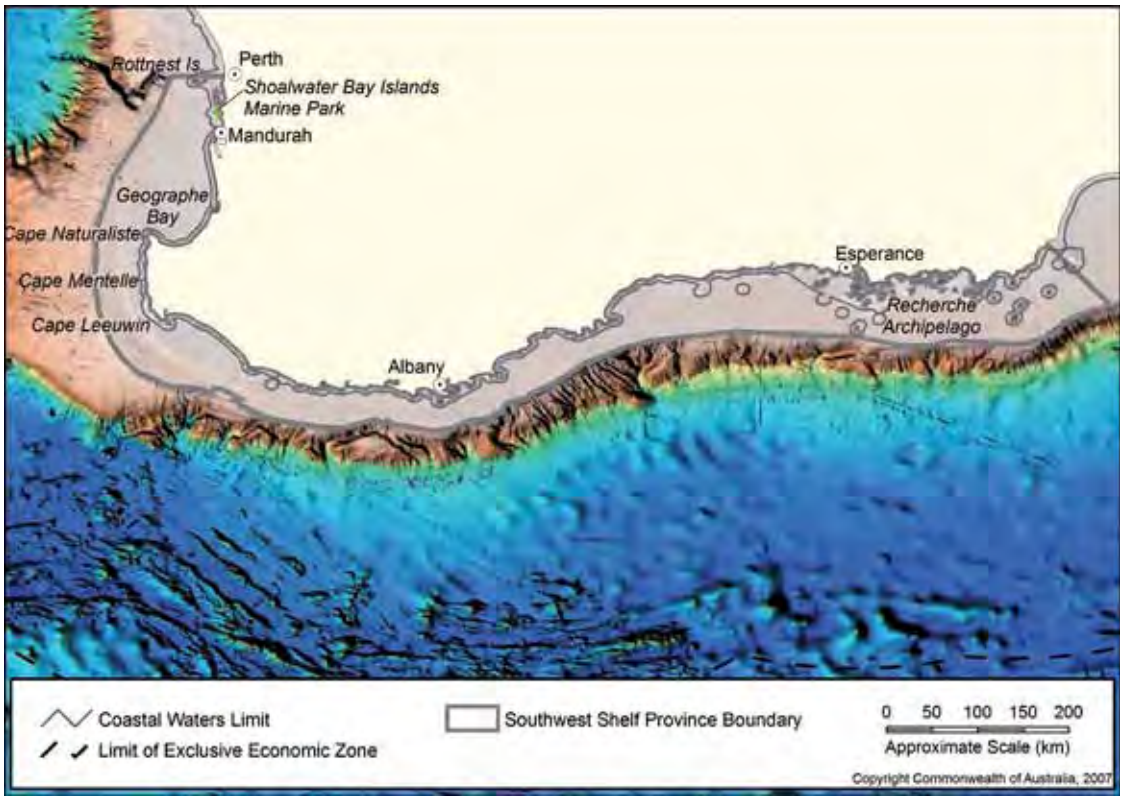
Gray's beaked whale. Photo: Nick Gales, Australian Government Antarctic Division.

Table 2.2 Key ecological features and other important areas of the Central Western Province

Feature or area	Rationale
Demersal slope fish communities	**Key ecological feature** (see Chapter 3.1) – high species biodiversity.
West Coast Canyons and adjacent shelf break	**Key ecological feature** (see Chapter 3.1) – associated with enhanced productivity and feeding aggregations of marine life. They are unique seafloor features. Important area for **protected species** (see Appendix D): • Pygmy blue whale (feeding aggregation area – Perth Canyon). Fin whales have also been observed in the Perth Canyon and it is thought that sei whales may also feed there.
Meso-scale eddies (predictable locations south-west of Shark Bay, west of the Houtman Abrolhos Islands, south-west of Jurien Bay and west of Perth Canyon)	**Key ecological features** (see Chapter 3.1) – associated with enhanced productivity and feeding aggregations of marine life.
Waters off the mid-west coast, WA	Important area for **protected species** (see Appendix D): • Leatherback turtle (foraging area). Although the importance of this area to the species is not well understood, leatherback turtles are known to feed in pelagic waters along the mid-west of WA.

2.1.3 Southwest Shelf Province

Figure 2.13 The Southwest Shelf Province



The Southwest Shelf Province is a nearshore bioregion that extends from Rottnest Island to Point Dempster, approximately 185 km east of Esperance (Figure 2.13). Approximately 78 per cent of the bioregion is under the jurisdiction of the Commonwealth. At the south-west corner of Australia at Cape Leeuwin, the Leeuwin Current changes direction from a southbound to an eastbound current. The bioregion is characterised by sub-tropical species in the north and temperate species along its southern extent. Species diversity of seagrasses and macro-algae is very high. A small upwelling of nutrient-rich water off Cape Mentelle during summer increases productivity locally, and this attracts aggregations of marine life. The sheltered waters of Geographe Bay and other inshore lagoonal areas support extensive seagrass beds that in turn provide important nursery habitat for a range of marine species. Further east, the Recherche Archipelago supports high species diversity of fish, molluscs, sponges and macro-algae. The islands provide shelter for marine communities and important haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals. The sheltered bays along the south coast are important southern right whale calving areas.

Geomorphology

The Southwest Shelf Province consists of an area of narrow continental shelf. The northern limits of the bioregion are an extension of the seafloor described in Chapter 2.1.1 (Southwest Shelf Transition). It includes features such as limestone ridges, depressions defining an inshore lagoon and a relatively smooth inner shelf plain that meets the South Bank Ridge on the outer shelf, and islands providing important habitat, such as Rottnest Island. The shelf progressively broadens to form the relatively sheltered waters of Geographe Bay before narrowing once again at Cape Mentelle.

On the south coast, the coastal geomorphology changes from the predominant limestone reefs to eroded Precambrian rocks, which form islands and submerged reefs such as the extensive reef systems of the Recherche Archipelago and those south of Albany. These reefs provide shelter for the coast, which would otherwise be exposed to high wave energy from the Southern Ocean.

Oceanography

This bioregion marks the change in direction of the Leeuwin Current, from a southbound to an eastbound current after passing Cape Leeuwin. The Leeuwin Current generates eddies at predictable locations (Cape

Naturaliste, Cape Leeuwin and offshore of Albany and Esperance), presumably as a result of changes in seafloor topography and topographical features. On the inner shelf, summer winds generate coastal currents – the Cresswell Current on the south coast and the Capes Current on the west coast – that flow in the opposite direction to the Leeuwin Current. The Capes Current is also associated with a seasonally predictable upwelling of nutrient-rich water off Cape Mentelle. Upwellings of cold deep water have also been observed in recent studies of the Recherche Archipelago.

Biological communities

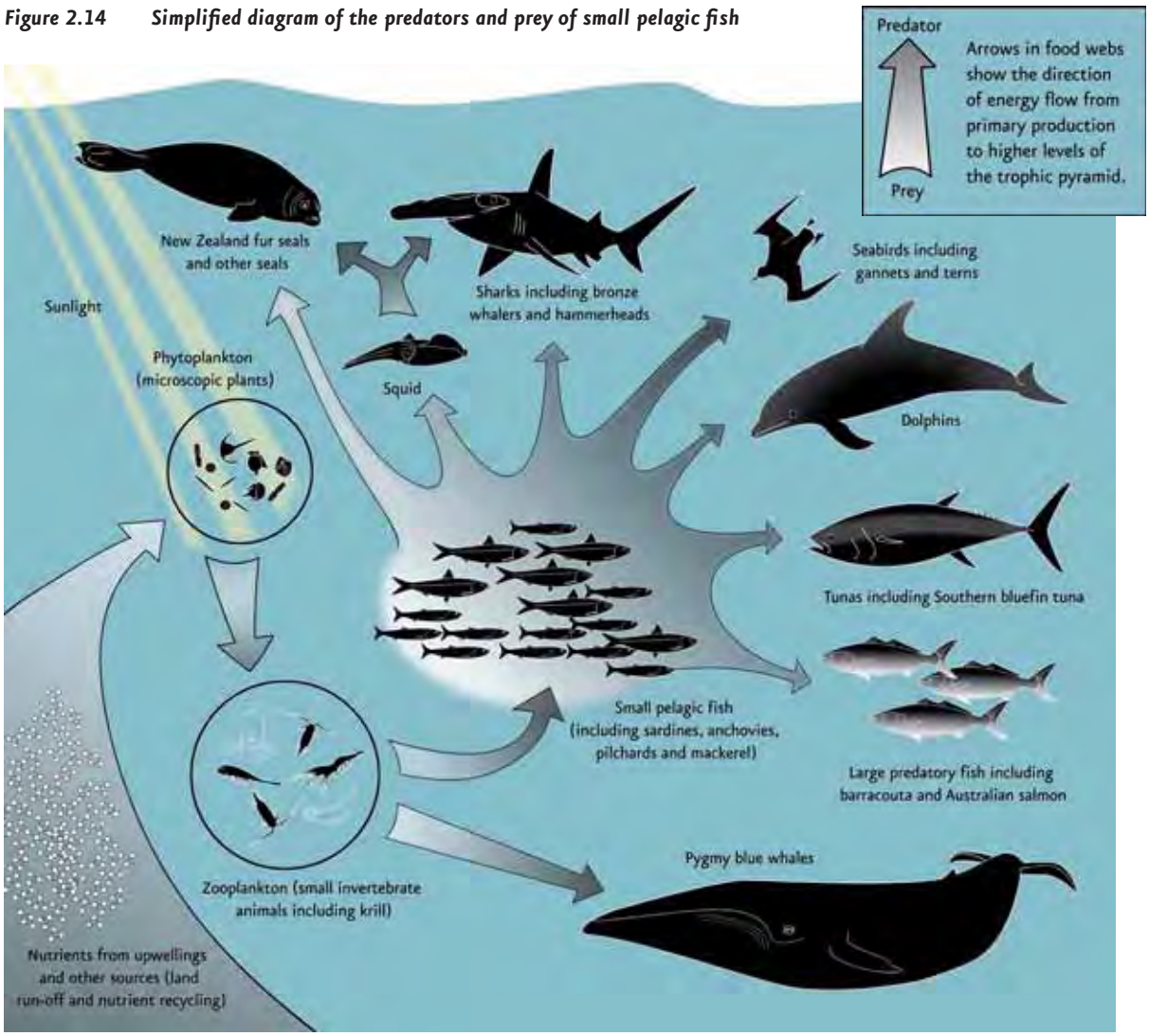
The faunal assemblages in this bioregion resemble the cooler water communities to the east, although a distinct sub-tropical element is maintained by the Leeuwin Current. The south coast of the bioregion is characterised by a relatively higher diversity of temperate macro-algal species compared with the Southwest Shelf Transition. These colonise the exposed rocky shorelines and rocky reefs, while extensive seagrass beds are found in sheltered bays, including Geographe Bay, estuaries and in the lee of some reef systems. Similar to the Southwest Shelf Transition, seagrass beds in this bioregion are noted for their high species biodiversity and endemism. In shallow waters, western blue groper and queen snapper (blue morwong) are prominent large benthic feeders. Small pelagic fish including herring, sardine, scaly mackerel, jack mackerel, yellow tail, blue mackerel, anchovy, blue sprat and sandy sprat are thought to be particularly important trophic links between plankton communities and larger fish-eating predators (Figure 2.14).

The omnivorous reef predators, the Western Australian dhufish and smaller breaksea cod, disappear from the shallow shelf assemblage just to the east of Albany, and are replaced by mulloway, harlequin cod and 'nannygai' Bight redfish. Greenlip abalone can reach a significant biomass on shallow reefs (less than 40 m deep) as they do to the east along the entire southern Australian coast. Greenlip abalone are not seen on the coastal reefs of the west coast of the Australian continent. East of Albany, the dominant lobster species changes from the western rock lobster to the southern rock lobster. The latter is common throughout temperate Australia and New Zealand. In this bioregion there is a notable increase in the ratio of benthic fish to crustaceans. Crustaceans appear to be less important in structuring shallow benthic communities here than in bioregions to the north and to the south-east of the Murray River mouth, around the Bonney Upwelling and Tasmania.

Adjacent to Commonwealth waters, the extensive area of granite reef (35 203 km^2 of reef habitat) and seagrass habitat of the Recherche Archipelago is noted for its high diversity of warm temperate species including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macro-algae. The many near-shore islands in this area are haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals. The sheltered bays along the south coast are important calving areas for southern right whales.

Temperate reef with swallowtail nannygai. Photo: Glen Cowans.

Figure 2.14 ***Simplified diagram of the predators and prey of small pelagic fish***



Ecosystem processes

On the west coast, the inshore lagoons of Geographe Bay and waters surrounding Rottnest Island are important areas for benthic productivity and as feeding, resting, breeding and nursery grounds for a range of marine species (see Southwest Shelf Transition for importance of the inshore lagoons). Geographe Bay is a large relatively sheltered area with extensive beds of tropical and temperate seagrass that are thought to account for about 80 per cent of benthic primary production in the area. These seagrass beds provide important nursery habitat for many shelf species, such as dusky whaler sharks that use the shallow seagrass habitat as nursery grounds for several years before moving out over the shelf to their adult feeding grounds along the shelf break. Shoals of small planktivorous fish (anchovies, silver sprat, pilchards, garfish and herring) and squid are also found in the bay. These species are preyed upon seasonally by large mobile schools of predatory fish, such as Australian salmon, snapper, dhufish, samson fish and whaler sharks.

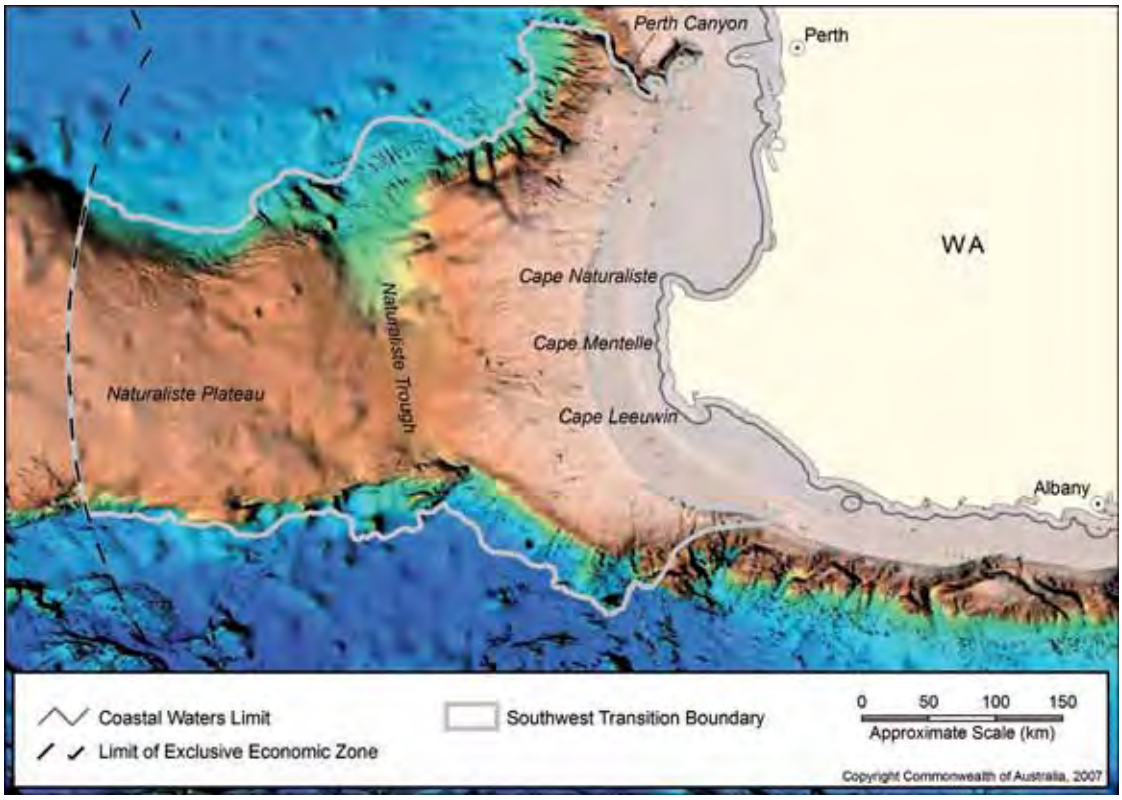
Other important ecological areas that are key to maintaining the biodiversity of the bioregion are the species-rich Recherche Archipelago and the seasonally productive waters off Cape Mentelle. The predictable summer upwelling off Cape Mentelle draws water from the base of the Leeuwin Current (where nutrient levels are higher) up the continental slope and on to the continental shelf, where it sustains blooms of phytoplankton in surface waters. Higher densities of phytoplankton provide the basis of an extended food chain characterised by aggregations of fish, which occur here at higher densities than in surrounding waters. It is also likely that detritus from these pelagic communities supports local hotspots of benthic biodiversity off Cape Mentelle.

Table 2.3 Key ecological features and other important areas of the Southwest Shelf Province

Feature or area	Rationale
Inshore lagoons	Commonwealth waters within and adjacent to the inshore lagoons are a **key ecological feature** (see Chapter 3.1) – the lagoons support enhanced benthic productivity and provide important breeding and nursery aggregation areas for marine life.
Rottnest Island	Important area for **protected species** (see Appendix D): • Wedge-tailed shearwater (rookery); and • Bridled tern (rookery).
Waters from Rottnest Island to Geographe Bay	Important area for **protected species** (see Appendix D): • Loggerhead turtle (foraging area). Although the importance of this area to the species is not well understood, resident adult loggerhead turtles and sub-adult turtles are known to forage in this area; and • Humpback whale (resting area). Recent surveys have also detected southern right whales in the area and have shown an increasing number of pygmy blue whales using the Bay in spring and also passing through the shelf area between Cape Naturaliste and Rottnest Island. However, the ecological or functional significance of the area to the species is unclear.
Geographe Bay	Commonwealth waters within and adjacent to Geographe Bay are a **key ecological feature** (see Chapter 3.1) – these waters support enhanced benthic productivity and high species biodiversity; they also provide important feeding, resting, breeding and nursery aggregation areas for marine life.
Cape Mentelle upwelling	**Key ecological feature** (see Chapter 3.1) – upwellings enhance pelagic productivity and attract feeding aggregations.
Recherche Archipelago	Commonwealth waters surrounding the Archipelago are a regional **key ecological feature** (see Chapter 3.1) – these waters support high species biodiversity and provide important breeding and resting areas for marine life. Important area for **protected species** (see Appendix D): • Flesh-footed shearwater (rookeries); • Short-tailed shearwater (rookeries); • Caspian tern (rookeries); • White-bellied sea eagle (nesting area); and • Australian sea lion (breeding colony).
Waters surrounding Cape Leeuwin/ Flinders Bay	Important area for **protected species** (see Appendix D): • Humpback whale (resting area); and • Southern right whale (calving area).
Doubtful Islands	Important area for **protected species** (see Appendix D): • Southern right whale (calving area).
Albany/Cape Riche area	Important area for **protected species** (see Appendix D): • Southern right whale (calving area).
Yokinup Bay/Cape Arid area	Important area for **protected species** (see Appendix D): • Southern right whale (calving area).
Safety Bay	Important area for **protected species** (see Appendix D): • Wedge-tailed shearwater (rookery); and • Bridled tern (rookery).
Cape Hamelin	Important area for **protected species** (see Appendix D): • Flesh-footed shearwater.
Waters of the south-west coast, WA	Important area for **protected species** (see Appendix D): • Leatherback turtle (foraging area). Although the importance of this area to the species is not well understood, leatherback turtles are known to feed in pelagic waters along the south-west of WA.
Small pelagic fish	**Key ecological feature** (see Chapter 3.1) – important trophic link between plankton communities and larger marine predators.

2.1.4 Southwest Transition

Figure 2.15 The Southwest Transition



The Southwest Transition is a deepwater bioregion that extends offshore from the Southwest Shelf Province out to the limit of the EEZ (Figure 2.15). The entire bioregion lies within the jurisdiction of the Commonwealth, and within the South-west Marine Region. The main features of the bioregion are the Naturaliste Plateau (the deepest submarine plateau along Australia's continental margins), and the deep water mixing that results from the dynamics of major ocean currents when these meet the seafloor, particularly the Naturaliste Plateau, the continental slope and Perth Canyon. Unusually deep eddies are known to form offshore of Cape Leeuwin, where some interact with the shallower parts of the Plateau. There is little available information on biological communities of this bioregion, however, information on demersal fish communities indicates that the bioregion is an area of transition between those communities found in the Central Western Province and those of the Southern Province. Scientists also speculate that the marine communities associated with the Naturaliste Plateau may have high species diversity and endemism.

Geomorphology

The Southwest Transition is an offshore deepwater bioregion with a submerged continental fragment as its dominant seafloor feature – the Naturaliste Plateau. The Plateau extends across an area of 90 000 km² of which only 29 825 km² is within Commonwealth waters. It is located west of Cape Leeuwin and Cape Naturaliste in water depths ranging from 2000-5000 m. It is relatively flat with a slight northward dip, and has steep southern and western sides and a more gently sloping northern side. The Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope (average depth 780 m). Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau.

Oceanography

The bioregion is characterised by complex water-mixing that is created by the interaction of ocean currents. The Leeuwin Current, the Leeuwin Undercurrent, the deeper Flinders Current and the Western Australian Current interact with each other and with seafloor features such as the Perth Canyon to the north, the continental slope and the Naturaliste Plateau. These interactions mix water layers and create turbulence and eddies in predictable locations (off the Perth Canyon, south-west of Cape Naturaliste and Cape Leeuwin). During summer, southerly coastal winds generate a small coastal upwelling that draws water up the continental slope from the base of the Leeuwin Current.

Biological communities

The demersal fish communities of this transitional bioregion reflect an overlap between species characteristics of the Southern Province and the Central Western Province. Scientists have described 398 species of demersal fish on the slope of the Southwest Transition. The northern boundary of the bioregion appears to mark a relatively sharp 'biotone' – a distinct boundary that demarks differences in assemblages of organisms – for some species of demersal fish that are commonly associated with the Great Australian Bight and the South-east Marine Region, such as orange roughy and oreos on the mid-slope, and blue grenadier on the upper slope. On the mid-slope, approximately 100 km offshore from Cape Mentelle, an orange roughy aggregation is fished occasionally by trawlers of the Great Australian Bight Fishery. This is the westernmost recorded occurrence of orange roughy. As in neighbouring deep water bioregions, the shelf break and upper parts of the slope are considered important for deep diving whales such as toothed and beaked whales, which are thought to hunt fish and squid feeding on the slope. Deep sea crabs, such as the champagne crab and crystal crab, inhabit the seafloor of the slope.

Ecosystem processes

As in the Central Western Province, eddies in this bioregion are considered important ecological features because they transport nutrients and inshore plankton communities to deeper waters offshore and in some instances may enrich nutrient supply in surface waters (see Chapter 2.1.2 Central Western Province for the importance of eddies). Some of the eddies generated west of Cape Leeuwin appear to penetrate to greater depths (down to 2000 m) than eddies elsewhere in the Region. The base of these deep eddies are thought to interact with the shallower parts of the Naturaliste Plateau.

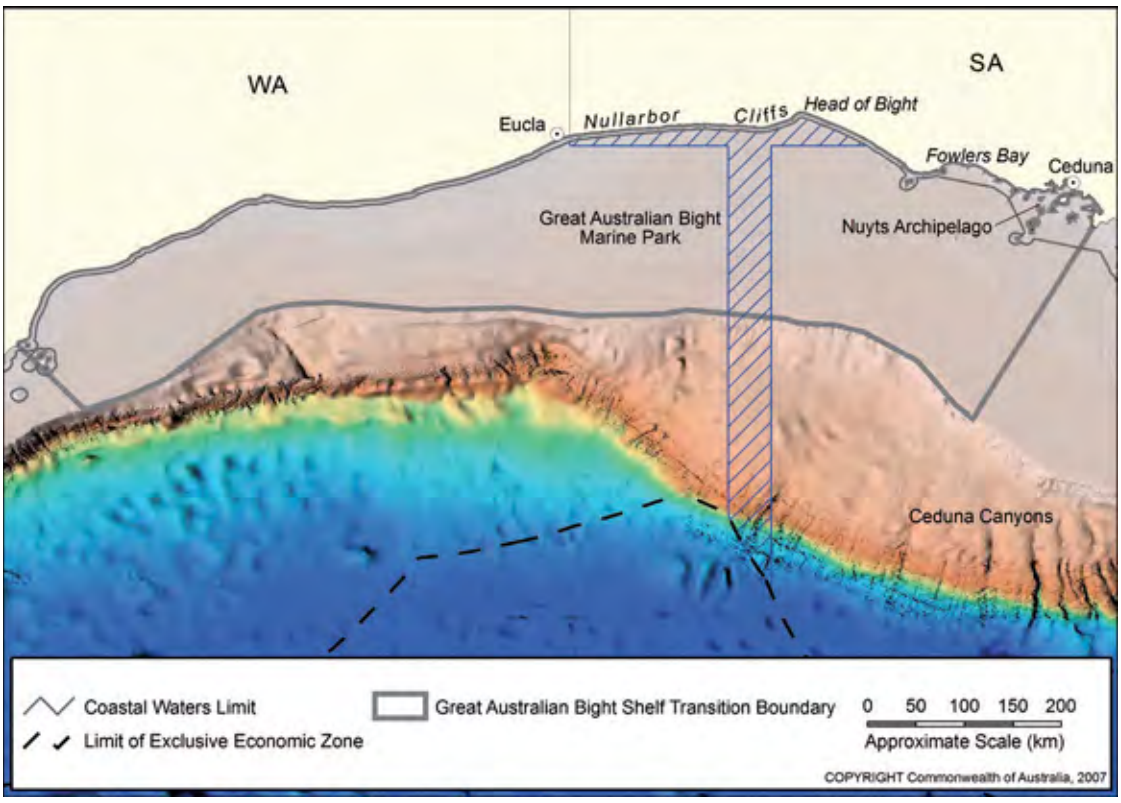
The Naturaliste Plateau is a large, complex area featuring cliffs up to 1000 m high, large canyons on its northern slope and a terrace on its southern slope. Its structural complexity, its proximity to the Sub-tropical Convergence Front (the Plateau is the only part of the Australian continent to interact directly with this front) and the complex system of water mixing between currents and deep-water eddies may contribute to high endemism and species biodiversity in its marine communities.

Table 2.4 Key ecological features and other important areas of the Southwest Transition

Feature or area	Rationale
Naturaliste Plateau	**Key ecological feature** (see Chapter 3.1) – a unique seafloor feature.
West Coast Canyons and adjacent shelf break	**Key ecological feature** (see Chapter 3.1) – associated with enhanced productivity and feeding aggregations of marine life. They are unique seafloor features. Important area for **protected species** (see Appendix D): • Pygmy blue whale (feeding aggregation area – Perth Canyon). Fin whales have also been observed in the Perth Canyon and it is thought that sei whales may also feed there.
Waters offshore of the south-west coast, WA	Important area for **protected species** (see Appendix D): • Leatherback turtle (foraging area). Although the importance of this area to the species is not well understood, resident adult leatherback turtles and sub-adult turtles are known to forage in this area.
Meso-scale eddies (predictable locations south-west of Cape Naturaliste and Cape Leeuwin)	**Key ecological feature** (see Chapter 3.1) – associated with enhanced productivity and feeding aggregations of marine life.

2.1.5 Great Australian Bight Shelf Transition

Figure 2.16 The Great Australian Bight Shelf Transition



The Great Australian Bight Shelf Transition, from Point Dempster (185 km east of Esperance) to Ceduna, includes a particularly wide area of continental shelf (Figure 2.16). The bioregion occurs on the continental shelf and 93 per cent of it is under the jurisdiction of the Commonwealth. Ocean currents flowing through the bioregion display marked seasonal patterns, particularly on the inner shelf. In summer, coastal winds generate west-bound coastal currents along the inner shelf, leading to the formation of an anti-clockwise gyre (a ringlike system of ocean currents) in the Bight. Marine life in this bioregion predominantly comprises temperate species of flora and fauna. The benthic invertebrate communities found on the inner shelf of the Great Australian Bight, particularly sponges, ascidians and bryozoans, are among the world's most diverse in soft sediment ecosystems. This bioregion is particularly poor in nutrients, lacking some of the seasonal small upwelling events that distinguish other bioregions, and receiving little nutrient inflow from the land.

The inner shelf is an important area for Australian sea lions that rest and breed on the rocky shores of the Bight and on numerous small islands in the eastern parts of the bioregion. The Head of Bight represents a hotspot of productivity in the bioregion and it is also an important calving area for southern right whales. Ecosystems representative of this bioregion are protected in the Great Australian Bight Marine Park, which extends across State and Commonwealth waters and is one of the largest Commonwealth marine reserves (this is described in detail in Chapter 3.3.1).

Geomorphology

The Great Australian Bight Shelf Transition is characterised by the largest seafloor feature of the Region – an extensive flat continental shelf covering 177 130 km^2. The centre of the shelf reaches widths of 260 km narrowing to 80 km at its margins. Geomorphology, sedimentology and hydrodynamics interact to create ideal conditions for carbonate organisms such as molluscs and bryozoans to flourish without being smothered or buried. As a result carbonate sediments derived from invertebrate skeletons and shells make up over 80 per cent of shelf sediments, making the Bight part of the world's largest modern cool-water carbonate bioregion that extends along Australia's southern margin. Within the wave abrasion zone (0-120 m) sediments are typically rippled and coarse-grained, forming a 'shaved shelf' where carbonate accumulation is less than the amount of active erosion and therefore there is a net loss of sediment from the shelf.

Oceanography

The system of ocean currents in this bioregion is complex, reflecting marked seasonal variation in wind patterns and in water density. Changes in water density are caused by fluctuations in temperature and salinity. During winter, water moves east through the bioregion, fuelled by wind-driven coastal currents on the inner shelf and by the Leeuwin Current on the shelf break. During summer, the strength of the Leeuwin Current weakens to the point where it is largely absent while coastal winds generate west-bound coastal currents along the inner shelf, leading to the formation of an anti-clockwise circulation gyre in the Bight. Swells are predominantly from the south-west, so the eastern Bight coastline is subject to higher wave energies, as the concave shape of the coastline affords some protection to western parts of the Bight.

Biological communities

Marine life in this bioregion comprises temperate species that are found throughout the continental shelf of south-eastern Australia. Some species characteristic of warm Indo-Pacific waters occur here, particularly plankton, fish, echinoderm and hydroid species. This is probably the result of seasonal fluxes of warm water transported by the Leeuwin Current. Within the bioregion, infauna (animals living within the sediments of the seabed) are likely to make up a large proportion of the overall biomass. The ecological importance of the infauna is reflected in the catch of the Great Australian Bight Trawl Fishery and mainly comprises latchet (incidental catch) and deep-water flathead (targeted catch). Latchet feed directly on large infaunal species, while deep-water flathead ambush smaller species that forage on the bottom for infauna. The infauna appears to be rich and diverse – probably reflecting the diversity in sediment types and the broad gradients of exposure and depth. Benthic invertebrate communities inhabiting the east shelf of the Great Australian Bight, particularly the inner shelf, have been identified as one of the world's most diverse soft sediment ecosystems (798 species have been identified so far, including 360 species of sponges, 138 ascidians and 93 bryozoans). The species that make up these communities tend to vary from the inner to the outer shelf, and also decrease in abundance moving away from the coast. On the inner shelf of the more eastern parts of this bioregion, marine plant communities are more diverse, particularly in the lee of islands in the Nuyts Archipelago, where significant beds of seagrass are found.

Australian sea lions forage on benthic communities throughout the bioregion and have established breeding colonies at Nuyts Reef and at numerous points along the base of the Bunda Cliffs. The Head of Bight is an important aggregation site for southern right whales and their calves, which migrate annually through the Region during autumn and winter. Juvenile southern bluefin tuna inhabit the area between December and April to predate on small pelagic fish, squid, krill and salps. The Great Australian Bight is the only area in the world where young southern bluefin tuna (1-5 year old fish) are known to surface consistently. Small pelagic fish including sardine, scaly mackerel, jack mackerel, yellow tail, blue mackerel, anchovy, blue sprat and sandy sprat are considered an important trophic link between plankton communities and larger fish-eating predators, such as sharks, bluefin tuna and seabirds (Figure 2.14).

Southern reef squid. Photo: Marine Life Society of South Australia.

Ecosystem processes

This bioregion is particularly nutrient-poor, lacking some of the seasonally predictable small upwelling events that occur in neighbouring bioregions. Biological productivity in this bioregion is driven mainly through pulses of mixed water that irregularly wash through the system from the west. Anecdotal evidence from fishers, who track aggregations of school shark through this system, describes pulses of 'dirty water', soon followed by increased availability of baitfish and subsequently squid and, later still, larger predators. Highly mobile, higher order predators (such as tuna, school and whaler sharks, dolphins and seabirds) that normally forage in other systems, appear to track the food chains associated with these pulses of productivity as they move through the bioregion. These productivity pulses are highly variable within and between years.

An ecologically important hotspot of productivity occurs on the inner shelf at the Head of Bight. Satellite images show higher concentrations of chlorophyll in this area, and this is supported by anecdotal observations of higher concentrations of a number of species, which appear to use the relatively sheltered area of mixed seagrass, sand and limestone reef as nursery and feeding grounds. These include juvenile Australian salmon, mulloway, King George whiting, school shark, sea lions (Figure 2.17), dolphins and southern right whales. Studies on benthic invertebrates also found the highest values of biomass and species richness at the Head of Bight.

Figure 2.17 Simplified diagram of the predators and prey of the Australian sea lion

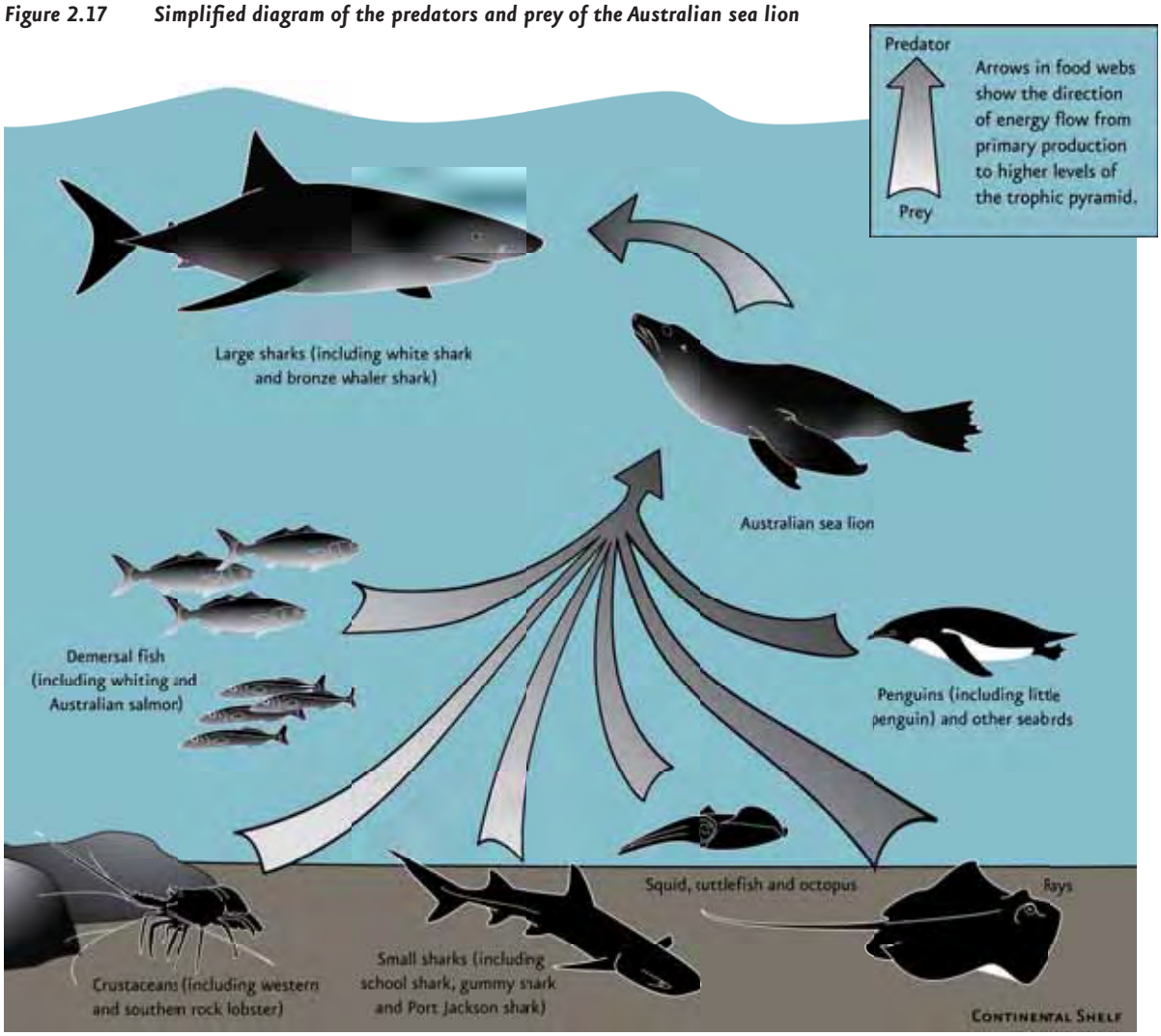


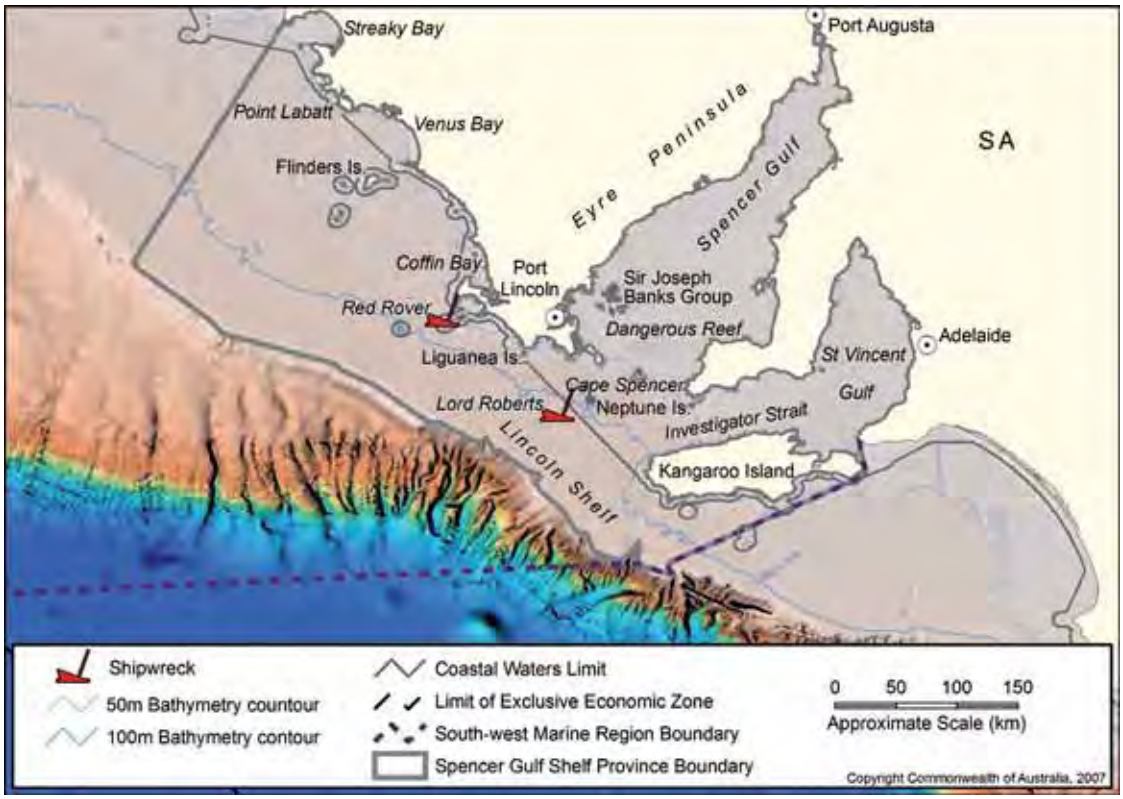
Table 2.5 Key ecological features and other important areas of the Great Australian Bight Shelf Transition

Feature or area	Rationale
Great Australian Bight Marine Park	**Protected place** (see Chapter 3.3).
Israelite Bay and coastal waters to the east	Important area for **protected species** (see Appendix D): • Southern right whale (calving).
Eastern part of the Great Australian Bight	Important area for **protected species** (see Appendix D): • Orange roughy (aggregations).
Inshore waters of the Great Australian Bight	Commonwealth waters adjacent to the Head of Bight are a regional **key ecological feature** (see Chapter 3.1) – these waters support enhanced productivity and high species biodiversity. They also provide important feeding and resting aggregation areas for marine life. Important areas for **protected species** (see Appendix D): • White shark (nursery area and feeding area); • Southern right whale (calving area); and • Australian sea lion (breeding colony).
Nuyts Archipelago	Important area for **protected species**(see Appendix D): • White shark (feeding area); • Caspian tern, flesh-footed shearwater, short-tailed shearwater (rookeries); and • Australian sea lion (breeding colony).
Twilight Cove	Important area for **protected species** (see Appendix D): • Southern right whale (calving).
Fowlers Bay	Important area for **protected species** (see Appendix D): • White shark (feeding area); • Australian sea lion (breeding colony); and • Southern right whale (calving).
Small pelagic fish	**Key ecological feature** (see Chapter 3.1) – important trophic link between plankton communities and larger marine predators.
Benthic invertebrate communities of the eastern Great Australian Bight	**Key ecological feature** (see Chapter 3.1) – high species biodiversity.

Flesh-footed shearwater. Photo: Ian Hutton, Department of the Environment, Water, Heritage and the Arts.

2.1.6 Spencer Gulf Shelf Province

Figure 2.18 Spencer Gulf Shelf Province



The Spencer Gulf Shelf Province extends over the continental shelf between Ceduna and Cape Jaffa (Figure 2.18). The bioregion straddles the South-east and the South-west Marine Regions. Thirty-nine per cent of the bioregion is under the jurisdiction of the Commonwealth, within the South-west Marine Region. The bioregion is represented in the National Representative System of MPAs through the Murray Commonwealth Marine Reserve, which is part of the South-east Network of Commonwealth Marine Reserves. A complex coastline of gulfs, peninsulas and islands characterise the bioregion (note – waters in the gulfs inside Kangaroo Island occur in State waters). Ocean currents flowing through the bioregion display marked seasonal patterns, particularly on the inner shelf where coastal winds generate west-bound coastal currents in summer. In autumn, a density current known as 'Bonaparte's Tongue' flows out from the Spencer Gulf and over the edge of the continental shelf.

Marine life in this bioregion comprises a mix of warm and cold temperate species, including New Zealand fur seals, Australian sea lions, little penguins and pygmy blue whales. The bioregion also features a number of local upwellings of nutrient-rich water south-west of Kangaroo Island and south and west of the Eyre Peninsula, between December and April. During summer, pygmy blue whales feed on krill aggregations associated with a small upwelling west of Kangaroo Island, known as the 'Kangaroo Island Pool' – a hotspot for marine productivity. Spawning aggregations of a number of commercially fished species are found in this area. The shield islands, characteristic of the bioregion, provide shelter for marine life and are associated with highly diverse benthic communities and are used by sharks as pupping grounds.

Geomorphology

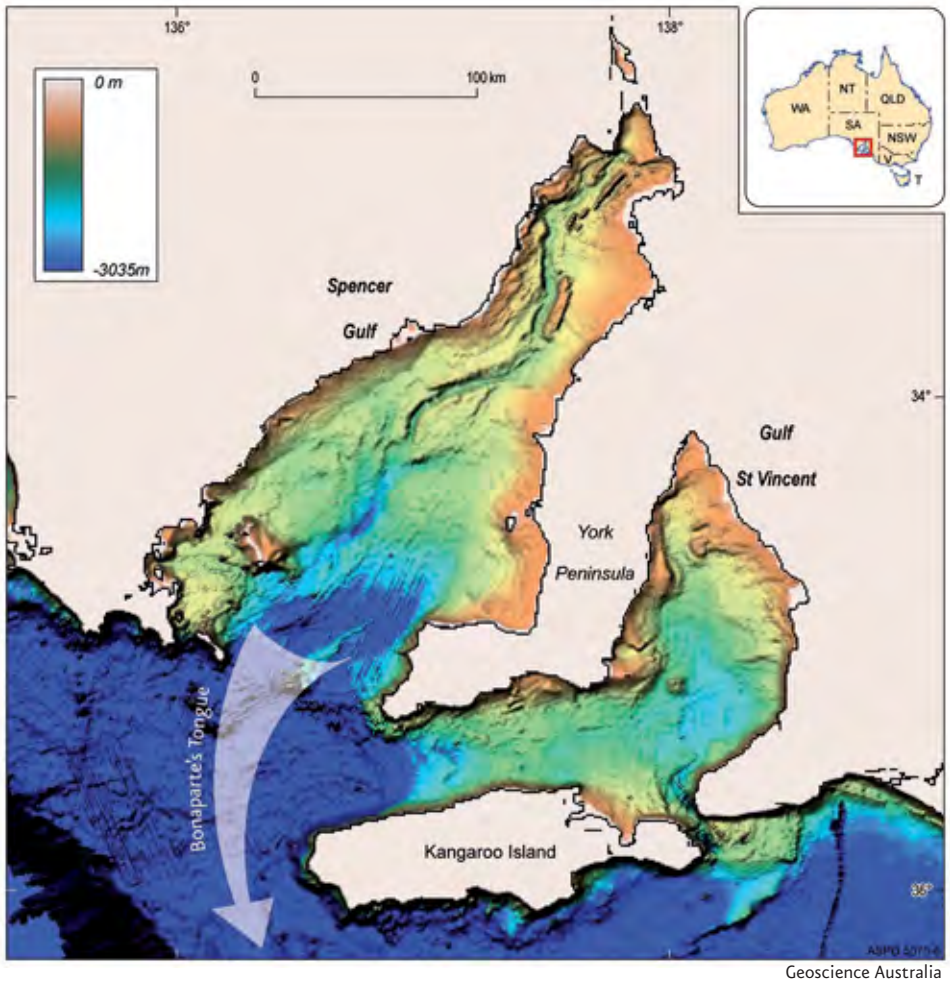
The bioregion has a complex coastline featuring the Eyre Peninsula, Spencer Gulf, Gulf St Vincent and Kangaroo Island. The gulfs are shallow bodies of water with depths less than 50 m in Spencer Gulf and 41 m in Investigator Strait and Gulf St Vincent. A bedrock ridge at 50 m depth marks the entrance to the Spencer Gulf and numerous islands rise from the ridge forming a partial barrier that isolates the gulf waters from the open ocean. The cool-water carbonate shelf described in Chapter 2.1.5 (Great Australian Bight Shelf Transition) also extends into this bioregion. The inner shelf is characterised by numerous shield islands – so called because of their shielding effect on the coast – the largest of these being Kangaroo

Island. These islands are scattered between Cape Spencer and the western boundary of the bioregion.

Oceanography

The ocean currents operating in this bioregion display similar characteristics to the Great Australian Bight Shelf Transition – during winter, water moves east through the bioregion, fuelled by wind-driven coastal currents on the inner shelf and by the Leeuwin Current on the shelf break. During summer, the Leeuwin Current weakens and coastal winds generate west-bound coastal currents along the inner shelf. West of the Eyre Peninsula and Kangaroo Island, local upwellings of nutrient-rich water create several predictable hotspots of productivity in an otherwise nutrient-poor environment. In the western limits of the bioregion, downwelling of waters from the inner shelf to the outer shelf and shelf break occurs during winter. The relatively shallow gulf waters are cooler than the continental shelf waters in winter (~12°C) and warmer in summer (~24°C), due to restricted mixing across the mouths of the gulfs. Sea surface temperature frontal systems have been observed at the mouths of the Spencer Gulf and Investigator Strait during summer months, with frontal temperature differences of 3-4°C in surface waters and 7-8°C in bottom waters. As the Spencer Gulf surface waters cool during the autumn, the high salinity water residing at the head of the Gulf becomes dense enough to form the outgoing bottom density current known as Bonaparte's Tongue. This tongue of dense, salty water, around 20 km wide and 20 m thick, flows out of the mouth of the Gulf and across the Lincoln Shelf for over 100 km, eventually falling over the edge of the shelf to depths of about 250 m (Figure 2.19). The outflow of dense water occurs in regular pulses over a period of approximately three months.

Figure 2.19 ***Bathymetry of Spencer Gulf and Gulf St Vincent showing outflow of Bonaparte's Tongue***



Geoscience Australia

Biological communities

Marine life in this bioregion is typical of a transition from warm to cold temperate waters, where cool temperate species of demersal fish from Bass Strait and Tasmania coexist with many demersal fish species characteristic of the Southwest Shelf Province. The eastern part of the bioregion appears to host a relatively different group of predators to those found in the Great Australian Bight Shelf Transition. This is possibly because of the higher biological productivity in this part of the Region. New Zealand fur seals (mostly feeding in pelagic habitats around the shelf break), Australian sea lions (mainly feeding in benthic habitats on the continental shelf), dolphins, penguins, blue whales and seabirds, such as shearwaters and albatross, have all been observed in this area. Small pelagic fish including sardine, scaly mackerel, jack mackerel, yellow tail, blue mackerel, anchovy, blue sprat and sandy sprat, are considered an important trophic link between plankton communities and larger fish-eating predators, such as New Zealand fur seals, sharks including bronze whalers and hammerheads, and predatory fish, like Australian salmon and barracouta (Figure 2.14). The salty warmer waters of the gulfs support unique benthic habitats, including one of the largest temperate seagrass ecosystems on earth.

The waters around the 'shield islands' support highly diverse benthic communities and aggregations of krill and salps. The islands also provide protection for shark pupping grounds, extensive seagrass beds to depths of 50 m, and sponge-dominated communities around the island below 50 m depth. This is an important area for Australian sea lions and New Zealand fur seals that haul out on the numerous islands in the area. In pelagic habitats, multiple patches of phytoplankton occur throughout the bioregion, while zooplankton appears to be largely confined to one large patch at the Spencer Gulf entrance.

Ecosystem processes

A distinguishing and ecologically important feature of this bioregion is the existence of seasonally predictable upwellings of nutrient-rich water between December and April, that enhance productivity and attract feeding aggregations. The main areas of surface upwelling are the Kangaroo Island Pool, south-west of Kangaroo Island along the 100 m depth contour and south and west of the Eyre Peninsula. Although the exact causes of the upwellings and where and when they occur are not clearly understood, it is likely that they are the result of interactions between wind, ocean currents and abrupt changes in the seafloor features, such as at the shelf break and near submarine canyons. These upwellings may also be connected to infiltration of ground water known to occur on the middle shelf in this system.

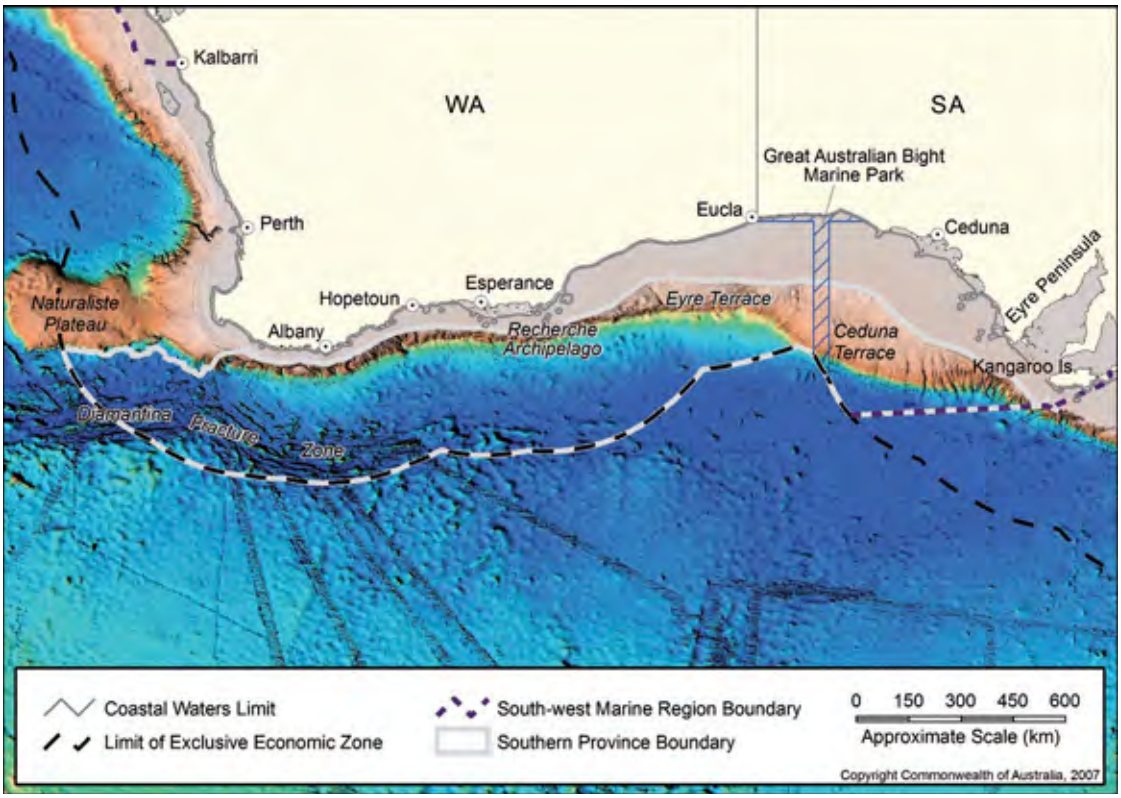
Table 2.6 Key ecological features and other important areas of the Spencer Gulf Shelf Province

Feature or area	Rationale
Murray Commonwealth Marine Reserve (in South-east Marine Region)	**Protected place**.
Yorke Peninsula	Important area for **protected species** (see Appendix D): • White-bellied sea eagle (nesting).
Great Althorpe Island	Important area for **protected species** (see Appendix D): • Short-tailed shearwater (rookery).
Gambier Island	Important area for **protected species** (see Appendix D): • Short-tailed shearwater (rookery).
Lewis, Hopkins and Williams Islands (Cape Catastrophe area, Southern Eyre Peninsula)	Important area for **protected species** (see Appendix D): • Short-tailed shearwater (rookeries).
Greenly Island	Important area for **protected species** (see Appendix D): • Short-tailed shearwater (rookery).

Feature or area	Rationale
Eyre Peninsula	Important area for **protected species**(see Appendix D): • Osprey and white-bellied sea eagle (nesting area).
Eyre Island and Little Eyre Island	Important area for **protected species** (see Appendix D): • Caspian tern (rookeries).
Investigator Group	Important area for **protected species** (see Appendix D): • Short-tailed shearwater (rookeries).
West Waldegrave Island	Important area for **protected species** (see Appendix D): • White shark (feeding area); and • Australian sea lion (breeding colony). One of the five known Australian sea lion breeding areas that produce more than 100 pups a year.
Kangaroo Island	Important area for **protected species** (see Appendix D): • White shark (feeding area). There is a large New Zealand fur seal colony on Kangaroo Island, providing food for white sharks; • Osprey (nesting area); and • Australian sea lion (breeding colony – Seal Bay). One of the five known Australian sea lion breeding areas that produce more than 100 pups a year.
Kangaroo Island Pool and Eyre Peninsula upwellings	**Key ecological feature** (see Chapter 3.1) – upwellings enhance marine productivity and attract feeding aggregations.
Spencer Gulf and the Gulf of St Vincent (including Sir Joseph Banks Group, Dangerous Reef and West Troubridge Shoal)	Important area for **protected species** (see Appendix D): • White shark (feeding area). These gulfs are considered important feeding grounds for sub-adult white sharks, although juvenile and large adult sharks have also been observed in these areas. The abundance of dolphins, finfish and other elasmobranchs are presumably targeted by white sharks occurring in these gulfs; • Caspian tern (rookeries – West Troubridge Shoal and Sir Joseph Banks Group); and • Australian sea lion (breeding colony – Dangerous Reef). One of the five known Australian sea lion breeding areas that produce more than 100 pups a year.
Olive Island	Important area for **protected species** (see Appendix D): • Australian sea lion (breeding colony). One of the five known Australian sea lion breeding areas that produce more than 100 pups a year; and • White shark (feeding area).
Liguanea Island	Important area for **protected species** (see Appendix D): • White shark (feeding area). There is a large New Zealand fur seal colony on Liguanea Island, providing food for white sharks.
Neptune Islands	Important area for **protected species** (see Appendix D): • White shark (feeding area). Large New Zealand fur seal colony provides food for white sharks.
Small pelagic fish	**Key ecological feature** (see Chapter 3.1) – important trophic link between plankton communities and larger marine predators.

2.1.7 Southern Province

Figure 2.20 The Southern Province



This is the largest bioregion in Australia's waters and includes the deepest ocean areas of the Australian EEZ – reaching depths of around 5900 m. The bioregion extends from the shelf break south of Kangaroo Island to the southern edge of the Naturaliste Plateau (Figure 2.20). The Southern Province is entirely under Commonwealth jurisdiction, straddling the South-east and the South-west Marine Regions. Eighty-five per cent of the bioregion occurs within the South-west Marine Region. It is characterised by a long continental slope incised by numerous, well-developed submarine canyons, two extensive mid-slope terraces (the Ceduna and Eyre Terraces) and the Diamantina Fracture Zone, a rugged area of deep seafloor comprising numerous ridges and troughs.

The demersal fish assemblages inhabiting the shelf break and slope resemble those found on the South-east Marine Region's continental slope more than those of the Central Western Province. The canyons south of Kangaroo Island and adjacent shelf break appear to be important areas for biological productivity and for spawning and aggregation for a range of marine species, particularly during winter. The Albany Group of submarine canyons south of Albany and Esperance are also considered important for biological productivity that attracts feeding aggregations. A representative transect of the benthic environment of this bioregion has been captured in the Benthic Protection Zone of the Great Australian Bight Marine Park, which extends offshore to the limit of the EEZ.

Geomorphology

The seafloor of the Southern Province is characterised by a long continental slope incised by numerous, well-developed submarine canyons. Although most of the slope is marked by canyons, the Albany Group (Figure 2.21) in the east and the canyons south of the Eyre Peninsula are the most dramatic, cutting deeply into areas of steep slope. Two extensive mid-slope terraces, the Ceduna and Eyre Terraces, collectively covering an area of 147 150 km^2, are also distinctive to the bioregion. The terraces are intersected by numerous canyons and gullies, which are broader and more widely spaced than the Albany Canyons. The Ceduna Terrace (200-3000 m water depth) is the most extensive, being about 700 km long and reaching 200 km in width. The Eyre Terrace (200-1600 m water depth) is smaller and narrower, reaching a maximum width of 70 km. A vast area of abyssal plain (200 651 km^2) gives

way, in the west, to the Diamantina Fracture Zone (Figure 2.22), an extremely rugged area of seafloor (more than 100 000 km²) composed of closely spaced ridges and troughs, with a characteristic east-west orientation. The Diamantina Fracture Zone also includes the greatest depths in Australian waters: approximately 5900 m. To the east of the Diamantina Fracture Zone, the South Australian Abyssal Plain is characterised by shallower depths and smoother topography.

Figure 2.21 Bathymetry of the Albany Canyons

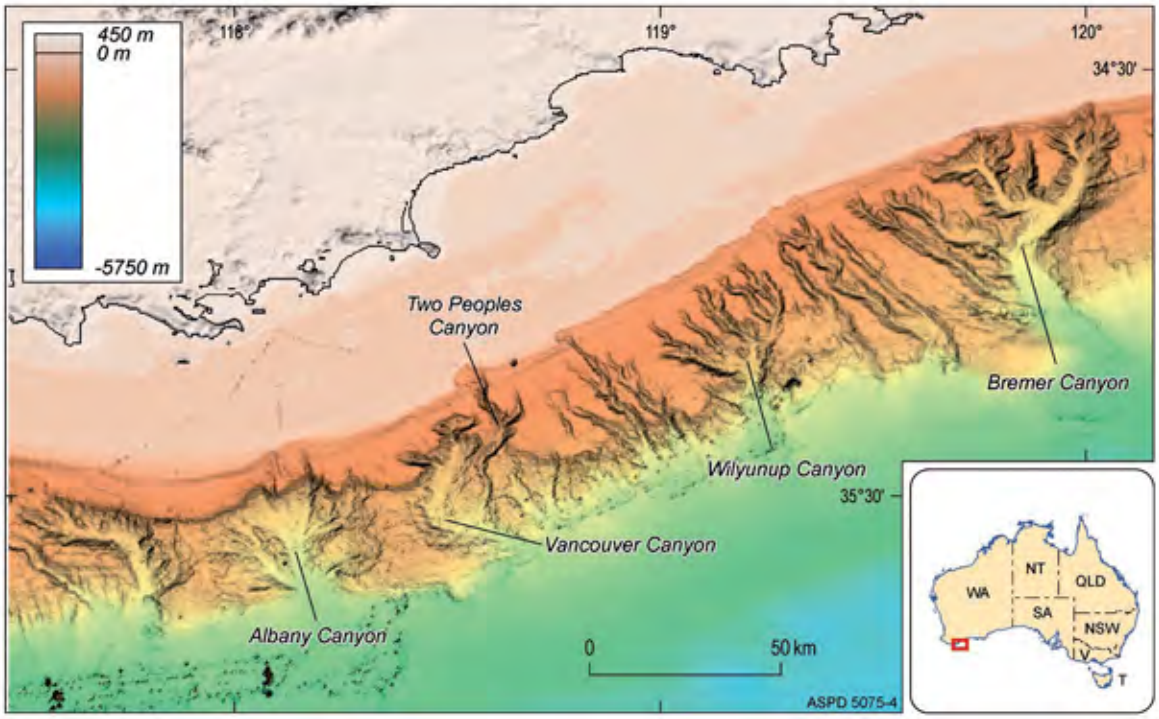


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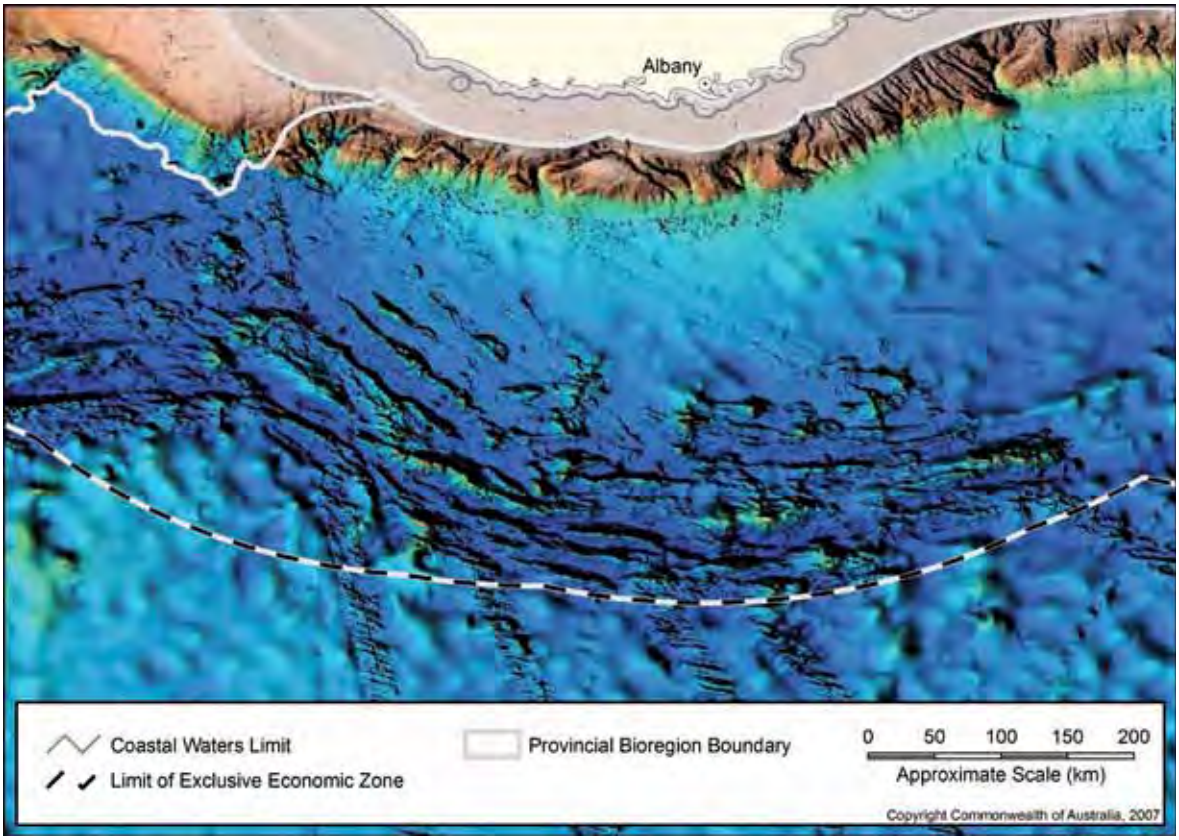
Figure 2.22 Bathymetry of the Diamantina Fracture Zone



Oceanography

The Leeuwin Current transports warm, nutrient-poor water eastward along the shelf break and upper slope. Meso-scale eddies form from the Leeuwin Current south of Albany, Esperance and the Eyre Peninsula, where coastal topography changes direction. Eddies also drift westward from south of Victoria and first encounter the slope south of the Recherche Archipelago. Here they take on warm water from the Leeuwin Current and strengthen, continuing their movement westward for up to 18 months. Beneath the Leeuwin Current the cooler waters of the Flinders Current, which has its core at approximately 600 m depth, appear to provide a deep westward conveyor belt for the Region's fauna. The strength and behaviour of the Flinders Current appears to be affected by wind and the density of the water bodies on the shelf, and at times may vanish or even reverse direction. The bioregion has areas of seasonal upwelling and downwelling along the continental slope. Downwelling from the shelf to the slope occurs in the western half of the Bight in summer, effectively suppressing upwelling in this area. South-west of Kangaroo Island and south of the Eyre Peninsula, currents, winds and topography interact to produce upwellings of nutrient-rich water from the slope onto the shelf. Local upwellings are also known to occur on the slope south of Esperance and Albany, onto the adjacent shelf area.

Biological communities

The demersal fish assemblages of the shelf break and slope of this bioregion are more like those on the slope of the South-east Marine Region than those of the Central Western Province. Scientists have described 463 species of fish on the slope of this bioregion, of which 26 are endemic. Only one extensive study of slope fish communities, undertaken during the late 1980s, has been conducted in this bioregion. There is a lower proportion of bottom-feeding demersal fish in this bioregion compared with the west coast, which appears to relate to greater availability of food such as meso-pelagic fish like myctophids (lantern fish) in the water column. Commercial fish landings taken from the shelf break and down the upper and mid-slope include orange roughy, blue grenadier, Bight redfish, school shark, gummy shark, angel shark, gemfish, deep water flatheads, leatherjackets, latchets, stingrays and stingarees. These fish are preyed on by deep-diving toothed whales and dolphins, including sperm whales and killer whales, seabirds, tunas and other large predatory fish. Blue whales, southern right whales and humpback whales also occur in this bioregion.

Ecosystem processes

The canyons and adjacent shelf break south of Kangaroo Island receive upwellings of nutrient-rich water. Anecdotal evidence indicates the canyons may also be an important spawning and aggregation area for a range of marine species, particularly during winter. Commercially fished species including blue grenadier, warehou, orange roughy and western gemfish may aggregate here to spawn (note that for orange roughy, no spawning aggregation has yet been found but a high density of eggs has been observed, pointing to a likely spawning aggregation in the area). Anecdotal accounts from fishers indicate the area is also used as a mating ground for school shark. Archival tags placed on school shark showed that they spent a considerable proportion of their time foraging around the canyon system. There are highly productive giant crab and lobster grounds along the shelf edge. It is to be expected that the water column above the canyons and shelf break is also an important foraging ground for large predators like sharks, cetaceans and New Zealand fur seals.

The Albany Group of submarine canyons – approximately 32 canyons encompassing 700 km of continental slope from longitude 115°E to 124°E – is considered an area of enhanced biological productivity. Small but significant numbers of school and gummy shark are caught along the shelf break, outside the Recherche Archipelago. Deep-water fishers sporadically fish a cluster of orange roughy aggregations along the mid-slope in the same area. Fisheries scientists and some fishers speculate that species such as blue grenadier and western gemfish may have spawning aggregations amongst the submarine canyons and other prominent geological features rising from the seafloor on the slope adjacent to Esperance and Hopetoun.

The Diamantina Fracture Zone represents a unique but virtually unknown region of deep-sea habitat and experts speculate it is highly likely that marine communities in this area comprise unique species with high biodiversity. The physical complexity of numerous troughs and ridges and complex water circulation that occurs in this area support these assertions.

Sperm whale. Photo: Rick Eaves

Table 2.7 Key ecological features and other important areas of the Southern Province

Feature or area	Rationale
Kangaroo Island Canyons and adjacent shelf break	**Key ecological feature** (see Chapter 3.1) – associated with enhanced productivity, aggregations of marine life and are unique seafloor features. Important area for **protected species** (see Appendix D): • Orange roughy (aggregation); • Pygmy blue whale (feeding area); • Fin whale (feeding area); and • Sperm whale (feeding area). Sei whales may also feed here.
Albany Canyons Group and adjacent shelf break	**Key ecological feature** (see Chapter 3.1) – associated with enhanced productivity, aggregations of marine life and are unique seafloor features. Important area for **protected species** (see Appendix D): • Orange roughy (aggregation); and • Sperm whale (feeding area – south of Esperance).
Meso-scale eddies (predictable locations south of Albany, Esperance, Eyre Peninsula and Kangaroo Island)	**Key ecological feature**(see Chapter 3.1) – associated with enhanced productivity and aggregations of marine life.
Diamantina Fracture Zone	**Key ecological feature** (see Chapter 3.1) – a unique seafloor feature.

Key references and further readings

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Potter, A., Southby, C., & Heap A.D., 2006, *Geomorphology and Sedimentology of the South Western Planning Area of Australia*, Geoscience Australia, Canberra, <www.environment.gov.au/coasts/mbp/south-west>.

Legislation

Available from <www.legislation.sa.gov.au>

Fisheries Act 1982 (SA).

National Parks and Wildlife Act 1972 (SA).

Map data

Figure 2.5 Bioregions of the South-west Marine Region
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data, Drainage and Roads
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
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Figure 2.6 The Southwest Shelf Transition
Department of the Environment, Water, Heritage and the Arts (2003): Historic Shipwrecks Register
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
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Figure 2.10 The Central Western Province
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
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Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
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Figure 2.13 The Southwest Shelf Province
Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
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Figure 2.15 The Southwest Transition
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
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Figure 2.16 The Great Australian Bight Shelf Transition
Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
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Figure 2.18 The Spencer Gulf Shelf Province
Department of the Environment, Water, Heritage and the Arts (2003): Historic Shipwrecks Register
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
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Figure 2.20 The Southern Province
Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
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Figure 2.22 Bathymetry of the Diamantina Fracture Zone
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
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A fly-trap anemone attached to an octocoral on steep rocky bottom. Central Western Province, 489 m deep. Photo: CSIRO.

Chapter 3 Conservation Values of the South-west 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 are for each Region 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*, 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 EPBC 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 are recognised conservation values. In the South-west Marine Region these include listed threatened, migratory and marine species, cetaceans (whales, dolphins and porpoises) 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 South-west Marine Bioregional Plan to:

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

The nature and location of the conservation values will also be considered in the establishment of marine protected areas (MPAs) as part of the National Representative System of MPAs (see Chapter 1). However, conservation values will not automatically be included in Commonwealth marine reserves. 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 MPA network for the Region.

Southern right whale and calf. Photo: Clive McMahon, Australian Government Antarctic Division, Department of the Environment, Water, Heritage and the Arts.

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 Section 23 of the EPBC 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 can be found at <www.environment.gov.au/epbc/policy>.

Marine Bioregional Plans will identify and describe key ecological features of a Region's marine environment. Once Plans are finalised, key ecological features will be considered in making decisions about whether an action is likely to have a significant impact on the Commonwealth marine environment.

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, prey 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 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.

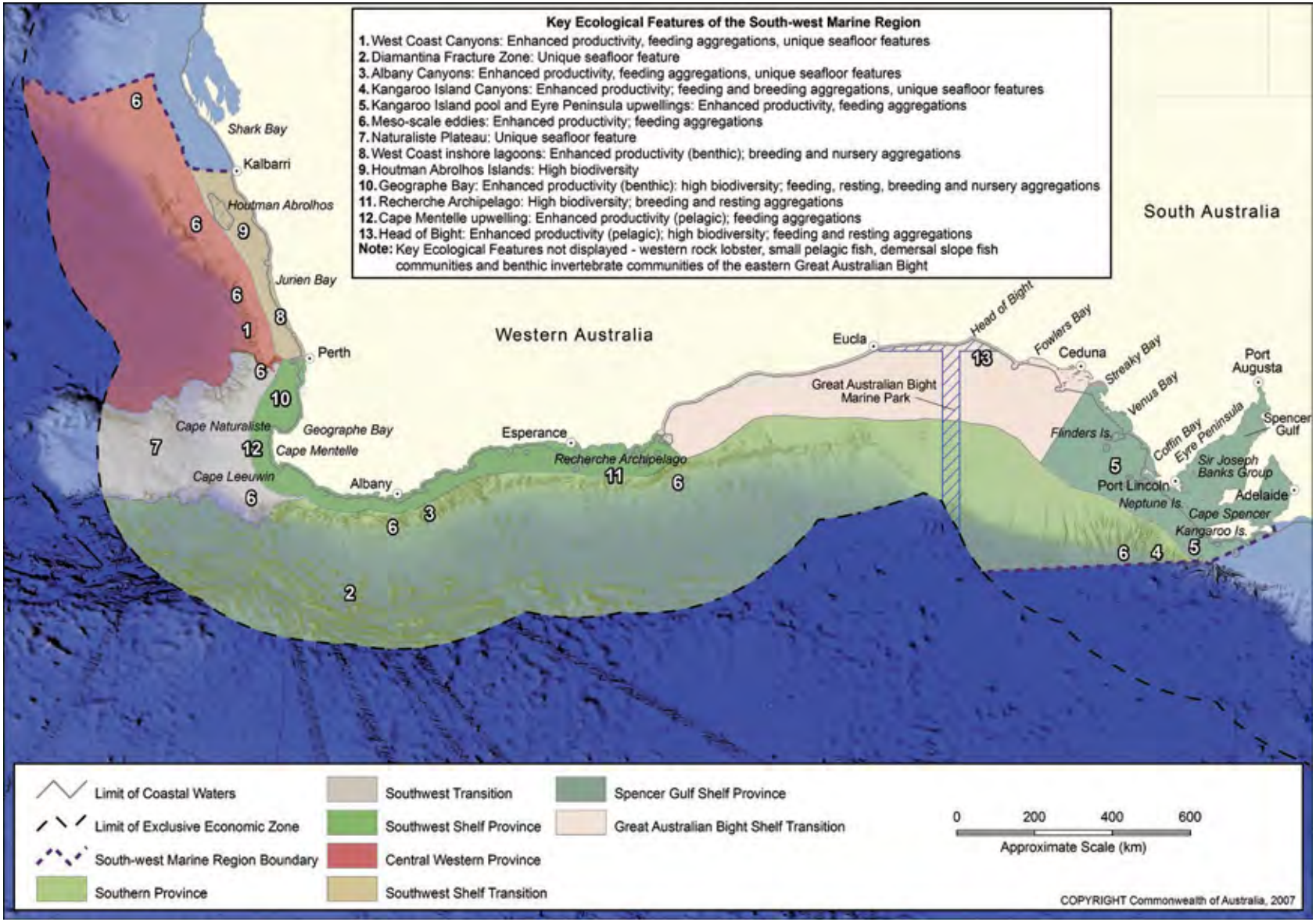
Key ecological features in the South-west Marine Region are identified by the Australian Government on the basis of advice from scientists about the ecological processes and characteristics of the Region. An important source of information used to identify key ecological features in the Region was the *South-west Marine Region Ecosystems and Key Species Groups Report* commissioned by the Department of the Environment, Water, Heritage and the Arts. A scientific workshop was conducted in September 2006, bringing together marine scientists with specific experience and expertise in the Region. The workshop explored what is currently known about the ecosystems of the South-west Marine Region, and scientific understanding of likely interactions and ecosystem processes. The outcomes of the workshop and the *Ecosystems and Key Species Groups Report* are available at <www.environment.gov.au/coasts/mbp/south-west>.

Table 3.1 identifies key ecological features in the South-west 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 improve our understanding of key ecological features in the Region. This information will also be used to confirm and refine the key ecological features identified during the profiling stage of the process. This information will underpin the analysis of the threats that the marine environment may face over the next 10 to 20 years. The Draft South-west Marine Bioregional Plan will include a refined list of key ecological features.

Seventeen key ecological features have been identified so far within the South-west Marine Region. These occur across 20 areas, and include one species and three communities/species groups (Table 3.1). Figure 3.1 provides location details for areas identified in Table 3.1.

Sea pen. Photo: Marine Life Society of South Australia.

Figure 3.1 *Key ecological features of the South-west Marine Region*



This is also available as a separate map in the envelope in the back cover of this book.

Table 3.1 Key ecological features of the South-west Marine Region

Key Ecological Features	Bioregions (IMCRA v.4.0)	Rationale
1. West Coast Canyons and adjacent shelf break	Central Western Province, Southwest Transition	**Enhanced productivity; feeding aggregations; unique seafloor feature** The West Coast Canyons are believed to be associated with small periodic upwellings that locally enhance productivity and attract aggregations of marine life. The Perth Canyon is prominent among these canyons because of its magnitude and ecological importance. The Perth Canyon marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs. Deep ocean currents upwelling in the canyon create a nutrient-rich cold-water habitat attracting feeding aggregations of deep diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid.
2. Diamantina Fracture Zone	Southern Province	**Unique seafloor feature** The Diamantina Fracture Zone is a rugged, deep-water environment composed of numerous closely spaced troughs and ridges covering more than 100 000 km^2. Marine experts point out that the size and physical complexity of the Diamantina Fracture Zone suggest that it is likely to support deep-water communities characterised by high species diversity and endemism.
3. Albany Canyons Group and adjacent shelf break	Southern Province	**Enhanced productivity; feeding aggregations; unique seafloor feature** The Albany Canyons, including 32 canyons along 700 km of continental slope, are believed to be associated with small periodic upwellings that enhance productivity and attract aggregations of marine life. Anecdotal evidence indicates that this area supports fish aggregations that attract large predatory fish, sharks and toothed, deep-diving whales such as the sperm whale.
4. Kangaroo Island Canyons and adjacent shelf break	Southern Province	**Enhanced productivity; feeding and breeding aggregations; unique seafloor feature** The Kangaroo Island canyons – a small group of steep-sided, narrow canyons – are associated with enhanced productivity that attracts aggregations of marine life. Seasonal upwellings are believed to be an important factor enhancing production. These upwellings support aggregations of krill, small pelagic fish and squid that in turn attract marine mammals (e.g. pygmy blue whales, fin whales, sperm whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds. Anecdotal evidence indicates that orange roughy, blue grenadier and western gemfish aggregate and are thought to spawn in this area. Empirical evidence shows that orange roughy eggs occur in high densities. The canyons are also thought to be an important pupping area for school shark and the adjacent shelf break is known for high yields of giant crab and southern rock lobster.
5. Kangaroo Island Pool and Eyre Peninsula upwellings	Spencer Gulf Shelf Province	**Enhanced productivity; feeding aggregations** The Kangaroo Island Pool and Eyre Peninsula upwellings are known to be associated with seasonal aggregations of marine life. The nutrient-rich upwellings enhance the production of plankton communities supporting seasonal aggregations of krill, small pelagic fish and squid which in turn attract marine mammals (e.g. toothed whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds.

Key Ecological Features	Bioregions (IMCRA v.4.0)	Rationale
6. Meso-scale eddies (several locations)	Central Western Province, Southwest Transition, Southern Province	**Enhanced productivity; feeding aggregations** Eddies and eddy fields form at predictable locations off the western and south-western shelf break (south-west of Shark Bay, offshore of the Houtman Abrolhos Islands, south-west of Jurien Bay, Perth Canyon, south-west of Cape Leeuwin and south of Albany, Esperance and the Eyre Peninsula). The meso-scale eddies of this Region are important transporters of nutrients and plankton communities, taking them far offshore into the Indian Ocean where they are consumed by oceanic communities. Clockwise eddies are considered to play an important role in lifting deep water, which can be relatively cooler and richer in nutrients, toward the surface where it can enhance production of plankton communities that attract aggregations of marine life.
7. Naturaliste Plateau	Southwest Transition	**Unique seafloor feature** The Naturaliste Plateau is a complex and isolated seafloor feature that occurs in an area where numerous water bodies and currents converge. It is also the only seafloor feature in the Region that interacts with the sub-tropical convergence front. Although there is very little known about the marine life of this part of the Region, experts point out that the combination of its structural complexity, mixed water dynamics and relative isolation is highly likely to support deep-water communities characterised by high species diversity and endemism.
8. Commonwealth waters within and adjacent to the west coast inshore lagoons	Southwest Shelf Transition, Southwest Shelf Province	**Enhanced productivity (benthic); breeding and nursery aggregations** An extended chain of inshore lagoons, extending from south of Mandurah to Kalbarri, is considered to be important for benthic productivity and recruitment for a range of marine species. Although macro-algae and seagrass appear to be the primary source of production, scientists suggest that ground water enrichment may supplement the supply of nutrients to the inshore lagoon. The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, and many other reef species.
9. Commonwealth waters surrounding the Houtman Abrolhos Islands	Southwest Shelf Transition, Central Western Province	**High biodiversity** The Houtman Abrolhos Islands and surrounding reefs have been relatively well studied and are noted for their high species diversity. The reefs are composed of 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae. The high biodiversity of the islands is attributed to the mix of temperate and tropical species resulting from the southward transport of species by the Leeuwin Current over thousands of years.
10. Commonwealth waters within and adjacent to Geographe Bay	Southwest Shelf Province	**Enhanced productivity (benthic); high biodiversity; feeding, resting, breeding and nursery aggregations** Geographe Bay is a large sheltered embayment with extensive beds of tropical and temperate seagrass that account for about 80 per cent of benthic primary production in the area. The seagrass beds are noted for their high species biodiversity and endemism. Similar to the lagoons to the north, Geographe Bay provides important nursery habitat for many shelf species (e.g. dusky whaler sharks use the shallow seagrass habitat as nursery grounds for several years before ranging out over the shelf to adult feeding grounds along the shelf break). Geographe Bay is also an important resting area for migrating humpback whales.

Key Ecological Features	Bioregions (IMCRA v.4.0)	Rationale
11. Commonwealth waters surrounding the Recherche Archipelago	Southwest Shelf Province, Southern Province	**High biodiversity; breeding and resting aggregations** The Recherche Archipelago is the most extensive area of reef in the South-west Marine Region (35 203 km² of reef habitat). Its reef and seagrass habitat supports a high species diversity of warm temperate species including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macro-algae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals.
12. Cape Mentelle upwelling	Southwest Shelf Province	**Enhanced productivity (pelagic); feeding aggregations** The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, where nutrient levels are higher, up the continental slope and on to the continental shelf, where it results in blooms of phytoplankton at the surface. Higher densities of phytoplankton provide the basis of an extended food chain characterised by aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks.
13. Commonwealth waters adjacent to the Head of Bight	Great Australian Bight Shelf Transition	**Enhanced productivity (pelagic); high biodiversity; feeding and resting aggregations** An ecologically important hotspot of higher productivity occurs on the inner shelf at the Head of Bight. Satellite images show higher concentrations of chlorophyll (an indicator for phytoplankton) in this area. This is supported by anecdotal observations of higher concentrations of a number of species that appear to use relatively sheltered areas of mixed seagrass, sand and limestone reef as nurseries and feeding grounds. These include juvenile Australian salmon, mulloway, school shark, sea lions, dolphins and southern right whales. Studies of benthic epifauna also found high biomass and species diversity at the Head of Bight.
14. Western rock lobster	Southwest Shelf Transition	**Species with important ecological role** This species is the dominant large benthic invertebrate in this bioregion. Western rock lobsters are an important part of the food web on the inner shelf, particularly when they are juveniles as they are preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper wirrah cod and breaksea cod. Western rock lobster are also particularly vulnerable to predation during seasonal moults in November-December and to a lesser extent during April-May. The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters. Western rock lobster is the basis of one of Australia's most valuable commercial fisheries. The Western Rock Lobster Fishery was the first Australian fishery to be accredited with Marine Stewardship Council certification.
15. Small pelagic fish	Southwest Shelf Transition, Southwest Shelf Province, Great Australian Bight Shelf Transition, Spencer Gulf Shelf Province	**Species group with important ecological role** Small pelagic fish are an extremely important component of pelagic ecosystems, providing a link between primary production and higher predators, such as other fish, sharks, seabirds, seals and cetaceans. Fluctuations in abundance of small pelagic fish have serious implications for the functioning of pelagic ecosystems. In the South-west Marine Region, the small pelagic fish include ten species: sardine, scaly mackerel, Australian anchovy, round herring, sandy sprat, blue sprat, jack mackerel, blue or slimy mackerel, red bait and saury. There is a Small Pelagics Fishery which is managed by the Australian Fisheries Management Authority and is a Wildlife Trade Operation under the EPBC Act.

Key Ecological Features	Bioregions (IMCRA v.4.0)	Rationale
16. Demersal slope fish communities	Central Western Province	**Communities with high species biodiversity** Demersal slope fish assemblages in this bioregion are characterised by high species diversity. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered endemic to the bioregion. Demersal fish on the slope in this bioregion in particular have high species diversity compared with other more intensively sampled oceanic regions of the world. Below 400 m water depth demersal fish communities are characterised by a diverse assemblage where relatively small, benthic species (grenadiers, dogfish and cucumber fish) dominate.
17. Benthic invertebrate communities of the eastern Great Australian Bight	Great Australian Bight Shelf Transition	**Communities with high species biodiversity** Soft-sediment benthic invertebrate communities of the eastern Great Australian Bight shelf form some of the world's most diverse soft sediment ecosystems. A 2002 survey of benthic marine life sampled 798 species, including 360 species of sponge, 138 ascidians and 93 bryozoans, many of which were new to science. The shelf in this area of the Region is part of the world's largest cool-water carbonate province. Invertebrate skeletons and shells make up over 80 per cent of the shelf sediments.

Large erect sponges with a mixture of small sponges, cnidarians and bryozoans. Southern Province, 193 m deep. Photo: CSIRO.

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 as 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* (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), or
    - 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 and CAMBA is provided in Appendix A;
- *Cetaceans* – all species of cetacean (including whales, dolphins and porpoises) are protected under the EPBC Act to ensure their future survival; and
- *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 South-west include:
    - sea snakes (Families Hydrophiidae and Laticaudidae),
    - pinnipeds, including fur seals and sea lions and true seals (Families Otariidae and Phocidae),
    - marine turtles (Families Cheloniidae and Dermochelyidae),
    - seahorses, sea-dragons, pipefish and ghost pipefish (Families Syngnathidae and Solenostomidae), and
    - seabirds (i.e. defined in the EPBC Act as bird species that occur naturally in the Commonwealth marine area).

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

Under the EPBC Act, species listed as 'threatened' or 'migratory' are matters of national environmental significance[1]. Proposals for activities likely to have a significant impact on matters of national environmental significance must be referred to the Australian Government Minister for the Environment, Heritage and the Arts for approval. The requirement to refer proposals for actions likely to have a significant impact on matters of national environmental significance applies to activities proposed not only in areas managed by the Commonwealth but also in areas managed by the States and Territories.

Significant Impact Guidelines – Matters of National Environmental Significance have been produced to provide advice to proponents on when referrals should be submitted for approval. These guidelines provide specific 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. These guidelines are available at <www.environment.gov.au/epbc/policy>.

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, over time, fisheries are managed in an ecologically sustainable way. These fishery

1 Species listed as extinct or conservation dependent are not matters of national environmental significance under the EPBC Act.

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>.

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 South-west Marine Region

The South-west 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 legislation. For instance the white shark is protected under the EPBC Act and under South Australian and Western Australian legislation.

In the South-west Marine Region there are 105 species protected under the EPBC Act that are *known to occur* in the Region: 26 species listed as threatened, 49 as migratory, 31 cetaceans and 70 listed as marine (Table 3.2)[2]. In addition, there are another 77 species that *may infrequently occur* in the Region. Species that *may infrequently occur* in the South-west Marine Region are defined as those:

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

Appendix C lists all species protected under the EPBC Act that are *known to occur* and all that *may infrequently occur* in the South-west Marine Region.

Note that, at the time of finalisation of this Bioregional Profile (2007), there are no species listed as 'critically endangered'. There are also no species known to have become extinct in the Region.

2 Species can be listed under more than one category under the EBPC Act. For instance, marine turtles are listed as threatened species, migratory species and as marine species.

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 South-west Marine 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/south-west> and will be updated as new information becomes available. Protected Species Group Report Cards are available for sharks, fish, reptiles (marine turtles and sea-snakes), birds, pinnipeds (seals, fur seals and sea lions), and cetaceans (whales, dolphins and porpoises) occurring in the South-west Marine Region.

Shy albatross. Photo: Mike Double.

Table 3.2 Number of protected species known to occur in the Region by broad taxonomic group (as at April 2007)

	Listed Threatened Species			Listed Migratory Species	Cetaceans (whales, dolphins and porpoises)	Listed Marine Species
	Endangered	Vulnerable	Conservation Dependent			
Sharks	-	3	-	2	-	-
Bony fish	-	-	1	-	-	1
Reptiles	1	2	-	3	-	4
Seabirds	2	11	-	35	-	62
Pinnipeds	-	1	-	-	-	3
Cetaceans	2	3	-	9	31	-
Totals	26			49	31	70

Important areas for species listed as 'threatened' or 'migratory' under the EPBC Act have been identified in the South-west Marine Region and in adjacent State waters. These important areas have been identified for species listed as 'threatened' or 'migratory' under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for further information on requirements under the EPBC Act for matters of national environmental significance).

Table 3.3 identifies breeding areas, nursery and calving areas, feeding areas and resting areas for protected sharks, fish, reptiles, seabirds (foraging areas only), pinnipeds and cetaceans within the South-west Marine Region. Table 3.4 identifies sea bird rookeries adjacent to the Region on islands and coastal areas. These areas were identified on the basis of available information, expert advice and the criteria below:

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

Additional important areas for species protected under the EPBC Act may be identified during the next stage of the planning process, as further and finer-scale information about the Region is collected to underpin the analysis of the threats protected species may face over the next 10-20 years. The Draft South-west Marine Bioregional Plan will include any additional important areas identified for protected species.

Australian sea lion.Photo: David Muirhead, Marine Life Society of South Australia.

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

Where available, further information and references for important areas for threatened and migratory species are provided in Appendix D of this Bioregional Profile.

Important Areas	Rationale
Inshore waters of the Great Australian Bight, including the Head of Bight	**Nursery area – white shark** Small juvenile white sharks (less than 2 m in length) are commonly encountered in this area. It is presumed that the apparent abundance of small white sharks in this area is the result of pupping in or near this area. **Feeding area – white shark** Movements of white sharks are known to increase seasonally at the Head of Bight and may be linked to the seasonal availability and movements of prey including snapper, gummy sharks, Australian salmon and to the calving of southern right whales. **Calving area – southern right whale** The Head of Bight is one of the main southern right whale calving areas in SA.
Pinniped (seal and sea lion) colonies	**Breeding area – Australian sea lion** Five of the known breeding sites for Australian sea lions produce more than 100 pups each year, representing more than 50 per cent of all pups born. These five sites are all off SA: Dangerous Reef (Southern Eyre Peninsula); the Pages Islands (outside the South-west Marine Region); West Waldegrave Island (Western Eyre Peninsula); Seal Bay (Kangaroo Island); and Olive Island (Western Eyre Peninsula). However, because of the closed breeding patterns of Australian sea lions and their threatened conservation status it is considered that all breeding sites for Australian sea lions are significant. **Feeding area – white shark** Evidence indicates that pinniped colonies are areas where white sharks can aggregate or frequently revisit to feed. In addition to the Australian sea lion colonies, most of the known breeding sites for the New Zealand fur seal are found in the Region (30 in SA and 17 in WA). Large breeding populations in the Region are at North and South Neptune Islands, Kangaroo Island and Liguanea Island, which account for more than 80 per cent of the national pup production for the species.
Spencer Gulf and Gulf St Vincent	**Feeding area – white shark** These gulfs are considered important feeding grounds for sub-adult white sharks, although juvenile and large adult sharks have also been observed in these areas. Dolphins, finfish and other elasmobranchs which are abundant here are thought to be targeted by white sharks occurring in these gulfs.
Waters in the east of the Great Australian Bight	**Aggregation – orange roughy** Aggregations have been targeted by commercial fishers in the Great Australian Bight Trawl Fishery sector of the Southern and Eastern Scalefish and Shark Fishery, particularly during the late 1980s and early 1990s, when large catches were taken in some years.
Albany Canyons Group and adjacent shelf break	**Aggregation – orange roughy** Aggregations are known to occur, and have been targeted by commercial fishers. With the decline of the fished aggregation in the eastern Great Australian Bight, virtually all recent (mid 1990s – early 2000s) orange roughy catches in the Region have been taken from two areas off WA, described as the 'Albany Hills' and 'Esperance' stocks. **Feeding area – sperm whale** Sperm whales have been recorded as being concentrated in a narrow area only a few kilometres wide at the shelf edge off Albany, WA.
Kangaroo Island canyons and adjacent shelf break	**Aggregation – orange roughy** Aggregations are known to occur in the area, including in the vicinity of the Murray Canyons, which is near the eastern boundary of the Region. **Feeding area – pygmy blue whale, fin whale and sperm whale** This area is a feeding area for pygmy blue whales, fin whales, sperm whales and possibly sei whales.

continued overleaf

Important Areas	Rationale
Houtman Abrolhos Islands and surrounding waters	**Feeding area – Australian lesser noddy** The sub-species is only known to forage between the islands and the continental shelf edge. **Foraging area – green turtle** Although the importance of this area to the species is not well understood, resident adult green turtles are observed at the reefs of the Houtman Abrolhos Islands. **Resting area – humpback whale** Humpback whales are known to rest in this area on migration. Sightings of Bryde's whales also suggest this area may be important for this rarely sighted species.
Doubtful Islands Bay	**Calving area – southern right whale** This area is one of the main calving areas for southern right whales in WA.
Israelite Bay	**Calving area – southern right whale** This area is one of the main calving areas for southern right whales in WA.
Fowlers Bay	**Calving area – southern right whale** This area is one of the main calving areas for southern right whales in SA.
Albany/ Cape Riche area	**Calving area – southern right whale** This area is one of the main calving areas for southern right whales in WA.
Yokinup Bay/Cape Arid area	**Calving area – southern right whale** This is one of the main calving areas for southern right whales in WA.
Perth Canyon	**Feeding area – pygmy blue whale** The Perth Canyon is a seasonally important aggregation area for krill at depths of 200-300 m and attracts many species of krill feeders, in particular pygmy blue whales. Fin whales have also been observed in the area and it is thought that sei whales may also feed there.
Waters from Rottnest Island to Geographe Bay	**Resting area – humpback whale** The bay and surrounding waters are an important resting area for humpback whales, particularly cow-calf pairs, as they migrate south at the end of the breeding season. Recent surveys have also detected southern right whales in the area and have shown an increasing number of pygmy blue whales using the bay in spring. They have been further observed passing through the shelf area between Cape Naturaliste and Rottnest Island, however the ecological or functional significance of the area to the species is unclear. **Foraging area – loggerhead turtle** Although the importance of this area to the species is not well understood, resident adult loggerhead turtles and sub-adult turtles are known to forage in this area.
Waters off the mid-west to south-west coast of WA	**Foraging area – leatherback turtle** Although the importance of this area to the species is not well understood, leatherback turtles are known to feed in pelagic waters along the mid-west and south-west coast of WA. Adult leatherback turtles have also been observed feeding in inshore waters, including in the Swan River estuary. The southern extent of leatherback turtles in WA is not well understood. They have been found stranded and caught as by-catch in fisheries along the southern coast of WA.
Coastal reefs around Kalbarri	**Foraging area – green turtle** Although the importance of this area to the species is not well understood, resident adult green turtles are observed in this area.
Jurien Bay south to Rottnest Island	**Foraging area – juvenile green turtle** Although the importance of this area to the species is not well understood, large juvenile green turtles are observed in this area.
Waters surrounding Cape Leeuwin/Flinders Bay	**Resting area – humpback whale** Humpback whales are known to rest in this area on migration.
Twilight Cove	**Calving area – southern right whale** This area is one of the main calving areas for southern right whales in WA.

Table 3.4 Seabird rookeries on islands and coastal areas adjacent to the South-west Marine Region

Nesting areas	Nesting species
Houtman Abrolhos Islands	Australian lesser noddy (Morley Island, Wooded Island and Pelsaert Island) Common noddy (Pelsaert Island) Bridled tern (Leo Island, Pelsaert Island, Little North Island) Caspian tern (Leo Island, West Wallabi Island and Pelsaert Island) Osprey (Pelsaert Island) White-bellied sea eagle (West Wallabi Island) Wedge-tailed shearwater
Rottnest Island	Wedge-tailed shearwater Bridled tern
Recherche Archipelago	Flesh-footed shearwater Short-tailed shearwater Caspian Tern White-bellied sea eagle
Penguin Island	Bridled tern
Eyre Peninsula	Osprey White-bellied sea eagle
Kangaroo Island	Osprey
Lancelin Island	Wedge-tailed shearwater Bridled tern
Safety Bay	Wedge-tailed shearwater Bridled tern
Great Althorpe Island	Short-tailed shearwater
Cape Hamelin	Flesh-footed shearwater
Yorke Peninsula	White-bellied sea eagle
Nuyts Archipelago	Caspian tern Flesh-footed shearwater Short-tailed shearwater
Neptune Islands (including North and South Neptune)	Short-tailed shearwater Caspian tern
Gambier Island	Short-tailed shearwater
Lewis, Hopkins and Williams Islands (near Cape Catastrophe)	Short-tailed shearwater
Greenly Island	Short-tailed shearwater
Investigator Group	Short-tailed shearwater
West Troubridge Shoal	Caspian tern
Sir Joseph Banks Group	Caspian tern
Eyre Island and Little Eyre Island	Caspian tern
Fisherman Islands	Bridled tern
Beagle Islands	Bridled tern

3.2.2 Flagship species of the South-west Marine Region

'Flagship' species have been identified in the South-west Marine Region on the basis of their unique association with the Region and its habitats. The concept of flagship species is not legislative and it does not change the conservation status or associated provisions under the EPBC Act. Identifying species that are uniquely associated with a Region – that is, flagship species – is useful for education purposes and to raise awareness about marine conservation matters among the public. Flagship species of the South-west Marine Region are the white shark, the Australian lesser noddy, the great-winged petrel, the Australian sea lion, the southern right whale and the beaked whales (which include at least five separate species). Further information on these species can be found in Appendix D.

White shark – The white shark (*Carcharodon carcharias*) is listed both as a threatened and a migratory species under the EPBC Act. It is classified as a vulnerable species for a number of reasons, including evidence of a declining population, its life history characteristics (long-lived with low levels of reproduction), limited local distribution and abundance and, at the time of listing, pressure from commercial fishing.

White shark. Photo: Rachel Robbins, Fox Shark Research Station.

Although the white shark is a wide-ranging species that is found in all seas, the South-west Marine Region appears to be an important area for the species. Available records of incidental catches of white sharks in Australian waters are higher in the South-west Marine Region than in any other region, and are not well correlated with fishing effort. Fishing activities along the west coast of Western Australia (Shark Bay to Bunbury) and in the Great Australian Bight appear to have significantly higher interactions with white sharks than in other areas, which indicates that these areas may be particularly important for the species. Because of the internationally threatened status of this species the Region may also be significant for the conservation and management of white sharks not only in Australian terms, but possibly also in a global context.

Australian lesser noddy – The Australian lesser noddy (*Anous tenuirostris melanops*) is listed as a marine and a threatened species under the EPBC Act. It is classified as a vulnerable species under the EPBC Act for a number of reasons including past population decline, possibly associated with guano mining in the Houtman Abrolhos Islands and the species' limited distibution.

Australian lesser noddy. Photo: WA Department of Environment and Conservation, Bert and Bab Wells.

The most significant breeding rookeries for the Australian lesser noddy are found in the Houtman Abrolhos Islands on Morley, Wooded and Pelsaert Islands. These islands are adjacent to the South-west Marine Region, and the species is known to forage both around breeding colonies and well out to sea.

Great-winged petrel – The great-winged petrel (*Pterodroma macroptera*) is listed as a marine species under the EPBC Act. The great-winged petrel is not listed as a threatened species under the EPBC Act as it has not been determined as a species threatened by extinction.

Great-winged petrel. Photo: Andrew Burbridge, WA Department of Environment and Conservation.

The great-winged petrel is the only petrel species that breeds adjacent to the Region. In addition, in Australia the great-winged petrel is only known to breed on islands of the Recherche Archipelago and islands offshore of Albany that are adjacent to the South-west Marine Region, with some 33 000 breeding pairs estimated to breed on the islands of the Recherche Archipelago.

Australian sea lion – The Australian sea lion (*Neophoca cinerea*) is listed as a marine and threatened species under the EPBC Act. It is classified as a vulnerable species under the EPBC Act for a number of reasons including lack of population recovery since the end of commercial sealing.

Australian sea lion. Photo: Glen Cowans.

The Australian sea lion is the only endemic species of pinniped in Australia and is currently found only on the west and south coasts of Western Australia, and on the coast of South Australia, although its historic range was far more extensive. It has 66 breeding colonies on islands from the Houtman Abrolhos Islands near Geraldton in Western Australia, to the Pages Islands near Kangaroo Island in South Australia. All of these colonies of Australian sea lions except the Pages Islands colony are on islands adjacent to the South-west Marine Region. All breeding colonies of the Australian sea lion are considered significant for the conservation of the species as it is known to have a low reproductive rate and a restricted capacity to form new colonies. Their limited capacity to form new breeding colonies is because females tend to return to the colony where they were born to reproduce.

Southern right whale – The southern right whale (*Eubalaena australis*) is listed as a cetacean and as a threatened and migratory species under the EPBC Act. It is classified as an endangered species under the EPBC Act. Southern right whales were heavily exploited for their oil and baleen in the early 1800s. Low level catches continued until at least the 1930s when worldwide protection for right whales was introduced in 1935. However, illegal catches continued until the late 1970s. Since the introduction of a moratorium on all commercial whaling in 1985/6 the Australian population of southern right whales has shown signs of a slow, steady recovery.

Southern right whales migrate each year from cold sub-Antarctic waters to breed and calve. They breed while fasting during winter-spring in shallow waters across

Southern right whale and calf. Photo: Clive McMahon, Australian Government Antarctic Division.

the south of the continent, with the majority of the Australian population of southern right whales breeding in the South-west Marine Region. The main calving areas (based on observations of mothers with very young calves in multiple years) currently known for southern right whales within and adjacent to the South-west Marine Region include: Doubtful Islands Bay (including Point Ann/Point Charles area), Israelite Bay area, Twilight Cove, Flinders Bay, Albany/Cape Riche area, and Yokinup Bay/Cape Arid area, Head of the Bight, Fowlers Bay, and Encounter Bay.

Beaked whales – Beaked whales are the least well studied of all marine mammals. This is primarily because of their oceanic distribution and their preferences for deep waters beyond the shelf edge, where few research vessels visit. However, a recent study by MacLeod and Mitchell (2006) indicates that waters south-west of Australia are probably important areas for beaked whales. Despite the limited number of recorded sightings (19) reported in this study in waters off south-west Australia, five species of beaked whales have been recorded. These include the poorly known Hector's beaked whale (*Mesoplodon hectori*) and Andrews' beaked whale (*Mesoplodon bowdoini*). Both of these species are also known from recorded strandings in Western Australia and South Australia. Cuvier's beaked whale (*Ziphius cavirostris*) has also been recorded at sea in this area and from a number of recorded strandings in Western Australia and South Australia.

Hector's beaked whale. Photo: Nick Gales, Australian Government Antarctic Division.

3.3 Protected Places

Protected places include marine protected areas (MPAs) and historic shipwrecks. Within the South-west Marine Region there is one Commonwealth marine reserve – the Great Australian Bight Marine Park – and five shipwrecks protected under the *Historic Shipwrecks Act 1976*. Any as yet undiscovered historic shipwrecks older than 75 years are also protected under the *Historic Shipwrecks Act 1976*. No heritage places occur within the Region, but the presence of the Shark Bay World Heritage Area just north of the northern boundary of the Region should be noted. The values of this World Heritage Area will be considered and described in the Bioregional Profile for the North-west Marine Region. In addition there are a number of marine reserves in State waters adjacent to the South-west Marine Region. For instance, in waters surrounding the Houtman Abrolhos Islands, the Western Australian Government has protected four areas for the conservation and study of resident reef fish species and their habitats.

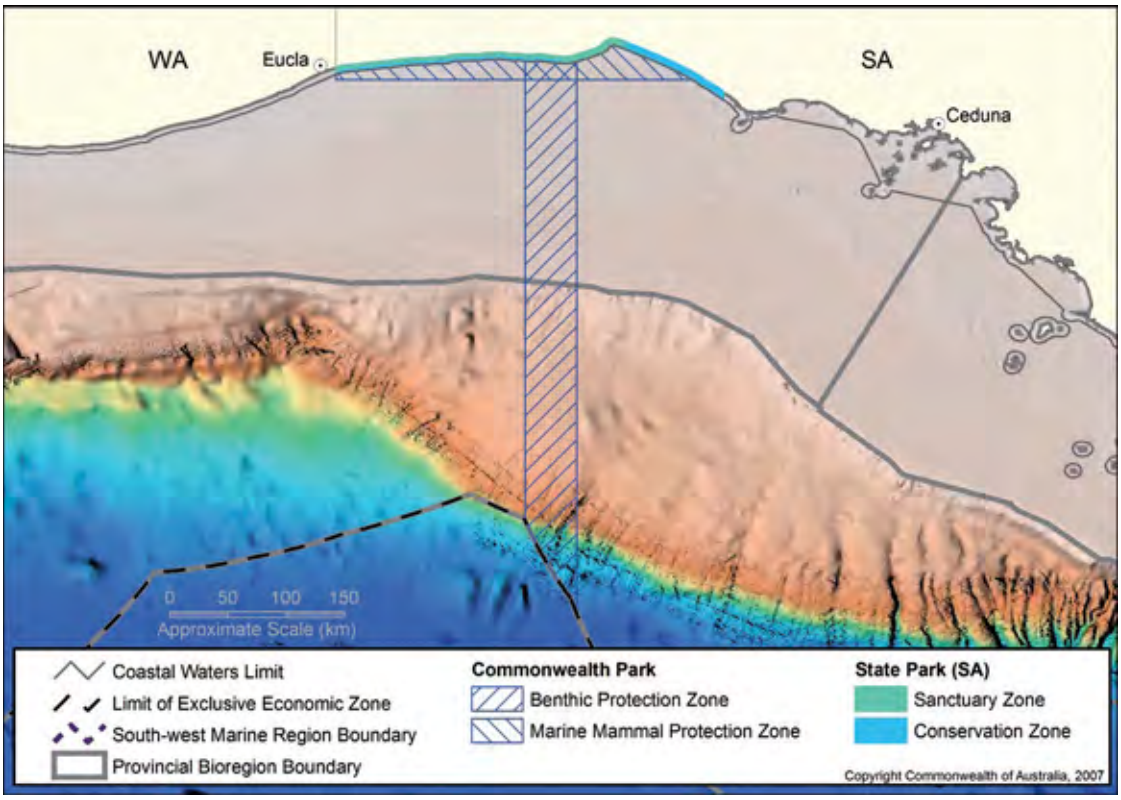
3.3.1 The Great Australian Bight Marine Park

The Great Australian Bight Marine Park (Commonwealth Waters), declared in 1998, is currently the only Commonwealth marine reserve within the Region. At around 19 700 km^2, the park is one of the Australian Government's largest MPAs. The park, including its South Australia State waters components, stretches from 200 km west of Ceduna in South Australia along the coast to the Western Australian border (Figure 3.2). The park is managed cooperatively by the Australian Government and the South Australian Government. It was also the first MPA to include an area especially designed to be representative of the Region.

The combined Commonwealth and State waters of the Park are split into four management zones. Within South Australian waters there are Sanctuary and Conservation Zones, and in Commonwealth waters there is a Marine Mammal Protection Zone and a Benthic Protection Zone. These zones are designed to protect the particular conservation values of the Park which are:

- globally significant habitat for the southern right whale – breeding and calving aggregations of this species, which is listed as endangered, are found in western South Australia and Western Australia along the shores of the Great Australian Bight to Cape Leeuwin;

Figure 3.2 The Great Australian Bight Marine Park



- haul-out, breeding and foraging grounds for the Australian sea lion, a species that occurs only in Australia's southern waters on offshore islands from the Houtman Abrolhos Islands off Western Australia to Kangaroo Island, and on some mainland South Australian sites; and
- habitat for other species of conservation significance, such as the humpback whale, the white shark and several species of albatross.

The Great Australian Bight Marine Park contributes to the National Representative System of MPAs by protecting a representative transect of the seabed on the continental shelf and slope of the Great Australian Bight.

Several unique factors combine to contribute to the high level of biodiversity and endemism in the area of the park. These include a long period of geological isolation, a persistent high wind and wave energy environment, warm-water intrusion via the Leeuwin current from Western Australia, and cold-water, nutrient-rich upwellings in the east. Taxonomic groups with exceptional diversity in this area include red algae (sea weed), ascidians (sea squirts), bryozoans (lace corals), molluscs (shellfish) and echinoderms (sea urchins and sea stars).

The EPBC Act (Section 354) prohibits actions affecting native species inside the park unless authorised under the *Great Australian Bight Marine Park (Commonwealth Waters) Management Plan 2005-2012*. The plan currently allows a range of activities, including fishing and scientific research, to be carried out under permit from the Director of National Parks. Other provisions of the EPBC Act prevent activities that affect species of particular conservation interest (in the park or other Commonwealth waters), and control actions that could have a 'significant' impact on the Commonwealth marine environment, including the park's seabed. The park's management plan supplements this protection by minimising disturbances to areas of habitat important to these species, and prohibiting disturbances to the seabed by benthic trawling, while allowing for other ecologically sustainable activities in the park.

Further information on the Great Australian Bight Marine Park is available at <www.environment.gov.au/coasts/mpa>.

3.3.2 Historic shipwrecks

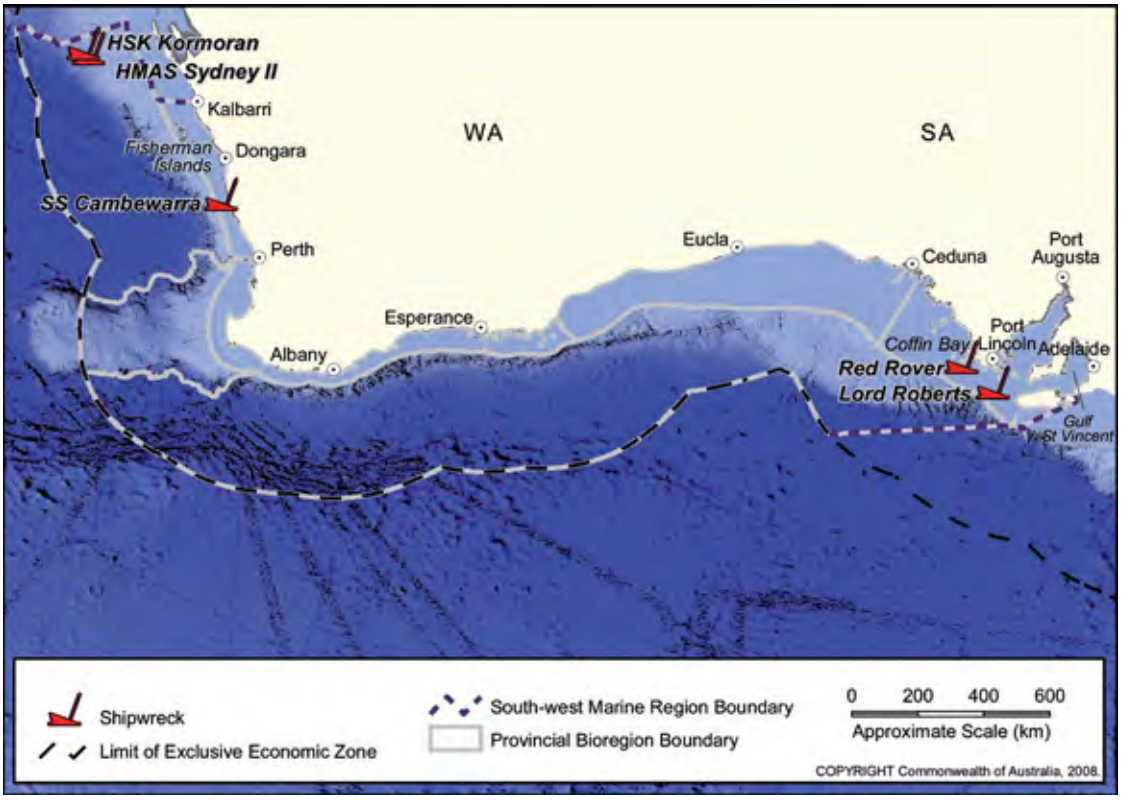
Within the South-west Marine Region there are currently five known historic shipwrecks protected under the *Historic Shipwrecks Act 1976* (note however that many more shipwrecks are located in State waters). These are the:

- ***SS Cambewarra***, a steam powered transport vessel that was wrecked in 1914 near Fisherman's Island, 80 km south of Dongara, Western Australia;
- ***Red Rover***, a fishing boat wrecked in September 1887 near Coffin Bay, South Australia;
- ***Lord Roberts***, wrecked in 1902 in the Gulf St Vincent Region, South Australia;
- ***HMAS Sydney II***, wrecked in 1941 while engaged in battle with the *HSK Kormoran*, approximately 250 km off the mid-west coast of Western Australia; and
- ***HSK Kormoran***, wrecked in 1941 while engaged in battle with the *HMAS Sydney II*, approximately 250 km off the mid-west coast of Western Australia.

The *HMAS Sydney II* and German raider *HSK Kormoran* were found in March 2008, some 66 years after they were lost. The Minister for the Environment, Heritage and the Arts has placed a provisional declaration over the *HMAS Sydney II* and German raider *HSK Kormoran* under the *Historic Shipwrecks Act 1976*. The declaration gives legal protection to these historically significant vessels and relics, from damage, disturbance or removal. Under the provisional declaration, unauthorised damage, disturbance or removal of the sites is prohibited. This action will ensure respect for all those that died in the battle but will not prevent further documentation of the site.

It should be noted that information about the location of shipwrecks is often approximate and that other historic shipwrecks may be located within the Region. Figure 3.3 shows the locations of known historic shipwrecks within the South-west Marine Region.

Figure 3.3 Historic shipwrecks with known locations in the South-west Marine Region



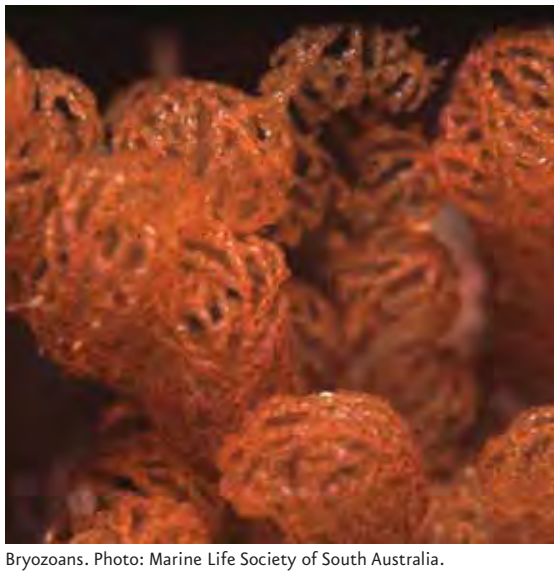
Historic shipwrecks are recognised and protected under the *Historic Shipwrecks Act 1976*, which protects historic wrecks and associated relics found in waters from the low water mark to the edge of the continental shelf. Under the Historic Shipwrecks Act, all wrecks more than 75 years old are protected, 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 Historic Shipwrecks Act aims to ensure that historic shipwrecks are protected for their heritage values and maintained 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 Historic Shipwrecks Act:

- anyone who finds the remains of a ship or articles associated with a ship 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 Historic Shipwrecks Act also provides for protected zones to be declared around wrecks that are at particular threat from interference. Permits are required to enter protected zones, which can cover an area up to a radius of 800 m. There are currently no declared protected zones under the Historic Shipwrecks Act in the South-west Marine Region.

Further information about historic shipwrecks and the Historic Shipwrecks Act can be found at <www.environment.gov.au/heritage/shipwrecks>.



Bryozoans. Photo: Marine Life Society of South Australia.

3.4 Consideration of pressures on regional conservation values

There are a range of pressures impacting, or potentially impacting upon conservation values in the Region. Many of these are outlined in Appendix D (i.e. those of relevance to threatened and migratory species) and in the Coasts and Oceans chapter of the 2006 *State of the Environment Report*.

Of additional concern are the potential impacts of climate change on the marine environment. 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>. The report provides a detailed overview of the potential impacts climate change could have on marine biodiversity and ecosystems. It also proposes research and adaptation strategies to ameliorate climate change impacts.

The information collected during the profiling stage will inform how pressures on the regional conservation values described in this chapter, will be addressed in the South-west Marine Bioregional Plan.

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.

Long-snouted boarfish. Photo: Marine Life Society of South Australia.

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Map data

Figure 3.1 Key Ecological Features of the South-west Marine Region

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Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Figure 3.2 Great Australian Bight Marine Park

Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Figure 3.3 Historic shipwrecks with known locations occurring in the South-west Marine Region

Department of the Environment, Water, Heritage and the Arts (2003): Historic Shipwrecks Register
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
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Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Trevally. Photo: David Muirhead, Marine Life Society of South Australia.

Chapter 4 Establishing New Marine Protected Areas in the South-west Marine Region

Australia is committed to the development of a National Representative System of Marine Protected Areas (MPAs). The primary goal of the National Representative System of MPAs is to establish and manage a comprehensive, adequate and representative system of MPAs 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. This means that:

- each distinct bioregion in Australian waters will be represented in an MPA network;
- that the design of the network should be sufficient to achieve the conservation of all major ecosystem functions and features; and
- that the network should properly represent the identified habitats and biota characteristic of each bioregion[1].

Since 1998, there have been many decisions that have helped formulate the Australian Government's approach to establishing an MPA network. These include the development of a clearer understanding of how the *National Representative System of Marine Protected Areas Guidelines* will be applied by the Australian Government, drawing on the best available scientific information. More recently, the Department of the Environment, Water, Heritage and the Arts has worked with Australian Government agencies to develop a single document that provides a clear approach to MPA development: 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 *National Representative System of Marine Protected Areas Guidelines* and the Australian Government's implementation experience to date, to ensure proper consideration of ecological and socio-economic requirements. The Goals and Principles do not introduce anything new, or replace existing policies.

The Australian Government considers that measures other than MPAs 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 MPA network.

In addition to MPAs, the Government supports the use of spatial measures, including both temporal and permanent area closures, in the management of fisheries. Fisheries-specific measures are developed according to the particular goals and circumstances of each fishery. MPAs 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. MPAs may lead to improved fisheries performance and fisheries closures may achieve biodiversity benefits. The Government seeks to ensure that the design of MPAs takes into account the potential for beneficial impacts on fishery resources, and that MPAs are selected and zoned to enhance or conserve fisheries wherever possible.

The Government develops and declares MPAs in the context of a commitment to minimise costs to industry under its policy on MPAs and displaced fishing: *Marine Protected Areas and Displaced Fishing* <www.environment.gov.au/coasts/mpa>. MPAs 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 MPA network may transfer some marine resources from current production to biodiversity conservation. Therefore, before any new MPAs are declared, it will assess the financial and economic costs and benefits of each regional MPA network and decide on the provision of any adjustment assistance to affected businesses.

The Government is committed to the establishment, through the marine bioregional planning process, of comprehensive, adequate and representative MPA networks throughout the Commonwealth marine area. These networks will include some highly protected zones (IUCN Categories I and II) and some large areas initially assigned to IUCN Category VI. This approach recognises that the MPAs are being developed in the absence of detailed information for many areas and applies a precautionary approach in determining size. Using a staged and adaptive approach to zoning is consistent with the principles of ecologically sustainable development. This approach also allows more

1 For the purpose of this document, 'bioregion' means provincial bioregion as defined in the *Integrated Marine and Coastal Regionalisation of Australia Version 4.0*.

information about the specific ecological, economic and social values of an area, and the threats to those values, to be gathered. In these instances, the Government will set out clear strategies for increasing information over time, including improved knowledge of biodiversity, other environmental values, and current and prospective commercial uses of these areas.

Australian lesser noddy. Photo: Andrew Burbidge, WA Department of Environment and Conservation.

4.1 Goals and Principles

The Australian Government is committed to develop, by 2012, a National Representative System of MPAs. This network will be, as a whole, representative of the 41 provincial-scale bioregions recognised in Commonwealth waters. Areas suitable for inclusion in the National Representative System of MPAs will be identified during the marine bioregional planning process. The National Representative System of MPAs is being developed using the *Guidelines for Establishing the National Representative System of Marine Protected Areas* <www.environment.gov.au/coasts/mpa> agreed between the Australian Government, the States and the Northern Territory in 1998.

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. The focus is on ensuring that MPAs are developed for those bioregions that are currently not represented, or are under-represented, in MPAs.

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

This approach draws 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, comprised of very deep water and has not been the subject of detailed study or data gathering. In these circumstances, the detailed and peer-reviewed data that does exist 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 into the process will include:

- existing scientific information underlying IMCRA v.4.0 (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 MPAs; and
- consideration of potential management effectiveness (e.g. feasibility of compliance).

4.1.1 The goals

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

Goal 1 – Each bioregion (as defined in IMCRA v.4.0, see Figure 4.1) occurring in the Region should be represented at least once in the MPA network. Priority will be given to bioregions not already represented in the National Representative System of MPAs.

Why this goal? Each **bioregion** has been identified because it reflects broad-scale patterns of biodiversity and evolution.

Goal 2 – The MPA network should cover all **depth ranges** (50-5000+ m, see Figure 4.2) occurring in the Region, or other gradients of light penetration in waters over the continental shelf.

Why this goal? Depth is one of the main factors determining the 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. In Australia's north, where there is an extensive expanse of relatively shallow water over the continental shelf, it is turbidity, rather than water depth, that 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.

Goal 3 – The MPA 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 kms) scale.

Why this goal? While including each bioregion in the MPA network ensures that we capture some of the biological diversity at a very large-scale, where we also have good biological information it will be used to guide selection of areas for inclusion in the National Representative System of MPAs.

Goal 4 – The MPA network should include all **types of seafloor features**[1] (see Figure 4.3). There are 21 seafloor types across the entire EEZ. Some bioregions will be characterised by the presence of a certain subset of features, such as continental slope or seamounts.

Why this goal? Different biological communities are often associated with different types of seafloor geomorphology. Ensuring that the characteristic features of each bioregion are represented is important in achieving a comprehensive and representative sample of biodiversity within the MPA network.

Warty prow fish. Photo: Marine Life Society of South Australia.

1 Seafloor features here refer specifically to the geomorphic features defined by IMCRA v.4.0.

4.1.2 Guiding Principles

Location of MPAs

In developing options that meet the four goals, the following **location principles** will be applied:

1. MPAs 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.

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

Selection

Where different options that meet the goals exist, the following **selection principles** should be considered in selecting areas suitable for inclusion in the National Representative System of MPAs:

3. The capacity of an MPA 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 MPA network would improve administration of protection regimes).

9. Socio-economic costs should be minimised.

Design

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

10. Individual areas should, as far as practicable, include continuous depth transects, (e.g. from the shelf to the abyss).

11. Whole seafloor (geomorphic) features should be included.

12. Features should be replicated wherever possible within the system of MPAs, (i.e. included more than once).

13. Size and shape should be orientated to account for inclusion of connectivity corridors and biological dispersal patterns within and across MPAs.

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

Zoning

Because zoning of MPAs (i.e. the allocation of appropriate management regimes to different zones) 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 MPAs:

17. Zoning will be based on the EPBC Act/World Conservation Union (IUCN) categories of protection (see Box 4.1).

18. The regional MPA network will aim to include some highly protected areas (IUCN Categories I and II) in each bioregion.

19. Zoning will be based on the consideration of the threat that specific activities pose to the conservation objectives of each MPA.

20. Zoning of MPAs 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 IUCN 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 the 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/theme/categories/what.html>.

Large sponges with small sponges, ascidians, bryozoans and octocorals. Central Western Province, 93 m deep. Photo: CSIRO.

4.2 Regional specifications for identifying representative MPAs in the South-west Marine Region

4.2.1 Meeting the goals in the South-west

To achieve the four goals for the establishment of the National Representative System of MPAs 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 (bioregions)

The network of representative MPAs in the South-west Marine Region will represent each of the seven bioregions as defined by IMCRA v.4.0 (Figure 4.1).

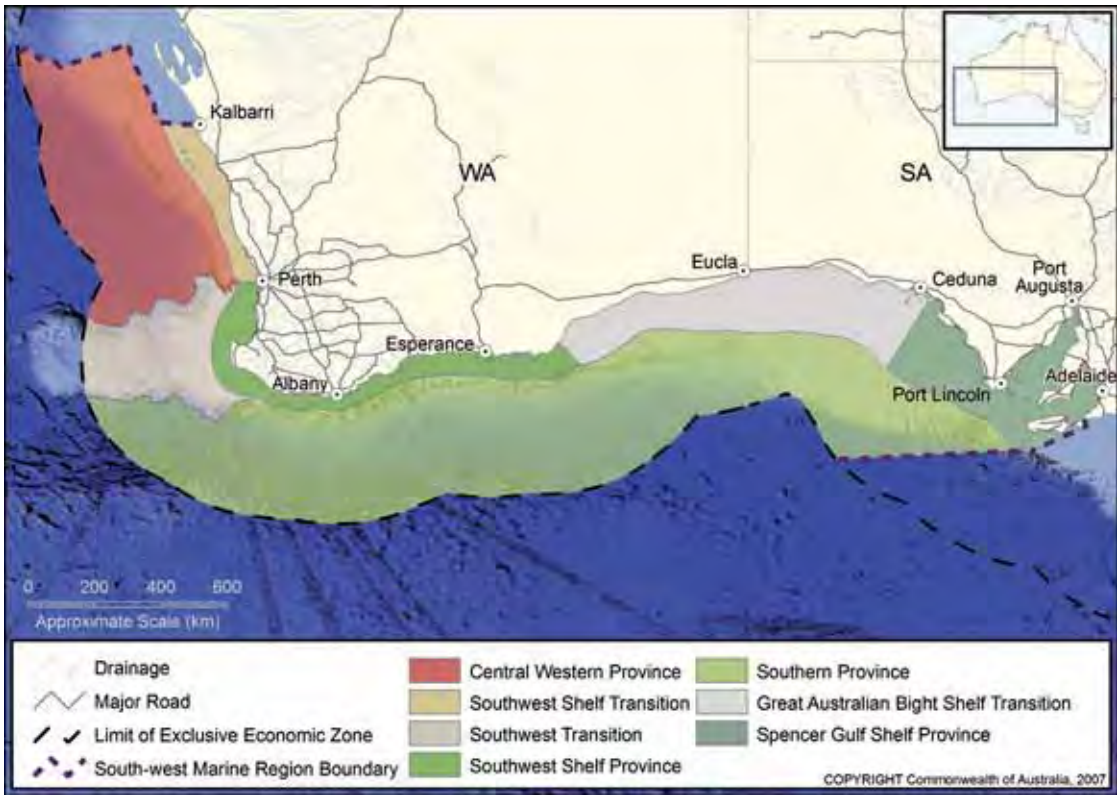
Of these, the Central Western Province and the Southwest Transition are wholly contained within the South-west Marine Region (Table 4.1). The Great Australian Bight Shelf Transition, the Southwest Shelf Province, and the South-west Shelf Transition are not represented in any other planning Regions, however some of their area is within State waters. The Spencer Gulf Shelf Province straddles State waters and the waters of the South-east Marine Region. The Southern Province, although mostly within the Region, also straddles waters of the South-east Marine Region (see Table 4.1).

The Great Australian Bight Shelf Transition and Southern Province are represented in an existing MPA, the Great Australian Bight Marine Park (see Chapter 3.3 for details). The Spencer Gulf Shelf Province is represented in the Murray Commonwealth Marine Reserve, established as part of the South-east Marine Region network of MPAs.

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

- Central Western Province;
- Southwest Transition;
- Southwest Shelf Transition; and
- Southwest Shelf Province.

Figure 4.1 ***Bioregions of the South-west Marine Region***



Specifying Goal 2 (depth ranges)

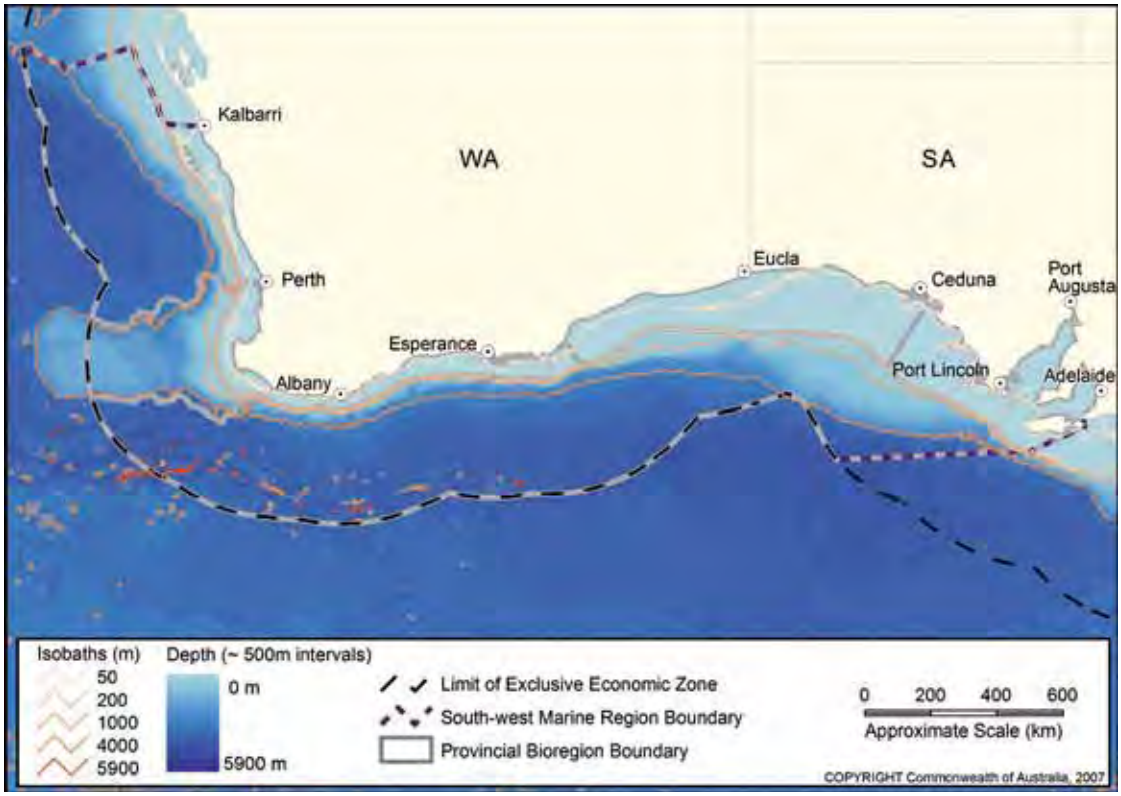
The range of depths that occur in the South-west Marine Region should be represented in the network of representative MPAs. Water depths in the South-west Marine Region range from 10-5900 m (Figure 4.2). The Region has more than 25 per cent of its area occurring in water depths of less than 150 m, with over 50 per cent of the area occurring in depths greater than 4000 m. This is a large proportion in comparison to the entire EEZ (only 35 per cent of the total EEZ has water depths greater than 4000 m). The depth range and area of each bioregion in the Region is shown in Table 4.1.

Some of the Region's bioregions occur exclusively on the continental shelf and as such do not display a significant variation in depth relative to the Region as a whole. Within such bioregions other factors that may affect the distribution of biota and habitats will be considered in the design of the MPA network.

Table 4.1 Depth and area of each bioregion

Bioregion	Total area (km²)	Percentage of the bioregion contained within the Region	Depth range (m)
Spencer Gulf Shelf Province	133 160	39	10 - 200
Southern Province	770 270	85	200 - 5900
Great Australian Bight Shelf Transition	146 547	93	10 - 200
Southwest Shelf Province	73 772	78	10 - 200
Southwest Transition	101 055	100	200 - 5190
Southwest Shelf Transition	32 809	81	10 - 200
Central Western Province	268 460	100	200 - 5795
Total	1 526 074	85 (approx. 1.3 million km²)	10 - 5900

Figure 4.2 Depth ranges in the South-west Marine Region



Specifying Goal 3 (large-scale biological features)
The network of MPAs in the South-west will seek to include examples of known large-scale benthic and demersal (i.e. associated with the seafloor) biological features. Due to a range of factors, including the remoteness of the Region, its environment is one of the least studied in Australia. With the exception of the benthic communities living across the continental shelf of the Great Australian Bight (which are represented in the Great Australian Bight Marine Park), little is known about other large-scale biological features that may exist within the Region. During the bioregional planning process, available biological datasets will be assembled, to assist in identifying other large-scale biological features that may be suitable for inclusion within this representative system.

Specifying Goal 4 (seafloor features)
The South-west network of MPAs will seek to include representative examples of the 15 seafloor features (geomorphic features) identified in the Region (see Figure 4.3).

Some geomorphic features have very few occurrences. As a result, the placement of MPAs may be influenced by the location of such regionally unique features.

Tam o'Shanter (pancake) sea urchin on fine sediments. Southern Province, 707 m deep. Photo: CSIRO.

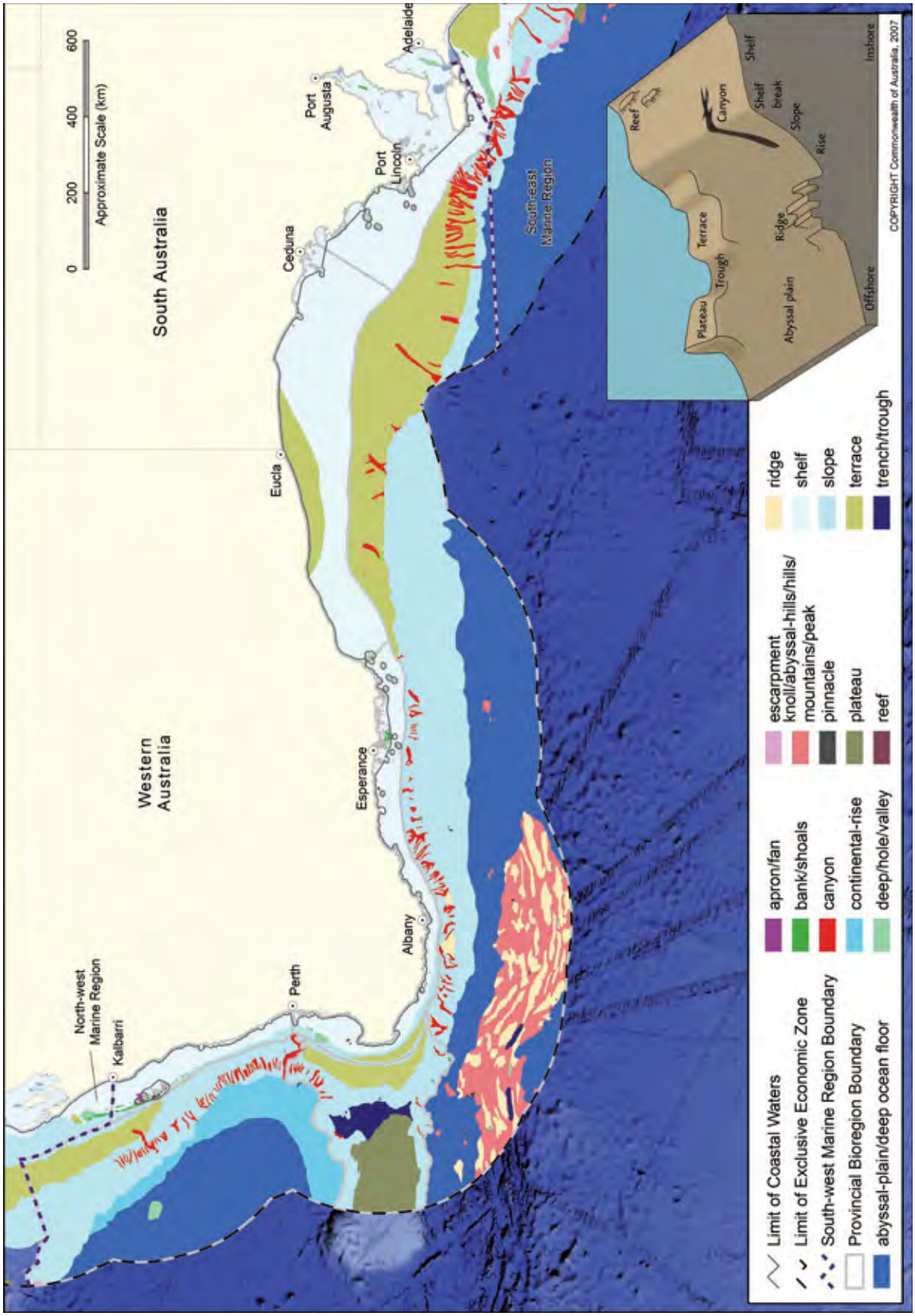


Figure 4.3 *Geomorphic features (seafloor features) of the South-west Marine Region*

This is also available as a separate map in the envelope in the back cover of this book.

4.2.2 Applying the principles in the South-west

This section outlines considerations relevant to the regional application of the location, selection, design and zoning principles as listed in Chapter 4.1. Note that only those principles that require a regional specification (i.e. require input of regionally specific data) are considered below. In any given Marine Region, there may be different options for MPAs that meet the four goals for the establishment of a representative network.

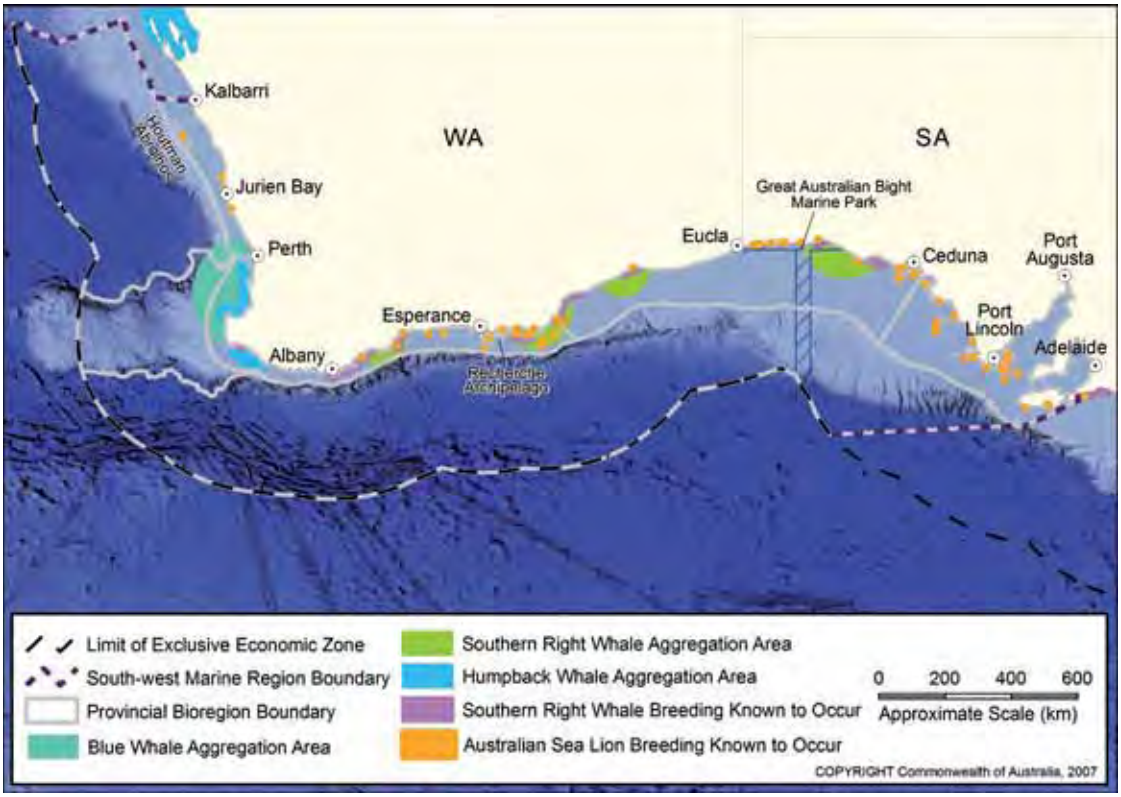
Existing spatial management measures (Principle 1)
According to the principles outlined in Chapter 4.1, the first step in determining the approximate location of suitable areas will be to consider the occurrence, extent and purpose of existing spatial management arrangements, such as existing protected areas and/or sectoral measures, with a view to assessing their ability to contribute to a representative network in the Region. Spatial management arrangements in the South-west include closures for commercial and recreational fishing and areas managed for conservation objectives.

Threats to the Region's conservation values (Principle 3)
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 of management. An analysis of the threats to the key ecological features identified in the Region (see Chapter 3) will take place during the next stage of the planning process. Those key ecological features subject to threats that are not currently managed and can best be mitigated through spatial management will be considered for inclusion in the proposed network of MPAs.

Habitat and aggregation areas of threatened or migratory species (Principle 4)
While there are no habitats in the South-west Marine Region listed in the *Register of Critical Habitats* under the EPBC Act, this Bioregional Profile identifies several sites of significance to threatened and migratory species that reside in, or transit through, the Region. A map of known aggregation areas and habitats for whales and Australian sea lions is at Figure 4.4 and further details are included in the Species Group Report Cards at Appendix D.

Ecologically important pelagic features (Principle 5)
Seven of the 17 key ecological features identified in the Region pertain to the pelagic environment (i.e. open waters) and have a consistent and definable spatial distribution, such as the eddy fields off the west coast. In accordance with Principle 5, these will be considered in selecting MPAs in those instances where multiple

Figure 4.4 Whale aggregation areas and Australian sea lion breeding sites in the South-west Marine Region



options exist that meet the four goals. The pelagic features of key ecological significance are shown in Figure 3.1.

Small-scale (tens of kilometres) benthic/demersal ecosystems (Principle 6)

Ecosystem structure and functioning have been considered and described in this Bioregional Profile at broad regional and bioregional scales. Where available, finer-scale data and information, such as information on meso-scale bioregions, will be considered to explore options that meet the four goals.

Small-scale distribution of sediment types and sizes (Principle 7)

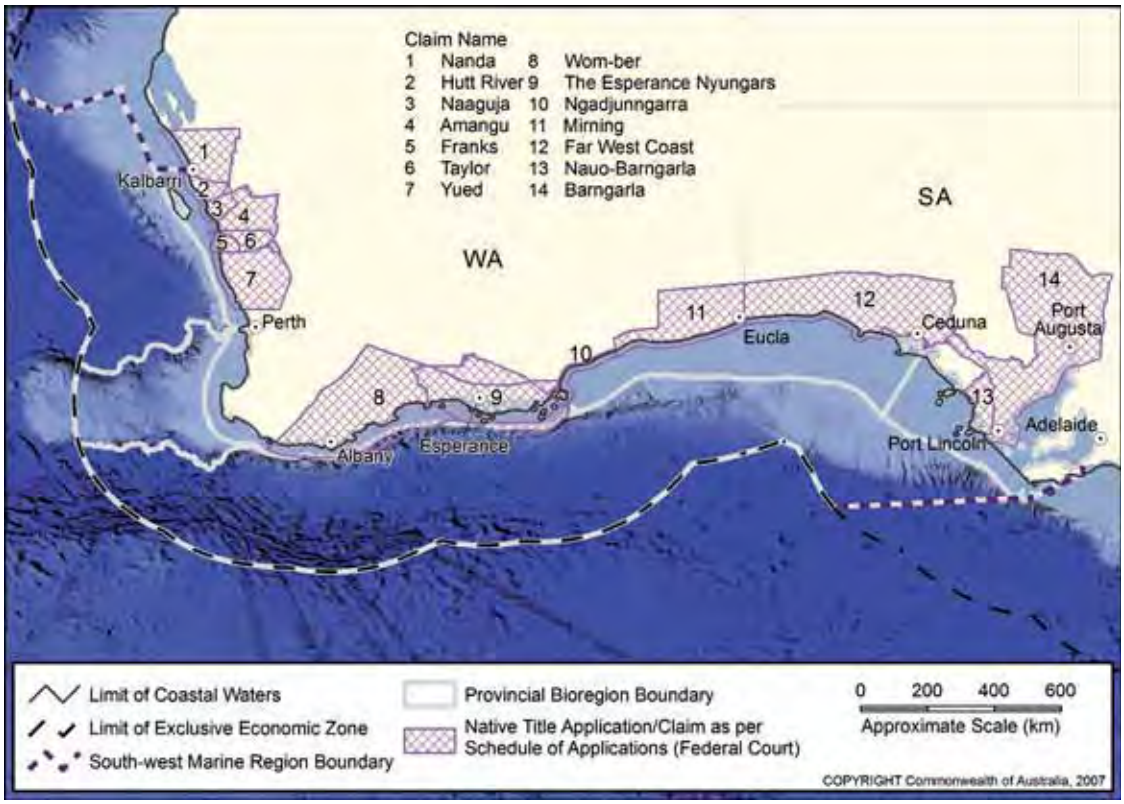
Scientists know that sediment type and size strongly influence the species and communities that are found on and near the seafloor. In the deeper parts of the Region, the types of sediments associated with different plants and animals are unknown. It is reasonable to expect that by including multiple and diverse types of sediments within an MPA, a larger variety of organisms will be protected. In those instances where different options to meet the four goals exist, data derived from a sediment study undertaken in collaboration with Geoscience Australia will be used during the selection of candidate MPAs, aiming to include areas that cover a broader range of sediment types.

Socio-economic factors (Principles 9 and 16)

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 MPAs. 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 MPAs may include consideration of native title rights and interests (see Section 227 of the *Native Title Act 1993*). Coastal Aboriginal peoples in the South-west Marine 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 currently 14 native title applications (11 in Western Australia and three in South Australia) that extend into Commonwealth waters of the South-west Marine Region (Figure 4.5).

Figure 4.5 Native title claims in the Region



Australian sea lions at Seal Bay on Kangaroo Island. Photo: Allan Fox and the Department of the Environment, Water, Heritage and the Arts.

4.3 Process for establishing new Commonwealth marine reserves in the South-west Marine Region

The identification of new MPAs in the South-west, in contribution to the National Representative System of MPAs, will occur during the next stages of the marine bioregional planning process (see Chapter 6).

Step 1

A proposed MPA network will be developed by the Department of the Environment, Water, Heritage and the Arts in accordance with the Goals and Principles and regional specifications outlined in Section 4.2. During this time, stakeholders will be consulted by the Department. Stakeholder participation will ensure that the Department has accurate and comprehensive details of the current uses and interests in the Region. This will help ensure that the impact of proposed MPAs on current users of the Region 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 MPA network will be agreed by Government and released in a Draft Plan for a 90 day 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 MPA network or other aspects of the Draft South-west 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 MPAs to be declared as marine reserves. Marine reserves will be declared 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 South-west Marine Region following the release of this Bioregional Profile.

Key references and further readings

Australian and New Zealand Environment and Conservation Council, Task Force on Marine Protected Areas (ANZECC TFMPA), 1998, *Guidelines for Establishing the National Representative System of Marine Protected Areas*, Environment Australia, Canberra, <www.environment.gov.au/coasts/mpa>, accessed 15/05/07.

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Potter, A., Southby, C., & Heap A.D., 2006, *Geomorphology and Sedimentology of the South Western Planning Area of Australia*, Geoscience Australia, Canberra, <www.environment.gov.au/coasts/mbp/south-west>

Scientific Peer Review Panel for the National Representative System of Marine Protected Areas, 2006, *Guidance on Achieving Comprehensiveness, Adequacy, and Representativeness in the Commonwealth Waters Component of the National Representative System of Marine Protected Areas*, Department of the Environment and Heritage, Canberra, <www.environment.gov.au/coasts/mbp>

World Conservation Union, 1994, *Guidelines for Protected Area Management Categories*, IUCN, <www.iucn.org/themes/wcpa/pubs/guidelines.htm>, accessed 15/05/07.

Legislation

Available from the Commonwealth of Australia Law website <www.comlaw.gov.au>.

Environment Protection and Biodiversity Conservation Act 1999 (Cth).

Native Title Act 1993 (Cth).

Map data

4.1 Bioregions of the South-west Marine Region
Department of the Environment and Heritage (2004): Collaborative Australian Protected Areas Database - CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

4.2 Depth ranges in the South-west Marine Region
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Figure 4.3 Geomorphic features (seafloor features) of the South-west Marine Region
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2004): Geomorphic Features of Australia's EEZ
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Figure 4.4 Whale aggregation areas and Australian sea lion breeding sites in the South-west Marine Region
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions

Department of the Environment, Water, Heritage and the Arts (2006): Species of National Environmental Significance Database
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
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Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

Figure 4.5 Native title claims in the Region
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
WA Landgate (2007): Schedule Native Title Claims of WA
National Native Title Tribunal (2007): Schedule of Native Title Applications (Excluding QLD and WA)
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN)

LPG tanker in Fremantle 's outer port. Photo: Fremantle Port Authority.

Chapter 5 Human Activities and the South-west Marine Region

Planning for long-term ecologically sustainable use in the South-west Marine Region requires an understanding of human interactions with the marine environment. Chapter 5 provides a broad overview of the nature and extent of the human activities that take place within and adjacent to the Region. It provides background information 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 South-west Marine Bioregional Plan. In addition to finer scale information, that assessment will also require consultation with stakeholders. More information on how the South-west Marine Bioregional Plan will be developed is provided in Chapter 6.

The South-west Marine Region hosts a range of economic, social and cultural activities. At present, the major industries within the Region are commercial fishing, marine tourism, petroleum exploration and production and shipping. Other marine-related activities include recreation, aquaculture, and defence training. The Region is also used as the location of a communication cable of national significance – the SEA_ME_WE3 cable which links Australia with South-East Asia. The commercial and other uses of the Region make an important economic and social contribution to the Australian economy and to settlements along the coast. These range from small fishing towns, to the metropolitan centres of Perth and Adelaide, which dominate the population and economic geography of the south-west.

Specific and detailed consideration of the potential impacts of current and future human activities on the Region will be the focus of the next stage of the planning process. Information about the interactions between specific activities and protected species that inhabit the Region, and about the potential implications for the long-term conservation of these species, is included in the Protected Species Group Report Cards in Appendix D.

Most of the information in this chapter has been drawn from the report *A Socio-economic Analysis and Description of the Marine Industries of Australia's South-west Marine Region*, commissioned by the Australian Government as part of the marine bioregional planning process. This report provides information on the economic value and employment associated with ports, shipping, ship and boat building, oil and gas, submarine cables, defence, marine tourism, commercial and recreational fishing and aquaculture. The reader is referred to this publication and other web-based resources at <www.environment.gov.au/coasts/mbp/south-west>.

Fishing nets and buoys. Photo: CSIRO.

5.1 The human dimension: an overview

Aboriginal people of the south-west and 'sea country'[1]

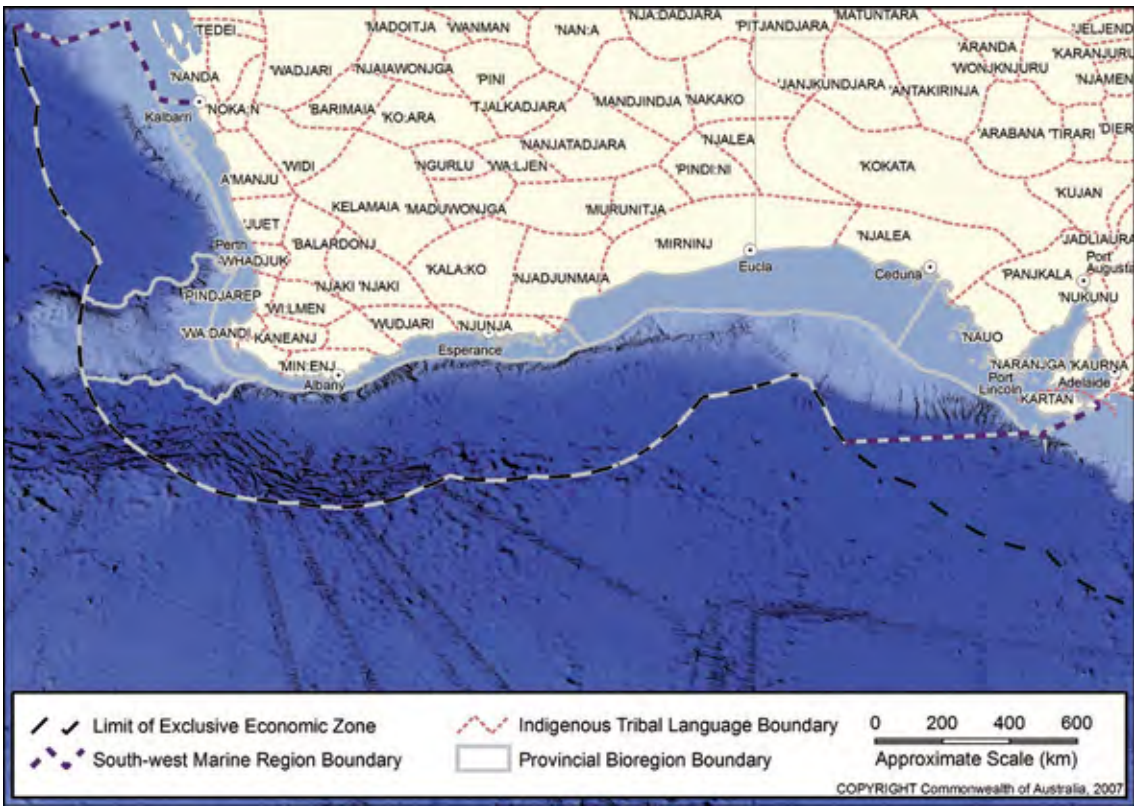
The South-west Marine Region lies adjacent to the coastline of both Western and South Australia. This coastline is home to over 30 Aboriginal coastal language or clan groups (Figure 5.1). The relationship of these groups with the sea is underpinned by a tradition of custodial rights and responsibilities that extend back many thousands of years. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge remain important activities for the region's Aboriginal people.

Aboriginal people continue to actively manage their sea country, including through cooperative arrangements with governments such as the Indigenous Protected Area Programme, administered by the Australian Government Department of the Environment, Water, Heritage and the Arts. The Indigenous Protected Area at Yalata in South Australia adjoins a number of conservation reserves, including the Great Australian Bight Marine Park. Together these areas form one of the world's largest contiguous areas of land and sea managed for biodiversity conservation, see <www.environment.gov.au/indigenous/ipa/declared/yalata.html>.

Aboriginal people are also negotiating, under the *Native Title Act 1993*, Indigenous Land Use Agreements that may be of relevance to the management, protection and traditional use of the Region's environment and resources. There are two Indigenous Land Use Agreements to date that include marine areas located adjacent to the South-west Marine Region – the Port Vincent Marina Indigenous Land Use Agreement, and the Nagunnga Local Government Indigenous Land Use Agreement – both in South Australia. For further information see the National Native Title Tribunal website at <www.nntt.gov.au/registers/Riluas.html>.

1 The Aboriginal English term 'sea country' describes both the customary Aboriginal and Torres Strait Islander clan estates in the sea and the economic, cultural and spiritual attributes that they embody.

Figure 5.1 Distribution of Aboriginal coastal language groups in the south-west



Coastal and marine development since European settlement

European use of the resources of the Region began with sealing and whaling in the early nineteenth century. Fishing, shipping and ports soon became important components of the economy of the south-west.

One of the most widely dispersed activities has been fishing. Initially constrained by transport and storage technology, commercial fisheries were small-scale and targeted coastal areas close to markets. With the introduction of new fishing technologies including trawling, and the capacity to access more distant markets both in Australia and overseas, the industry expanded during the twentieth century and particularly after World War II.

Other industries with an important early influence on the economic geography of the south-west were whaling, sealing and sandalwood forestry. However, it was the gradual emergence of a large-scale, export-oriented agricultural industry that has had the most sustained impact on the economic development of the South Australian and Western Australian economies.

The early expansion of farming, particularly from the 1890s, resulted in the development of extensive port and shipping industries throughout the south-west. Between 1890 and 1930, an extensive network of railways was constructed in Western Australia, radiating out from coastal towns such as Esperance, Albany, Bunbury and Geraldton. The colonial (and later State) governments invested heavily in port infrastructure in these towns in order to improve the efficiency of transporting wheat and wool to overseas markets. Significant port facilities also underpinned the development of South Australian towns such as Port Lincoln, Port Augusta, Port Pirie, Whyalla and Kingscote.

The south-west today

The south-west has a complex socio-economic structure based on a wide range of industries. The industries and activities of most significance to the South-west Marine Region include aquaculture, commercial and recreational fishing, defence, marine tourism and recreation, petroleum exploration and production, ports, and shipping. In addition, a number of emerging industries such as carbon capture and storage and biotechnology may be significant in the future.

The marine and marine-related industries operating within and adjacent to the South-west Marine Region are far from static, and have experienced dynamic changes in their economic structure and economic geography. Some key industries have grown rapidly over the past decade or so, most notably marine tourism and recreation. More mature industries like commercial fishing tend not to have experienced the same growth. All of these industries underpin economic growth, employment, and social wellbeing in the cities, towns and small communities of the south-west. At the same time it is apparent that lower intensity uses have gradually emerged along other parts of the coast. These uses include suburban and other residential developments within the south-west, and the development of significant coastal tourism and recreational industries. While there is a degree of concentration associated with both, they are now affecting quite large parts of the coastline adjacent to the Region.

Today, the population along the south-west coast is concentrated in and around the major urban centres of Adelaide and Perth, and a number of other regional centres including Geraldton, Albany, Esperance, Port Lincoln and Whyalla (Table 5.1).

Large parts of the coast have very small populations consisting of rural communities and dispersed settlements. This population geography reflects not only the history of European settlement, but also the availability of natural resources. The establishment of Perth and Adelaide as colonies in the nineteenth century, and the rise of these centres as political capitals, played an important role in their subsequent dominance of the population and economic geographies of their respective States.

The Adelaide coastline. Photo: Coast Protection Board of South Australia.

Table 5.1 Population of major cities/towns adjacent to the South-west Marine Region (2001)

City/town	Population	Percentage of coastal population
Western Australia		
Perth	1 457 600	53.9
Albany	31 981	0.1
Geraldton	19 054	less than 0.1
Esperance	13 265	less than 0.1
South Australia		
Adelaide	1 124 300	41.6
Whyalla	24 000	less than 0.1
Port Lincoln	14 563	less than 0.1
Ceduna	3 536	less than 0.1
Streaky Bay	2 014	less than 0.1

Outside the capital cities, the distribution of population is linked largely to primary industries, particularly agriculture, mining and fisheries. In the areas between Geraldton and Esperance in Western Australia, and Ceduna and the South Australia-Victorian border, settlement is dominated by small agricultural service settlements and fishing communities, many of which have diversified more recently into tourism. In the more remote, arid parts of the south-west, the population is extremely sparse and concentrated around a handful of small fishing villages.

As in other parts of the country, many coastal settlements in the south-west have recorded significant increases in population over the past decade or so. Between 1986 and 2001, the coastal population grew by 19.7 per cent – twice the national average. However, population growth is not evenly distributed and tends to be concentrated in areas of high environmental amenity and the extended metropolitan commuter belts of Perth or Adelaide. Between the years 1986 to 2001, the population of Perth increased by 34.7 per cent (some 345 000 people), representing over 76 per cent of the total coastal population growth within the south-west. Trends observed between 1986 and 2001 appear to have continued. Figure 5.2 shows the average annual population growth between the years 2001 to 2006.

There have been a number of drivers of population growth, including lifestyle and retiree migration to coastal communities, a general movement of people from inland agricultural regions to the coast, and the rise of tourism and recreation in marine and coastal areas. Given Australia's ageing population and rising level of affluence, together with the increasing popularity of coastal and marine tourism, this trend is likely to continue into the foreseeable future. However, not all coastal areas adjacent to the Region have experienced population growth and many remote communities have experienced population decline.

Of the population aged 15 years and older living in the south-west in 2001, approximately 59.7 per cent were in the labour force (a figure close to the national average). The aggregated labour force statistics for the south-west indicate that the majority of people are employed in retail trade (15.3 per cent), manufacturing (12.6 per cent), property and business services (11.1 per cent) and health and community services (10.9 per cent). The education and construction industries also account for a considerable proportion of the labour force, with employment within these sectors representing 7.3 and 6.8 per cent respectively.

The aggregated labour force statistics tend to mask significant geographical variations. Figure 5.3 shows the labour force structure according to different settlement types. The most apparent feature is the importance of agriculture, forestry and fishing in settlements with fewer than 10 000 people. This reflects the dependence of these economies on primary industries, particularly agriculture and, to a lesser extent, fishing.

Figure 5.2 *Average annual population growth adjacent to the South-west Marine Region (2001 – 2006)*

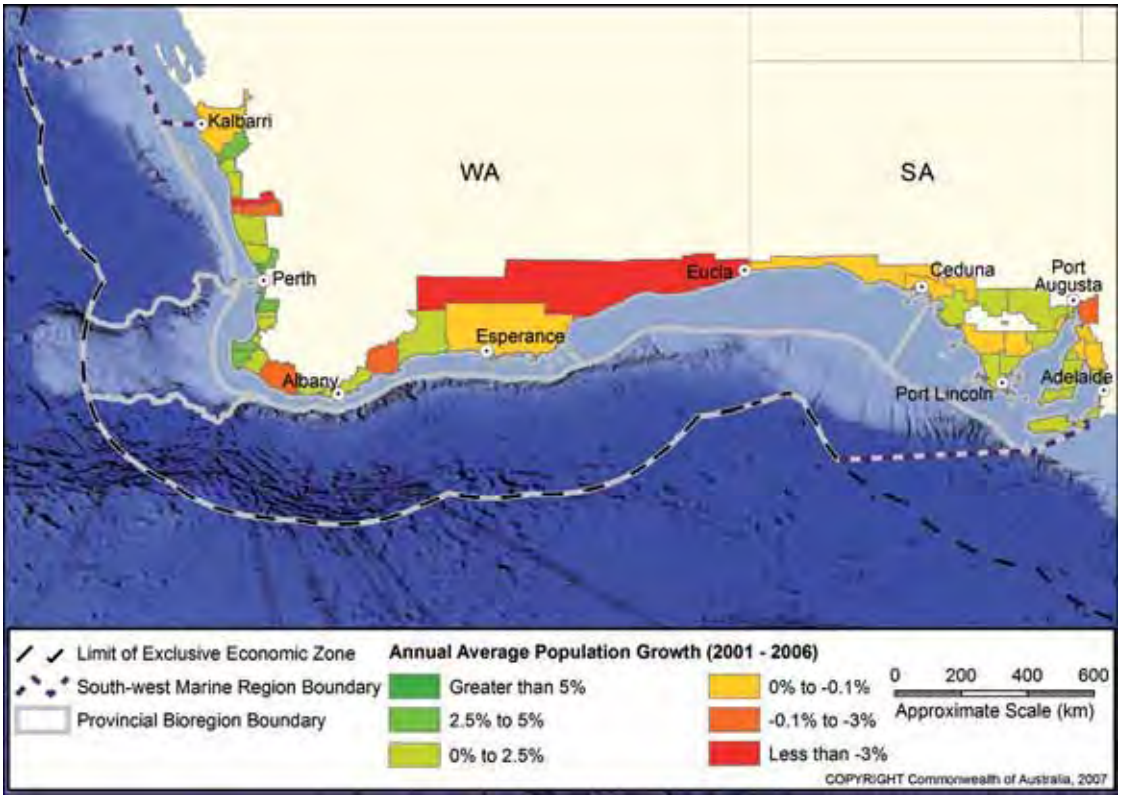
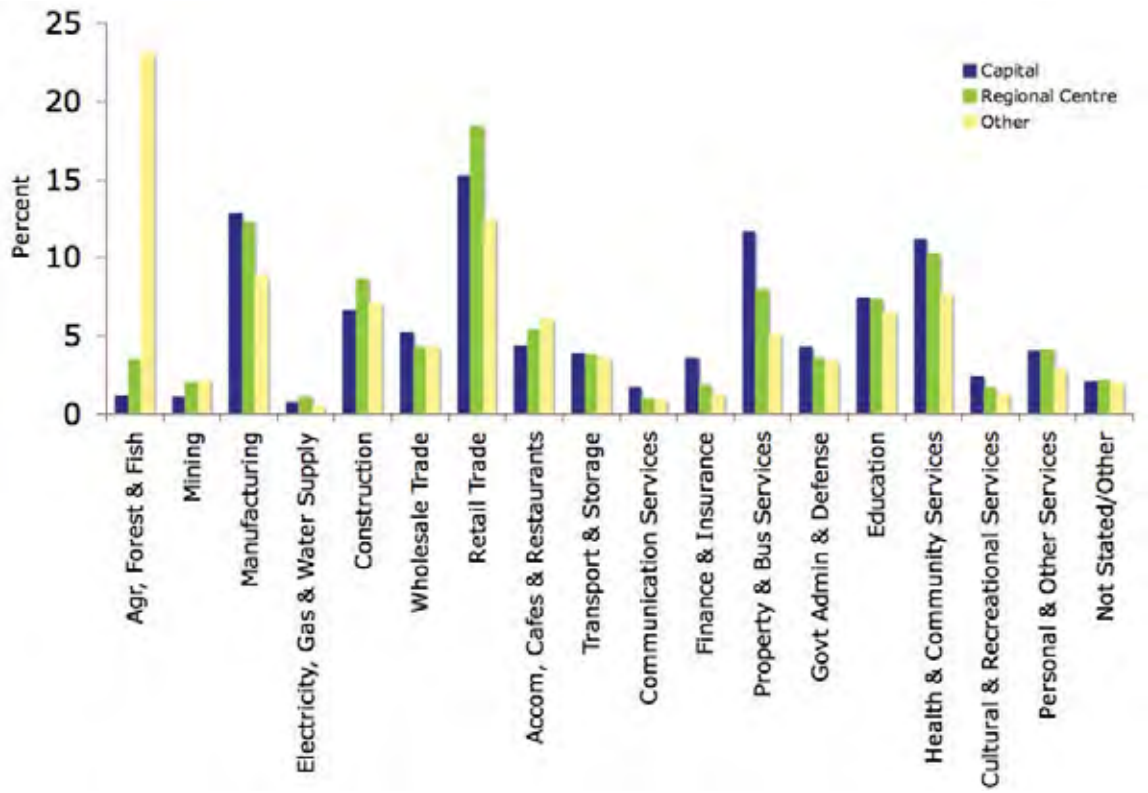


Figure 5.3 *Labour force structure by settlement type (2001)*



(Source: ABS 2004)

5.2 Marine activities

This section provides a background to the most prominent sectors that operate in the Region as well as those sectors that are active both within the Region and State waters.

5.2.1 Commercial fishing

Of the 34 fisheries active off the Western and South Australian coastlines, only 17 have a major presence in the South-west Marine Region. These include deep-water fisheries such as the Great Australian Bight, Abrolhos Islands and Mid West Trawl fisheries. There are also a range of coastal fisheries active in Commonwealth waters. These coastal fisheries include the West Coast Rock Lobster Fishery and South Australian managed Northern Zone Rock Lobster Fishery. In 2004/05, the fisheries active in the South-west Marine Region caught around 82 000 tonnes of fish, with a landed value of approximately $446 million. Figure 5.4 shows the location of fish catches within and adjacent to the Region for all fisheries (averaged over 2000-02). Within the Region, fisheries are managed either by the Australian Government through the Australian Fisheries Management Authority, or by the relevant State Government. One fishery, the Demersal Gillnet and Longline Fishery, is jointly managed by the Australian and the Western Australian Governments.

Australian Government-managed (including jointly-managed) fisheries

There are currently five fisheries in the Region managed solely by the Australian Government and one managed jointly with the Western Australian Government. Fisheries managed solely by the Australian Government are active within Commonwealth waters. The jointly-managed Demersal Gillnet and Longline Fishery operates in both Western Australian and Commonwealth waters. In 2004/05, the combined value of Australian Government (and jointly-managed) fisheries was approximately $96 million on a catch of around 18 600 tonnes. Of these fisheries, the Southern Bluefin Tuna Fishery is the most important and represents about 46 per cent of the total Australian Government-managed catch-by-value, and 29 per cent by volume. The next most important fishery is the Southern and Eastern Scalefish and Shark Fishery (Gillnet, hook and trap sector) followed by the Great Australian Bight Trawl Fishery. Table 5.2 provides more information on Australian Government-managed fisheries in the Region.

Figure 5.4 South-west Marine Region all fisheries combined catch (2000-02)

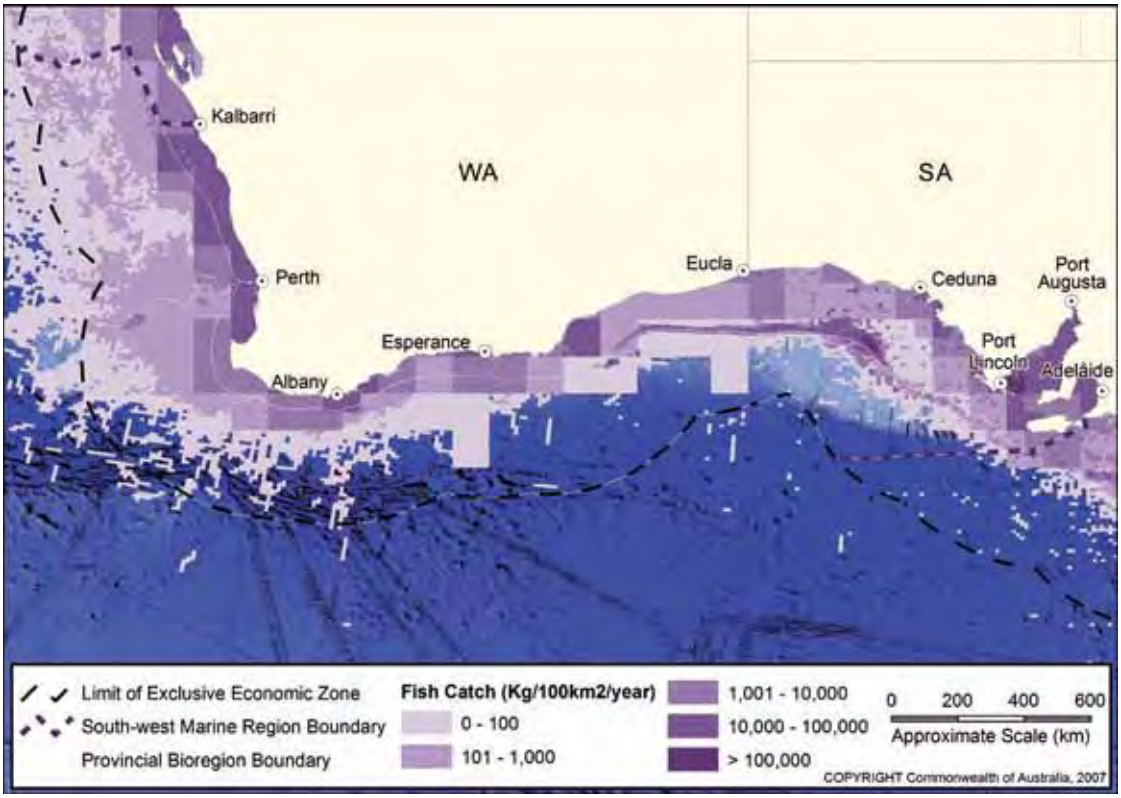


Table 5.2 Commonwealth and jointly-managed fisheries active within the Region (2004/05)

Fishery	Main area of fishery by catch (and bioregion)	Main species targeted	Main fishing method	Tonnes caught	Number	GVP ($ million)	Status of stock
Commonwealth fisheries							
Great Australian Bight Trawl	On and around the shelf break across the Great Australian Bight (Great Australian Bight Shelf Transition).	Deepwater flathead, orange roughy, Bight redfish	Demersal otter trawl, limited midwater trawl	6 263	10 vessels	16.7	All species uncertain.
Southern Bluefin Tuna	On and near the shelf break to the south-west of Ceduna (Great Australian Bight Shelf Transition).	Southern bluefin tuna	Purse seining	5 421	112 vessels	43.8	Overfished, and overfishing is occurring. Spawning stocks severely depleted and current catches severely limit likelihood of rebuilding.
Southern and Eastern Scalefish and Shark (Gillnet, Hook and Trap sector)	For gillnet – across shelf from Kangaroo Island to SA-WA border (Great Australian Bight Shelf Transition). For hook – on and around shelf from Kangaroo Island to SA-WA border (Great Australian Bight Shelf Transition).	Mixed fish species, particularly pink ling, blue-eye trevalla, gummy shark	Demersal gillnet, dropline	5 041	116 vessels	24.6	Shark sector – school shark overfished, gummy shark not overfished, sawshark and elephant fish uncertain.
Southern and Western Tuna and Billfish	From shelf outwards across Region with main effort concentrations off Port Lincoln and off the WA west coast (Spencer Gulf Shelf Province, Southwest Shelf Transition and Central Western Province).	Yellowfin, bigeye, skipjack, albacore tuna, some billfish species	Pelagic longline	495	125 permits	3.6	Bigeye tuna not overfished; yellowfin tuna and broadbill swordfish uncertain; overfishing of bigeye tuna is occurring in the broader Indian Ocean.
Western Deepwater Trawl	On and near shelf break with main effort concentration off mid-west coast WA (Central Western Province).	Mixed fish species	Otter trawl	67.48 (2003)	11 permits	0.83 (2003)	Uncertain.
Commonwealth/WA jointly-managed fishery							
Demersal Gillnet and Longline	Along the WA coast. Gillnet – across shelf hook – on and around shelf (Southwest Shelf Province).	Dusky whaler, whiskery, gummy sharks	Demersal gillnet	1 305 (shark) 148 (scalefish) (2003/04)	83 licence holders (2003)	6 (2003/04)	Dusky, whiskery and school sharks overfished, gummy sharks not overfished.

Sources: McLoughlin et.al. (2006), ABARE 2006.

South Australian Government-managed fisheries

The South Australian Government has responsibility for four fisheries active both in the Region and adjacent waters. These are the Northern Zone Rock Lobster, the Giant Crab, the Sardine and the Marine Scalefish fisheries. The Sardine Fishery targets the majority of its catch in State waters. Some Giant Crab Fishery effort occurs within the Region, but the majority of the catch is currently derived from Commonwealth waters to the east of the Region. The Northern Zone Rock Lobster Fishery is active in both Commonwealth and State waters. Of the four South Australian-managed fisheries, only the Marine Scalefish Fishery appears to rely primarily on Commonwealth waters within the Region for the majority of its catch.

In 2004/05, the four fisheries' combined catch was over 43 000 tonnes of fish, worth around $57 million. The most important of South Australian-managed fisheries by value was the Sardine Fishery with a catch value of over $28 million and landings of over 39 000 tonnes. The second most valuable fishery was the Marine Scalefish Fishery. Table 5.3 details a range of statistics for South Australian-managed fisheries.

Table 5.3 South Australian-managed fisheries active within the Region (2004/05)

Fishery	Main area of fishery by catch (and bioregion)	Main species targeted	Main fishing method	Tonnes caught	Number	GVP ($ million)	Status of stock
Northern Zone Rock Lobster	Along the SA coast from Kangaroo Island to Cape Adieu west of Ceduna (Spencer Gulf Shelf Province and Great Australian Bight Shelf Transition).	Southern rock lobster	Pots	446	68 licences	11.6	Overfished.
Giant Crab (Northern zone)	Across shelf in waters greater than 60 m deep to SA-WA border (Spencer Gulf Shelf Province and Great Australian Bight Shelf Transition).	Giant crab	Pots	Not available	2 full time, 7 part time, 62 by-catch only	Not available	Fully fished.
Sardine	On shelf with main effort inside Spencer Gulf and Gulf St Vincent. Effort also extending into Commonwealth waters outside of the Spencer Gulf and off the western side of the Eyre Peninsula (Spencer Gulf Shelf Province).	Sardines (pilchards)	Purse seining	56 952	14	28.4	Fully fished.
Marine Scalefish	Across the shelf from Kangaroo Island to the SA-WA border (Spencer Gulf Shelf Province and Great Australian Bight Shelf Transition).	Mixed species, particularly King George whiting, snapper, garfish, southern calamari, ocean leatherjacket, molluscs	Multi-gear, including haul and gill netting, handlining, longlining and trapping	3 643	377 licence holders	17.2	West coast population of King George whiting fully fished, snapper overfished, garfish overfished, southern calamari fully fished, ocean leatherjacket not assessed.

Source: PIRSA 2007.

Western Australian-managed fisheries

Within the Region, the Western Australian Government has the responsibility for the management of seven fisheries that are active in both State and Commonwealth waters. Of these, the Abrolhos Islands and Mid West Trawl, the West Coast Deep Sea Crab, the West Coast Demersal Scalefish, the South Coast Trawl and the South-west Trawl fisheries are most active within the Region. The West Coast Rock Lobster and the South Coast Crustacean fisheries are mainly confined to State waters although some effort occurs within Commonwealth waters.

In 2004/05, the seven fisheries landed over 20 000 tonnes of fish worth around $293 million. The most important of Western Australia's fisheries active wholly or partly within the Region is the West Coast Rock Lobster Fishery. In 2004/05, 12 138 tonnes of lobster were landed with a value of approximately $259 million. This fishery alone represents around 88 per cent of the total catch-by-value of Western Australian-managed fisheries. The second most important fishery was the Abrolhos Islands and Mid West Trawl Fishery. Table 5.4 provides more information on Western Australian-managed fisheries within the Region.

Table 5.4 Western Australian-managed fisheries active within the Region (2004/05)

Fishery	Main area of fishery by catch (and bioregion)	Main species targeted	Main fishing method	Tonnes caught	Number	GVP ($ million)	Status of stock
West Coast Rock Lobster	Along the WA coast with main catches from Perth to Shark Bay (Southwest Shelf Transition).	Western rock lobster	Pot	12 138	536 boats (56 838 pots)	259	Fully exploited.
Abrolhos Islands and Mid West Trawl	Around the Houtman Abrolhos Islands (Central Western Province).	Southern saucer scallops, western king prawns	Demersal otter trawl	6 470	Not available	22	Fully exploited.
South-west Trawl	In State and Commonwealth waters to shelf break with main effort concentration off Perth (Southwest Shelf Transition).	Saucer scallops, western king prawns	Demersal otter trawl	14 (prawns) 1 (scallops)	18 vessels (2003)	0.18	Not assessed.
West Coast Deep Sea Crab	In Commonwealth waters around the shelf break with main effort concentrations Geraldton to Bunbury and from Albany to Esperance (Central Western Province, Southwest Shelf Transition and Southern Province).	Giant (king) crabs, crystal (snow) crabs, champagne (spiny) crabs	Pot	207	7 permits issued (5 full time, 2 part time) (2004)	2.7	Not assessed.
West Coast Demersal Scalefish	Across the shelf along the WA coastline (Southwest Shelf Transition, Southwest Transition, Southwest Shelf Province and Southern Province).	West Australian dhufish, pink snapper, baldchin groper	Demersal handline, drop line	1 220	262 licensed vessels (2003)	7.8	Not assessed.

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Fishery	Main area of fishery by catch (and bioregion)	Main species targeted	Main fishing method	Tonnes caught	Number	GVP ($ million)	Status of stock
South Coast Crustacean	Along the shelf off the WA south coast (Southwest Shelf Transition and Great Australian Bight Shelf Transition).	Southern rock lobster, western rock lobster, giant (king) crabs, crystal (snow) crabs, champagne (spiny) crabs	Pots	39	44 licensed vessels (2003)	1.4	Fully exploited
South Coast Trawl	In State and Commonwealth waters to shelf break off the WA South coast (Southwest Shelf Province).	Scallops	Otter trawl	30	4 licensed vessels (2003)	0.1	Not assessed

Source: Fletcher *et.al.* (2006)

The factors affecting commercial fisheries in the Region include the availability of fish, existence of and access to markets for fish products, and the industry's cost structures and regulatory arrangements. Many fish stocks within the Region have been classified as 'fully exploited'. As a result, with the exception of the small pelagic fish, which are relatively lightly fished within the Region, there appears to be limited opportunity to increase catches beyond current levels. There are, however, initiatives underway to increase the value of commercial fishing by improving fish quality and developing new and more valuable markets for fish and fish products.

Fisheries in the Region are known to interact with some of the Region's conservation values, including cetaceans, marine reptiles, sharks, seals and seabirds. Interactions between fisheries and conservation values are governed by a range of regulations and codes of conduct. The Australian Government assesses fisheries under the EPBC Act against criteria that may include progress in implementing practices to minimise impacts on the marine environment and protected species. Further information on fisheries assessments can be found at <www.environment.gov.au/coasts/fisheries>.

Both Australian and State Government fisheries agencies have a range of initiatives in place to reduce the potential for adverse environmental impacts by fisheries. The sustainable management of fisheries by the Australian Government is undertaken through the *Fisheries Management Act 1991*. Supporting initiatives include the *National Policy on Fisheries Bycatch 2000* (DAFF 2000) which sets a requirement for by-catch actions in each major Commonwealth fishery to improve the protection of threatened species and minimise adverse impacts upon the marine environment. Similarly, State fisheries agencies use a range of measures to minimise adverse impacts on both target and non-target species. Measures include output controls to limit the amount of target species landed, and input controls such as gear restrictions and seasonal or area closures, to avoid wider impacts on the marine environment, protected species and/or the target species itself.

Fishing boat. Photo: Chloe Lucas.

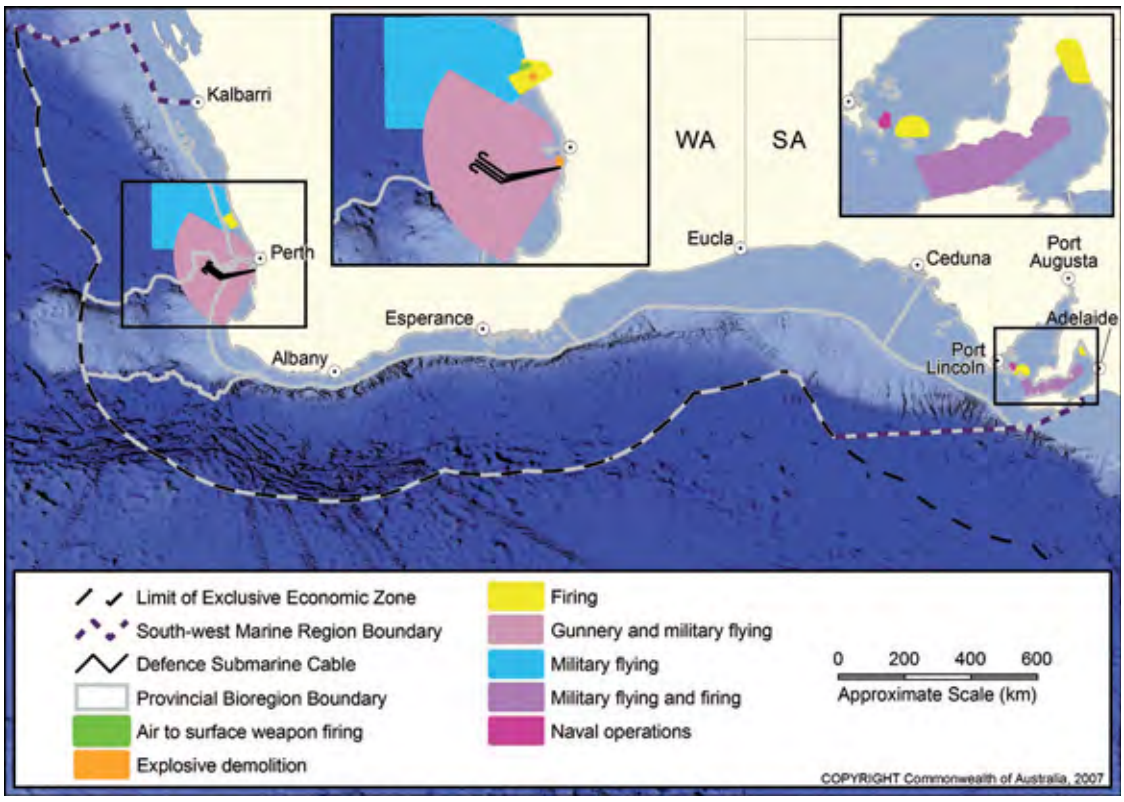
5.2.2 Defence activities

The Australian Defence Forces conduct a range of military training, research and preparatory operations in the Region. Training occurs within Commonwealth waters at the Western Australia Exercise Area (WAXA) situated off Perth, at Swanbourne, just north of Fremantle, and at Greenhough, south of Geraldton (Figure 5.5). There are also marine training areas in State waters, both contiguous with WAXA, Swanborne and Greenhough and in South Australian waters in Investigator Strait and adjacent gulfs.

WAXA is the largest training area in the Region, and is used for both training and military research, and also includes an underwater torpedo tracking range. The Stirling Naval Base on Garden Island located within WAXA is home to part of the Navy's complement of Collins Class submarines and Anzac Class frigates.

An 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, has been established to assess and manage defence training activities at sea. In addition, defence activities that are considered likely to impact upon matters of national environmental significance are required to be referred under the EPBC Act.

Figure 5.5 Defence training areas within and adjacent to the Region



5.2.3 Marine tourism

Whale, seal and dolphin watching, together with charter fishing, are the main commercial tourism activities in the Region.

Charter fishing

Charter fishing is a popular tourism activity with around 258 registered charter boat businesses operating within and adjacent to the Region in 2005. In Western Australia, the most important centres from which charter fishing operates are Geraldton, Perth, Mandurah, Bunbury, Albany, Bremer Bay and Esperance. In South Australia, charter fishing operators are based on Kangaroo Island, the Eyre Peninsula and at Streaky Bay. Of particular relevance to Commonwealth waters are those charter fishing operators targeting deeper water or 'offshore' species including tunas, snapper, samson fish (off Western Australia) and striped marlin (off South Australia).

Management of charter fishing operations is a State Government responsibility and all charter boat operators in both Western Australia and South Australia require a licence to operate.

Marine mammal watching

A range of commercial ventures cater to the marine mammal watching market off both Western Australia and South Australia. In Western Australia, the industry has focused primarily on observing humpback whales and is based in Esperance, Bremer Bay, Albany, Augusta, Geographe Bay, Bunbury, Cevantes, Dongara and Kalbarri.

In South Australia, the focus is mainly on the southern right whale, and tours are conducted along the coast of the southern Fleurieu Peninsula and within the Great Australian Bight Marine Park.

In 2003, around 77 000 people observed whales from tourist vessels within or adjacent to the Region, with a further 235 000 watching from land. In 2005, there were 110 active whale watching permits, 95 dolphin watching permits, 49 seal watching permits and two sea lion watching permits off Western Australia. There were six active whale watching permits in South Australia.

The industry has experienced rapid growth over the past decade. In Western Australia, the number of permits for marine mammal watching increased from 113 to 256 between 1997 and 2005. While whale watching permits increased by 20 per cent, during the same period dolphin and seal and sea lion watching permits increased by around 400 per cent and 1100 per cent respectively.

Whales and dolphins may be disturbed by the presence of people. The Australian Government is responsible for ensuring that any threat from tourism interactions with marine mammals and other protected species is minimised. Whale and dolphin watching is regulated in Australia's waters and regulations apply to all people interacting with whales and dolphins, including commercial tourism operators and people conducting recreational activities. The Australian *National Guidelines for Whale and Dolphin Watching 2005*, developed jointly by the Australian and all State and Territory Governments, outline the standards that allow people to observe and interact with whales and dolphins in a way that ensures animals are not harmed or disturbed.

Tuna fishing charter boat. Photo: Elise Hardiker, Department of the Environment, Water, Heritage and the Arts.

5.2.4 Offshore aquaculture

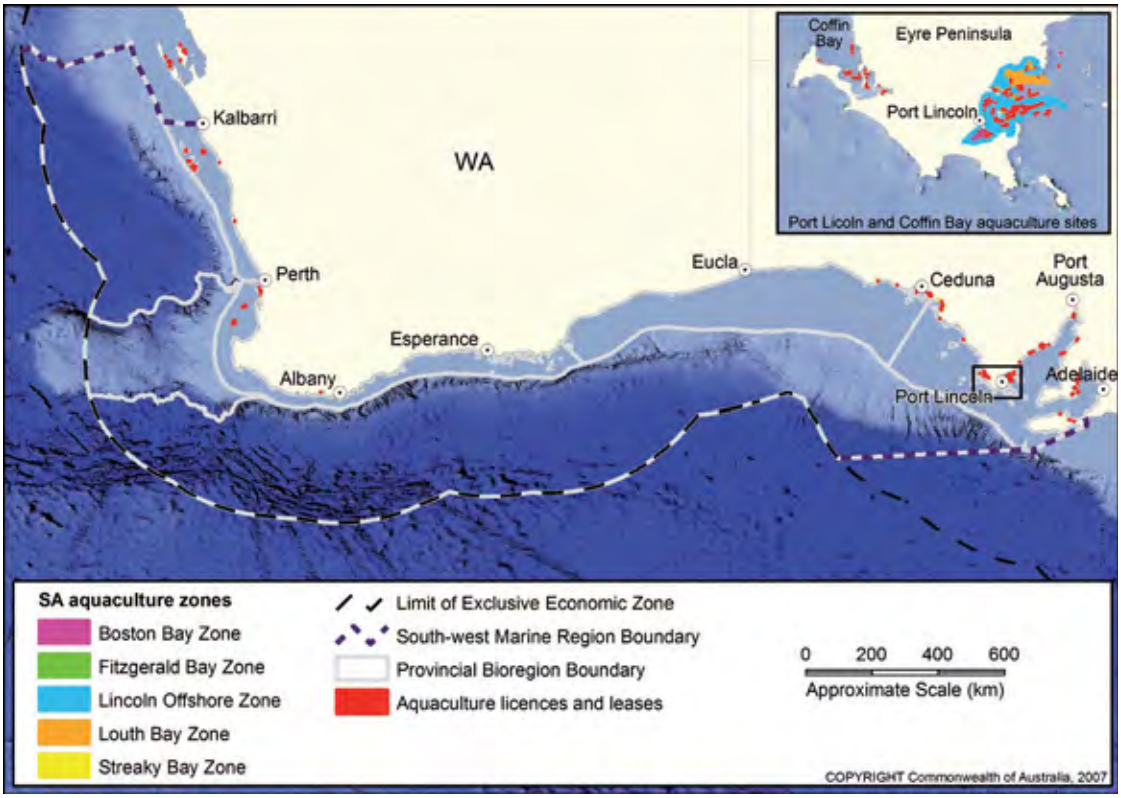
There are currently only three aquaculture sites in the Region – one in the Geelvink Channel off Geraldton, and a further two leases off Mandurah and Bunbury. All sites are for scallop production (Figure 5.6).

Most aquacultural activity occurs within State waters adjacent to the Region. Off the Eyre Peninsula in South Australia, the sea-cage culture of southern bluefin tuna captured in the Great Australian Bight has become the most economically important component of Australia's aquaculture industry. In 2002/03, sales of southern bluefin tuna, predominantly on the Japanese market, were worth around $267 million – representing around 90 per cent of the total South Australian and Western Australian aquaculture production combined. Second in importance is the oyster industry, with production occurring at various sites in State waters, including a small but growing industry centred around Albany. Other species include blue mussels, abalone, marine algae and pearl oysters.

Aquaculture activity is likely to increase in and adjacent to the Region. Factors affecting the development of the sector include identification and farming of new species, development of new farming technologies and competition for suitable locations for aquaculture, particularly in nearshore areas. Issues that will need to be managed with the growth of off-shore aquaculture include the potential for escapees to have adverse environmental impacts and the management of waste.

Offshore aquaculture is regulated under the EPBC Act and relevant State legislation. In 2006, the Department of the Environment and Heritage released the *EPBC Act Policy Guidelines 2.2 – Offshore Aquaculture* to assist proponents to decide whether proposed actions require assessment and approval under the EPBC Act.

Figure 5.6 ***Aquaculture production sites within and adjacent to the Region***

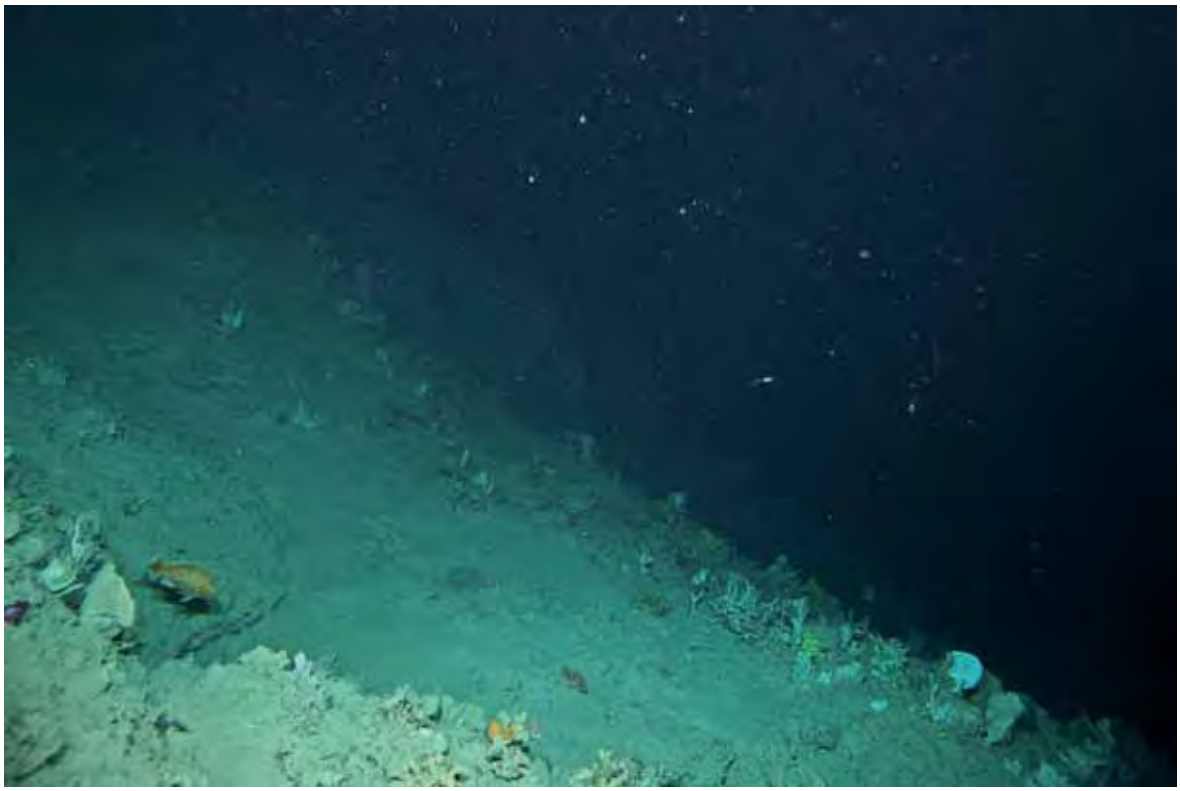


5.2.5 Offshore minerals

Mineral resources that have been discovered within the South-west Marine Region include manganese nodules and crusts in deep waters off south-west Western Australia, and cobalt and shell sands within the Great Australian Bight. Offshore diamondiferous placer deposits may also exist near Kangaroo Island and in South Australian waters in the Spencer Gulf and Gulf St Vincent. The location of these mineral occurrences can be viewed on the Offshore Mineral Locations map that can be accessed at <www.ga.gov.au/image_cache/GA8484.pdf>.

A total of 66 offshore mineral exploration licence applications were received from 1990 to August 2003 for all Commonwealth waters around Australia. None are currently active in the South-west Marine Region. Mining activity in and adjacent to the Region is confined to State waters near Fremantle, where Cockburn Cement Limited has been dredging shell sand from Owen Anchorage for the production of quick lime since 1972.

The Region's mineral resources may become a focus for development in the future. Offshore mining has the potential to radically alter patterns of sediment movement and significantly affect ecological processes and associated biodiversity. Exploration and production of minerals (other than petroleum) in Commonwealth waters is regulated through the *Offshore Minerals Act 1994*. Both the Commonwealth and the States and Territories share the administration of the Offshore Minerals Act. A Joint Authority, consisting of the relevant Australian Government and State and Territory ministers is responsible for major decisions. Under the EPBC Act any proposals for mining activity would need to be referred to the Minister for the Environment, Heritage and the Arts for assessment and approval, if they were considered likely to have a significant impact upon the Commonwealth marine environment or other matters of national environmental significance.



Yellow-eyed nannygai over large boulders in the rugged, and newly mapped, Kalbarri Canyon. Central Western Province, 293 m deep. Photo: CSIRO.

5.2.6 Petroleum exploration and production

The Region is considered highly prospective for economically viable petroleum deposits. The Australian Government policy on energy security promotes exploration and recognises the value of the offshore petroleum sector to Australia. The sedimentary basins considered prospective include the Perth Basin off the west coast of Western Australia, the Mentelle Basin east of the Naturaliste Plateau, and the Bight Basin off the south-east coast of Western Australia. Moderate levels of petroleum exploration have been undertaken in the Region over a number of years, mainly through seismic surveys, with only a few exploratory wells being drilled (see Figure 5.7). To date, the only production from the Region involves the extraction of oil from the Cliff Head Oil Field located 10 km offshore from Dongara (50 km south of Geraldton). Production commenced in May 2006 with two million barrels extracted by December 2006.

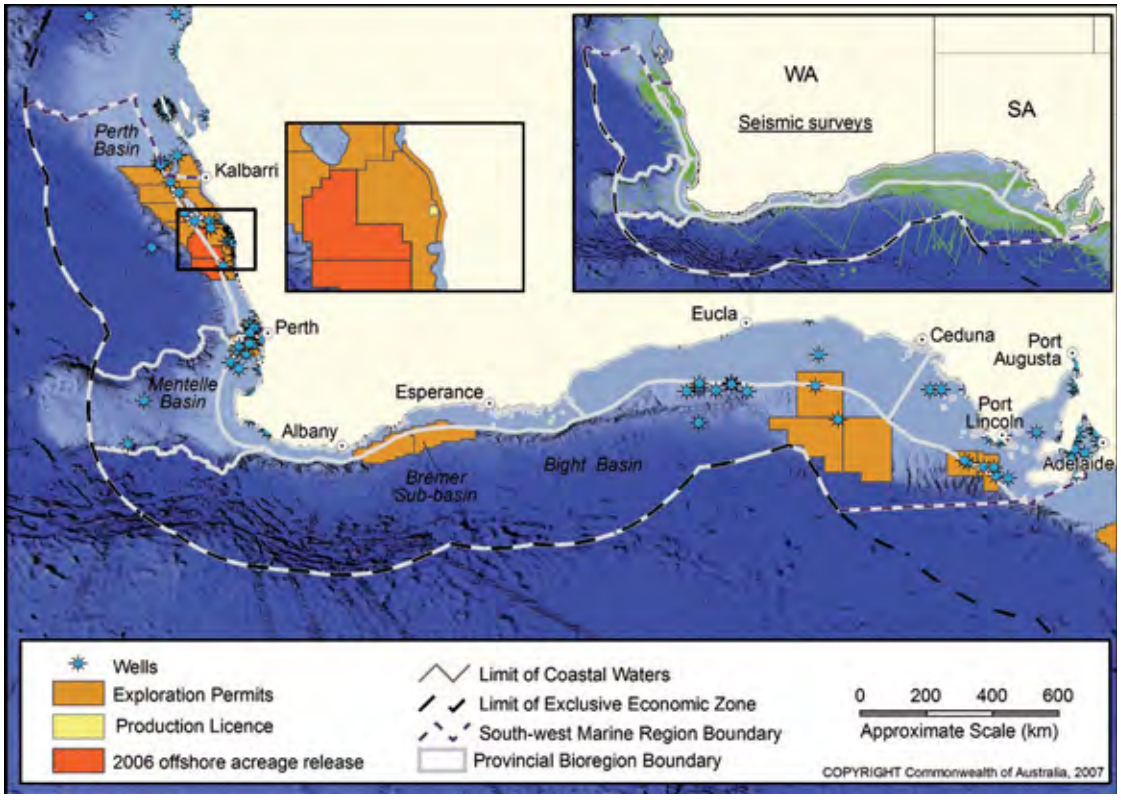
As of November 2006, there were 18 exploration permits active within the Region – five off South Australia in the Bight Basin, and 13 off Western Australia (11 in the Perth Basin and two in the Bremer Sub-basin of the Bight Basin).

Petroleum exploration activity is expected to increase in the Region. Factors such as falling Australian petroleum production (excluding gas), expectations of continuing high global petroleum prices and increasing demand for energy are expected to drive exploration.

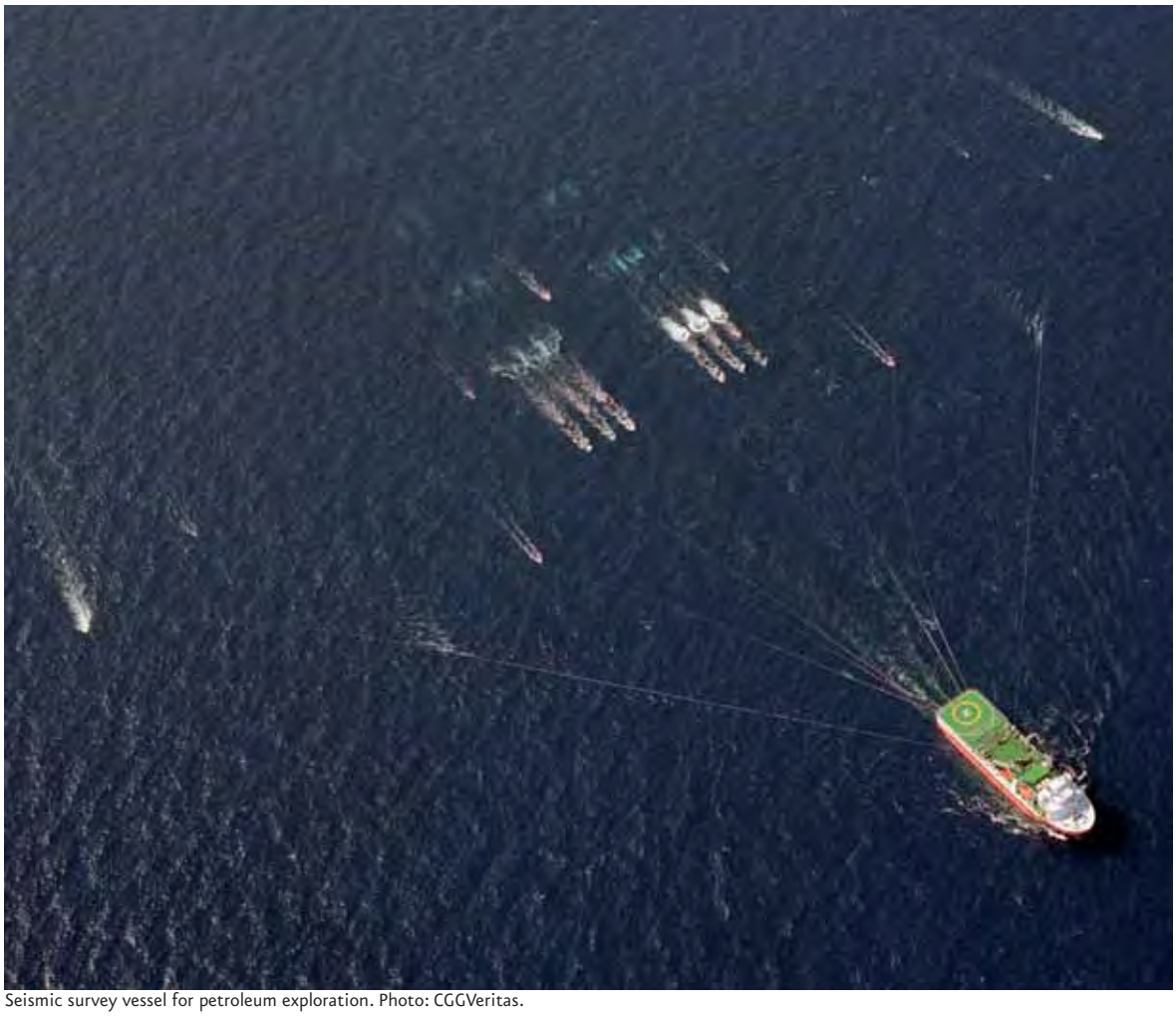
Seismic surveys have the potential to cause physical, behavioural and perceptual effects on whales. Baleen whales such as humpback, blue and fin whales may be more affected by seismic surveys than toothed whales, as their acoustic range is thought to operate in the same frequency as air gun pulses used in seismic exploration. Seismic operations are regulated by the Australian Government's *EPBC Act Policy Statement 2.1 – Interactions between Offshore Seismic Exploration and Whales* (DEWR 2007). This is available at: <www.environment.gov.au/epbc/publications/seismic>. The petroleum industry has taken an active role in the development and implementation of measures to minimise the potential impacts of exploration on cetaceans. The industry seeks to undertake exploration, where practicable, during times when encounters with whales are generally least likely to occur.

The petroleum industry is regulated through the *Petroleum (Submerged Lands) Acts 1967*, the *Petroleum (Submerged Lands) (Management of Environment) Regulations*

Figure 5.7 Petroleum activities in the Region



1999 and the EPBC Act. Best-practice and consistency in environmental regulation across Australia is pursued through the Environmental Assessors Forum and the Standing Committee on Environmental Approval Processes for Offshore Acreage. These fora provide an avenue for regulators to engage industry and conservation groups as required on relevant issues. Key issues progressed through these groups, with high levels of stakeholder consultation and agreement, include the 2005 review of the Management of Environment Regulations and the review of the *Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions between Offshore Seismic Operations and Larger Cetaceans* (see also Appendix B). A key feature of the Environment Regulations is the requirement that an operator submit an Environment Plan before commencing any petroleum activity. An accepted Environment Plan establishes legally binding environmental management conditions that must be met by the operator of an offshore petroleum activity.



Seismic survey vessel for petroleum exploration. Photo: CGGVeritas.

5.2.7 Recreational use

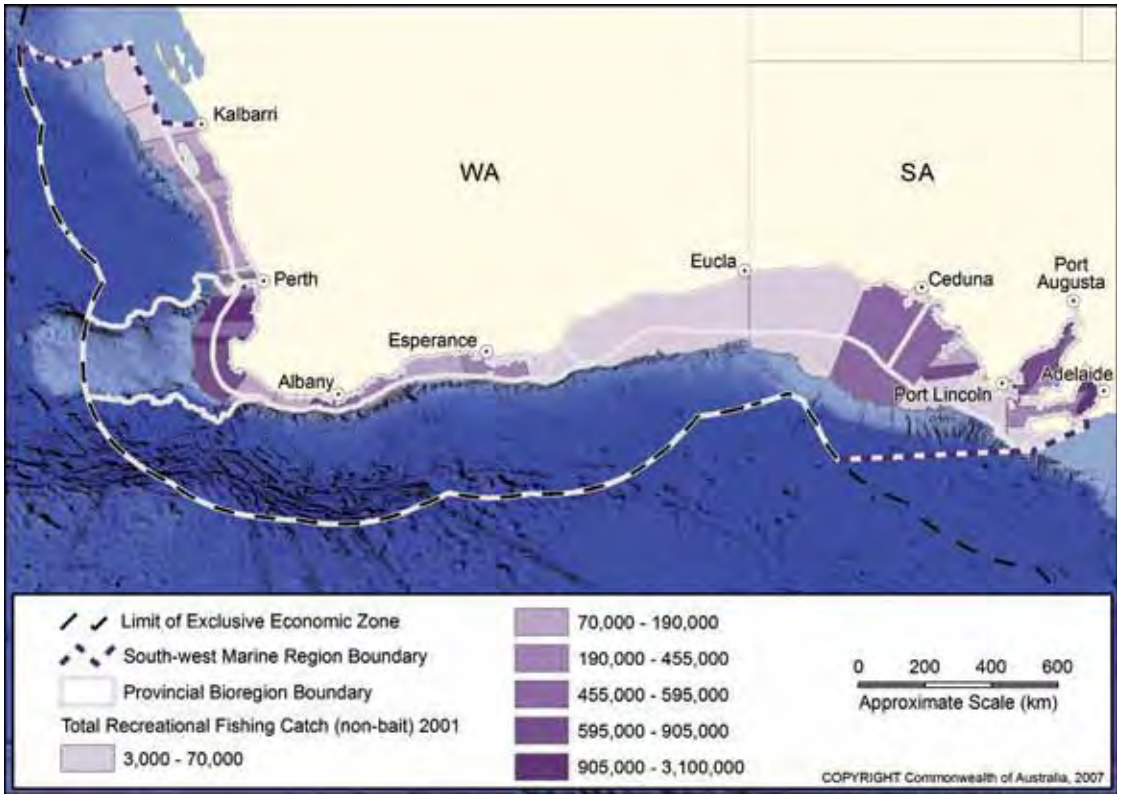
The main recreational use currently undertaken in the Region is offshore recreational fishing. Other important recreational activities such as SCUBA diving are mostly confined to inshore areas.

Recreational fishers of the Region target a range of deep-water fish including snapper, samson fish, groper, Australian salmon and tunas off Western Australia, and tunas, striped marlin, snapper, Australian salmon and trevally off South Australia. Major areas of activity include waters off the Eyre Peninsula and Kangaroo Island, and off Perth and the Capes Region (Figure 5.8). While no reliable figures exist on the extent of fishing activity specifically within the South-west Marine Region, in 2001 recreational fishers across the whole of Western Australia and South Australia spent the equivalent of about 436 000 days fishing within 'offshore areas'. The distribution of fishing effort in offshore areas differed markedly by State. In Western Australia in 2001, over 11 per cent of fishing effort (out of the total of 3.4 million fishing days reported by Western Australian fishers) was carried out in offshore areas, while in South Australia the figure was only three per cent (of the 1.9 million reported fishing).

Given the south-west's expanding population, the continuing popularity of recreational fishing, the increasing availability and affordability of sea-going vessels and improvements in boating and fishing technologies, it is likely that Commonwealth waters will experience increasing growth in recreational fishing activity.

Management of recreational fishing, both in State waters and offshore areas is currently the responsibility of the adjacent State. Both Western Australia and South Australia have a range of management initiatives in place including bag possession limits, size limits, gear restrictions, seasonal closures and area closures. Further information on the rules and regulations applying to recreational fishing is available at <www.pir.sa.gov.au/dhtml/ss/section.php?sectID=268> and <www.fish.wa.gov.au/sec/rec/index.php>.

Figure 5.8 Distribution of recreational fishing effort (2001)



Note that the outer limits of recreational fishing effort shown on the map are indicative only and may not represent the actual range of recreational fishers within these areas – generally effort will occur closer to the coast.

5.2.8 Sea dumping

Prior to 1981, waste including vessels, ammunition and chemicals were regularly dumped in the Region's waters. Today, little sea dumping occurs.

The marked reduction in sea dumping activity is due to a range of regulatory measures introduced by the Australian Government. The *Beaches, Fishing Grounds and Sea Routes Protection Act 1932* placed the first controls on the dumping of obsolete vessels. The Act specified that vessels could only be dumped in any one of four designated areas in waters off South Australia and Western Australia – two in State waters near Albany and two in Commonwealth waters off the western tip of Rottnest Island and off eastern Kangaroo Island. The Act also prohibited the dumping of "any garbage, rubbish, ashes or organic refuse" in designated exclusion zones.

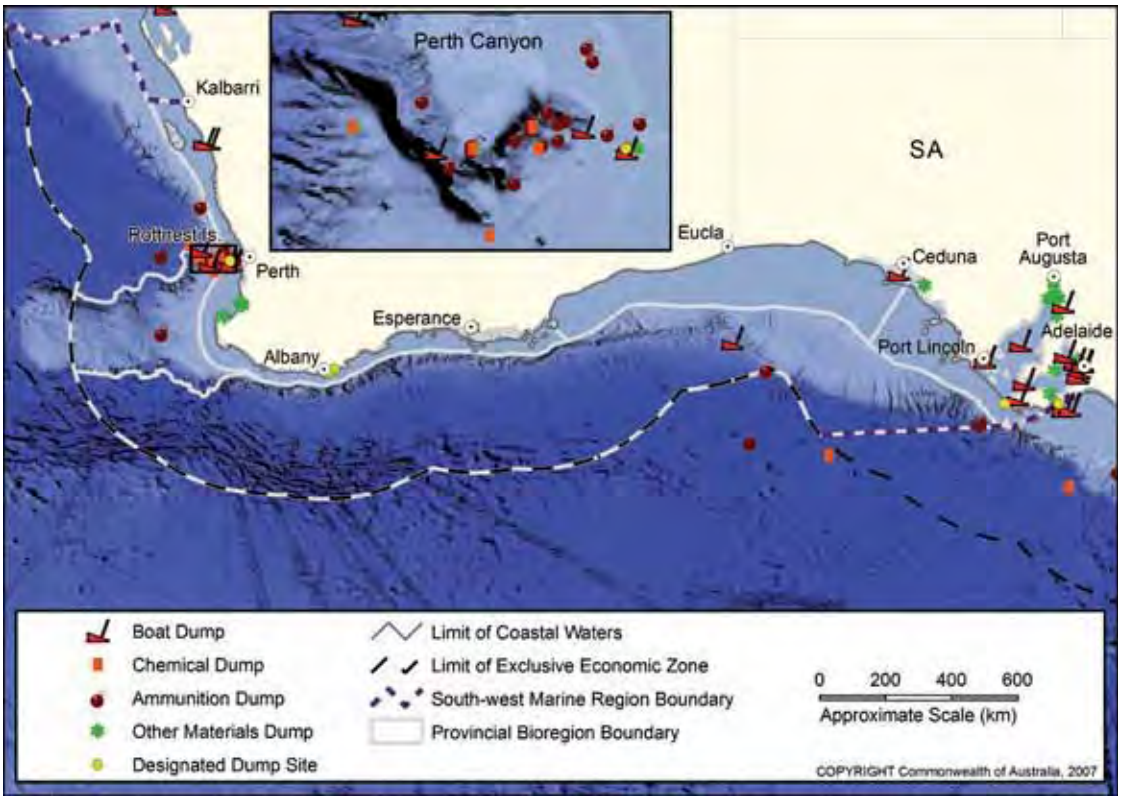
While restrictions were placed on the location of dumping of vessels, dumping of a range of harmful chemicals and pollutants was still permitted, and benzene, cyanide, pesticides and arsenic have been disposed of in the Region's waters. Following its ratification of the London Convention of 1972, the Australian Government enacted the *Environment Protection (Sea Dumping) Act 1981* to fulfil its obligations as a signatory to convention. In 1996, the Sea Dumping Act was amended to implement the 1996 Protocol to the London Convention (ratified by Australia in 2000). Under the Protocol, Australia prohibits ocean disposal of waste materials considered harmful to the marine environment, and regulates dumping of waste at sea to minimise environmental impacts.

Within coastal waters, there is a low level of dumping mainly involving the disposal of dredge spoil from port shipping channels and berths to maintain clearance depths for shipping. Decommissioned vessels are also dumped in shallow water as diving attractions and artificial reefs (Figure 5.9).

The impact of past sea dumping on the conservation values of the Region is unknown. Chemicals dumped within the Region may pose some threat to the marine environment. While no studies appear to have been undertaken within the Region, limited studies on chemical warfare agents disposed off Australia's east coast by Australian forces after World War II point to minimal threat upon the marine environment except within the immediate vicinity of a dump.

A permit is required under the Sea Dumping Act to authorise the dumping, and the loading for the purposes of dumping, of any wastes or other matter into Australian waters, or from an Australian vessel or platform, anywhere at sea. Further information on sea dumping and legislative requirements is available at <www.environment.gov.au/coasts/pollution/dumping>.

Figure 5.9 Sea dumping in the South-west Marine Region prior to the Environment Protection (Sea Dumping) Act 1981



5.2.9 Shipping and ports

Shipping is a vital industry for the Western and South Australian economies. Ships transit through the Region on the way to and from Australian ports adjacent to the Region, the eastern seaboard of Australia and overseas destinations. The main port of call in 2005-06 was the Port of Fremantle, which recorded 1641 ship visits. The next most important port destination was the Port of Adelaide, with 1113 ship visits. In 2004, the total number of commercial voyages within/through the Region was 3861. Figure 5.10 shows the main routes used by commercial shipping while within the Region.

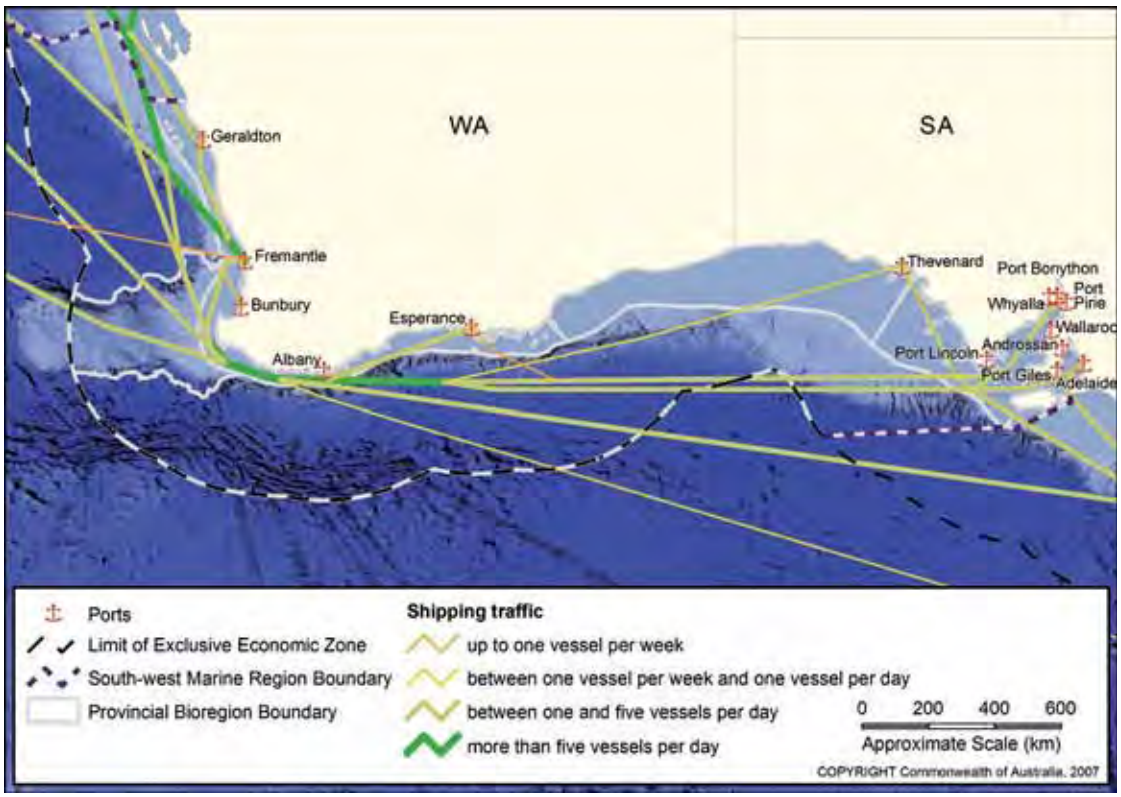
The ports of Albany, Bunbury, Esperance and Geraldton are important for the shipping of minerals and agricultural commodities from Western Australia. Important ports in South Australia include Port Lincoln, Port Pirie, Thevenard and Whyalla. In Western Australia, due to the strong commodity demand, all south coast ports are undertaking expansions or port upgrades with most of the ports experiencing record trade activity. In addition, the resource boom has initiated planning for a new port at Oakajee, north of Geraldton, to provide for further iron ore exports.

Economic growth in Australia and overseas has led to increasing ship movements related to the import and export of commodities and goods, and the volume of cargo shipped is likely to increase in the foreseeable future. For example, container traffic is expected to rise by 66 per cent on average across Australia by 2011.

The implications of increased maritime transport activity include both the potential for higher rates of interaction between vessels and protected species, and an intensification of the potential threats associated with shipping activities. Potential threats may include oil spills, the introduction of marine pests through ballast water exchange and bio-fouling, and the indirect environmental effects of increased port use and port expansion.

The environmental management of shipping is governed by a range of national and international agreements, regulations and codes of practice. In Australia, the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* gives effect to the core provisions of the international *Convention for the Prevention of Pollution from Ships 1973* (MARPOL). In relation to marine pests, Australia has in place a range of initiatives under the Australian Ballast Water Management Strategy. These set a range of requirements regarding ballast water, where it can be exchanged and how it must be treated.

Figure 5.10 Shipping routes within the Region



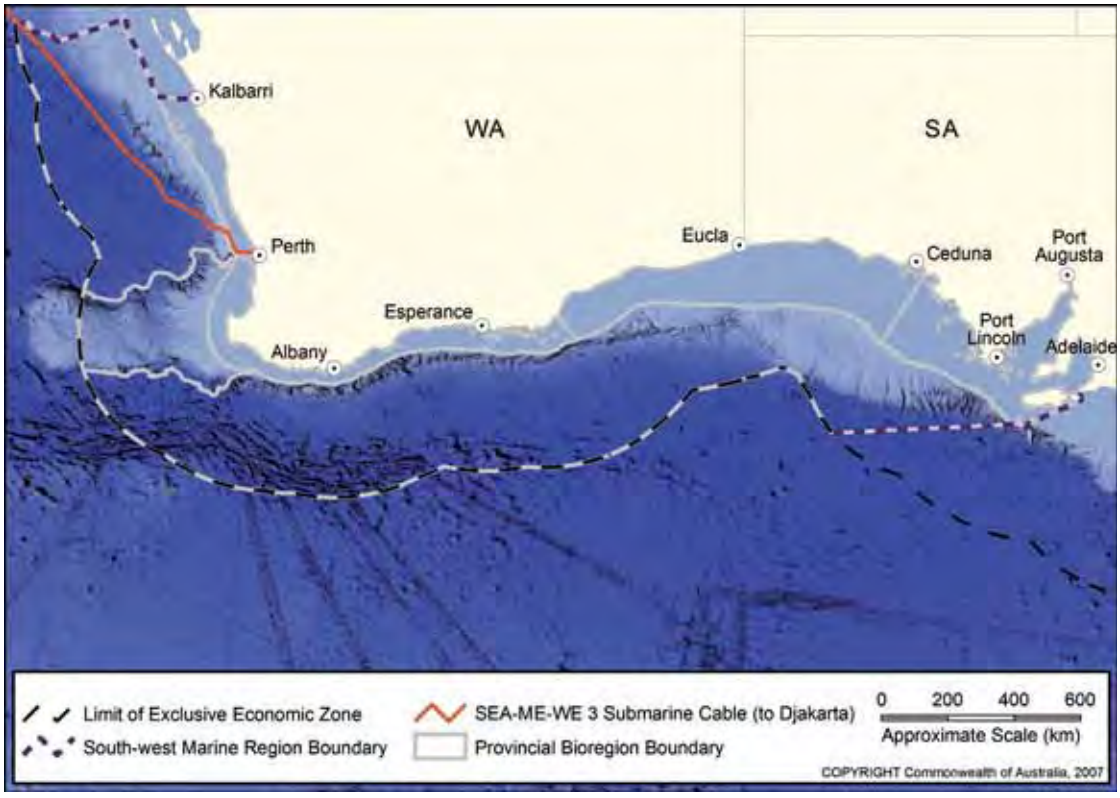
5.2.10 Submarine telecommunication cables

Since 1901, there have been a total of five submarine telecommunication cables laid in the Region. Today, only one telecommunication cable, the SEA_ME_WE3 cable, linking Australia, via Perth, with South-East Asia, is still in use (Figure 5.11).

The SEA_ME_WE3 cable has recently been declared a submarine cable of national significance under the *Telecommunications and Other Legislation Amendment (Protection of Submarine Cables and Other Measures) Act 2005*. As a result, the Australian Communications and Media Authority has declared a protection zone over the cable to prohibit and/or restrict activities that may damage the cable. The protection zone over the cable is two nautical miles wide, and extends to a depth of 2000 m (approximately 94.5 km from land).

While there are a range of regulations governing the laying and protection of cables, the EPBC Act is the main legislative instrument concerned with the environmental impact of cables. Under the EPBC Act, any proposals for submarine cables must be referred to the Minister for the Environment, Heritage and the Arts for assessment and approval if they are considered likely to have a significant impact on the Commonwealth marine environment or other matters of national environmental significance.

Figure 5.11 Location of the SEA_ME_WE$_3$ submarine cable



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Map data

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South Australia Museum: Tindale Tribal Boundaries
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts. COPYRIGHT Commonwealth of Australia, 2007.

Figure 5.2 Average annual population growth adjacent to the South-west Marine Region (2001-2006)
Australian Bureau of Statistics (2007): Australia, Estimated Resident Populations
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Figure 5.4 South-west Marine Region all fisheries combined catch (2000-2002)
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Figure 5.5 Defence training areas within and adjacent to the Region
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Figure 5.6 Aquaculture production within and adjacent to the Region
Australian Bureau of Statistics (2001): Australia, Census of Population and Housing
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Department of Fisheries Western Australia: Aquaculture Zones
Primary Industries and Resources South Australia: Aquaculture Zones
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Figure 5.7 Petroleum activities in the Region
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Figure 5.8 Distribution of recreational fishing effort (2001)
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Figure 5.9 Sea dumping in the South-west Marine Region prior to the Environment Protection (Sea Dumping) Act 1981
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Figure 5.10 Shipping routes within the Region
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Figure 5.11 Location of the SEA_ME_WE3 submarine cable
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Bryozoan. Photo: David Muirhead, Marine Life Society of South Australia.

Chapter 6 Developing a South-west Marine Bioregional Plan: Next Steps

The environment of the South-west Marine Region experiences relatively little pressure from human activities in comparison to many other parts of the ocean in Australia and elsewhere. Large areas of the Region are remote, with human development concentrated in relatively restricted stretches of the coast. However, human activities over the last 200 years have had an impact on the marine environment of the South-west Marine Region. For instance, it is possible that intensive harvesting of seals, whales, large pelagic fish and sharks may have changed the relative distribution of species and altered ecologically important relationships between prey and predators.

The economies of the States of South Australia and Western Australia are predicted to experience substantial growth over the coming years. This will be driven primarily by growth in the onshore mining and offshore petroleum sectors, prompted by increasing demand from the fast-growing economies of Asia. The growth in these sectors together with growth in supporting services and infrastructure sectors and the populations of coastal centres is likely to result in increasing human interactions with the conservation values of the South-west Marine Region.

This Bioregional Profile provides a snapshot of what we know about the environment of the South-west Marine Region and the ways in which we use it. This Bioregional Profile and supporting reports (see Chapter 1.2) provide an information-base for the next stages (Figure 6.1) of marine bioregional planning in the south-west. While the Department of the Environment, Water, Heritage and the Arts has endeavoured to ensure that the information in this Bioregional Profile is comprehensive, up to date and accurate, we recognise that stakeholders may have additional information that will contribute to our understanding of the Region. The Department welcomes comments on the Bioregional Profile and any additional information that may assist in developing a Marine Bioregional Plan for the South-west Marine Region.

Comments and additional information can be sent by email to:

<SW_marine_plan@environment.gov.au>

or by post to :

The Director, South Planning Section
National Oceans Office Branch
Department of the Environment, Water, Heritage and the Arts
Edgar Waite Building
203 Channel Highway
Kingston Tasmania 7050

All information provided will be considered by the Department in developing the Draft South-west Marine Bioregional Plan.

The next phase of the planning process will involve developing the Draft South-west Marine Bioregional Plan under Section 176 of the EPBC Act. Developing the Draft Plan will entail:

- identifying conservation priorities for the Region;
- identifying appropriate measures available to Government to address the conservation priorities; and
- developing a network of representative marine protected areas (MPAs) for the Region.

A ghost shark swims over fine sediment bottom. Southwest Transition, 385 m deep. Photo: CSIRO.

The Department of the Environment, Water, Heritage and the Arts will consult stakeholders and interested parties in developing the Draft Plan and, in particular, will seek their input on:

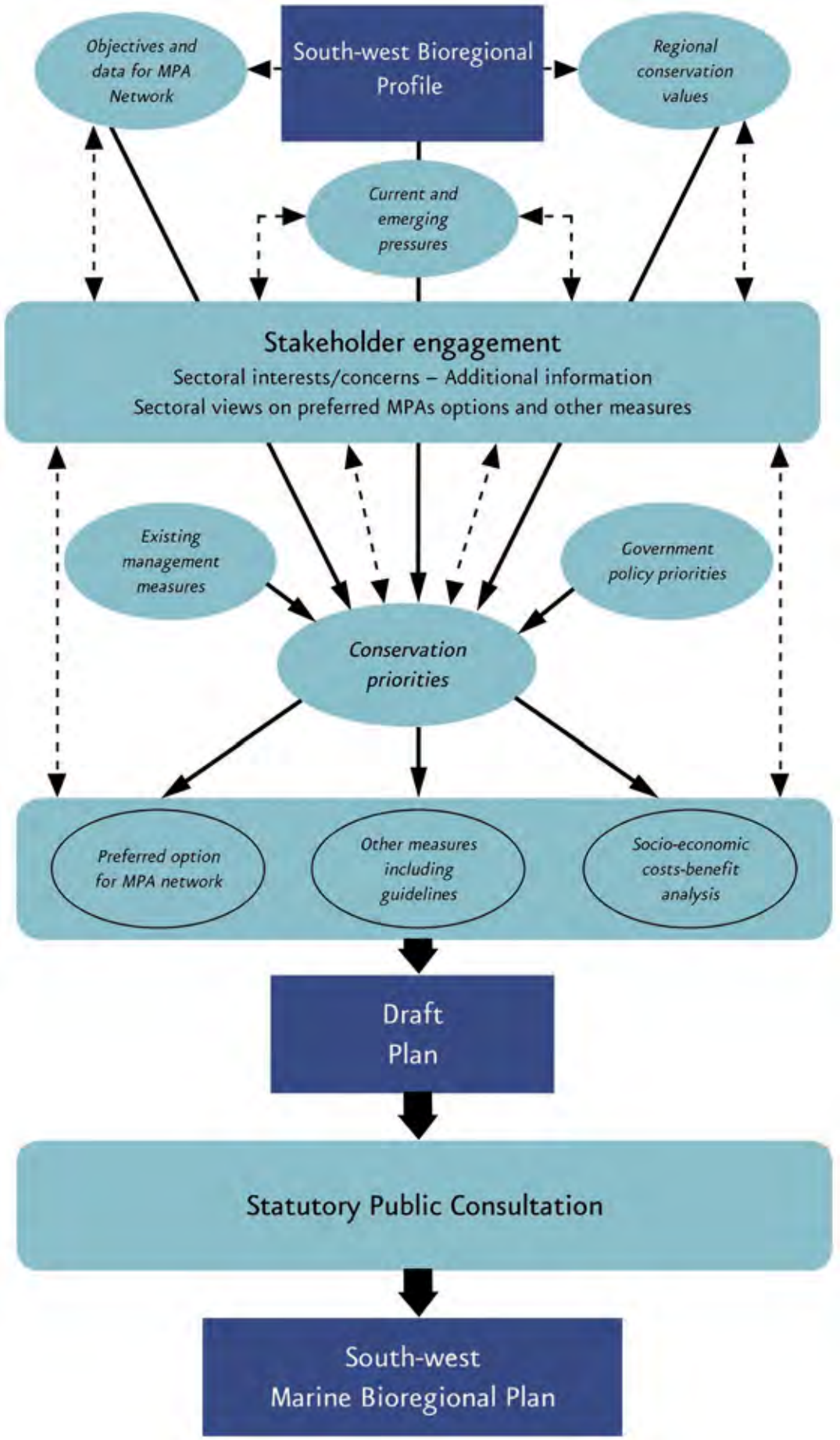
- the conservation values identified in this Bioregional Profile;
- the identification of conservation priorities;
- the identification of MPAs, and
- the social and economic implications of proposed conservation measures, including possible MPAs.

Further information about how you can be involved in the development of the South-west Marine Bioregional Plan is available on the Department's website at <www.environment.gov.au/coasts/mbp/south-west>.

Following the release of the Draft South-west Marine Bioregional Plan there will also be a statutory consultation period. At least 60 days will be provided for public comment on the Draft Plan. During this period, the Department of the Environment, Water, Heritage and the Arts will facilitate meetings with stakeholders to discuss and clarify specific issues and comments. After considering comments and any additional information provided, the Department will finalise the Plan for consideration and approval by the Minister for the Environment, Heritage and the Arts.

Rainbow cale. Photo: Marine Life Society of South Australia.

Figure 6.1 *Stages of marine bioregional planning in the South-west*



Diver on the wreck of HMAS Swan in Geographe Bay. Photo : Glen Cowans.

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 two categories: those concerned with regulating activities to protect the marine environment and those relating specifically to the conservation of biodiversity. The following sections outline the main international agreements that influence Australia's approach to conserving marine biodiversity and protecting the marine environment.

- Australia also recently became a Contracting Party to the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001. The convention will enter into force in Australia when it enters into force internationally.

- Australia has also signed, subject to ratification, two other international agreements which regulate activities to protect the marine environment and which are not yet in force:

    - the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004; and

    - the International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001.

International agreements regulating maritime activities to protect the marine environment

United Nations Convention on the Law of the Sea (UNCLOS) 1994

The Australian Government has rights and responsibilities under the United Nations Convention on the Law of the Sea 1994 (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 protect and preserve the marine environment.

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 fish stocks and those that straddle the high seas and areas within 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 do not constitute normal operations. In Australia, 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 has the power to submit properties for inclusion on the World Heritage List. This 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 both 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 pollution from ships. The convention has six annexes that specifically address different sources of pollution from shipping:

- Annex I addresses the discharge of oil from ships and regulates how and when a ship may discharge oil into the sea;
- Annex II addresses the discharge or escape of noxious liquid substances (i.e. chemicals);
- Annex III addresses harmful substances carried in packaged forms (i.e. freight containers);
- Annex IV addresses the discharge of sewage from ships;
- Annex V addresses discharge of garbage from ships into the sea; and
- Annex VI addresses air pollution from ships, including engine 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 1969

This convention requires oil tankers to have compulsory insurance against pollution damage liabilities. The convention applies to an oil spill occurring in the Australian Exclusive Economic Zone (EEZ), 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 companies are required to be parties to pay damages and to cover the clean-up costs of oil spills.

Regional Fisheries Management Organisations

The Australian Government Department of Agriculture, Fisheries and Forestry develops policies and programmes 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 are 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 voluntary 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 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.

Indian Ocean Tuna Commission 1993

The Agreement for the Establishment of the Indian Ocean Tuna Commission (IOTC), in force since 1996, promotes cooperation in the conservation of tuna and tuna-like species in the Indian Ocean, including within areas of national jurisdiction for coastal states (including Australia). The commission promotes their optimum utilisation, and the sustainable development of the fisheries. The IOTC has deferred management of the Southern Bluefin Tuna Fishery to the CCSBT where they are located in its area of competence. The IOTC currently has 26 Members which are the coastal states of the region and distant water fishing nations.

Other fisheries arrangements

Australia also participates in a number of fora that aim to promote regional development through sustainable fisheries management. These include:

- the FAO, through its Committee on Fisheries;
- the Asia-Pacific Economic Cooperation (APEC) Fisheries Working Group; and
- 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 1994* (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 Stocks Agreement);
- *United Nations Food and Agriculture Organisation's (FAO) 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

The International Convention for the Regulation of Whaling was signed on 2 December 1946. The purpose of the convention was "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 legally 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 has 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 are:

- *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); and
- *The Republic of Korea-Australia Migratory Bird Agreement 2006* (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, 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 the Conservation of Migratory Species of Wild Animals 1979

The convention on the Conservation of Migratory Species of Wild Animals (also known as the CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. The CMS 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 significantly supported their implementation since they have been finalised. For instance, Australia has hosted the interim Secretariat of ACAP since its inception and the headquarters will be established in Australia in due course. Australia has also taken the lead in progressing 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 the Convention on Biological Diversity, which was made at the 1992 Earth Summit in Rio de Janeiro. The convention establishes 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 on Biological Diversity 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 on Biological Diversity.

Convention on the Conservation of Antarctic Marine Living Resources 1980

This convention was established in response to concerns that an increase in krill catches in the Southern Ocean could have a serious negative impact on populations of krill and other marine life; particularly on birds, seals and fish, which mainly depend on krill for food. The aim of the convention is:

- to conserve marine life of the Southern Ocean by ensuring that all harvesting and research activities are conducted in accordance with the convention;
- to formulate, adopt and revise conservation measures;
- to compile, analyse and disseminate information on the status of resources; and
- to facilitate research activities.

Convention for the Conservation of Antarctic Seals 1972

The convention was set up to protect all six species of seal found in the Antarctic, following concerns about a possible resumption of commercial sealing in the region in the mid-1960s. Commercial sealing has not resumed in the Antarctic.

A scampi at the mouth of its burrow in fine sediments. Central Western Province, 408 m deep. Photo: CSIRO.

Key references and further readings

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), <www.environment.gov.au/biodiversity/migratory>, accessed 10/05/07.

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), <www.environment.gov.au/biodiversity/migratory>, accessed 10/05/07.

Agreement for the Establishment of the Indian Ocean Tuna Commission 1993, <www.iotc.org>, accessed 10/05/07.

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 (UN Fish Stocks Agreement.) <www.un.org/Depts/los>, accessed 10/05/07.

Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas 1995 (Compliance Agreement), <www.fao.org/fi>, accessed 10/05/07.

Code of Conduct for Responsible Fisheries 1995, <www.fao.org/fi>, accessed 10/05/07.

Convention Concerning the Protection of the World Cultural and Natural Heritage 1972 (World Heritage Convention), <whc.unesco.org/en/conventiontext>, accessed 10/05/07.

Convention for the Conservation of Antarctic Seals 1972, <www.unep.ch/regionalseas/legal/ccas.htm>, accessed 10/05/07.

Convention on Biological Diversity 1992, < www.biodiv.org>, accessed 10/05/07.

Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES), <www.cites.org>, accessed 10/05/07.

Convention on the Conservation of Antarctic Marine Living Resources 1982, <www.ccamlr.org>, accessed 10/05/07.

Convention on the Conservation of Migratory Species of Wild Animals 1979, <www.cms.int>, accessed 10/05/07.

Convention for the Conservation of Southern Bluefin Tuna 1994, <www.ccsbt.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.

Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969, <www.imo.org>, accessed 10/05/07.

International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL 73/78), <www.imo.org>, accessed 10/05/07.

International Convention for the Regulation of Whaling 1946, <www.iwcoffice.org/commission/convention.htm>, accessed 10/05/07.

International Convention on Civil Liability for Oil Pollution Damage 1969, <www.imo.org>, accessed 10/05/07.

International Convention on Oil Pollution Preparedness, Response and Cooperation 1990, < www.imo.org>, accessed 10/05/07.

International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1992, < www.imo.org>, accessed 10/05/07.

Republic of Korea – Australia Migratory Bird Agreement (ROKAMBA) 2006, <www.environment.gov.au/biodiversity/migratory/waterbirds>, accessed 10/08/07.

Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America 1987 (Pacific Island Countries-US Treaty), <www.daffa.gov.au/fisheries/international/multilateral/pacific-ocean-fora>, accessed 10/05/07.

United Nations Convention on the Law of the Sea 1994 (UNCLOS), <www.un.org/Depts/los>, accessed 10/05/07.

Sponge crab. Photo: Marine Life Society of South Australia.

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 for more information on the Commonwealth marine area.

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.

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 to have regard, where relevant, to Bioregional Plans when making decisions under the EPBC Act. Marine Bioregional Plans also aim to streamline conservation and environmental management, and to create marine protected areas (MPAs) in Commonwealth waters that will further the development of the National Representative System of MPAs.

The marine bioregional planning programme 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, and with input from stakeholders.

Referral, assessment and approval

Central to the EPBC Act is the concept of matters of national environmental significance. Matters of national environmental significance 'trigger' the referral, assessment and approval of activities under the EPBC Act. The EPBC Act requires that proposals for actions that have, will have, or are likely to have a significant impact on a matter of national environmental significance must 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 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 dependent);
- listed migratory species;
- the 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 marine environment.

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 for a decision on whether assessment and approval is required under the EPBC Act. 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 the Commonwealth marine area 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, with a view to refinement based on operational experience and public and expert comments. The policy statement will be available for public comment until 31 August 2007. It has been prepared to: 1) provide practical standards to minimise the risk of acoustic injuries to whales in the vicinity of seismic survey operations; 2) provide a framework that minimises the risk of biological consequences from acoustic disturbance from seismic surveys to whales in biologically important habitat areas or during critical behaviours; and 3) provide advice to proponents of offshore seismic operations on their legal responsibilities under the EPBC Act;
- *EPBC Act Policy Statement 2.2 Industry Guidelines – Offshore Aquaculture* (August 2006) These provide guidance to proponents of marine aquaculture activities to determine 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*; and
- Nationally threatened species and ecological community guidelines have been prepared for a number of land-based threatened species or ecological communities. To date no nationally threatened species or ecological community guidelines have been developed for marine species.

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.

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 programmes are in place under the EPBC Act for the protection, conservation and recovery of marine biodiversity. The EPBC Act contains provisions that protect members of listed threatened species, listed migratory species and listed marine species and cetaceans. Commonly, species listed under the EPBC 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 threat 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 community 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 and 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 that these species require protection to ensure their long-term conservation. The EPBC Act also established the Australian Whale Sanctuary, which includes 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, and have been identified as 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 248 of the EPBC 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 MPAs. 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. The *Guidelines for the Ecologically Sustainable Management of Fisheries* outlines 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 Historic Shipwrecks Act does not apply to wrecks and relics in internal waters, such as rivers, lakes, bays, or harbours of a State. Each of the States has complementary legislation that protects historic shipwrecks in internal waters of the State.

The Historic Shipwrecks Act 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, 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 Historic Shipwrecks 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. A 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 threat from 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 Historic Shipwrecks Act.

The Historic Shipwrecks 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), which entered 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 too 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 of the Environment, Water, Heritage and the Arts will also refer the proposal for assessment under the EPBC Act, in accordance with Part 11 of the EPBC Act. In such cases the Department seeks 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. Another relatively uncommon activity that requires a permit under the Sea Dumping Act is the creation of artificial reefs. The *National Ocean Disposal Guidelines for Dredged Material* (2002) have been prepared to assist

proponents with the assessment and management of dredged material.

The Sea Dumping Act, the administration of which is the responsibility of 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 Sea Dumping 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 Sea Dumping 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 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 outer 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 also sets out the legislative basis for statutory fishing rights, licences and permits.

The Fisheries Management Act 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 the objectives of the plan, measures by which the objectives are to be attained, and performance criteria against which the measures taken may be assessed. These plans are prepared in consultation with participants in the fishery and all draft plans are made available for public comment before they are finalised.

Section 3(1) (b) of the Fisheries Management Act sets out the Australian Government's responsibilities regarding the pursuit of ecologically sustainable development (ESD). The Fisheries Management 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 minimises the impact of fishing on biological diversity and ecosystem habitat.

The Fisheries Management Act interacts with the EPBC Act through the independent assessments required under the EPBC Act. Further information on these assessments is provided below.

Petroleum (Submerged Lands) Act 1967

The *Petroleum (Submerged Lands) Act 1967* regulates the exploration for 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 installed in adjacent areas 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 Sea Installations Act.

The *Sea Installations Act 1987* applies to waters within the outer 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 the environmental implications and the safety of the proposal. 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 GBRMPA will also refer the proposal for assessment under the EPBC Act, in accordance with Division 4 of Part 11 of the EPBC Act. In such cases the Department seeks to undertake both assessments concurrently.

Native Title Act 1993

The *Native Title Act 1993* 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 Native Title Act seeks to regulate acts that have an impact on the native title rights of Indigenous Australians.

The Native Title Act and the EPBC Act

The EPBC Act does not affect the operation of the Native Title Act, which provides for the recognition and protection of native title and establishes ways in which dealings affecting native title may proceed.

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 the means of 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 Native Title Act as any land or waters other than those lands and waters within the limits of a State or Territory. Section six of the Native Title Act extends the operation of the Act to each external Territory, to the coastal sea of Australia and of each external Territory, and to any waters over which Australia asserts sovereign rights under the *Seas and Submerged Lands Act 1973*. Under the Native Title Act, 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 dugong and turtle; 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 Native Title Act 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, 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.

Key references and further readings

Legislation

Available from the Commonwealth of Australia Law website <www.comlaw.gov.au>

Acts Interpretation Act 1901

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 1991

Great Barrier Reef Marine Park Act 1975

Historic Shipwrecks Act 1976

Native Title Act 1993

Navigation Act 1912

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

Policies & Guidelines

The following EPBC Act policy statements are available from <www.environment.gov.au/epbc/policy>.

Department of the Environment and Heritage (DEH), 2006, *EPBC Act Policy Statement 1.1 Significant Impact Guidelines – Matters of National Environmental Significance*, Canberra.

Department of the Environment and Heritage (DEH), 2006, *EPBC Act Policy Statement 1.2 Significant Impact Guidelines – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies*, Canberra.

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Department of the Environment, Water, Heritage and the Arts (DEW), 2007, *Draft EPBC Act Policy Statement 2.1 – Interactions Between Offshore Seismic Exploration and Whales*, Canberra.

Environment Australia (EA), 2001, *Guidelines for the Ecologically Sustainable Management of Fisheries*, Canberra <www.environment.gov.au/coasts/fisheries>, accessed 10/05/07.

Environment Australia (EA), 2002, *National Ocean Disposal Guidelines for Dredged Material*, Canberra <www.environment.gov.au/coasts/pollution/dumping/guidelines>, 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.

Black-browed albatross. Photo: Robert Tomkins, Australian Government Antarctic Division.

Appendix C Nationally Protected Species in the South-west Marine Region

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

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 as marine species:

- Threatened species are those species that have been identified as being in danger of becoming extinct.
- Migratory species are those species that are listed under:
    - *the Convention for the Conservation of Migratory Species of Wild Animals 1979* (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 People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA); or
    - 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 and CAMBA is provided in Appendix A.
- Cetaceans – whales, dolphins and porpoises – are protected under the EPBC Act to ensure their future survival.
- 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 South-west Marine Region include species of:
    - sea-snakes (Families Hydrophiidae and Laticaudidae);
    - seals, both eared and true seals (Families Otariidae and Phocidae);
    - marine turtles (Families Cheloniidae and Dermochelyidae);
    - seahorses, sea-dragons, pipefish and the ghost pipefish (Families Syngnathidae and Solenostomidae); and
    - seabird species that occur naturally in the Commonwealth marine area.

This appendix lists species protected under the EPBC Act that are known to occur (Table C1) or that may occur infrequently (Table C2) in the South-west Marine Region.

Species that may infrequently occur are defined as:

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

Table C1 Protected species known to occur in the South-west Marine Region

Further information on these species is provided in the Protected Species Group Report Cards in Appendix D.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Sharks	White shark (*Carcharodon carcharias*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix I & II)	Global species found throughout temperate seas. Region falls within known range of the species.	Known to feed in the Region and may also breed in the Region.	Feeding areas near seal colonies. May have important nursery grounds located in inshore coastal waters.
	Grey nurse shark (*Carcharias taurus*)	Vulnerable	Known range of the west coast population falls almost entirely within the Region.	Known to feed in the Region and may also breed in the Region.	Found primarily in waters along the south-west coast of WA to Shark Bay. Breeding sites unknown.
	Whale shark (*Rhincodon typus*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix II)	Found in tropical and warm-temperate seas, both oceanic and coastal, between 30°N and 35°S. Part of the known range of the species extends into the Region.	Data deficient.	None identified.
Bony fish	Indonesian pipehorse, Günther's pipehorse (*Solegnathus lettiensis/ Solegnathus guentheri*)	Marine	Found in temperate to tropical waters around WA, the NT, the Arafura Sea and Indonesia. Part of the known range extends into the Region.	Probably resident in the Region throughout the year. Likely to feed and breed in the Region.	Data deficient – none identified.
	Orange roughy (*Hoplostethus atlanticus*)	Conservation dependent	Orange roughy live in cold, deep waters in the Atlantic, Pacific and Indian Oceans. In Australia, orange roughy are found across the southern half of the continent, from central NSW, through to southern WA, including Tas.	The species is known to aggregate to spawn in areas within the Region.	Aggregations have been targeted by commercial fishers in the Great Australian Bight, shelf break off Albany (Albany Canyons), shelf break off Esperance and at the Kangaroo Island canyons and adjacent shelf break.
Reptiles	Yellow-bellied sea-snake (*Pelamis platurus*)	Marine	Global species found throughout tropical and sub-tropical seas, except the Atlantic. Numerous records of this species in the Region with the southern-most record from around Esperance.	A pelagic species that inhabits the slicks and drift lines of ocean currents. In the Region, it is most frequently observed at the shelf edge or beyond the continental shelf.	Data deficient – none identified.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Reptiles	Leatherback turtle, leathery turtle (*Dermochelys coriacea*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)	This species has the widest distribution of all marine turtles, occurring from the North Sea and the Gulf of Alaska in the Northern Hemisphere, to Chile and New Zealand in the Southern Hemisphere.	Migratory visitor to the Region that feeds in pelagic waters on the mid-west and south-west of WA.	Mid-west to south-west coast of WA where they have been observed feeding on soft bodied invertebrates such as jelly fish.
	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 to cooler waters.	Migratory visitor to the Region. Resident adult and sub-adult turtles have been sighted around Perth.	Waters from Rottnest Island to Geographe Bay. Resident adult and sub-adult loggerheads are known to forage in these areas.
	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 to cooler waters.	Migratory visitor to the Region. Resident green turtles have been seen around reefs south of Shark Bay down to around Kalbarri and around the reefs of the Houtman Abrolhos Islands.	Resident green turtles forage around coastal reefs of Kalbarri and the reefs of the Houtman Abrolhos Islands. Large juvenile green turtles are observed in the area from Jurien Bay south to Rottnest Island and are assumed to be foraging.
Birds	Blue petrel (*Halobaena caerulea*)	Vulnerable, Marine	Breeds on sub-Antarctic islands. Disperses south to pack ice and north to 30°S.	Regular visitor to offshore waters of Region. Probably feeds in the Region.	None identified.
	Cape petrel (*Daption capense*)	Marine	Breeds on Antarctic coasts and sub-Antarctic islands. Disperses through southern oceans.	Regular visitor to offshore waters of the Region. Probably feeds in the Region.	None identified.
	Great-winged petrel (*Pterodroma macroptera*)	Marine	Breeds May-November in the Recherche Archipelago and offshore islands of Albany in WA, New Zealand and sub-Antarctic Islands. Forages in offshore waters from Geraldton, WA, and southern waters around to Qld.	Known to breed adjacent to the Region and feed in the Region.	Recherche Archipelago and Eclipse Island WA.
	Soft-plumaged petrel (*Pterodroma mollis*)	Vulnerable, Marine	Breeds on sub-Antarctic islands in south Atlantic and south Indian Oceans. Six burrows found on Maatsuyker Is, Tas.	Common visitor throughout the Region.	None identified.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	White-chinned petrel (*Procellaria aequinoctialis*)	Migratory, Marine Listed under CMS (Appendix II)	Breeds in the sub-Antarctic. Occasional visitor to Australian seas.	Occasional visitor to the Region.	None identified.
	Southern giant-petrel (*Macronectes giganteus*)	Endangered, Migratory, Marine Listed under CMS (Appendix II)	Breeds on Antarctic coast, sub-Antarctic islands, including Macquarie. Disperses widely over southern oceans.	Regular visitor to oceanic waters of Region in winter. Known to feed in the Region.	None identified.
	Northern giant-petrel (*Macronectes halli*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	Breeds on sub-Antarctic islands, including Macquarie. Disperses in southern oceans foraging throughout the Region.	Known to forage in the Region.	None identified.
	White-faced storm-petrel (*Pelagodroma marina*)	Marine	Breeds on offshore islands of southern Australia in summer, also Kermedecs, New Zealand and sub-Antarctic islands, north and south Atlantic. Migrate in winter.	Known to breed adjacent to the Region.	Beacon Island, Morley Island, Leo Island, Stick Island at the Houtman Abrolhos Islands WA, and Lancelin Island WA.
	Wilson's storm-petrel (*Oceanites oceanicus*)	Migratory, Marine Listed under JAMBA	Breeds on Antarctic coast and sub-Antarctic islands November -May. Disperses over all oceans, foraging pelagically.	Common visitor throughout the Region. Known to feed in the Region.	None identified.
	Sooty albatross (*Phoebetria fusca*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	Breeds on sub-Antarctic Islands in southern Indian and southern Atlantic Oceans.	Known to feed in the Region.	None identified.
	Southern royal albatross (*Diomedea epomophora*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	Breeds in New Zealand. Disperses north to 36°S.	Probably feeds in the Region.	None identified.
	Northern royal albatross (*Diomedea sanfordi*)	Endangered, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea epomophora*)	Breeds in New Zealand, ranging over the Southern Ocean from 36°S to 52°S.	Probably feeds in the Region.	None identified.
	Wandering albatross (*Diomedea exulans*)	Vulnerable, Migratory, Marine Listed under JAMBA & CMS (Appendix II)	Breeds on sub-Antarctic islands mostly in southern Indian Ocean, including Macquarie Island, and islands off New Zealand.	Rare visitor north to Houtman Abrolhos Islands in offshore waters.	None identified.
	Black-browed albatross (*Thalassarche melanophris*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea melanophris*)	Breeds on sub-Antarctic Islands, including Macquarie, with widespread dispersal in pelagic zones of southern oceans, including the Region.	Very common visitor to the Region.	Waters offshore of SA.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Indian yellow-nosed albatross (*Thalassarche carteri*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea chlororhynchos*)	Breeds in sub-Antarctic islands of the southern Indian Ocean.	Common visitor to the Region.	None identified.
	Shy albatross (*Thalassarche cauta*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea cauta*)	Breeds on offshore islands of Tas.	Known to feed in the Region.	None identified.
	Fluttering shearwater (*Puffinus gavial*)	Marine	Breeds in New Zealand. Migrates to coastal waters from Qld round to Eyre Peninsula SA.	Forages in eastern waters of the Region.	Eastern waters of the Region.
	Streaked shearwater (*Calonectris leucomelas*)	Migratory, Marine Listed under CAMBA (as *Puffinus leucomelas*) & JAMBA	Breeds in South-East Asia and migrates to the north coast of Australia and to the Houtman Abrolhos Islands, WA.	Known to feed in the Region.	North-west waters of the Region.
	Little shearwater (*Puffinus assimilis*)	Marine	Breeds in winter on Norfolk, Lord Howe Islands and WA from Recherche Archipelago to Houtman Abrolhos Islands. Common in offshore waters of WA.	Breeds adjacent to the Region and feeds in the Region.	Recherche Archipelago and Cape Leeuwin WA, islands between Fremantle and Dongara WA and 26 of the Houtman Abrolhos Islands.
	Sooty shearwater (*Puffinus griseus*)	Migratory, Marine Listed under CAMBA & JAMBA	Breeds in south-east Australia on offshore islands of NSW and Tas, as well as New Zealand and sub-Antarctic islands.	Known to feed in the Region.	None identified
	Hutton's shearwater (*Puffinus huttoni*)	Marine	Breeds in New Zealand. Present in offshore waters of Australia from Dampier, WA, south to Torres Strait and Qld.	Known to feed in the Region.	Houtman Abrolhos Islands WA.
	Wedge-tailed shearwater (*Puffinus pacificus*)	Migratory, Marine Listed under JAMBA	Breeds October-May from Cape Naturaliste in southern WA to Cape Leveque in northern WA, and from Cape Howe in south-east Australia to Cape York. Forages in pelagic waters while breeding and migrates to equatorial waters when non-breeding.	Known to breed adjacent to the Region and feed in the Region.	Offshore islands of WA – West Wallabi and Pelsaert Island (Houtman Abrolhos Islands), Lancelin Island, Rottnest Island and Safety Bay.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Short-tailed shearwater (*Puffinus tenuirostris*)	Migratory, Marine Listed under JAMBA	Breeds only in Australia. Breeds in the Region from Recherche Archipelago WA to Great Althorpe Island SA. Forage as far afield as the sub-Antarctic during breeding season (October- April). Migrate to the north Pacific when non-breeding.	Known to breed adjacent to the Region and feed in the Region. Forages throughout Region, as far north as Busselton WA.	Breeding colonies include: Recherche Archipelago, Great Althorpe Island, Gambier, North and Neptune Islands, Lewis, Hopkins and Williams Island near Cape Catastrophe, Greenly Island and islands in the investigator group, and Nuyts Archipelago (including Franklin, St Peter, Goat, Evans and Massilon Islands).
	Flesh-footed shearwater, fleshy-footed shearwater (*Puffinus cameipes*)	Migratory, Marine Listed under JAMBA	Breeding grounds include Recherche Archipelago WA to Cape Hamelin WA. Migrate in the winter to the Indian Ocean.	Known to breed adjacent to the Region.	Recherche Archipelago WA, and Cape Hamelin WA.
	Antarctic prion (*Pachyptila desolata*)	Marine	Breeds in Antarctica and on sub-Antarctic islands. Common winter-spring visitor to south Australian waters.	Probably feeds in the Region.	None identified.
	Salvin's prion (*Pachyptila salvini*)	Marine	Breeds on sub-Antarctic islands. Fairly common in south WA and SA.	Known to feed in the Region.	None identified.
	Fairy prion (*Pachyptila turtur*)	Marine	Breeds on offshore islands of Tas and Vic, New Zealand and southern Indian Ocean ranging to SA and south WA.	Known to feed in the Region.	None identified.
	Bridled tern (*Sterna anaethetus*)	Migratory, Marine Listed under CAMBA & JAMBA	Breeds on islands offshore of western, northern and eastern Australia, migrating northwards to tropical seas during non-breeding (April-October). The range includes tropical and sub-tropical coasts of eastern Indian Ocean into western Pacific Ocean and north to Taiwan.	Known to breed adjacent to the Region.	Significant breeding colonies in the Region: Penguin Island, Lancelin Island, Fisherman and Beagle Islands; at the Houtman Abrolhos Islands, (Gun Island, Leo Island, Pelsaert Island, Little North Island).
	Fairy tern (*Sterna nereis*)	Marine	Breeds on offshore islands throughout Region, to north of Broome in the west, to Tas, Bass Strait and NSW in the east. Also breeds on some islands of the Great Barrier Reef.	Known to breed adjacent to the Region.	Pelsaert Island, West Wallabi Island.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Sooty tern (*Sterna fuscata*)	Marine	Breeds on 10 islands at the Houtman Abrolhos Islands, and Lancelin Island (less than 10 pairs). In WA forages as far south as 32°S, and may forage as far as 1500 km from breeding areas.	Known to breed adjacent to the Region and feed in the Region.	Pelsaert, Alexander, Wooded and Leo Islands, (Houtman Abrolhos Islands), Lancelin Island WA.
	Gull-billed tern (*Sterna nilotica*)	Marine	Breeds in small colonies on islands and inland lakes, mostly in southern Australia.	Scarce and patchy visitor to Region, occasional breeder in Region.	None identified.
	Arctic tern (*Sterna paradisaea*)	Marine	Breeds in the Northern Hemisphere, migrates to the Antarctic. Occurs on beaches and mudflats of southern areas of the Region.	Passes through the Region on migration.	None identified.
	Caspian tern (*Sterna caspia*)	Migratory, Marine Listed under CAMBA (as *Hydroprogne caspia*) & JAMBA (as *Hydroprogne caspia*)	Breeds (September-December in southern Australia) in small colonies and often solitarily. Forages on offshore islands throughout the Region.	Are resident in all main island groups of the Region and nest in pairs and in colonies of up to 50 nests at the Houtman Abrolhos Islands.	Breeding colonies in SA on West, Troubridge and Shoal Islands (Sir Joseph Banks Group), South Neptune, St Peter (Nuyts Archipelago) and Eyre Islands. In WA nests on many islands from Recherche Archipelago to Shark Bay. Significant islands with colonies (up to 70 pairs) include: Leo Island, West Wallabi Island and Pelsaert Island.
	Lesser crested tern (*Sterna bengalensis*)	Migratory, Marine Listed under CAMBA	Breeds on offshore islands in coastal northern Australia in spring or autumn.	Probably feeds in the Region.	None identified.
	Crested tern (*Sterna bergii*)	Marine	Breeds on offshore islands of coastal Australia, breeds September-January in southern Australia, with some autumn breeding occurring at the Houtman Abrolhos Islands (March-July).	Known to breed adjacent to the Region and feed in the Region.	Rottnest Island, Pelsaert Island, Lancelin Island. Offshore islands throughout Region.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Roseate tern (*Sterna dougallii*)	Marine	Breeds on tropical offshore islands of Australia, south to Cape Naturaliste WA. Both spring (November-January) and autumn (April-June) breeding populations occur within the Region.	Known to breed adjacent to the Region and feed in the Region.	Large breeding colonies recorded at the Houtman Abrolhos Islands (Pelsaert Island 1700 pairs, Square Island 500 pairs, Jon Jim Island 964 pairs, Leo Island 627 pairs), Safety Bay WA (less than 1000 pairs), Rottnest Island WA (less than 1000 pairs), Lancelin Island WA (less than 1000 pairs).
	Common noddy (*Anous stolidus*)	Migratory, Marine Listed under CAMBA & JAMBA	Breeds in north Australia, islands of WA and on tropical/sub-tropical islands in the Indian, Pacific and Atlantic Oceans.	Known to breed adjacent to the Region.	Pelsaert Island, (Houtman Abrolhos Islands) WA.
	Australian lesser noddy (*Anous tenuirostris melanops*)	Vulnerable, Marine	About 68,000 pairs currently breed in the Houtman Abrolhos Islands. Breeds on Morley and Wooded Islands in the Easter Group, and Pelsaert Island in the Pelsaert Group of the Houtman Abrolhos Islands WA. Forages about 180 km west of breeding islands, between the islands and the continental shelf edge.	Known to breed adjacent to the Region and feed in the Region.	Houtman Abrolhos Islands WA.
	Common greenshank, greenshank (*Tringa nebularia*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Northern Hemisphere south to Africa and South-East Asia. Summer migrant to Australian coastal areas.	Summer migrant to the Region.	None identified.
	Red-necked stint (*Calidris ruficollis*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in Siberia and Alaska. Abundant summer migrant to Australia.	Summer migrant to the Region.	None identified.
	Sharp-tailed sandpiper (*Calidris acuminate*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in Siberia. Regular summer visitor to coastal areas of the Region.	Summer migrant to the Region.	None identified.
	Sanderling (*Calidris alba*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Arctic Circle. Regular summer migrant to coastal Australia.	Summer migrant to the Region.	None identified.
	Curlew sandpiper (*Calidris ferruginea*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in Siberia. Summer migrant to Australia.	Summer migrant to the Region.	None identified.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Red knot, knot (*Calidris canutus*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Arctic Circle. Regular summer migrant to Australia.	Summer migrant to the Region.	None identified.
	Grey plover (*Pluvialis squatarola*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Arctic Circle. Regular summer migrant to Australia.	Summer migrant to the Region.	None identified.
	Ruddy turnstone (*Arenaria interpres*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Arctic Circle. Regular summer migrant to Australia.	Summer migrant to the Region.	None identified.
	Pacific golden plover (*Pluvialis fulva*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)	Breeds in the Arctic Circle. Regular summer migrant to Australia..	Summer migrant to the Region.	None identified.
	Common sandpiper (*Actitis hypoleucos*)	Migratory, Marine Listed under CAMBA (as *Tringa hypoleucos*), JAMBA (as *Tringa hypoleucos*) & CMS (Appendix I & II)	Breeds in the Northern Hemisphere. Regular summer migrant to the Region.	Summer migrant to the Region.	None identified.
	Kelp gull (*Larus dominicanus*)	Marine	Breeds patchily in coastal south and south-east islands of Australia. Also breeds in New Zealand and sub-Antarctic.	Known to breed adjacent to the Region.	Breeds at Bremer Bay.
	Silver gull (*Larus novaehollandiae*)	Marine	Breeds on mainland and on offshore islands throughout Australia from August-December (southern Australia).	Known to breed adjacent to the Region.	Penguin Island, Carnac Island, Houtman Abrolhos Islands.
	Pacific gull (*Larus pacificus*)	Marine	Breeds on offshore islands in pairs and small, loose colonies throughout the South-west Marine Region, (August-December). Moves to coastal regions during winter to feed.	Known to breed adjacent to the Region.	Pelsaert Island (Houtman Abrolhos Islands).
	Arctic jaeger (*Stercocarius parasiticus*)	Migratory, Marine Listed under JAMBA	Breeds throughout Arctic, dispersing to Australian waters October-April.	Summer migrant to the Region.	None identified.
	Little penguin (*Eudyptula minor*)	Marine	Known to breed on Carnac Island WA through SA, Vic and Tas, north to NSW, and in New Zealand.	Known to breed adjacent to the Region and feed in the Region.	Offshore islands within the Region.
	Red-tailed tropicbird (*Phaethon rubricauda*)	Marine	Breeds on offshore islands and some coastal areas of Australia.	Known to breed adjacent to the Region.	Sugarloaf Rock and Pelsaert Island (Houman Abrolhos Islands) WA.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Birds	Pelican (*Pelecanus conspicillatus*)	Marine	Breeds throughout mainland Australia in all seasons.	May breed adjacent to the Region.	None identified.
	Australasian gannet (*Morus serrator*)	Marine	Breeds Tas, Vic. and New Zealand, but regular visitor to Region.	Common visitor throughout offshore waters of the Region.	None identified.
	Osprey (*Pandion haliaetus*)	Migratory, Marine Listed under CITES (Appendix II) & CMS (Appendix II)	Breeds on coasts and islands of Australia.	Known to breed adjacent to the Region.	Pelsaert Island (Houtman Abrolhos Islands) WA, Eyre Peninsula SA, Kangaroo Island SA.
	White-bellied sea-eagle (*Haliaeetus leucogaster*)	Migratory, Marine Listed under CAMBA & CMS (Appendix II)	Breeds in coastal areas throughout Australia.	Known to breed adjacent to the Region.	West Wallabi Island, Houtman Abrolhos Islands WA, Recherche Archipelago WA, Eyre Peninsula SA, Yorke Peninsula SA.
	Cape Barren goose (south-western), Recherche Cape Barren Goose (*Cereopsis novaehollandiae grisea*)	Vulnerable, Marine	Breeds in the Recherche Archipelago, dispersing west and north to the mainland (Cape Arid and Esperance).	Known to breed adjacent to the Region.	Recherche Archipelago WA.
	Black-faced cormorant (*Phalacrocorax fuscescens*)	Marine	Breeds on islands of southern Australia.	Known to breed adjacent to the Region.	None identified.
	Rainbow bee-eater (*Merops ornatus*)	Migratory, Marine Listed under JAMBA	Summer breeding migrant in Region except on Rottnest Island, WA where it is a summer breeder.	Known to breed adjacent to the Region.	Rottnest Island WA.
	Fork-tailed swift (*Apus pacificus*)	Migratory, Marine Listed under CAMBA & JAMBA	Breeds in northern Asia, and is a regular summer migrant to the Region.	Summer migrant to the Region	Usually observed around islands.
Seals, Fur Seals & Sea Lions	Australian sea lion (*Neophoca cinerea*)	Vulnerable, Marine	Known range of species falls throughout the Region.	Known to breed and feed adjacent to the Region throughout the year.	Colonies occur from Houtman Abrolhos Islands WA to the Pages Islands in SA, including 28 breeding colonies in WA and 38 in SA.
	New Zealand fur seal (*Arctocephalus forsteri*)	Marine Listed under CITES (Appendix II)	Ranges from the south coast of WA to New Zealand. Part of the known range of the species extends into the Region.	Known to breed adjacent to the Region and feed in the Region.	Colonies occur on the south coast of WA and SA, including 17 breeding colonies in WA and 13 in SA (two in Tas.).

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Seals, Fur Seals & Sea Lions	Australian fur seal (*Arctocephalus pusillus*)	Marine Listed under CITES (Appendix II)	Ranges from eastern SA to southern NSW and Tas. Part of the known range of the species extends into the Region.	Known to feed in the Region.	Important feeding areas in the eastern part of the Region. Large numbers haul-out adjacent to the Region on Kangaroo Island (Cape Gantheaume and Cape du Couedic), and are occasionally seen at the Neptune Islands.
Whales, Dolphins & Porpoises	Sei whale (*Balaenoptera borealis*)	Vulnerable, Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix I & II)	Global species found in all sub-polar, temperate and sub-tropical waters. The Region falls within the known range of the species.	Known to feed in the Region.	Possible feeding areas in the Perth Canyon and waters to the south of Kangaroo Island.
	Blue whale (*Balaenoptera musculus*)	Endangered, Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix I)	Global species. Region falls within the known range of the species.	Known to feed in the Region.	Feeding areas in the Duntroon Basin, Perth Canyon and waters to the south of Kangaroo Island. Possible resting area in Geographe Bay.
	Fin whale (*Balaenoptera physalus*)	Vulnerable, Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix I & II)	Global species found in polar and temperate waters. Region falls within the known range of the species.	Known to feed in the Region.	Feeding areas in the Perth Canyon and waters to the south of Kangaroo Island.
	Bryde's whale (*Balaenoptera edeni*)	Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix II)	Found in tropical and temperate waters between 40°N and 40°S. Part of the known range extends into the Region possibly in association with the Leeuwin Current.	Data deficient.	None identified. Records from the Houtman Abrolhos Islands.
	Minke whale, dwarf minke whale (*Balaenoptera acutorostrata*)	Cetacean Listed under CITES (Appendix I)	Found in tropical and warm temperate waters of the Southern Hemisphere. Part of the known range extends into the Region.	Data deficient. Possibly migrates through the Region.	None identified.
	Humpback whale (*Megaptera novaeangliae*)	Vulnerable, Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix I)	Found in several parts of the Northern and Southern Hemispheres. Migrate from polar summer breeding grounds to subtropical winter breeding grounds. Part of the migration route falls within the Region.	Migrate through Region. Important resting areas.	Resting areas in Geographe Bay, Cape Leeuwin/Flinders Bay and the Houtman Abrolhos Islands.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Whales, Dolphins & Porpoises	Southern right whale (*Eubalaena australis*)	Endangered, Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix I)	Found in sub-Antarctic, temperate and sub-tropical waters. Region falls within the known range of the species.	Known to breed in the Region.	The main calving areas currently known for southern right whales within and adjacent to the Region include: Doubtful Islands Bay (including Point Ann/ Point Charles area), Israelite Bay area, Twilight Cove, Flinders Bay, Albany/Cape Riche area, and Yokinup Bay/ Cape Arid area, Head of Bight, Fowlers Bay, and Encounter Bay.
	Pygmy right whale (*Caperea marginate*)	Migratory, Cetacean Listed under CITES (Appendix I) and CMS (Appendix II)	Found in temperate and sub-Antarctic waters. Region falls within the known range of the species.	Data deficient. Possibly feeds in the Region.	Possibly feed in areas of upwelling around Kangaroo Island, southern Eyre Peninsula and possibly south-western WA.
	Sperm whale (*Physeter macrocephalus*)	Migratory, Cetacean Listed under CITES (Appendix I as *Physeter catodon*) and CMS (Appendix I & II)	Global species found in deep tropical and temperate waters. Males also found in polar regions. Region falls within the known range of the species.	Feeding aggregations occur in the Region.	Concentrations in areas of upwellings close to the edge of the continental shelf at Albany, south-west of Kangaroo Island and between Cape Leeuwin and Esperance. Possible feeding area in Perth Canyon.
	Pygmy sperm whale (*Kogia breviceps*)	Cetacean Listed under CITES (Appendix II)	Oceanic distribution in all tropical and temperate waters of the world. Mostly beyond the edge of the continental shelf. Region falls within known range of the species.	Data deficient. Possibly feeds in the Region.	None identified.
	Dwarf sperm whale (*Kogia simus*)	Cetacean Listed under CITES (Appendix II)	Found over the continental shelf and slope off all tropical and temperate coasts.	Data deficient.	None identified.
	True's beaked whale (*Mesoplodon mirus*)	Cetacean Listed under CITES (Appendix II)	Thought to occur in deep temperate oceans. Region falls within the presumed range of the species.	Data deficient.	May be associated with colder shelf edge waters and canyon habitats
	Andrew's beaked whale (*Mesoplodon bowdoini*)	Cetacean Listed under CITES (Appendix II)	Circumpolar distribution north of the Antarctic convergence between 32°S and 54°30'S. Part of known range extends into Region.	Data deficient.	Primarily off the shelf.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Whales, Dolphins & Porpoises	Gray's beaked whale, scamperdown whale (*Mesoplodon grayi*)	Cetacean Listed under CITES (Appendix II)	Circumglobal in temperate waters of the Southern Hemisphere. Region falls within the known range of the species.	Data deficient.	May be associated with colder shelf edge waters and canyon habitats. Possible feeding area in Geographe Bay.
	Hector's beaked whale (*Mesoplodon hectori*)	Cetacean Listed under CITES (Appendix II)	Circumglobal in the Southern Hemisphere between 35°S and 55°S. Part of presumed range extends into Region.	Data deficient.	May be associated with colder shelf edge waters and canyon habitats.
	Strap-toothed beaked whale, strap-toothed whale, Layard's beaked whale (*Mesoplodon layardii*)	Cetacean Listed under CITES (Appendix II)	Widespread and common in the Southern Ocean and adjoining waters, occurring between approximately 30°S and the Antarctic Convergence. Region falls within the known range of the species. Seasonally common in the Region between January and April.	Possibly feeds and breeds in or adjacent to the Region.	May be associated with colder shelf edge waters and canyon habitats.
	Shepherd's beaked whale, Tasman beaked whale (*Tasmacetus shepherdi*)	Cetacean Listed under CITES (Appendix II)	Circumpolar in mid-latitudes of the Southern Hemisphere from 33°S to 50°S. Part of the range extends into Region.	Data deficient.	Primarily off the shelf. May be associated with canyon habitats.
	Arnoux's beaked whale (*Berardius arnuxii*)	Cetacean Listed under CITES (Appendix I)	Circumglobal in temperate and Antarctic waters of the Southern Ocean. The Region falls within the known range of the species.	Data deficient.	Primarily off the shelf.
	Cuvier's beaked whale, goose-beaked whale (*Ziphius cavirostris*)	Cetacean Listed under CITES (Appendix II)	Oceanic species. Worldwide distribution in all temperate and tropical waters between 60°N and 55°S. Region falls within known range of the species.	Data deficient.	Primarily off the shelf. May be associated with canyon habitats.
	Southern bottlenose whale (*Hyperoodon planifrons*)	Cetacean Listed under CITES (Appendix I)	Circumglobal distribution in the mid to high latitudes of the Southern Hemisphere. Region falls within the known range of the species.	Data deficient.	None identified.
	Killer whale, orca (*Orcinus orca*)	Migratory, Cetacean Listed under CITES (Appendix II) and CMS (Appendix II)	Global species found in all oceans and seas ranging from polar to tropical. Region falls within the known range of the species.	Known to feed in the Region.	No specific areas. Often observed near pinniped colonies on the west coast, in the Great Australian Bight and around Kangaroo Island and the Eyre Peninsula.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Whales, Dolphins & Porpoises	False killer whale (*Pseudorca crassidens*)	Cetacean Listed under CITES (Appendix II)	Global species found in deep temperate and tropical waters. Region falls within the known range of the species.	Possibly resident in the Region throughout the year.	None identified.
	Long-finned pilot whale (*Globicephala melas*)	Cetacean Listed under CITES (Appendix II)	Circumglobal in the Southern Hemisphere. Region falls within the known range of the species.	Possible resident in the Region throughout the year.	None identified.
	Short-finned pilot whale (*Globicephala macrorhynchus*)	Cetacean Listed under CITES (Appendix II)	Found in tropical and warm-temperate waters world-wide, between about 41°S and 45°N. Part of range extends into Region.	Data deficient.	None identified.
	Common dolphin (*Delphinus delphis*)	Cetacean Listed under CITES (Appendix II)	Found in tropical, subtropical and temperate waters of the Atlantic, Pacific and Indian Oceans, in both shallow and deep offshore waters. Region falls within the known range of the species.	Resident throughout the year.	No specific areas but common in SA and south south-western WA.
	Risso's dolphin, grampus (*Grampus griseus*)	Cetacean Listed under CITES (Appendix II)	Inhabits tropical, sub-tropical, temperate and sub-Antarctic waters between 60°N and 60°S. Region falls within known range of the species.	Data deficient.	None identified.
	Striped dolphin, euphrosyne dolphin (*Stenella coeruleoalba*)	Cetacean Listed under CITES (Appendix II)	Found in deep temperate and tropical waters. Part of the range extends into the Region.	Data deficient.	None identified.
	Spotted dolphin, pantropical spotted dolphin (*Stenella attenuate*)	Cetacean Listed under CITES (Appendix II)	Found in tropical and warm temperate oceanic zones between 40°N and 40°S. Both inshore and oceanic. Region falls within known range of the species.	Data deficient. Possibly feeds in the Region.	None identified.
	Long-snouted spinner dolphin (*Stenella longirostris*)	Cetacean Listed under CITES (Appendix II)	Found in tropical, subtropical and occasionally temperate waters. Part of known range extends into the Region (associated with Leeuwin Current).	Data deficient.	None identified.

	Species	Conservation Status	Distribution	Known Use of the Region	Important Areas in or adjacent to the Region
Whales, Dolphins & Porpoises	Bottlenose dolphin (*Tursiops truncates*)	Cetacean Listed under CITES (Appendix II)	Found in all temperate and tropical waters of the world. Usually in latitudes lower than 45°. Region falls within known range of the species.	Resident throughout the year.	None identified.
	Southern right whale dolphin (*Lissodelphis peronii*)	Cetacean Listed under CITES (Appendix II)	Circumglobal in the Southern Hemisphere. Region falls within the known range of the species.	Data deficient.	None identified.

Table C2 Protected species that may infrequently occur in the South-west Marine Region

	Species	Conservation Status
Bony fish	Blue-finned ghost pipefish, robust ghost pipefish (*Solenostomus cyanopterus*)	Marine
	Robust spiny pipehorse, robust pipehorse (*Solegnathus robustus*)	Marine
	Shaggy pipefish, prickly pipefish (*Hypselognathus horridus*)	Marine
	Leafy sea-dragon (*Phycodurus eques*)	Marine
	Weedy sea-dragon, common sea-dragon (*Phyllopteryx taeniolatus*)	Marine
	Gale's pipefish (*Campichthys galei*)	Marine
	Brock's pipefish (*Halicampus brocki*)	Marine
	Bentstick pipefish, bendstick pipefish, short-tailed pipefish, double-ended pipefish (*Trachyrhamphus bioarctatus*)	Marine
	Port Phillip pipefish (*Vanacampus phillipi*)	Marine
	Wide-body pipefish (*Stigmatopora nigra*)	Marine
	Bony-headed pipefish (*Nannocampus subosseus*)	Marine
	West Australian seahorse (*Hippocampus subelongatus*)	Marine Listed under CITES (Appendix II)
	Western spiny seahorse, narrow-bellied seahorse (*Hippocampus angustus*)	Marine Listed under CITES (Appendix II)
	Short-headed seahorse, short-snouted seahorse (*Hippocampus breviceps*)	Marine Listed under CITES (Appendix II)
	Southern potbelly seahorse, potbelly seahorse, pot-bellied seahorse (*Hippocampus abdominalis*, *Hippocampus bleekeri*)	Marine Listed under CITES (Appendix II)

	Species	Conservation Status
Reptiles	Elegant sea-snake, bar-bellied sea-snake (*Hydrophis elegans*)	Marine
	Ocellated (or spotted) sea-snake (*Hydrophis ocellatus*)	Marine
	Olive-headed sea-snake (*Disteira major*)	Marine
	Shark Bay sea-snake (*Aipysurus pooleorum*)	Marine
	Flatback turtle (*Natator depressus*)	Vulnerable, Migratory and Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)
	Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable, Migratory and Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)
	Olive ridley turtle (*Lepidochelys olivacea*)	Vulnerable, Migratory and Marine Listed under CMS (Appendix I, II) and CITES (Appendix I)
Birds	Gould's petrel (*Pterodroma leucoptera*)	Marine (subspecies *P. l. leucoptera* listed as Endangered & Migratory. Listed under JAMBA)
	Grey petrel (*Procellaria cinerea*)	Migratory, Marine Listed under CMS (Appendix II)
	Kerguelen petrel (*Lugensa brevirostris*)	Marine
	Black-bellied storm-petrel (*Fregetta tropica*)	Marine
	Grey-backed storm-petrel (*Garrodia nereis*)	Marine
	Leach's storm-petrel (*Oceanodroma leucorhoa*)	Migratory, Marine Listed under CAMBA & JAMBA
	Light-mantled sooty albatross (*Phoebetria palpebrata*)	Migratory, Marine Listed under CMS (Appendix II)
	Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered, Migratory, Marine Listed under CMS (Appendix I)
	Gibson's albatross (*Diomedea gibsoni*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea exulans*)
	Tristan albatross (*Diomedea dabbenena*)	Endangered, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea exulans*)
	Buller's albatross (*Thalassarche bulleri*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea bulleri*)
	Campbell albatross (*Thalassarche impavida*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea melanophris*)
	Grey-headed albatross (*Thalassarche chrysostoma*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea chrysostoma*)
	Salvin's albatross (*Thalassarche salvini*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II; as *Diomedea cauta*)

	Species	Conservation Status
Birds	Yellow-nosed albatross, Atlantic yellow-nosed albatross (*Thalassarche chlororhynchos*)	Migratory, Marine Listed under CMS (Appendix II; as *Diomedea chlororhynchos*)
	Common diving-petrel (*Pelecanoides urinatrix*)	Marine
	Broad-billed prion (*Pachyptila vittate*)	Marine
	Slender-billed prion (*Pachyptila belcheri*)	Marine
	Southern fulmar (*Fulmarus glacialoides*)	Marine
	White tern (*Gygis alba*)	Marine
	White-winged black tern (*Chlidonias leucoptera*)	Migratory, Marine Listed under CAMBA & JAMBA
	Whiskered tern (*Chlidonias hybrida*)	Marine
	Antarctic tern (*Sterna vittata*)	Marine
	Common tern (*Sterna hirundo*)	Migratory, Marine Listed under CAMBA & JAMBA
	Little tern (*Sterna albifrons*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix II)
	Marsh sandpiper, little greenshank (*Tringa stagnatilis*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)
	Latham's snipe, Japanese snipe (*Gallinago hardwickii*)	Migratory, Marine Listed under CAMBA, JAMBA & CMS (Appendix I & II)
	Australian painted snipe (*Rostratula australis*)	Vulnerable, Migratory, Marine Listed under CAMBA (as *Rostratula benghalensi* s. lat.)
	Oriental plover, oriental dotterel (*Charadrius veredus*)	Migratory, Marine Listed under JAMBA & CMS (Appendix I & II)
	Hooded plover (eastern subspecies) (*Thinornis rubricollis rubricollis*)	Marine
	Great skua (*Catharacta skua*)	Marine
	South polar skua (*Catharacta maccormicki*)	Migratory, Marine Listed under JAMBA (as *Stercorarius maccormicki*)
	Great egret, white egret (*Ardea alba*)	Migratory, Marine Listed under CAMBA (as *Egretta alba*), JAMBA (as *Egretta alba*) & CITES (Appendix III; as *Casmerodius albus*)
	Cattle egret (*Ardea ibis*)	Migratory, Marine Listed under CAMBA (as *Ardeola ibis*), JAMBA (as *Ardeola ibis*) & CITES (Appendix III; as *Bubulcus ibis*)
	King penguin (*Aptenodytes patagonicus*)	Marine

	Species	Conservation Status
Birds	Erect-crested penguin (*Eudyptes sclateri*)	Marine
	Fiordland penguin (*Eudyptes pachyrhynchus*)	Marine
	Rockhopper penguin (*Eudyptes chrysocome*)	Marine
	Cape gannet (*Morus capensis*)	Marine
	Lesser frigatebird (*Fregata ariel*)	Migratory, Marine Listed under CAMBA & JAMBA
	White-throated needletail (*Hirundapus caudacutus*)	Migratory, Marine Listed under CAMBA & JAMBA
	Orange-bellied parrot (*Neophema chrysogaster*)	Endangered, Migratory, Marine Listed under JAMBA & CITES (Appendix I)
Seals & Fur Seals	Southern elephant seal (*Mirounga leonine*)	Vulnerable, Marine Listed under CITES (Appendix II)
	Leopard seal (*Hydrurga leptonyx*)	Marine
	Crabeater seal (*Lobodon carcinophagus*)	Marine
	Weddell seal (*Leptonochotes weddellii*)	Marine
	Antarctic fur seal (*Arctocephalus gazella*)	Marine Listed under CITES (Appendix II)
	Sub-Antarctic fur seal (*Arctocephalus tropicalis*)	Vulnerable, Marine Listed under CITES (Appendix II)
Dugong	Dugong (*Dugong dugon*)	Migratory, Marine Listed under CITES (Appendix I) and CMS (Appendix II)
Whales, Dolphins & Porpoises	Antarctic minke whale, dark-shoulder minke whale (*Balaenoptera bonaerensis*)	Migratory, Cetacean Listed under CITES (Appendix I) & CMS (Appendix II)
	Blainville's beaked whale, dense-beaked whale (*Mesoplodon densirostris*)	Cetacean Listed under CITES (Appendix II)
	Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*)	Cetacean Listed under CITES (Appendix II)
	Melon-headed whale (*Peponocephala electra*)	Cetacean Listed under CITES (Appendix II)
	Pygmy killer whale (*Feresa attenuate*)	Cetacean Listed under CITES (Appendix II)
	Spotted bottlenose dolphin, Indo-Pacific bottlenose dolphin (*Tursiops aduncus*)	Cetacean Listed under CITES (Appendix II)
	Dusky dolphin (*Lagenorhynchus obscurus*)	Migratory, Cetacean Listed under CITES (Appendix II) and CMS (Appendix II)
	Rough-toothed dolphin (*Steno bredanensis*)	Cetacean Listed under CITES (Appendix II)
	Fraser's dolphin, Sarawak dolphin (*Lagenodelphis hosei*)	Cetacean Listed under CITES (Appendix II)

Grey nurse sharks. Photo: David Harasti.

Appendix D South-west Marine Region Protected Species Group Report Cards

These report cards summarise information on those species that occur in the South-west Marine Region and 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 April 2007. Updates of the report cards will be available on the web at <www.environment.gov.au/coasts/mbp/south-west>.

Protected species occurring in the South-west Marine Region for which species group report cards have been compiled include:

D1 Sharks

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)

D1 South-west Marine Region Protected Species Group Report Card – Sharks

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>

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 152 occur in the South-west Marine Region. The *South-west Marine Region: Ecosystems and Key Species Groups* report provides an overview of this species group in the South-west Marine Region.

Nationally protected species

Three species of sharks found in the Region are listed under the EPBC Act (Table D1). White and whale sharks are also listed under international instruments. Recovery Plans are in force for each of these three species and can be found at <www.environment.gov.au/coasts/species/sharks>.

Table D1 Sharks listed as threatened or migratory under the EPBC Act that are known to occur in the South-west 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 (*Carcharias taurus*) – west coast population	Vulnerable	
Whale shark (*Rhincodon typus*)	Vulnerable, Migratory Listed under CITES (Appendix II) and CMS (Appendix II)	

White shark. Photo: Rachel Robbins, Fox Shark Research Station.

Ecology of protected sharks in the South-west Marine Region

White shark

The white shark is widely distributed throughout temperate and sub-tropical regions, and is most frequently observed and captured in inshore cool to warm temperate continental waters. Available data from recent tracking studies show that white sharks can travel thousands of kilometres. Their movements appear to have seasonal patterns, with individual sharks moving up the west coast as far as North West Cape in Western Australia during spring, and returning south during the summer.

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 South-west Marine Region appears to be an important area for the species as available records of incidental catches in fisheries are highest in the Region and are not well correlated with fishing effort (Malcolm *et al*. 2001). White sharks thus appear to be more abundant in the South-west Marine Region, particularly in the waters from Shark Bay to Bunbury and in waters of the Great Australian Bight, than in other parts of Australian waters (Malcolm *et al*. 2001). Due to the internationally threatened status of this species, the Region may not only be significant for the conservation and management of white sharks in Australia, but possibly also in a global context.

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. The species is thought to occur in all waters off the Australian mainland but is considered rare in the Northern Territory and through the southern extent of its range, thus it is thought that the west and east coast populations are separate. The extent to which the west coast population of the grey nurse shark extends into South Australian waters has not been well established to date.

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. 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 in Australia has not been well studied, but it 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.

While grey nurse sharks are known to aggregate at sites on the east coast of Australia, aggregation sites for this species in Western Australia are less well understood. To date, no aggregation areas have been identified in Western Australia, but this could be because of the limited number of studies on grey nurse shark habitat in this State. A recent tracking study showed that juveniles can move hundreds of kilometres north along the Western Australia coast, from Perth to Kalbarri, before returning south (McAuley 2004). The length of the

migration indicates that grey nurse sharks do not need to stay close to what is considered their 'typical' habitat, such as rocky ledges, gutters and caves (McAuley 2004). The study also suggests that grey nurse sharks in Western Australia spend most of their time at depths between 20 m and 60 m but can spend periods of up to two weeks at depths greater than 110 m (McAuley 2004).

Whale shark

Whale sharks are a 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 of up to hundreds of sharks. Although it has been suggested that this species prefers waters with temperatures between 21-25°C, the whale sharks sighted at Ningaloo Marine Park (which is located to the north of the Region) are predominantly found in waters with temperatures averaging 27°C.

No whale shark aggregation areas have been identified in the Region and no interactions with the species, such as capture in fisheries, are known to occur in the Region, so the species will not be considered further here. Further information on whale sharks and threats to the species is available at <www.environment.gov.au/biodiversity/threatened/publications/recovery/r-typus>.

Grey nurse shark. Photo: David Harasti.

Important areas for sharks in the South-west Marine Region

Important areas in the South-west Marine Region are identified for species listed as threatened or migratory under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for more information on matters of national environmental significance and requirements under the EPBC Act). Important nursery and feeding areas in the Region have been identified for white sharks. These areas are located in both waters of the South-west Marine Region and in coastal waters under the jurisdiction of the South Australian and Western Australian Governments.

The following areas are known to be particularly important for white sharks:

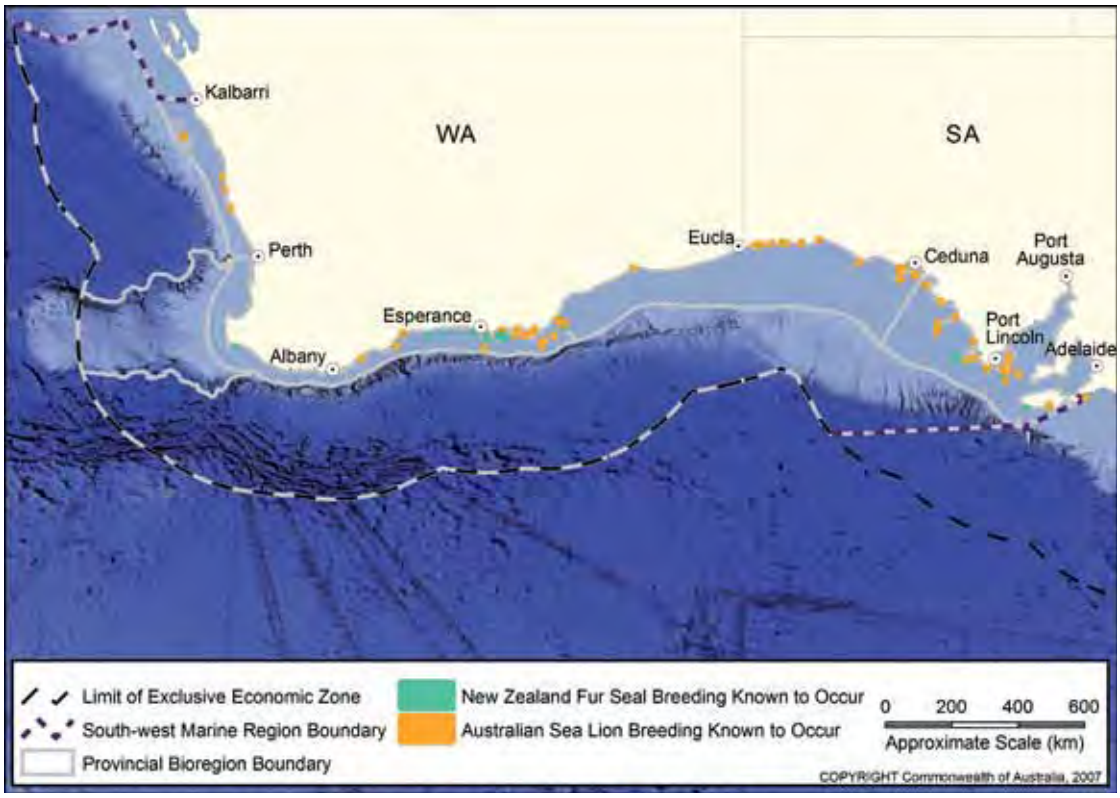
The inshore waters of the Great Australian Bight – Small juvenile white sharks (under 2 m) are commonly encountered in this area. It is presumed that the apparent abundance of small white sharks in this area is due to pupping in this area or nearby.

Head of Bight – Movements of white sharks are known to increase seasonally at the Head of the Great Australian Bight and may be linked to the seasonal availability and movements of prey including snapper, gummy sharks and Australian salmon, and to the calving of southern right whales.

Pinniped (seals and sea lion) colonies – Evidence suggests that these are areas where white sharks can aggregate or frequently revisit to feed and are most likely areas of habitat critical to the survival of the species (Bruce *et al*. 2005). For instance, white sharks are regularly observed around the Neptune Islands and Dangerous Reef, which have large breeding colonies of New Zealand fur seals and Australian sea lions respectively. See Figure D1.1 for locations of pinniped colonies in the Region.

Spencer Gulf and *Gulf St Vincent* – These areas are considered important feeding grounds for sub-adult white sharks, although juvenile and large adult sharks have also been observed in these areas. White sharks presumably target dolphins, finfish and other elasmobranchs abundant in these gulfs.

Figure D1.1 Pinniped colonies identified as important feeding grounds for white sharks



Known interactions, threats and mitigation measures

Fisheries

Sharks are particularly susceptible to fishing pressure because of their specialised life history strategies. They generally show slow growth, late attainment of sexual maturity, low fecundity and a close stock-recruitment relationship. White sharks are considered to be naturally low in abundance, producing relatively few young. Similarly the grey nurse shark matures slowly and is thought to only reproduce every second year, producing a maximum of two pups each litter.

In addition, the demand and prices for shark products, including fins, is relatively high, which adds to the susceptibility of some shark species to fishing pressure.

Commercial fisheries

White sharks and grey nurse sharks are known to interact with commercial fishing operations in the Region. Although these species are not targeted, they are inadvertently caught as by-catch.

It is considered that the incidental capture of white sharks on longlines and in nets poses the greatest threat to the species. White sharks have been reported as by-catch in a number of fisheries including the Southern and Eastern Scalefish and Shark Fishery, Western Australian Temperate Shark Fisheries, various demersal longline fisheries and in tuna 'grow out' cages in South Australia. They are also occasionally caught in crab trap and rock lobster pot ropes and in demersal trawls.

Catches of white sharks are not evenly distributed across southern Australia and are not well correlated with effort, nor are there many independent observer programmes in the Region to verify interaction rates with threatened species. However, available information suggests that there are more interactions between white sharks and fishing activities along the west coast of Western Australia, from Shark Bay to Bunbury, and in the Great Australian Bight than other areas of Australia (Malcolm *et al*. 2001). Most white sharks reported as caught in fishing operations are either juveniles or sub-adults (Malcolm *et al*. 2001).

The actual rate of capture of white sharks by commercial fishers is difficult to assess, however some commercial fisheries are introducing measures to monitor and verify protected species interactions. Estimates based on anecdotal reports range from less than 10 to 100 a year caught in South Australia and 100 to 440 a year for all fisheries (recreational and commercial combined) in Australian waters (Malcolm *et al*. 2001). However,

catch rates and interactions are highly variable between fishers, regions and years and there are few independent observer programmes in the Region to verify interaction rates with threatened species. About 40 per cent of captured white sharks are reported as being released alive, although post-release survival rates are unknown (Malcolm *et al*. 2001).

White sharks are the only protected species of shark that have been recorded in and around tuna pens in South Australia. Because of the white shark's status as a threatened species, any mortality may adversely affect the conservation status of the species. The South Australian Research and Development Institute is investigating ways of removing entangled or entrapped sharks from tuna pens in a manner that is safe for both farm staff and sharks.

Grey nurse sharks are incidentally caught in commercial demersal nets, droplines, and other line fishing gear. Within the Region, a significant cause of death to grey nurse sharks has been incidental capture in the demersal gillnet fishery that operates between Steep Point and the South Australian border (Chidlow *et al*. 2005; Pollard *et al*. 2003). From 1989 to 1997, catches of between 70 and 105 grey nurse sharks were recorded annually in the demersal gillnet fishery (Pollard *et al*. 2003).

Recreational fishing

Prior to the implementation of protective legislation (the white shark was protected in Western Australia in November 1997, South Australia in January 1998, and listed under the EPBC Act in July 1999), game fishing for white sharks was carried out mainly in South Australia, Queensland and New South Wales, but also in Victoria and Western Australia. Game fishing for white sharks was at its height in South Australia in the 1950s. Prior to protection, captures of white sharks by game fishers declined by 86 per cent in South Australia between the 1950s and the 1980s. However, it is considered that the decline in captures was most likely a result of changes in the areas fished and moves to tag-release in later years. From the late 1980s until sharks were protected in the late 1990s, catch rates appear to have been reasonably stable (Malcolm *et al*. 2001).

Although game fishing is a potential threat to grey nurse sharks, they 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 but is not considered to pose a significant threat to the species in the Region.

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 (EA 2002b). However, grey nurse sharks in Western Australia have never been subjected to intensive targeted fishing (Chidlow *et al*. 2005; Pollard *et al*. 2003).

Tourism

White shark cage diving and shark boat tours are dependent on attracting sharks to their vessels by berleying, also known as 'chumming'. To date, research undertaken in South Australia indicates that there is little evidence that berleying activities of tour operators are significantly influencing white shark behaviour (Bruce *et al*. 2005). This is probably because of the tourism industry regulations in place in South Australia and the code of practice that the tour operators work under (Bruce pers. comm. 2006). No grey nurse shark aggregation areas have been identified in Western Australia and consequently there are no operations that target this species for nature-based tourism.

Degradation to areas of important habitat

The degradation of inshore waters used by white sharks as nursery areas could have an effect on breeding and/or juvenile survival (Pogonoski *et al*. 2002).

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Map data

Figure D1.1 Pinniped colonies which are identified as important feeding grounds for white sharks

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Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
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Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
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Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts.

D2 South-west Marine Region Protected Species Group Report Card – Bony Fish

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

General information

The fish fauna of the South-west Marine Region is diverse, with more than 900 species inhabiting a large variety of habitats. Much of the information in this report card is drawn from the report *South-west Marine Region: Ecosystems and Key Species Groups*. The report contains separate reviews of the inshore, shelf and slope demersal fish species, the large pelagic species, small pelagic and meso-pelagic species. It also considers separately the approximately 40 species of syngnathids (seahorses, pipefish and sea-dragons) that have been recorded in coastal waters adjacent to the Region. For further information please see this publication at <www.environment.gov.au/coasts/mbp/south-west>.

Nationally protected species

Only one species of bony fish is listed as threatened under the EPBC Act, the orange roughy (*Hoplostethus atlanticus*). 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 programme to be implemented by the Australian Fisheries Management Authority (See Table D2).

All syngnathids (seahorses, seadragons, pipefish and pipehorses) and solenostomids (ghost pipefish) in Australia are listed as 'marine species' under Section 248 of the EPBC Act and are protected. There are 44 species of syngnathids that are known to occur in the coastal waters adjacent to the South-west Marine Region. Almost all syngnathids live in near-shore and inner shelf habitats and, on the basis of current information on ecology and distribution, only one species of syngnathid, Günther's Pipehorse *Solegnathus lettiensis/S. guentheri*, is found with certainty in Commonwealth-managed waters within the Region.

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 are 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.

Orange roughy catch. Photo: CSIRO.

Table D2 Bony fish listed as threatened under the EPBC Act that are known to occur in the South-west Marine Region

Species	Conservation Status	Australian Government Conservation Plans or Strategies for the Species
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)

Other species of syngnathid that *may* occur in parts of the South-west Marine Region include:

- robust spiny pipehorse, robust pipehorse (*Solegnathus robustus*);
- shaggy pipefish, prickly pipefish (*Hypselognathus horridus*);
- leafy seadragon (*Phycodurus eques*);
- weedy seadragon, common seadragon (*Phyllopteryx taeniolatus*);
- Gale's pipefish (*Campichthys galei*);
- Brock's pipefish (*Halicampus brocki*);
- bentstick pipefish, bendstick pipefish, short-tailed pipefish (*Trachyrhamphus bicoarctatus*);
- Port Phillip pipefish (*Vanacampus phillipi*);
- wide-body pipefish (*Stigmatopora nigra*);
- bony-headed pipefish (*Nannocampus subosseus*);
- West Australian seahorse (*Hippocampus subelongatus*);
- western spiny seahorse, narrow-bellied seahorse (*Hippocampus angustus*);
- short-headed seahorse, short-snouted seahorse (*Hippocampus breviceps*); and
- southern potbelly seahorse, potbelly seahorse, pot-bellied seahorse (southern form of *Hippocampus abdominalis* = '*Hippocampus bleekeri*')

There is only one species of the family Solenostomidae (ghost pipefish) that may occur in the Region. This is the blue-finned ghost pipefish or robust ghost pipefish (*Solenostomus cyanopterus*).

Leafy seadragon. Photo: Marine Life Society of South Australia.

Ecology of protected species in the South-west Marine Region

Orange roughy

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, and examinations of the otoliths (ear bones) of orange roughy suggest maximum ages of between 125 and 156 years. Its longevity means that orange roughy 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)

There is a paucity of knowledge on the distribution, relative abundance and habitats of species of syngnathids in the South-west Marine Region. However, at least 14 species of syngnathids are recorded as being endemic to South Australian or Western Australian waters. Syngnathids 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. Habitat that supports syngnathid populations is 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 fishes.

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 South-west Marine Region

Important areas in the South-west Marine Region are identified for species that are listed as threatened or migratory under the EPBC Act. Thus important sites are only identified for the orange roughy.

Orange roughy are known to aggregate, particularly around underwater features such as seamounts. While most of the better known aggregation areas occur in the South-east Marine Region, there is evidence of aggregation within, and adjacent to, the South-west Marine Region, including:

Eastern Great Australian Bight – Aggregations have been targeted by commercial fishers in the Great Australian Bight Trawl Fishery sector of the Southern and Eastern Scalefish and Shark Fishery, particularly during the late 1980s and early 1990s, when large catches were taken in some years (for example, 3532 tonnes, in 1989; Ward *et al*. 2003, Caton & McLoughlin 2005).

Albany Canyons Group and adjacent shelf break – Aggregations are known to occur, and have been targeted by commercial fishers in the Great Australian Bight Trawl Fishery sector of the Southern and Eastern Scalefish and Shark Fishery. With the decline of the fished aggregation in the eastern Great Australian Bight, virtually all recent (mid 1990s to early 2000s) orange roughy catches in the Region have been taken from two areas off Western Australia, described as the 'Albany Hills' and 'Esperance' stocks (Caton & McLoughlin 2005).

South of Kangaroo Island – Aggregations are known to occur in the area, for example, in the vicinity of the Murray Canyons, near the eastern boundary of the Region.

Known interactions, threats and mitigation measures

Orange roughy

Commercial fishing

Huge catches of orange roughy were made during the 1980s and 1990s, before the stocks were given some protection. Most of the exploitation of this species occurred in the South-east Marine Region. However, significant catches have also been made in the South-west Marine Region. In the eastern Great Australian Bight, an aggregation was discovered in 1987 off South Australia and was subsequently heavily fished. Catches swiftly declined during the early 1990s, and catches in the entire Great Australian Bight during the early 2000s were an order of magnitude lower (around 250-350 tonnes per annum) than catches during the late 1980s and early 1990s (Caton & McLoughlin 2005, ABARE & FRDC 2004). In 2003-2005, annual catches of orange roughy in the Great Australian Bight were in the vicinity of 185-237 tonnes (ABARE & FRDC 2006). Within the Region, orange roughy has also been taken in the Western Deepwater Trawl Fishery. Catches in this fishery peaked at 237 tonnes in 1994-1995 but remained at less than 20 tonnes for the next five years, increasing to 104 tonnes in 2001-2002. However, there has been no targeting of orange roughy since then (BRS 2006).

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 total allowable catches to negligible quantities from 2007 onwards, to enable recovery of the commercial fishery. For example, in 2005 in the Great Australian Bight Trawl Fishery, the Australian Fisheries Management Authority Board supported an upper limit trigger of 200 tonnes for orange roughy in the Eastern Statistical Zone, a 1000 tonne trigger for Esperance and Albany Hills combined, and an additional 800 tonnes for all other areas of the fishery (AFMA 2005). By 2007, the total allowable catch for the Albany/Esperance Zone was down to 50 tonnes (by-catch only), reduced from 212 tonnes in 2006, with a further reduction in 2008 (AFMA 2007).

The *Orange Roughy Conservation Programme* has been implemented by the Australian Fisheries Management Authority. The conservation programme allowed the then Minister for the Environment and Heritage to list the orange roughy as conservation dependent. This conservation programme aims to protect orange roughy from over-fishing, in part by prohibiting targeted fishing in the management zones. Catch limits at the Cascade Plateau in the South-east Marine Region, the only area where the this species is currently targeted, are set at levels that aim to allow recovery of the species. Such measures are now considered essential for long-term protection of the stocks against further depletion. 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 2000s was that stocks would 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 2000s, 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 of achieving any specific rebuilding target will be high, when cost is measured in proportion to the catch reduction required. 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 & McLoughlin 2005, Francis & 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 programme being implemented by the Australian Fisheries Management Authority includes a prohibition on targeted fishing in known aggregation areas over seamounts.

The extent and implications of by-catch of orange roughy by fisheries such as the Great Australian Bight Trawl Fishery and the Western Deepwater Trawl Fishery that target species occurring in similar habitats is currently unknown.

Syngnathids

Commercial fishing and trade

Syngnathids are harvested both as target species in State waters 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. Several of the seahorse species (such as southern potbelly seahorse (*H. abdominalis/H. bleekeri*), western spiny seahorse (*H. angustus*), West Australian seahorse (*H. subelongatus*) and short-headed seahorse (*H. breviceps/H. tuberculatus*) exported from Australia may occur in the South-west Marine Region.

The *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes* 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, including three species that may occur in the Commonwealth waters of the South-west Marine Region: the leafy seadragon (*Phycodurus*

eques), the weedy or common seadragon (*Phyllopteryx taeniolatus*) and the short-headed seahorse (*Hippocampus breviceps*).

Trade of seahorses is heavily regulated in Australia under international and Commonwealth law. Licences are granted under Appendix II of CITES 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, and the Department relies heavily on the Australian Customs Service to implement CITES at ports of exit and entry for the syngnathid trade. State Governments also have permit systems regulating the trade of syngnathids.

Between 1994 and 2002 the reported capture of syngnathids by licensees in Western Australia increased approximately six-fold for the weedy seadragon, from 50 to 332. This species makes up approximately half of the annual quota of 750 for the trade of syngnathids in the State. In 2005 in Western Australia, there were 13 licences in the commercial syngnathid fishery. In South Australia, a permit system exists under the *Fisheries Act 1982* for the collection of a small number of syngnathids from the wild, to stock breeding aquaria. This industry is concentrated within coastal waters.

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.

Measures to increase the information on syngnathid by-catch in State-managed waters include voluntary monitoring of specified syngnathid by-catch by fishers in Spencer Gulf in South Australia, and syngnathid by-catch identification studies are also undertaken in some trawl fisheries in Western Australia, such as in Shark Bay. In parts of the South-west Marine Region, scientific observer programmes in trawl, gillnet and longline fisheries indicate that syngnathids are not a significant component of the by-catch. For example, in a detailed by-catch monitoring in the Great Australian Bight Trawl Fishery during the early 2000s, no syngnathids were recorded as being caught (Brown & Knuckey 2002). More recently, during a draft ecological risk assessment for species in the Great Australian Bight Trawl Fishery, all syngnathids were listed as being at low risk, apart from the West Australian seahorse *Hippocampus subelongatus* (listed as medium risk; Daley *et al*. 2006). In the South Coast Trawl fishery in Western Australia, syngnathids are reported to be "occasionally incidentally caught", and are "generally discarded, presumed to be dead" (WA Department of Fisheries 2005: 36).

Habitat degradation

Endemic species of limited geographic range may be particularly susceptible to habitat degradation, particularly those species that occur in the vicinity of urbanised and industrial areas, or in rural areas where nearshore waters are subject to run-off and other pollutants. The *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes* identifies inshore habitat degradation as a potential threat to the survival of some populations of syngnathid species due to decreasing available habitat for the animals. This includes species assessed as occurring in the South-west Marine Region. Degradation of nearshore habitats is especially prevalent in highly urbanised areas such the metropolitan coast of Gulf St Vincent in South Australia, and off Perth and Fremantle (in Cockburn Sound, for example) in Western Australia.

Poaching

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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D3 South-west Marine Region Protected Species Group Report Card – Reptiles

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

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 threatened, migratory and marine species. Of the six species of marine turtle found in Australian waters, only three species are known to inhabit the South-west Marine Region. These are the loggerhead turtle (*Caretta caretta*), the green turtle (*Chelonia mydas*) and the leatherback turtle (*Dermochelys coriacea*) (Table D3). Although there are some records in the Region of the flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*) and olive ridley turtles (*Lepidochelys olivacea*), it is considered that the Region is on the margin of their distribution (Limpus pers. comm. 15/04/07). As such these species are considered to be 'vagrant' species in the Region.

Most sea snakes have tropical to subtropical distributions. Few sea snakes inhabit oceanic waters and most species live in shallower waters around reefs and inshore environments. Only one species, the yellow-bellied sea snake (*Pelamis platurus*), is known to inhabit the sub-tropical and temperate waters of the South-west Marine Region. Other species of sea snake may be carried from warmer waters by the southward flowing Leeuwin Current and occur as vagrants in the Region. The elegant sea snake (*Hydrophis elegans*), olive-headed sea snake (*Disteira major*) and the ocellated, or spotted sea snake (*Hydrophis ocellatus*) are all species that have been found along the coastline of the South-west Marine Region, according to museum records. The Shark Bay sea snake (*Aipysurus pooleorum*) may also occur in the Region in the southward flowing waters of the Leeuwin Current.

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.

Loggerhead turtle. Photo: Tim Harvey.

Table D3 Marine turtles listed as threatened or migratory under the EPBC Act that are known to occur in the South-west Marine Region

Species	Conservation Status	Australian Government Conservation Plans or Strategies for the Species
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 Turtle 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)	

Ecology of protected reptile species in the South-west Marine Region

Marine turtles

All species of marine turtle follow a life cycle with many common features. Adult marine turtles migrate from feeding habitats to the region of their birth to breed. Females lay their eggs on sandy beaches in tropical or subtropical regions. Each female lays several clutches of eggs in a nesting season but does not necessarily nest every year. After the nesting season, marine turtles migrate back to feeding areas.

Once the eggs hatch the hatchlings scramble down the beach to the sea. Although many will be eaten by predators within a short time, the surviving hatchlings will drift and feed in ocean currents for some time. On reaching their juvenile stage, most marine turtles move to shallow waters and begin to feed on benthic organisms. The leatherback turtle is the exception, as it remains a pelagic species and continues to feed on soft-bodied animals.

All species are long lived and take many years, even decades, to reach sexual maturity. In any one year, only a proportion of the adult population will visit a breeding area. These life history characteristics make marine turtle populations susceptible to impacts.

As marine turtles can migrate thousands of kilometres between nesting beaches and feeding areas, international cooperation is necessary for their conservation. To promote marine turtle conservation with other countries in the Indian Ocean and South-East Asian regions, the Australian Government is a signatory state to the Indian Ocean South-East Asian Marine Turtle Memorandum of Understanding (IOSEA Marine Turtle MoU), which has been established under the Convention on Migratory Species. Information about the IOSEA Marine Turtle MoU is available at <www.ioseaturtles.org>.

The southward flowing Leeuwin Current and the northward flowing West Australian Current are considered to be important conduits for marine turtles. Within these water masses, hatchlings of species of marine turtle nesting in Western Australia are dispersed from their breeding beaches in the Gascoyne, Pilbara and Kimberley regions.

The Region is also a nesting migration pathway for reproductive adults and possibly an inter-nesting habitat (used by turtles between nestings in the one nesting season) for loggerhead turtles nesting on Dirk Hartog Island at the mouth of Shark Bay. Moreover, the leatherback turtle is known to drift and feed in the Leeuwin and West Australian currents, which may provide a migratory corridor for the species to the south western Pacific Ocean. However, the extent to which marine turtles use the currents within the Region for dispersal, migration and feeding, requires further investigation. Further information about the ecology of the species known to occur in the Region is provided below.

Leatherback turtle

No major breeding aggregation sites have been recorded in Australia (Limpus, in press). However low density nesting has been recorded around Wreck Rock Beaches and Rules Beaches in southern Queensland and at Coburg Peninsula, in north-west Arnhem Land (Limpus in press). Large nesting aggregations of leatherbacks are found to the north of Australia in Papua New Guinea, Malaysia and in West Papua (EA 1998). It is thought that most leatherback turtles found in Australian waters have migrated from these nesting areas to feed in temperate waters (EA 1998). Leatherback turtles are occasionally observed at sea, mostly around the mid-west and the south-west of Western Australia, where they feed on soft bodied invertebrates such as jelly fish (WA Department of Environment and Conservation 2007).

Leatherback turtles are the largest of all marine turtles, weighing up to 500 kg and with shells averaging 1.6 m in length (EA 1998). Their large body size, high metabolism, thick fatty tissue layer and regulation of blood flow to the body surface allows them to use cold water foraging areas (DEW 2007).

This species is primarily pelagic in both the juvenile and adult phases of its life history. Small juveniles seem to disappear for several years but may concentrate around upwellings where food sources are abundant. Large juvenile and adult turtles are found in both pelagic and coastal waters from tropical to cold temperate areas. Foraging occurs throughout the water column, from close to the surface to depths of more than 1200 m (Gulko & Eckert 2004). The deep dives of which the leatherback is capable are made possible by its flexible carapace (top shell) and plastron (bottom shell) that are made of cartilage embedded with miniature bones and which resist cracking under pressure, and the turtle's ability to retain large amounts of oxygen in its blood and muscles (Gulko & Eckert 2004).

Loggerhead turtle

Nesting is mainly concentrated on subtropical beaches with major aggregations occurring in Western Australia from Shark Bay to the Pilbara Region. Loggerheads are one of the most commonly sighted marine turtles along the coast adjacent to the South-west Marine Region. Resident adult and sub-adult loggerheads have been sighted around Perth (WA Department of Environment and Conservation 2007). Small post-hatchling loggerheads originating from the Gascoyne area (Western Australia) are also regularly washed ashore during winter and early spring storms along the south-western and southern coasts of Western Australia (WA Department of Environment and Conservation 2007). Stranded sub-adult loggerheads have been collected from Albany, Esperance and further east in the Great Australian Bight (Naturebase: Western Australia museum database). Such strandings are more common in years with an early onset and strong flow of the Leeuwin Current (WA Department of Environment and Conservation 2007).

Loggerhead turtles enter the benthic foraging habitat at a larger size than other hard-shelled marine turtles. Adults and large juveniles, with a curved carapace greater than 70 cm in length, inhabit environments with both hard and soft substrata, including rocky and coral reefs, muddy bays, sand flats, estuaries and seagrass meadows. Loggerheads are carnivorous, feeding primarily on benthic invertebrates in depths ranging from near shore to 55 m. In their juvenile stage, they feed on algae, pelagic crustaceans, molluscs, flotsam and anthropogenic debris.

Green Turtle

One genetic stock of green turtle nests along the West Australian coast from the Ningaloo Coast to the Lacepede Islands (Limpus in press). This is one of the largest green turtle populations remaining in the world and appears to be the largest for the eastern Indian Ocean (Limpus in press). The numbers of green turtles that nest each season in Western Australia is affected by the El Niño or Southern Oscillation of the Pacific Ocean, so numbers visiting a breeding beach can vary between a few dozens to hundreds in very poor seasons and several thousands in productive seasons.

Post hatchling and juvenile green turtles (up to 30 cm curved carapace length) are pelagic, drifting on the surface of the water, usually associated with drift-lines and floating sargassum rafts. When they develop a curved carapace length of 30-40 cm, they move to shallow benthic foraging habitat and feed primarily on seagrass and algae. Habitats include coral and rocky reefs, inshore seagrass beds and algal mats. Resident green turtles have been seen around reefs south of Shark Bay down to around the mouth of the Murchison River at Kalbarri and around the reefs of the Houtman Abrolhos Islands. Large juveniles are also seen around Rottnest Island (WA Department of Environment and Conservation 2007).

Sea snakes

The yellow-bellied sea snake is the only species known to inhabit the South-west Marine Region. The species has a broad distribution and it is found throughout the Pacific and Indian Oceans. Within the South-west Marine Region, numerous specimens have been washed ashore along the Western Australia coast reaching as far as Esperance.

The yellow-bellied sea snake is a pelagic species that inhabits the slicks and drift lines of ocean currents, where it feeds on fish. The species hunts for food by remaining motionless on the surface, mimicking an inanimate floating object, thereby attracting prey species that aggregate beneath it, apparently deceived by its shape. Fish are captured either by a sideways movement of the head or by swimming backwards, enabling the snake to seize the prey with a sudden lunge forward.

Important areas for marine reptiles in the South-west Marine Region

Important areas in the South-west Marine Region are identified for species that are listed as threatened or migratory under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for more information on matters of national environmental significance and requirements under the EPBC Act). Although marine turtles do not nest in the Region, they are known to feed within the Region and in State waters adjacent to the Region. While fine-scale information on the relative importance of these feeding areas is not well understood, the following areas are known to be used by marine turtles:

Mid-west to south-west coast of Western Australia – leatherback turtles are observed at sea, where they feed on soft bodied invertebrates such as jelly fish (WA Department of Environment and Conservation 2007, Prince pers comm. 30/04/07). Adult leatherback turtles

have also been observed feeding in inshore waters, including in the Swan River estuary (Prince pers. comm. 30/04/07). The southern extent of leatherback turtles in Western Australia is not well understood, but they have been caught as by-catch in fisheries and have been found stranded along the southern coast of Western Australia (Prince pers. comm. 30/04/07).

Waters from Rottnest Island to Geographe Bay – Resident adult and sub-adult loggerheads are known to forage in these areas (WA Department of Environment and Conservation 2007). The southern extent of the range of loggerheads is not well understood, however incidental captures in commercial fisheries and strandings of loggerheads have also occurred on the southern coast of Western Australia (Prince pers. comm. 30/04/07).

Coastal reefs around Kalbarri – Resident adult green turtles are known to forage in this area (WA Department of Environment and Conservation 2007).

Reefs of the Houtman Abrolhos Islands – Resident green turtles forage in this region (WA Department of Environment and Conservation 2007).

Jurien Bay south to Rottnest Island – large juvenile green turtles are observed in this area and assumed to be foraging (Prince pers. comm. 30/04/07).

Known interactions, threats and mitigation measures

Marine turtles

Past commercial exploitation

Commercial exploitation of green turtles in Western Australia occurred from at least the 1930s until 1973, when the commercial harvest of marine turtles ended (Limpus in press). Although data on the number of green turtles harvested commercially in Western Australia is incomplete, it is estimated that around three or four thousand green turtles were harvested annually during the period 1960-1972 (Limpus in press).

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 dugong (Australian Government 2005). In 2005 a 'National Partnership Approach' for the sustainable harvest of turtles and dugong 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 dugong is sustainable by outlining how Governments and Indigenous communities can work more closely together to increase the effectiveness of the protection and conservation of dugong and marine turtles. Importantly, the approach also aims to contribute to the conservation of turtles and dugong while ensuring that the important economic, spiritual and cultural relationships Indigenous people have with these animals are maintained for future generations.

Commercial fishery interactions

Marine turtles are sometimes inadvertently caught as by-catch in commercial fisheries activities. Marine turtles are known to get caught as by-catch in a range of fisheries operating in Australian waters, including trawl, longline and pot fisheries (through entanglement in pot lines and entrapment in pots).

In the South-west Marine Region small numbers of marine turtles have been reported as by-catch in the Southern and Eastern Scalefish and Shark Fishery, Southern Bluefin Tuna Fishery, Southern and Western Tuna Billfish Fishery, the South Australia Prawn Trawl Fishery and the Western Australia Western Rock Lobster Fishery. However there is generally a low level of interaction between commercial fisheries operating in the Region and marine turtles.

Around 20 loggerhead and leatherback turtles are caught each year in the Southern and Western Tuna Billfish Fishery, however the majority are released alive (DEH 2004). A small amount of leatherback turtle entanglement (1-2 per year) has been reported in buoy lines of pots in the Western Australian Rock Lobster Fishery (EA 2002). Western Australia Museum data indicates 65 per cent of turtle mortalities in Western Australia waters are associated with the western rock lobster fishery, although the overall recorded frequency is 1-2 incidents (including those that are not fatal) a year (EA 2002). Although the level of mortality resulting from such entanglement has not been quantified, it has been suggested that leatherback turtle entanglement in buoy lines of rock lobster pots throughout Australia may be the most significant cause of anthropogenic

mortality for the species in Australian waters (Limpus in press). Ongoing monitoring programmes, based on onboard observers, are now in place to better determine the level of interaction between the Western Australian Rock Lobster Fishery and leatherback turtles (EA 2002).

Petroleum industry

Lighting and flares associated with oil and gas facilities have the potential to affect marine turtles. Marine turtle hatchlings can be prone to disorientation from lighting sources close to nesting beaches. While marine turtles do not nest in the South-west Marine Region, impacts on nesting beaches to the north of the Region have the potential to affect marine turtle populations in the Region.

An investigation of the affect of flares and facility lighting on marine turtles in Western Australia has been carried out. Preliminary results suggest that impacts on marine turtle nesting beaches are determined in part by the phase of the moon, with disorientation of hatchlings greatest on new moon nights (EA 2003). The other factor, indicated by the preliminary results of this study is that the brightness and wavelengths of the light sources also influence the degree to which hatchling disorientation occurs (EA 2003).

The *Recovery Plan for Marine Turtles in Australia* indicates that:

- weathered petroleum, emanating from heavy crude oil, has been observed to seal the mouth and nostrils of turtles;
- tar balls are also known to be mistaken for food items by marine turtles; and
- one incident in Australia of a marine turtle being affected by weathered petroleum has been reported (EA 2003).

Seismic activity

The response of turtles to sound varies with different frequencies and intensities of the sound. Under experimental conditions marine turtles can detect low frequency noise and modify their behaviour or, at least, demonstrate a startle response. Seismic testing and explosive removals of platforms have been shown to impact on marine turtles, particularly if the survey runs over mating grounds or near nesting beaches during breeding season. The use of soft start procedures is required in areas within the distribution of marine turtles under the *Petroleum Submerged Lands (Management of Environment) Regulations 1999* (EA 2003).

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 such as plastics disposed of by ships at sea 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 poses to all marine life, and is an added danger to the survival of species listed as threatened under the EPBC Act.

All marine turtles nesting in Australia are considered to be threatened by marine debris (DEH 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. Discarded fishing nets are a particular problem for marine turtles, with a significant number of entanglements occurring around Cape Arnhem and in the Gulf of Carpentaria (DEH 2003).

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>.

Other threats to marine turtles

There are several other potential threats to marine turtle populations identified in the *Recovery Plan for Marine Turtles in Australia* (EA 2003). They include:

- factors that reduce successful marine turtle nesting are a threat to some populations of marine turtles. However, there are no nesting sites within the Region. These factors are: light pollution, tourism and recreational activities, vehicle damage, particularly where there is recreational four wheel drive beach access, and faunal predation on marine turtle eggs;
- change in land use practices has been identified as a potential threat to marine turtles. Land clearing, urban and industrial development and their associated management are issues for concern in regard to water quality degradation, loss of sea grass and other impacts on nesting habitats; and
- training activities undertaken by the Department of Defence, such as the use of explosives or landing craft on nesting beaches, have the potential to impact on marine turtles. An environmental

management plan, supported by planning guides and procedural tools, has been prepared by Defence for the purpose of managing training activities at sea and mitigating their potential impacts.

Sea snakes

Commercial fisheries

Sea snakes are known to be inadvertently caught as by-catch in trawl fisheries. In the South-west Marine Region sea snakes are inadvertently caught in the Houtman Abrolhos Islands and Mid West Trawl Managed Fishery. However, there is generally a low level of interaction between sea snakes and the fishery. Low numbers are taken as by-catch and they are generally returned to the water alive (WA Department of Fisheries 2004). A study on sea snake survival after being caught by trawlers has shown that a high proportion survived following release (DEH 2005). Therefore, it is considered that the interactions between this fishery and sea snakes are likely to have a low to negligible impact on the conservation status of the species (DEH 2005).

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.

Other interactions/threats

There is evidence from northern Australian waters of interactions between sea snakes and marine debris, specifically discarded trawl nets. Being air breathers and inhabitants of slicks and drift lines, the yellow-bellied sea snake is vulnerable to the adverse effects of oil spills at sea.

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D4 South-west Marine Region Protected Species Group Report Card – Seabirds

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

General information

A wide range of birds are found in the Region. These include seabirds, such as albatrosses and shearwaters, which breed or forage in the Region; shorebirds, such as sandpipers and plovers that only fly over the Region during migration; and coastal birds, such as pelicans, ospreys and white-bellied sea-eagles that may only occasionally feed in the waters of the Region. Most of the Region's bird species spend the majority of their time close to the shore, wading or feeding in coastal waters. Some species, however, range widely, foraging over thousands of kilometres, targeting fish over the shelf and in the open ocean. This report card discusses only seabirds, which are defined here as:

"Species of birds whose normal habitat and food source is derived from the sea" (Surman & Nicholson 2006).

Further, this report card focuses on those seabirds that are known to commonly occur in the South-west Marine Region. Appendix C lists all bird species protected under the EPBC Act that *may infrequently occur* in the South-west Marine Region.

Nationally protected species

Of the 38 seabirds known to occur in the Region, 22 are listed as threatened and/or migratory under the EPBC Act (Table D4.1). These include species of: albatrosses, petrels, shearwaters, noddies and terns. The seabird species found within the Region are described in further detail below.

Australia is also a signatory to four international agreements for the conservation of migratory birds. These agreements are:

- 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* 2006 (ROKAMBA). This agreement will come into force in the second half of 2007.

Australian lesser noddy. Photo: WA Department of Environment and Conservation, Bert and Bab Wells.

Table D4.1 Seabirds listed as threatened or migratory under the EPBC Act that are known to occur in the Region

Species	Conservation Status	Australian Government Conservation Plans and Policies for the Species
Blue petrel (*Halobaena caerulea*)	Vulnerable, Marine	• *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)
Soft-plumaged petrel (*Pterodroma mollis*)	Vulnerable, Marine	
White-chinned petrel (*Procellaria aequinoctialis*)	Migratory, Marine Listed under CMS (Appendix II)	
Southern giant petrel (*Macronectes giganteus*)	Endangered, Migratory, Marine Listed under CMS (Appendix II)	
Northern giant petrel (*Macronectes halli*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Wilson's storm-petrel (*Oceanites oceanicus*)	Migratory, Marine Listed under JAMBA	
Sooty albatross (*Phoebetria fusca*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Southern royal albatross (*Diomedea epomophora*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II)	
Northern royal albatross (*Diomedea sanfordi*)	Endangered, Migratory, Marine Listed under CMS (Appendix II as *Diomedea epomophora*)	
Wandering albatross (*Diomedea exulans*)	Vulnerable, Migratory, Marine Listed under JAMBA & CMS (Appendix II)	
Black-browed albatross (*Thalassarche melanophris*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II as *Diomedea melanophris*)	
Indian yellow-nosed albatross (*Thalassarche carteri*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II as *Diomedea chlororhynchos*)	
Shy albatross (*Thalassarche cauta*)	Vulnerable, Migratory, Marine Listed under CMS (Appendix II as *Diomedea cauta*)	
Streaked shearwater (*Calonectris leucomelas*)	Migratory, Marine Listed under CAMBA (as *Puffinus leucomelas*) & JAMBA	
Sooty shearwater (*Puffinus griseus*)	Migratory, Marine Listed under CAMBA & JAMBA	
Wedge-tailed shearwater (*Puffinus pacificus*)	Migratory, Marine Listed under JAMBA	
Short-tailed shearwater (*Puffinus tenuirostris*)	Migratory, Marine Listed under JAMBA	
Flesh-footed shearwater, fleshy-footed shearwater (*Puffinus cameipes*)	Migratory, Marine Listed under JAMBA	
Bridled tern (*Sterna anaethetus*)	Migratory, Marine Listed under CAMBA & JAMBA	
Common noddy (*Anous stolidus*)	Migratory, Marine Listed under CAMBA & JAMBA	
Australian lesser noddy (*Anous tenuirostris melanops*)	Vulnerable, Marine	
Arctic jaeger (*Stercocarius parasiticus*)	Migratory, Marine Listed under JAMBA	

Ecology of protected seabird species in the South-west Marine Region

As described in Chapter 2 of this Bioregional Profile, the Region's marine environment has a range of unique environmental characteristics including nutrient rich upwellings and sub-Antarctic water masses, as well as areas dominated by tropical water currents and warm in-shore areas. These characteristics create an environment that supports a large number of seabird species. Adjacent to the Region there are also many breeding sites, particularly islands, which are under State jurisdiction. Table D4.2 outlines the estimated proportion of some Australian nesting seabird populations known to breed on islands adjacent to the Region.

Table D4.2 The proportion of Australian seabird nesting populations that breed in areas immediately adjacent to the Region

Species	Percentage Breeding
Australian lesser noddy	100
Great-winged petrel	100
Flesh-footed shearwater	72
Little shearwater	58*
Wedge-tailed shearwater	71
Sooty tern	72
Common noddy	66.7
Roseate tern	59.7
Bridled tern	50

(Surman & Nicholson 2006)

* 100 per cent of the south-west Australian subspecies of the little shearwater (*Puffinus assimilis tunneyi*) breeds adjacent to the Region.

Petrels

Seven species of petrels, including giant-petrels, regularly visit the Region. The majority of petrels found in the Region are winter migrants that breed on sub-Antarctic islands. Petrels range widely for food within the Region, feeding on small fish, cephalopods (octopus, squid and cuttlefish) and crustaceans along the edge of the continental shelf and over open waters. They are often observed over offshore areas near the continental shelf break.

The only petrel species that breeds adjacent to the Region is the great-winged petrel with some 33 000 breeding pairs estimated to breed on the islands of the Recherche Archipelago. This population is also the only breeding population of great-winged petrels in Australia.

Storm-petrels

Five species of storm-petrels have been recorded in the Region, with the only regular visitors being the white-faced and Wilson's storm-petrels. White-faced storm-petrels breed throughout the Region as far north as the Houtman Abrolhos Islands, with an estimated 160 000 pairs breeding adjacent to the Region (Ross *et al*. 1995). The other three species of storm-petrel observed in the Region – Leach's, grey-backed and black-bellied – are considered vagrants. Storm-petrels feed on small crustaceans and fish in the top few centimetres of the sea.

Albatrosses

Although seven species of albatrosses are known to feed in the Region there are no breeding populations in or adjacent to the Region. Albatrosses typically feed in offshore areas during the winter months, with most observations along the edge of the continental shelf and over open waters where they glide on thermal currents and catch fish and cephalopod prey by diving into the water.

Shearwaters

Eight species of shearwaters are regularly found within the Region with four species (wedge-tailed, little, flesh-footed, and the short-tailed) known to breed in areas adjacent to the Region. The only rookeries of the south-west Australian subspecies of the little shearwater (*Puffinus assimilis tunneyi*) occur on islands off south-west Western Australia with between 27 000 and 62 000 pairs recorded (Baker *et al*. 2002). About 104 000 pairs of flesh-footed shearwaters breed on islands between the South Australia border and Cape Leeuwin, while West Wallabi Island, Pelsaert Island (within the Houtman Abrolhos Islands) and Rottnest Island represent the most important breeding sites in Australia for the wedge-tailed shearwater. One million breeding pairs are known to nest on West Wallabi, 75 000 pairs on Pelsaert Island, and 5800 pairs on Rottnest Island (Surman & Nicholson 2006).

Terns

Fifteen species of terns have been recorded within the Region. Of these, only the bridled, fairy, sooty, Caspian, crested, lesser-crested and roseate terns regularly occur within the Region. The Arctic and Antarctic terns are irregular visitors, while the white tern and common tern are vagrants. In contrast to albatrosses and petrels, most terns feed in waters over the continental shelf, usually in sight of land, preying on small to medium sized fish, squid and, in some instances, pelagic hydrozoans

(jellyfish), terrestrial insects and crustaceans (Surman & Wooller 2003).

Noddies

Two species of noddy occur in the Region and both breed in significant numbers. The Houtman Abrolhos Islands support the only Australian breeding population of Australian lesser noddies, which consists of about 68 000 pairs spread over three islands. The only other breeding populations of this species occur in the western Indian Ocean. The common noddy also has a major breeding area on the Houtman Abrolhos Islands (130 000 pairs; Dunlop *et al*. 2001) with a smaller satellite population (less than 1000 pairs; Dunlop 2005) breeding on Lancelin Island. In Australian waters, noddies breed annually during the autumn. During non-breeding periods, lesser noddies tend to remain near breeding sites. However, they can forage well out to sea and have been observed hundreds of kilometres from breeding sites and over open ocean. In contrast, the common noddy moves away from breeding sites to feed in tropical waters during non-breeding periods. Both species forage for a diverse range of food including fish, squid, pelagic molluscs and insects.

Gannets

Two species of gannets are found within the Region: the cape gannet and the Australasian gannet, however, only the Australasian gannet occurs regularly in the Region. Gannets range across continental shelf waters of southern Australia as far north as Cape Cuvier in Western Australia. They feed on medium-sized fish and cephalopods (such as squid and octopus) taken from continental shelf waters. The Australasian gannet breeds outside the Region in both Victoria and Tasmania. The cape gannet was once thought not to breed in Australia, but small numbers (seven pairs in 1994) have been recorded breeding at an Australasian gannet colony on Lawrence Rocks near Portland, in Victoria, and some interbreeding between the two species has occurred (Norman *et al*. 1998).

Tropicbirds

The red-tailed tropicbird is found breeding in very small numbers on two islands adjacent to the Region – Sugarloaf Rock (34 pairs in 1969, declining to around 15 at present) and up to three pairs intermittently on Pelsaert Island (Surman & Nicholson 2006). Movements and ecology away from the breeding sites are poorly known with only a few sightings at sea. Interestingly, the only banding recovery of a red-tailed tropicbird away from the banding site was a bird from Sugarloaf Rock that was recovered on Reunion Island in the Western Indian Ocean – a movement of about 5000 km (Le Corre *et al*. 2003).

Penguins

The little penguin is the only penguin species that occurs regularly in the Region. The rockhopper, fiordland, king and erect-crested penguins are considered vagrants as they have only rarely been recorded in the Region. The little penguin nests on islands along the coast from Kangaroo Island to Perth, with approximately 3500 pairs, representing 5 per cent of the total Australian breeding population (Ross *et al*. 1995).

Important areas for seabirds in the South-west Marine Region

Important areas in the South-west Marine Region are identified for species listed as threatened or migratory under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for more information on matters of national environmental significance and requirements under the EPBC Act). Important feeding areas for seabirds are identified in the South-west Marine Region and important rookeries are identified in areas under the jurisdiction of the South Australian and Western Australian Governments. The important areas identified for seabirds include:

Houtman Abrolhos Islands – These islands have rookeries for a number of species, including the bridled tern, Caspian tern, common noddy, Australian lesser noddy and wedge-tailed shearwaters. The Houtman Abrolhos Islands are particularly important for the Australian lesser noddy as it is the only place the species has rookeries in Australia. About 68 000 pairs of Australian lesser noddies currently breed on Morley and Wooded Islands in the Easter Group, and Pelsaert Island in the Pelsaert Group of the Houtman Abrolhos Islands, Western Australia. The species is known to forage between the islands and the continental shelf edge. The osprey and the white-bellied sea eagle are also known to nest on these islands (Pelsaert Island and West Wallabi Island respectively). The common noddy has a rookery on Pelsaert Island. Caspian terns nest in colonies of up to 70 pairs on Leo Island, West Wallabi Island and Pelsaert Island. Bridled terns have rookeries on Gun Island, Leo Island, Pelsaert Island and Little North Island.

Rottnest Island – Rookeries for wedge-tailed shearwaters and bridled terns.

Recherche Archipelago – Rookeries for flesh-footed shearwaters, short-tailed shearwaters and Caspian Terns. Nesting area for white-bellied sea eagles.

Penguin Island – Rookery for bridled terns.

Eyre Peninsula – Nesting area for ospreys and white-bellied sea eagles.

Kangaroo Island – Nesting area for ospreys.

Lancelin Island – Rookeries for wedge-tailed shearwaters and bridled terns.

Safety Bay – Rookeries for wedge-tailed shearwaters and bridled terns.

Great Althorpe Island – Rookery for short-tailed shearwaters.

Cape Hamelin – Rookery for flesh-footed shearwaters.

Yorke Peninsula – Nesting area for white-bellied sea eagles.

Nuyts Archipelago (including Franklin, St Peter, Goat, Evans and *Massilon Islands)* – Rookeries for Caspian terns, flesh-footed shearwaters and short-tailed shearwaters.

Neptune Islands (including North and *South Neptune)* – Rookeries for short-tailed shearwaters and Caspian terns.

Gambier Island – Rookeries for short-tailed shearwaters.

Lewis, Hopkins and *Willaims Islands (near Cape Catastrophe)* – Rookeries for short-tailed shearwaters.

Greenly Island – Rookery for short-tailed shearwaters.

Investigator Group – Rookeries for short-tailed shearwaters.

West Troubridge Shoal – Rookery for Caspian terns.

Sir Joseph Banks Group – Rookeries for Caspian terns.

Eyre Island and *Little Eyre Island* – Rookeries for Caspian terns.

Fisherman Islands – Rookeries for bridled terns.

Beagle Islands – Rookeries for bridled terns.

Known interactions, threats and mitigation measures

At sea, seabirds may interact with human activities in a number of ways, including encounters with fishing vessels and entanglement in marine debris. Some birds may also be affected by disturbance at rookeries adjacent to the Region. These interactions are discussed in more detail below.

Another potential threat to seabirds is climatic and oceanic change (DEH 2005c). However given poor knowledge of the oceanic distribution of most seabirds it is difficult to assess the likely impact of climate change on seabirds (DEH 2005d).

Commercial fisheries

Seabirds foraging for fish alongside commercial fishing operations may interact with vessels in several ways: birds may collide with trawl apparatus, become entangled in nets, ingest discarded hooks or be caught on longlines. In the South-west Marine Region, the Western Australian-managed South Coast Purse Seine Fishery has a high level of interaction with flesh-footed shearwaters during their summer breeding season. Estimates of the level of mortality during the three month peak of the breeding season are around six birds per day per boat (DEH 2005a). In 2003 there were approximately 16 boats operating within this fishery (Gardner *et al*. 2006). As part of the assessment of this fishery under the EPBC Act, the Western Australian Department of Fisheries is required to:

- develop a monitoring programme to determine the number of protected species being inadvertently caught as by-catch;
- develop specific performance measures and indicators for interactions with flesh-footed shearwaters and report annually on the performance of the fishery at minimising seabird interactions; and
- trial mitigation mechanisms to minimise protected/listed species interactions, particularly with flesh-footed shearwaters and that measures are implemented within six months of being demonstrated effective (DEH 2005a).

The Southern and Western Tuna and Billfish Fishery is also known to interact with a range of seabirds including albatrosses, petrels and shearwaters, with the capture of seabirds hooked and/or entangled during setting or hauling of longlines. Between 1998 and 2002; 25 seabirds were reported as taken by longliners operating within the fishery (DEH 2004a). Research points to a mortality rate of seabirds captured of around 40 per cent. However, the Southern and Western Tuna and Billfish Fishery is currently fishing at a low level of effort compared with 2002 (Gardner *et al*. 2006). As a

result, interactions with birds of the Region are likely to have declined during the past few years.

Outside the Region, the Eastern Tuna and Billfish Fishery – which operates in waters down the eastern seaboard of Australia and off Tasmanian and Victoria out to the edge of the EEZ – is known to interact with seabirds. Given the foraging ranges of many of the bird species occurring in the Region, this fishery has the potential to interact with species that are also found within the Region, particularly albatrosses. Since 2002, around 350 birds have been reported killed within the fishery (DEH 2005b). During the year 2003-2004, a total of 32 seabirds were reported as taken by longliners operating in the fishery with none released alive (DEH 2005b). The main species caught were flesh-footed shearwater (16), short-tailed shearwater (two), and a range of petrel and albatross species (DEH 2005b).

In recognition of the threat posed to seabirds from longline fishing, the incidental catch, or by-catch, of seabirds during oceanic longline fishing operations is listed under the EPBC Act as a key threatening process. A *Threat Abatement Plan for the Incidental Catch (or By-catch) of Seabirds During Oceanic Longline Fishing Operations* is in place and available at <www.aad.gov.au/default.asp?casid=20587>. In addition, By-catch Action Plans have been developed to identify by-catch issues in specific fisheries and to outline actions required to address those issues. Mitigation measures include the implementation of fishery observer programmes, weighted lines and night-setting. Data are also collected on the nature and extent of interactions and the range of species involved, as well as on the effectiveness of current management actions.

The trawl operations of the Region, such as the Great Australian Bight Trawl Fishery[1] and the Western Deepwater Trawl, may also threaten the Region's bird species because birds can accidentally become caught in nets. While there is some evidence, particularly from overseas studies, that these types of interactions may occur, the threat to seabirds in the Region by trawl fisheries is considered low (DEH 2004b).

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 (such as plastics) disposed of by ships at sea are all considered harmful marine debris. Marine debris islisted as a key threatening process under the EPBC Act because of the threat it poses to all marine life, especially to species listed as threatened under the EPBC Act (DEH 2003).

The ingestion of, or entanglement in harmful marine debris is recognised as a key threatening process affecting seabirds (DEH 2003). Entanglement in marine debris such as abandoned fishing lines, nets or other debris can restrict mobility, reducing the ability of seabirds to catch prey and avoid predators and lead to increased mortality through starvation or drowning. Entanglement can also constrict growth and circulation resulting in infection or asphyxiation.

Plastic bags and other marine debris may be mistaken for food items and ingested by seabirds. This can result in a wide range of lethal and sub-lethal effects including physical damage, perforation, blockage or impairment of the digestive system. Some plastics are also a source of toxic pollutants, which may lower fitness, thus reducing the bird's ability to reproduce successfully, catch prey and avoid predators.

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>

Disturbance at rookeries

Introduced species are the most significant threat to seabirds at their breeding sites. Species such as rabbits may cause nest destruction and habitat modification, while cats and rats can reduce reproductive success through predation on eggs, chicks and breeding adults. Disturbance by humans at nesting sites can also cause breeding failure through nest destruction, nest desertion or the inadvertent crushing of eggs or small chicks by stressed adult birds.

1 The Great Australian Bight Trawl Fishery is a sector of the Australian Government-managed Southern and Eastern Scalefish and Shark Fishery.

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D5 South-west Marine Region Species Group Report Card – Pinnipeds

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

General information

Pinnipeds are part of the order Carnivora, which includes the families: Otaridae (fur seals and sea lions); Phocidea (true or earless seals); and the Odobenidae (the walruses).

Of the 10 species of pinnipeds that occur in Australian waters (which includes the Australian Antarctic Territory and Heard and MacDonald Islands), three are known to occur in the South-west Marine Region. These are the Australian sea lion *(Neophoca cinerea)*, the New Zealand fur seal (*Arctocephalus forsteri*) and the Australian fur seal (*Arctocephalus pusillus*). Another six species have been recorded in the Region and are considered as vagrant species. These are the southern elephant seal (*Mirounga leonine*), the leopard seal (*Hydrurga leptonyx*), the crabeater seal (*Lobodon carcinophagus*), the Weddell seal (*Leptonochotes weddellii*), the Antarctic fur seal (*Arctocephalus gazella*) and the sub-Antarctic fur seal (*Arctocephalus tropicalis*).

Nationally protected species

All pinnipeds are protected as listed marine species under Section 248 of the EPBC Act. Of the species of pinniped occurring in the South-west Marine Region only one, the Australian sea lion, is listed as a threatened species (see Table D5). A recovery plan for this species is currently under preparation.

Ecology of pinnipeds in the South-west Marine Region

Australian sea lions

Australian sea lions are endemic to Australia and occur in coastal habitats, waters and islands offshore of South Australia and Western Australia. The species is one of five sea lion species in the world. It has an estimated population of fewer than 11 000 - 12 000 individuals (Goldsworthy *et al*. 2006).

While the current range of the Australian sea lion extends to the Houtman Abrolhos Islands in Western Australia, most of the population is found in South Australia. The species 'hauls-out' (or rests) and breeds on rocks and sandy beaches on the sheltered sides of islands, although there are some small colonies on the Australian mainland. Australian sea lions are relatively easily seen at colonies on islands adjacent to the Region and are the focus of nature-based tourism enterprises.

The current distribution of the Australian sea lion largely falls within the Region and adjacent State waters. Prior to sealing, the species was known to have a more extensive range. Australian sea lions have an unusually long breeding cycle – 17 to 18 months – and the timing of cycles varies between closely situated breeding sites (different colonies breed at different times). The Australian sea lion is unique among pinnipeds in being the only species that has a non-annual breeding cycle and that also breeds at different times across its range (Goldsworthy *et al*. 2006). Female Australian sea lions also show strong breeding site fidelity. Recent population genetic studies have indicated little or no interchange of female Australian sea lions among breeding colonies, even those separated by short distances (McKenzie *et al*. 2005). These breeding characteristics make the Australian sea lion particularly vulnerable to disturbance by humans (DAFF 2007).

Table D5 Pinnipeds listed as threatened under the EPBC Act that are known to occur in the Region

Species	Conservation Status	Australian Government Conservation Plans and Policies for the Species
Australian sea lion (*Neophoca cinerea*)	Vulnerable Marine	• *The Action Plan for Australian Seals* (1999) • *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)

Australian sea lions feed on the continental shelf in the Region, most commonly in depths of 20-100 m (Shaughnessy 1999). They appear to be mainly benthic foragers (Goldsworthy *et al*. 2006) and eat a wide variety of prey including fish, small sharks, invertebrates (such as rock lobster), cephalopods (octopus, squid, cuttlefish and nautilus) and occasionally seabirds.

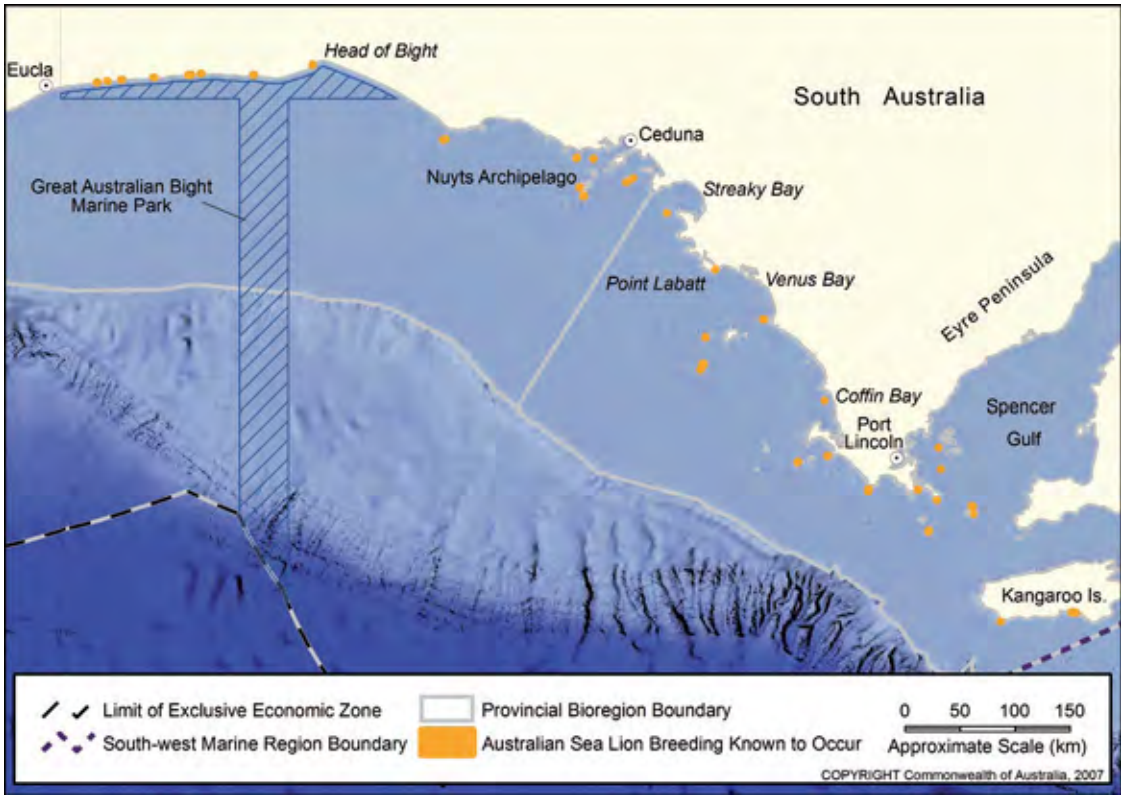
New Zealand fur seals

New Zealand fur seals breed in the Region on rocky islands off South Australia and the southern coast of Western Australia. They also breed on the south-west coast of Tasmania and on some offshore islands in Victoria. More than 80 per cent of Australia's population of New Zealand fur seals occur in South Australia (Goldsworthy *et al*. 2006). In Western Australia, the population of this species appears to be recovering to the size and range that occurred prior to commercial hunting, as they are occupying new breeding sites and extending their range westwards. The species is also found at many locations around New Zealand's rocky coastline, mostly on the southern shores of the country's South Island and on many of the offshore and sub-Antarctic islands (Seal Conservation Society n.d.). New Zealand fur seals are relatively easily seen in the Region and are the subject of targeted tourism enterprises.

There are about 51 known breeding sites for this species in Australia with most in South Australia (30) and Western Australia (17). Large breeding populations adjacent to the Region are found at North and South Neptune Islands, Kangaroo Island and Liguanea Island, and account for more than 80 per cent of the national pup production for the species (Goldsworthy *et al*. 2006). New Zealand fur seal colonies in Western Australia are centred on the islands of the Recherche Archipelago, with the westernmost population near Cape Leeuwin. Available information suggests that the range of this species is expanding in Western Australia, with an increasing number of animals hauling out and breeding on the south-west coast (Goldsworthy *et al*. 2006).

New Zealand fur seals feed at the surface to depths generally not exceeding 200 m and eat mainly fish and cephalopods (DAFF 2007). Lactating female New Zealand fur seals feed predominantly in mid to outer continental shelf waters. The males feed in deeper waters of the continental shelf, while juveniles forage in oceanic waters (Goldsworthy *et al*. 2006).

Figure D5.1 Australian sea lion breeding sites in the South-west Marine Region (South Australia)



Australian fur seals

Australian fur seals do not breed in the Region but are reasonably common in the eastern part of the Region where the species feeds and hauls out (Goldsworthy *et al*. 2006). They are known to haul-out among and near to New Zealand fur seal colonies on Kangaroo Island and are sometimes seen around the Neptune Islands.

Like Australian sea lions, Australian fur seals feed mainly in the waters of the shelf and are known to dive to at least 164 m. Australian fur seals are generally benthic foragers, which is unusual for a fur seal. They take a wide variety of prey, particularly fish, squid, cuttlefish and octopus (DAFF 2007).

Important areas for pinnipeds in the South-west Marine Region

Important areas in the South-west Marine Region are identified for species listed as threatened or migratory under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for more information on matters of national environmental significance and requirements under the EPBC Act). The Australian sea lion is the only species of pinniped listed as threatened under the EPBC Act with breeding colonies adjacent to the Region.

There are 73 known breeding locations for Australian sea lions (47 colonies in South Australia and 26 colonies in Western Australia) (McKenzie *et al*. 2005). However, Goldsworthy *et al*. (2006) report the presence of Australian sea lion pups at 76 sites over the past 20 years in the Region (48 in South Australia and 28 in Western Australia). Most of these colonies are found on islands adjacent to the South-west Marine Region. Five of the known Australian sea lion breeding colonies produce more than 100 pups each year, representing more than 50 per cent of all pups born (McKenzie *et al*. 2005). These five sites are all in South Australia: Dangerous Reef (Southern Eyre Peninsula), the Pages Islands (which is adjacent to the South-east Marine Region), West Waldegrave Island (Western Eyre Peninsula), Seal Bay (Kangaroo Island), and Olive Island (Western Eyre Peninsula) (McKenzie *et al*. 2005). Because of the closed breeding patterns of Australian sea lions and their conservation status as a threatened species it is considered that all breeding sites for Australian sea lions are significant. Figure D5.1 and Figure D5.2 show the locations of Australian sea lion breeding colonies in South Australia and Western Australia respectively.

Figure D5.2 Australian sea lion breeding sites in the South-west Marine Region (Western Australia)

Known interactions, threats and mitigation measures

The Australian sea lion, Australian fur seal and New Zealand fur seal populations were substantially reduced in the eighteenth, nienteenth and early twentieth centuries as a result of commercial sealing. While fur seal populations show some evidence of recovery since the cessation of commercial sealing, there is limited data to confirm the extent of recovery (DAFF 2007).

There is limited historic information on the size and range of Australian sea lion populations prior to European colonisation. However, before sealing, the range of Australian sea lions was more extensive (McKenzie *et al*. 2005). Although the Australian sea lion was eliminated from parts of its range, the lower prices for Australian sea lion skins and the difficulties involved in accessing small, isolated populations meant that sealing activity had a lesser impact on Australian sea lion populations than on fur seal populations (McKenzie *et al*. 2005).

Activities in the Region with the most potential to impact on pinnipeds if not managed appropriately include commercial fishing, aquaculture activities, tourism activities and through interactions with marine debris and pollution.

Commercial fisheries

Interactions with fisheries are an important issue for the conservation and management of seals and sea lions in Australia. The impacts on pinnipeds from commercial fishing relate mainly to entanglement in nets and death by drowning through capture or entanglement in fishing gear. Additional and less well understood impacts relate to potential trophic or ecological interactions between seals and fisheries operations.

Fishery by-catch and entanglement have been identified as factors contributing to limited growth in some populations of Australian sea lions (McKenzie *et al*. 2005).

Interactions between seals or sea lions and fisheries in Commonwealth waters in the Region occur mainly in the Commonwealth Southern and Eastern Scalefish and Shark Fishery, the South and Western Australian Rock Lobster Fisheries, and the Southern Bluefin Tuna Aquaculture Fishery in South Australia. There are many anecdotal and some documented reports of pinnipeds being caught and drowned incidentally in trawl fishing operations (Shaughnessy 1999).

Trawl fishing operations: A 15 year study on Kangaroo Island estimated that a minimum of 64 Australian sea lions die each year in southern Australia from entanglement with fishing gear (McKenzie *et al*. 2005). Australian fur seals, and to a lesser extent, New Zealand fur seals, have been reported to interact with the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (DAFF 2007; DEH 2006).

Australian fur seals, New Zealand fur seals and Australian sea lions have been reported to interact with the Gillnet Hook and Trap Sector of the Southern and Eastern Scalefish and Shark Fishery. The known interactions that are detrimental to seals and sea lions are incidental capture in gillnets that may lead to death by drowning or injury; and entanglement in fishing gear such as trawl nets, monofilament nets, nylon ropes, and bait straps and bait containers (DAFF 2007).

Australian fur seal. Photo: Graham Blight, CSIRO.

A number of measures are in place in the Southern and Eastern Scalefish and Shark Fishery to mitigate effects on marine species. There is an inshore closure of the fishery in South Australian waters from the head of the Great Australian Bight to the Western Australian border, to minimise fishing impacts on large breeding-age sharks, white sharks and Australian sea lions (DEH 2006). An industry-based Fisheries Research and Development Corporation funded project has trialled measures to promote comprehensive reporting of seal interactions in the trawl sectors of the Southern and Eastern Scalefish and Shark Fishery (DEH 2006). There is direction to install seal excluder devices in mid-water trawl nets in the winter blue grenadier fishing component of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery (DEH 2006). A mandatory requirement to fit seal excluder devices to mid water trawl nets in the winter blue grenadier processing/ freezing component of the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery was implemented in 2005 (AFMA 2006).

The Assessment of the Southern and Eastern Scalefish and Shark Fishery done under the EPBC Act in 2006 also specifies the need for the Australian Fisheries Management Autority to:

- develop and implement further measures to verify the extent and type of interactions with protected species in the fishery, with priority given to sea lions and fur seals;
- give priority to developing specific mitigation measures to reduce fishing impacts on sea lions and fur seals across the sectors of the fishery (DEH 2006).

Pot fishing operations: There are instances of Australian sea lion pups and juveniles being caught and drowning in lobster pots of the Western Rock Lobster and South-coast Crustacean fisheries in Western Australia and the Rock Lobster Fishery in South Australia. While the encounter and mortality rate of Australian sea lion pups in these fisheries is likely to be a rare event (McKenzie *et al*. 2005), the large number of pots and the small size of most Australian sea lion populations, particularly on the west coast of South Australia, means that even these low levels may have adverse population effects. The South Australian Department of Primary Industries and Resources is giving priority to quantifying and mitigating seal interactions in the South Australia Rock Lobster Fishery (DEH 2003a).

Ongoing monitoring programmes using onboard observers are in place in the Western Rock Lobster Fishery (EA 2002). The data from these programmes and from fishery logbooks is being used to validate the ranking of threat level to the Australian sea lion population from the fishery (EA 2002). In an effort to reduce seals and sea lions' interactions with lobster pots, bait protection and seal exclusion devices have been developed and are being introduced into the rock lobster fisheries. A number of different sea lion exclusion device designs are being tested and implemented in some parts of the Western Rock Lobster Fishery by the Western Australian Department of Fisheries (McKenzie *et al*. 2005).

Deliberate killing

Although hunting is illegal, there have been a number of anecdotal reports of the shooting of Australian sea lions by commercial fishers and past reports of occasional shooting and harassing of seals around tuna aquaculture farms. Five Australian sea lions were known to be shot in the Port Lincoln area between 1995 and 2000 (McKenzie *et al*. 2005). The most common unnatural causes of death recorded in stranded Australian sea lions in Western Australia between 1980 and 1996 were shootings (14 animals), with a further three deaths resulting from spearing or shooting with arrows and one death due to clubbing (McKenzie *et al*. 2005). There is little information on the mortality of Australian sea lions from illegal shooting and therefore it is not possible to assess the impact of this interaction on the recovery of Australian sea lion populations (McKenzie *et al*. 2005).

Aquaculture

Finfish aquaculture farms are known to pose a threat to seals and sea lions (DAFF 2007). The known interactions that are detrimental are entanglement in fish-farm nets and entrapment in fish cages resulting in injury and possibly death to the seals. Fatal entanglement of seals can occur in anti-predator nets, and illegal killing of seals and Australian sea lions near finfish operations has been reported (DAFF 2007).

Seals and Australian sea lions are known to interact with the activities and infrastructure of tuna farms near Port Lincoln in South Australia. A low number of Australian sea lions were recorded entangled and drowned in anti-predator nets used in the southern bluefin tuna feed lots in the Port Lincoln area in South Australia in the 1990s. The industry has reported that the use of anti-predator nets and improved farm management has greatly reduced seal interactions. However, there is a paucity

of data on interactions between seals and Australian sea lions and marine finfish aquaculture farms as there are no formal observer programmes operating on marine finfish aquaculture farms (McKenzie *et al*. 2005).

Because of the lack of an observer programme, details of the current level and nature of interactions between pinnipeds and marine finfish aquaculture in the Region is unknown.

Tourism

There is the potential for seal and sea lion populations to be disturbed by tourism and recreational activities, particularly populations of the more vulnerable Australian sea lion during breeding seasons (McKenzie *et al*. 2005; DAFF 2007). Tourism activities that could potentially affect seals and Australian sea lions are boat cruises, swimming, snorkelling and scuba diving with seals, and land-based viewing of seal colonies. Human disturbance of seals and Australian sea lions can lead to mortalities and injuries, especially to pups. However no research is available to date on the long-term impact of disturbance by humans on population growth of Australian sea lions or establishment of breeding colonies (McKenzie *et al*. 2005).

Tourism based activities occur at Australian sea lion breeding colonies and haul-out sites in Western Australia and in South Australia. In Western Australia, tourism activities at Australian sea lion colonies occur in the Perth region, the Jurien Bay area and at colonies along the south coast in the Recherche Archipelago near Esperance. In South Australia, tourism activities at Australian sea lion, Australian fur seal and New Zealand fur seal colonies occur at Baird Bay, Kangaroo Island (two locations), Neptune Island, Point Labatt; Encounter Bay, Rapid Bay, and on islands in the Spencer Gulf. In Western Australia, Australian fur seals are viewed at Bunker Bay, Flinders Islet, St Alouran Island Nature Reserve and Seal Island Nature Reserve (off Albany), and Seal Rock and Doubtful Island Nature Reserve (off Bremer Bay).

Commercial seal watching by tourists at locations on Kangaroo Island (Cape de Coudedic and Seal Bay Conservation Park) in South Australia is a threat to specific colonies, particularly as visitor numbers increase (Shaughnessy 1999). Efforts have been made at the largest of these sites, Seal Bay on Kangaroo Island, to regulate tourism activities to keep people away from breeding sites. The long-term nature of tourism activities at these sites is believed to have caused the Australian sea lions at these sites to have a higher than usual level of tolerance for the presence of humans, which may be mitigating the potential for negative impacts on the population.

Marine debris and contaminants

Rubbish washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers, and solid non-biodegradable floating materials such as plastics disposed of by ships at sea are all considered to be harmful marine debris. Marine debris was listed as a key threatening process under the EPBC Act in 2003 because of the threat it poses to all marine life, and is an added danger to the survival of species listed as threatened under the EPBC Act.

Seals and Australian sea lions interact with human-made marine debris including 'ghost nets' (which are discarded, free-floating fishing nets), rubber rings from bait boxes, ropes and plastic bags. This can result in strangulation as a result of plastic or net fragments becoming entangled around the necks of seals and sea lions. It can also lead to starvation, or death by predation, because of reduced mobility from entanglement. Records of entanglements on Kangaroo Island indicate that both New Zealand fur seals and Australian sea lions interact with marine debris that is likely to have been lost from the commercial Southern Rock Lobster Fishery, including plastic straps that surround cardboard boxes of bait, and rope from rock lobster pot floats (McKenzie *et al*. 2005). In Western Australia the Department of Fisheries has undertaken to educate and encourage fishers in the Western Australian Rock Lobster Fishery to bring all waste back to port, in part to reduce the threat of Australian sea lions becoming entangled in bait bands (EA 2002). In recognition of possible threats to seals, the South Australian Southern Rock Lobster industry has been phasing out the use of bait supplied in packaging that requires strapping.

The Australian Government is also currently developing a threat abatement plan that aims to minimise the impacts of marine debris on threatened marine species. Further information available at <www.environment.gov.au/biodiversity/threatened/publications/marine-debris.html>.

Marine pollution

Oil spills and chemical contaminants are a known threat to Australian pinniped species. Many of the seal and sea lion colonies in the Region occur close to major shipping lanes and are therefore vulnerable to oil spills in the event of shipping accidents. However, there is no evidence to date that pollution and toxins are significant factors currently impacting the growth of

fur seal or Australian sea lion populations. The sinking of the bulk ore carrier, the 'Sanko Harvest' off Esperance in 1991 led to oil fouling of fur seal pups in at least two breeding colonies in Western Australia. The degree to which this fouling, and the ensuing clean-up, affected fur seal mortality or reproductive performance is not known (Gales pers. comm. 23/02/07; DAFF 2007).

Other potential threats

There are several other potential threats to pinniped species identified in recent literature, including:

- the release back into the wild of rehabilitated (from disease) and stranded pinnipeds, may pose a threat as a vector of disease in healthy, wild populations of seals. However, information on the type of disease agents and their prevalence in seal populations throughout Australia is limited;
- the effect of seismic activity for petroleum exploration on pinnipeds is not well understood, but could possibly impact on prey availability in feeding grounds for seals if not adequately managed; and
- a number of whole-of-ecosystem factors, which may inhibit the recovery of Australian sea lion populations. These are climate change, constraints on food availability and loss of foraging habitat through degradation (DEH 2005).

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Map data

Figure D5.1 Australian sea lion breeding sites in the South-west Marine Region (South Australia)

Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database – CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
Department of the Environment, Water, Heritage and the Arts (2006): Species of National Environmental Significance Database
Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
Geoscience Australia (2004): Gazetteer of Australia
Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts. COPYRIGHT Commonwealth of Australia, 2007.

Figure D5.2 Australian sea lion breeding sites in the South-west Marine Region (Western Australia)

Department of the Environment, Water, Heritage and the Arts (2004): Collaborative Australian Protected Areas Database – CAPAD
Department of the Environment, Water, Heritage and the Arts (2006): Commonwealth Marine Planning Regions
Department of the Environment, Water, Heritage and the Arts (2006): Integrated Marine and Coastal Regionalisation of Australia v4.0 - Provincial Bioregions
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Geoscience Australia (1998): Australia, TOPO-2.5M Topographic Data
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Geoscience Australia (2005): Australian Bathymetry and Topography
Geoscience Australia (2006): Australian Maritime Boundaries (AMB) v2.0
Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts. COPYRIGHT Commonwealth of Australia, 2007.

D6 South-west Marine Region Protected Species Group Report Card – Cetaceans

Current at May 2007. For updates see <www.environment.gov.au/coasts/mbp/south-west>.

General information

Globally, the order Cetacea comprises more than 80 species of marine mammals known as whales, dolphins and porpoises. There are two extant sub-orders. These are:

- the Mysticeti, or baleen whales, which are distinguished by their generally large size (8-30 m); twin blowholes; and keratinous baleen plates that hang from the upper jaw and are used to filter out schooling prey such as crustaceans and small fish; and
- the Odontoceti, or toothed whales, which are more diverse and extremely variable in size (1.5 - 18 m); have a single blowhole; and true teeth for holding prey, which are usually individually caught. Most species have well-developed echo-location (Gill *et al*. 2006).

Of the 45 cetacean species recorded in Australian waters, 31 are known to occur in the South-west Marine Region. A further nine species may occur infrequently in the Region.

Nationally protected species

All cetaceans are protected under the EPBC Act by virtue of their listing as 'cetacean' and the establishment of the Australian Whale Sanctuary. Nine species of cetacean found in the Region are listed as threatened and/or migratory (Table D6). Additionally, the long-snouted spinner dolphin is considered a 'priority species' under the 1996 Action Plan for Australian Cetaceans although information is still too scarce to assign it to a conservation category (Ross 2006).

Ecology of protected cetaceans in the South-west Marine Region

Cetaceans found in the South-west Marine Region include both inshore and offshore species as well as a mix of Southern Ocean species (for example, blue whales, southern right whales, and southern right whale dolphins) and species associated with warmer tropical waters (for example, short-finned pilot whales, and striped and spinner dolphins). Use of the Region's marine habitats and resources varies broadly among cetaceans. Some species are rarely sighted in the Region, others migrate annually from Antarctic waters into the Region while others are found throughout the year and are thought to be permanent residents of the Region.

Southern right whales migrate from their summer feeding grounds in the Southern Ocean to calve and breed in the warmer waters of the Region, and females in particular appear to have strong fidelity to breeding sites. Humpback whales traverse the Region every year between their tropical and sub-tropical breeding areas, and their feeding areas in the Antarctic. Other species, such as the long-finned pilot whale and the killer whale, move across very large distances and are observed in the Region occasionally, possibly at times when their preferred prey is more abundant. Common and bottlenose dolphins are resident in the Region throughout the year and are frequently observed. Finally, some species, like the pygmy right whale and beaked whales, are known to inhabit the Region but have been observed only rarely due possibly to their 'cryptic' behaviour.

Some highly visible species, such as the southern right and humpback whales, do not usually feed in the Region, and so may play only a minor ecological role within their breeding and migratory habitats. However, most species of cetaceans, including pygmy blue whales, regularly feed in the Region's waters. Sperm, pilot and beaked whales are likely to forage along the upper slope and in canyons, while pelagic dolphins appear to aggregate in response to seasonal fish production. Collectively, cetaceans are likely to be significant predators of a number of prey groups, including squid, myctophids such as lantern fish, clupeids (sardines and herrings), and crustaceans including euphausiids (krill), amphipods and copepods. However, until it is possible to estimate trophic requirements as well as predator and prey population size and dynamics, the exact nature and extent of their ecological role remains unclear. The biomass of all the large whale species (with the possible exception of sperm whales; Gill *et al*. 2006) is still greatly reduced from past whaling activity and it is thought that much greater numbers were supported within the Region prior to commercial whaling.

Table D6 Cetaceans listed as threatened or migratory under the EPBC Act that are known to occur in the South-west Marine Region

Species	Conservation Status	Australian Government Conservation Plans and Policies for the Species
Southern right whale (*Eubalaena australis*)	Endangered, Migratory Listed under CITES (Appendix I) and CMS (Appendix I)	*Recovery Plan for Australia's Threatened Whales 2005-2010: Humpback, Southern Right Whale, Blue, Fin and Sei* (2005) *Australian National Guidelines for Whale and Dolphin Watching* (2005) *Guidelines on the application of the Environment Protection and Biodiversity Conservation Act to interactions between offshore seismic operations and larger cetaceans* (2001) *The Action Plan for Australian Cetaceans* (1996)
Blue whale* (*Balaenoptera musculus*)	Endangered, Migratory Listed under CITES (Appendix I) and CMS (Appendix I)	
Sei whale (*Balaenoptera borealis*)	Vulnerable, Migratory Listed under CITES (Appendix I) and CMS (Appendix I & II)	
Fin whale (*Balaenoptera physalus*)	Vulnerable, Migratory Listed under CITES (Appendix I) and CMS (Appendix I & II)	
Humpback whale (*Megaptera novaeangliae*)	Vulnerable, Migratory Listed under CITES (Appendix I) and CMS (Appendix I)	
Bryde's whale (*Balaenoptera edeni*)	Migratory Listed under CITES (Appendix I) and CMS (Appendix II)	
Pygmy Right whale (*Caperea marginata*)	Migratory Listed under CITES (Appendix I) and CMS (Appendix II)	
Killer whale, orca (*Orcinus orca*)	Migratory Listed under CITES (Appendix II) and CMS (Appendix II)	
Sperm whale (*Physeter macrocephalus*)	Migratory Listed under CITES (Appendix I) and CMS (Appendix I & II)	

* The taxonomy of blue whales is unclear, however it is generally accepted that there are two sub-species in the Southern Hemisphere: the 'true' Antarctic blue whale, *Brevicauda musculus intermedia*, and the pygmy blue whale, *B. m. brevicauda*. Both these sub-species are thought to occur in the South-west Marine Region, although their respective distributions are uncertain. One notable difference is that during the Southern Hemisphere summer, 'true' blues are usually found south of 60°S, while 'pygmy' blues are usually found north of 55°S. Blue whales are listed under the EPBC Act at the species level, however, where possible, this report card distinguishes between sub-species. Where sub-species cannot be identified, both sub-species are referred to collectively as 'blue whales'.

Important areas for cetaceans in the South-west Marine Region

Important areas in the South-west Marine Region are identified for cetaceans listed as threatened or migratory under the EPBC Act as they are matters of national environmental significance (see Chapter 3.2 for more information on matters of national environmental significance and requirements under the EPBC Act). Important feeding areas, calving areas and resting areas are identified for cetaceans listed as threatened or migratory under the EPBC Act. Some of these areas are within the South-west Marine Region, while others are under the jurisdiction of the South Australian and Western Australian Governments. The important areas identified for cetaceans listed as threatened or migratory under the EPBC Act include:

The Great Australian Bight – This area is of particular significance for southern right whales with one of the main calving areas in South Australia at the Head of Bight.

Doubtful Islands Bay – This area is one of the main calving areas for southern right whales in Western Australia.

East of Israelite Bay – This area is one of the main calving areas for southern right whales in Western Australia.

Fowlers Bay – This is one of the main calving areas for southern right whales in South Australia.

Albany/ Cape Riche area – This is one of the main calving areas for southern right whales in Western Australia.

Yokinup Bay/Cape Arid area – This is one of the main calving areas for southern right whales in Western Australia.

Perth Canyon – The Perth Canyon is a seasonally important aggregation area for krill at depths of 200-300 m and attracts many species of krill feeders, in particular pygmy blue whales. Fin whales have been observed in the area and it is thought that sei whales may also feed there.

Waters from Geographe Bay to Rottnest Island – The bay and surrounding waters are an important resting area for humpback whales, particularly cow-calf pairs, as they migrate south at the end of the breeding season. Recent surveys have also detected southern right whales in the area. Research in recent years has shown an increasing number of blue whales using the bay in spring and also passing through the shelf area between Cape Naturaliste and Rottnest Island, however the ecological or functional significance of the area to the species is unclear.

Waters to the south of Kangaroo Island – This area is a feeding area for pygmy blue whales, fin whales, sperm whales and possibly sei whales.

Waters adjacent to the Houtman Abrolhos Islands – This area is a resting site for humpback whales on migration. Sightings of Bryde's whales also suggest this area may be important for this rarely sighted species;

Waters surrounding Cape Leeuwin/Flinders Bay – This is a resting area for humpback whales.

Encounter Bay – This is one of the main calving areas for southern right whales in South Australia.

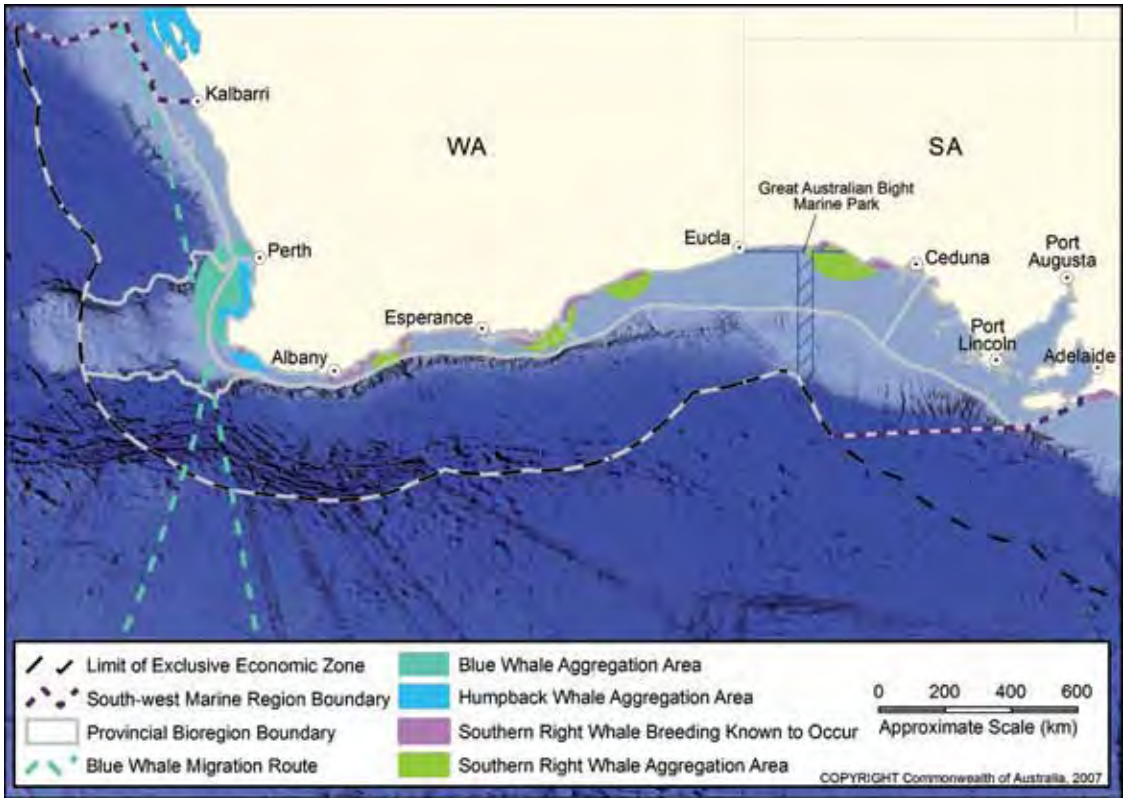
Twilight Cove – This is one of the main calving areas for southern right whales in Western Australia.

Albany Canyons Group and adjacent shelf break – This area is a feeding area for sperm whales. Sperm whales have been recorded as concentrated in a narrow area only a few miles wide at the shelf edge off Albany, Western Australia (Bannister *et al*. 1996).

Apart from the specific areas identified above, other features of the Region's marine environment are thought to be important to some cetaceans. There is some evidence to suggest that canyons in the continental slope, such as the Ceduna Canyons and the Perth Canyon, are aggregation areas for fish, krill and deep-sea cephalopods (squids, octopus and cuttlefish). It is also thought that these aggregations may be important food sources for sperm whales, beaked whales, and krill-eating fish, which, in turn, may be preyed upon by pelagic dolphins. Strandings of Gray's beaked whales in Geographe Bay may suggest that nearby areas may be important for this species, however, little is known about this species presence in the Region. In the Great Australian Bight area, pinniped colonies may be important feeding grounds for killer whales although this requires further investigation.

Diving whale. Photo: Robert Thorne, Department of the Environment, Water, Heritage and the Arts.

Figure D6.1 Important areas for southern right, humpback and blue whales in the South-west Marine Region



Known interactions, threats and mitigation measures

During the early 1800s, whaling was an important industry in the Region. Semi-permanent camps were set up on the Eyre Peninsula, Kangaroo Island, the Esperance area of Western Australia and as far north as Shark Bay, to target a range of the larger whale species. Over-exploitation and dramatic declines in whale numbers eventually led to the demise of the whaling industry. Australia's last whaling station, at Cheynes Beach near Albany, closed in 1978. In 1979, Australia adopted an pro-conservation policy, putting a permanent end to whaling in Australian waters.

Although there has been a global moratorium on commercial whaling effective since 1986, populations of all species are still below pre-whaling estimates – most considerably so. Two populations of targeted species have been recovering – the southern right whale and the west coast population of the humpback whale are increasing at rates close to their respective biological capacity. While not a current threat to most species, whaling is still listed as the most threatening anthropogenic activity in all five threatened cetacean recovery plans under the EPBC Act. Antarctic minke whales, which may migrate past Australian shores, are the primary target of 'scientific' whaling by Japan. In addition to 850 minke whales, 50 humpback and 50 fin whales are proposed to be taken under Japan's Antarctic Research Programme, JARPA II, during the 2007/08 summer.

Under the EPBC Act, all cetaceans are protected within the Australian Whale Sanctuary, and measures are in place to mitigate potential negative impacts of human actions on whale and dolphin species. However, interactions between cetaceans and humans do occur in Australian waters. Most of these interactions are accidental as they do not result from activities deliberately aiming to interact with cetaceans. Collecting information on feeding habits, migration routes and preferred habitats is important in preventing significant incidental interactions with cetaceans. Behavioural differences between species also influence the likelihood of interactions, with some cryptic species, like the Bryde's whales, being rarely encountered.

Activities in the Region with the most potential to impact on cetaceans if not managed appropriately include commercial fishing, oil and gas exploration and development, defence activities, shipping, human maritime and shore sourced pollution, recreational boating and whale/dolphin watching activities.

Commercial fisheries

Interactions between cetaceans and fisheries can include competition for target species, depredation of catch, entanglement by cetaceans in gear, or injury or death through incidental capture.

Information on trophic interactions between cetaceans and fisheries is limited. Work on marine mammals generally indicates that cetaceans at the top of the food chain may have a significant effect on the structure of the marine ecosystem. Competition between cetaceans and fisheries may be direct, where both are targeting a common prey species, or indirect through complex trophic interactions. In particular, fisheries targeting small pelagic species, such as pilchards and redbait, may have a significant effect on some cetacean species as small pelagic fish are thought to be important to many components of the marine ecosystem generally. In the South-west Marine Region, these fisheries are likely to be competing with common and bottlenose dolphins.

Competition for targeted species can lead to direct interactions between cetaceans and fisheries. Depredation or the 'robbing' of fish caught on longlines, by species such as killer whales and pilot whales, may be a problem in some Australian longline fisheries, especially tuna fisheries, which increases the threat of entanglements, injuries and incidental by-catch (AFMA 2005a).

Although not associated with depredation, humpback whales and southern right whales have also been known to become entangled in fishing gear during their annual migration. In the past 20 years, more than 40 entanglements have been reported with the majority occurring in floating lines of the Western Rock Lobster Fishery (Keys 2007). The problem is expected to increase as the whale populations recover. An industry protocol has been developed to reduce pot rope lengths to minimise the possibility of interactions with whales and a code of conduct is in also in place to assist the industry reduce the threat of entanglements. Most instances of entanglement result in the whales being released alive.

Species such as bottlenose and common dolphins may interact with a range of fisheries in the Region through incidental capture. In the South-west Marine Region, by-catch of dolphins has been reported in the Australian Government-managed Southern and Eastern Scalefish and Shark Fishery and the South Australian-managed Sardine Fishery.

In the gillnet sector of the Australian Government-managed Southern and Eastern Scalefish and Shark Fishery, 10 dolphin mortalities were recorded over a two-year period (DEH 2003). Measures including observer programmes and improved collection of incidence data were subsequently put in place to better quantify interactions with cetaceans and other protected species (DEH 2006).

In 2005, the South Australian Department of Primary Industries and Resources closed the South Australian-managed Sardine Fishery for four weeks after dolphins were killed in pilchard nets. The fishery was reopened once the Department implemented ongoing monitoring of interactions with protected and endangered species through an independent observer programme (DEH 2004a).

By-catch of dolphins in waters outside the Region, which may reduce the populations of dolphins in the Region, has also occurred in the Australian Government-managed Small Pelagics Fishery and the West Australian-managed Pilbara Trawl Fishery. Dolphin by-catch in the Australian Government-managed Small Pelagics Fishery in waters around Tasmania resulted in 14 dolphin mortalities being recorded in 2004 (AFMA & DEH 2005) and a further 11 dolphin mortalities in 2005 despite a suite of mitigation measures being implemented (SPFMAC 2005). A Natural Heritage Trust project was set in place with joint partners the Australian Fisheries Management Authority, the Department of the Environment and Heritage, the operator, the Whale and Dolphin Conservation Society and the Tasmanian Aquaculture and Fisheries Institute to trial underwater cameras and mitigation methods. However, no further interactions with dolphins have been recorded (AFMA 2005b).

In 2005, the West Australian-managed Pilbara Trawl Fishery, which operates in waters to the north of the South-west Marine Region, captured 56 dolphins, of which 52 died as a result (WA Department of Fisheries 2006). By-catch reduction grids are now being trialled in the Fishery and a By-catch Action Plan is being developed (WA Department of Fisheries 2006).

Aquaculture/mariculture

Aquaculture activities and equipment located adjacent to the Region may be a source of interaction with cetacean species, particularly smaller whales and dolphins, often with negative results. Dolphins are attracted by the feed-types used in tuna farms and are regularly caught, and sometimes die, in aquaculture nets. Between 1990 and 1999, at least 29 common and

spotted bottlenose dolphins were reported to have died from becoming entangled in southern bluefin tuna feedlots at Port Lincoln (Kemper & Gibbs 2001).

Petroleum exploration

Oil and gas exploration and other geophysical surveys involve the use of seismic 'air-guns', which generate a rapid release of air under high pressure. Seismic surveys have the potential to cause physical, behavioural and perceptual effects on whales. Seismic surveys are thought to cause cetaceans to detour away from migration routes or from feeding or breeding areas. Extremely close encounters may cause damage to their ears.Baleen whales such as humpback, blue and fin whales may be more affected by seismic surveys than toothed whales as their acoustic range is thought to operate in the same frequency as air gun pulses used in seismic exploration. Seismic operations are regulated by the Australian Government's *Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions between Offshore Seismic Operations and Larger Cetaceans* (EA 2001). These guidelines have just been revised and are currently available for public comment at: <www.environment.gov.au/epbc/publications/seismic>. The petroleum industry has taken an active role in the development and implementation of measures to minimise the potential impacts of exploration on cetaceans. The industry seeks to undertake exploration, where practicable, during times when encounters with whales are generally least likely to occur.

Defence activities

Within the Region, and particularly within the Western Australian Exercise Area (WAXA) off Perth, the Department of Defence conducts a range of activities such as target practice and the use of active sonar to locate targets that involves the use of live ammunition within the marine environment. While the use of live ammunition in the marine environment may be an issue specific to training areas, to date most research on the interaction of defence activities and cetaceans centres around the use of active sonar devices and their effect on cetaceans. Noise from some types of military sonar has been linked elsewhere to strandings and deaths in some species of deep-diving beaked whales. To date, there is no evidence of whale strandings linked to defence training activities within WAXA or any other Australian training area.

In order to mitigate any impacts on cetaceans the Royal Australian Navy has developed procedures for detecting whales during defence training activities. These procedures provide advice for operators of military aircraft and equipment and naval vessels that produce sonar or sources of underwater sounds such as explosions. The Department of Defence, in cooperation with the Department of the Environment, Water, Heritage and the Arts, develops guidelines when planning activities in the marine environment. These guidelines provide advice on any approval required from the Australian Government and how to avoid any interactions with migrating, breeding and feeding whales. However, for some species, beaked whales in particular, interactions are difficult to mitigate as these species spend very little time at the surface. The effectiveness of visual detection to initiate mitigation measures is probably limited for these species. To better understand its obligations, the Department of Defence has also provided financial, technical and material support to a range of research activities related to cetaceans. Most research in the Region has focused on the Perth Canyon and blue whales, and has investigated the ecology of the whales and the habitat attributes of the canyon.

Shipping

Shipping is a major activity in the Region's waters, transporting goods through the Region and to and from the ports in the Region. Ship strikes are likely to affect the larger whale species such as blue, humpback and the southern right whales, and result in an unknown number of injuries and deaths within the Region. Overseas studies indicate that ship strikes may be a major cause of mortality for some cetacean species. Of the 45 known mortalities of the northern right whales that occurred within the North Atlantic between 1970 and 1999, 36 per cent were the result of ship strikes (Knowlton & Kraus 2001). Care should be taken with these figures in the Australian context because there is far more shipping activity in the North Atlantic than in the waters of the South-west Marine Region.

Marine debris

Plastic garbage washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers, and solid non-biodegradable floating materials (such as plastics) disposed of by ships at sea are all considered to be harmful marine debris. Marine debris is listed as a key threatening process under the EPBC Act because of the threat it poses to all marine life, especially to species listed as threatened under the EPBC Act.

Marine debris may contribute to the death of cetaceans, with plastic bags being a known problem. For example, a Bryde's whale stranded near Cairns in August 2000 was found to have almost 6 m^2 of plastic in its stomach <www.environment.gov.au/coasts/publications/cetacean-poster.html>. In addition, fishing gear such as lost nets and pots from international waters may enter the Region and cause whales to become entangled.
The Australian Government is currently developing a threat abatement plan which 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>.

Whale watching
Recreational and tourism activities have the potential to affect the behaviour of cetaceans. Because of their presence in shallower coastal waters in the Region, species such as southern right and humpback whales and some species of dolphin may be susceptible to disturbance from tourism operations. Potential disturbance centres around behavioural changes due to the proximity of vessels and/or aircraft.

In response to concerns regarding the impact on whales and dolphins of the growing cetacean watching industry, the Australian Government and all State and Territory governments jointly developed the *Australian National Guidelines for Whale and Dolphin Watching* (DEH 2006b). These guidelines apply equally to commercial and recreational whale watching and have the dual aims of:

- minimising harmful impacts on whales, dolphins and porpoises; and
- ensuring that people have the best opportunity to enjoy and learn about the whales, dolphins and porpoises found in Australian waters.

The guidelines set out a number of requirements of relevance to both commercial and recreational whale and dolphin watching, including minimum distance requirements for vessels, aircraft and helicopters. State Governments manage the day-to-day activities of the cetacean watching tourism sector in State waters, and their management arrangements are consistent with the national guidelines. The Australian Government implemented the latest National Guidelines into the EPBC Regulations in June 2006 <www.environment.gov.au/coasts/publications/whale-watching-guidelines-2005.html>.

Recreational activities
Recreational boating may also affect cetaceans through direct strikes resulting in injury or death, physical disturbance, or noise that can disturb cetaceans and mask the acoustic cues on which they depend for communication, orientation or food-finding.

Offshore installation
Offshore installations such as wind farms or wave generators are currently under assessment overseas for their potential to impact on cetaceans.

Aircraft
Aircrafts may disturb whales and dolphins due to their speed, noise, shadow or, downdraft in the case of helicopters. Provisions for the operation of aircraft in the vicinity of whales and dolphins are outlined in the *Australian National Guidelines for Whale and Dolphin Watching 2005*.

Land-based activities
Closer inshore, animals such as inshore bottlenose dolphins may be locally at threat from disturbance by humans, habitat modification or toxic pollution. Organochlorines are synthetic compounds that are commonly used in insecticides and enter the marine ecosystem through soil erosion and agricultural run-off. While usually only found at very low concentrations in seawater, they can accumulate up the food chain to toxic levels (EA 2002). Organochlorines are soluble in fat and heavy doses may be passed to offspring through mother's milk. Concentrations of organochlorines and other toxic contaminants such as heavy metals have been found in marine mammals throughout the world, including sperm whales off Tasmania, and in dolphins off South Australia (Correll *et al*. 2004, Evans *et al*. 2004). It is thought that organochlorines and other toxins may have deleterious effects on the immune, endocrine and nervous systems of cetaceans, and that such effects may contribute to mass mortality events and strandings.

Climate change
The long-term effects of global warming on marine species are still speculative, however it is predicted that there will be reduced productivity of Southern Ocean ecosystems and unpredictable weather events caused by increasing ocean temperatures, changing ocean currents, rising sea levels and reductions in sea ice (DEH 2005). The *Recovery Plan for Australia's Threatened Whales* indicates that humpacks, southern right, blue, fin and sei whales may be affected by habitat loss and reduction in food availability. Whale migration, feeding and calving site selection may be influenced by ocean currents and

water temperature and changes to these factors could affect cetacean populations by rendering current habitat unsuitable (DEH 2005). Similarly, changes to climate and oceanographic processes may lead to reduced productivity and different patterns of prey distribution and availability (DEH 2005). Changes in krill biomass in particular could result in significant reductions in food for baleen whales.

Cetacean strandings adjacent to the Region

The relationship between stranding events and human activities is not well understood. Possible natural causes of whale strandings include disease, injury, ocean currents and topographical features of the coastline. Pollution, ship strikes and anthropogenic marine noise have also been suggested as contributing to strandings (for example, Engel *et al*. 2004, Laist *et al*. 2001).

Since 1984 there have been 21 mass strandings of whales and dolphins along the coast of Western Australia. The majority of these have taken place in the State's south-west, in particular along a stretch of coastline between Busselton and Augusta.

Along the coast of South Australia, the most common animals to strand are bottlenose and common dolphins. Other species of cetacean that have multiple stranding records are strap-toothed beaked whale, sperm whale, minke whale, long-finned pilot whale and pygmy sperm whales.

The South Australian Museum and associates are carrying out long-term studies on the carcasses of dead cetaceans from South Australia with about 10 animals collected from the Great Australian Bight region each year. These studies are important for the conservation of cetaceans as they provide vital details on cetacean life history, distribution, taxonomy, pathology, toxic contaminant loads and incidence of entanglement and intentional killing.

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Map data

Figure D6.1 Important areas for southern right, humpback and blue whales in the South-west Marine Region

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Projection: Geographics, Datum: GDA94
Produced by the Environmental Resources Information Network (ERIN) Australian Government Department of the Environment, Water, Heritage and the Arts.

Acronyms and Abbreviations

Use of acronyms and abbreviations has been kept to a minimum. All acronyms and abbreviations have been defined in the text, with the exception of the shortened forms for States and Territories, which are as follows:

NT Northern Territory

NSW New South Wales

Qld Queensland

SA South Australia

Tas. Tasmania

Vic. Victoria

WA Western Australia

Glossary

abyssal plain

The flat, relatively featureless bottom of the deep ocean at a depth greater than 2000 m. The average depth of the abyssal floor is about 4000 m.

aggregating behaviour

The concentration of fish for unknown reasons or direct causes such as the concentration of food organisms, or for spawning.

anti-cyclonic

Rotation about a vertical axis that is clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere.

assemblage

A collection of plants and/or animals characteristically associated with a particular environment, that can be used as an indicator of the health of that environment.

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 tanks to maintain stability when a ship is lightly loaded. It is normally discharged to the sea when the ship is loaded with cargo.

bathymetry

The measurement of ocean depths to determine the sea floor topography.

benthic

Refers to all marine organisms living upon or in the bottom of the sea.

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.

biogeographic

Relating to large regions with distinct fauna and flora.

biological or ecological productivity

The ability of an ecosystem to produce, grow or yield products – whether trees, fish or other organisms.

biomass

The quantity of organic matter within an ecosystem (usually expressed as dry weight for unit area or volume).

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.

biota

All of the organisms at a particular locality.

bryozoans

Marine animals commonly known as moss animals, sea mats or (for some forms) lace coral. The majority of living bryozoans are encrusting, forming flat sheets that spread out over the substrate but others grow upwards into the water column.

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.

cetaceans

Members of the mammalian group Cetacea, including whales, dolphins and porpoises.

conservation dependent (see also: threatened species)

The definition of a conservation dependent 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 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.

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

A class of arthropods that have gills and bodies covered by a hard shell (including crabs, lobsters and shrimps).

decapods

Order of crustacea comprising lobsters, crabs and shrimps. Decapods have a fused cephalothorax covered by a chitinous carapace, and five pairs of legs.

demersal

Living on or near the bottom of the sea.

detritus

Any loose, unconsolidated debris that is either finely divided rock or the finely divided remains of animal or plant tissue, or both.

downwelling

A downward current of surface water in the ocean.

echinoderms

Exclusively marine coelomate 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.

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-making;

(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.

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.

epifauna

Animals living attached to rocky reefs or on the seafloor. They include hydroids, sea-pens, small bryozoans and sponges (compare to infauna).

Exclusive Economic Zone

The sovereign waters of a nation, recognised internationally under the United Nations Convention on the Law of the Sea as extending out 200 nautical miles from shore.

fauna

The entire group of animals found in an area.

flora

The entire group of plants found in an area.

genera

The plural of genus, the scientific grouping of plants and animals immediately above the species level. When combined with species this provides a unique identifier of a type of plant or animal in scientific nomenclature.

geomorphology

The study of landforms and the processes which shape them.

geo-oceanographic

Concerning the nature of the earth beneath the oceans, topography, structure, and geological processes of the ocean floor.

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.

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 composed of vertebrae (including insects, worms, snails, mussels, prawns and cuttlefish).

isobath

A mapping line connecting points of equal depth below the sea's surface.

krill

Shrimp-like marine euphausiid crustaceans, dense swarms of which occur in ocean waters. They feed on diatoms 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.

La Niña

Warming of the western equatorial Pacific warm pool, north of New Guinea, accompanied by cooling in the equatorial eastern Pacific Ocean. La Niña is often associated with above average rainfall in eastern Australia.

macro-algae

The algae are a major group of plants without a vascular or 'vein' system, living in fresh or marine water. Macro-algae are the large, visible algae, such as kelps, as opposed to micro-algae, the microscopic algae that form phytoplankton.

macrophytes

Large water plants.

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 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 (sea-snakes);

(b) all species in the Family Laticaudidae (sea-snakes);

(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* (dugong);

(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 the Commonwealth marine area.

meso-scale

Of intermediate size (e.g. hundreds of kilometres).

migratory species (listed)

A migratory species included in the list referred to in Section 209 of the EPBC Act. Under the EPBC 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".

myctophids

Lanternfish: large family of marine, mainly deep-water, fish, which have a slender and compressed body, a single dorsal and adipose fin, and a distinct anal fin. The mouth and eyes are large. Generally small fish, they are probably the most abundant deep-sea fish, occurring in schools at depths exceeding 500 m during the day, but sometimes found near the surface at night.

pelagic

Associated with the surface or middle depths of the water column, e.g. fish swimming freely in the open sea.

phytoplankton

Small plants, mostly microscopic, which are suspended in water and free-drifting.

planktivorous

Organisms that eat plankton.

propagules

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 EPBC Act).

province

A large-scale biogeographic unit derived from evolutionary processes in which suites of endemic species co-exist.

prospective

Referring to the likelihood of finding commercial mineral deposits.

recruitment

The influx of new members into a population by reproduction or immigration.

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.

spawning

A reproductive strategy where eggs and sperm are released into water.

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.

substrate

A surface on which organisms live.

sub-tropical

Relating to or occurring in a region intermediate between tropical and temperate.

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 degrees latitude in both hemispheres.

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.

trophic level

The position an organism occupies in a food chain. Levels include primary producers, herbivores, primary, secondary and tertiary carnivores, and decomposers.

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

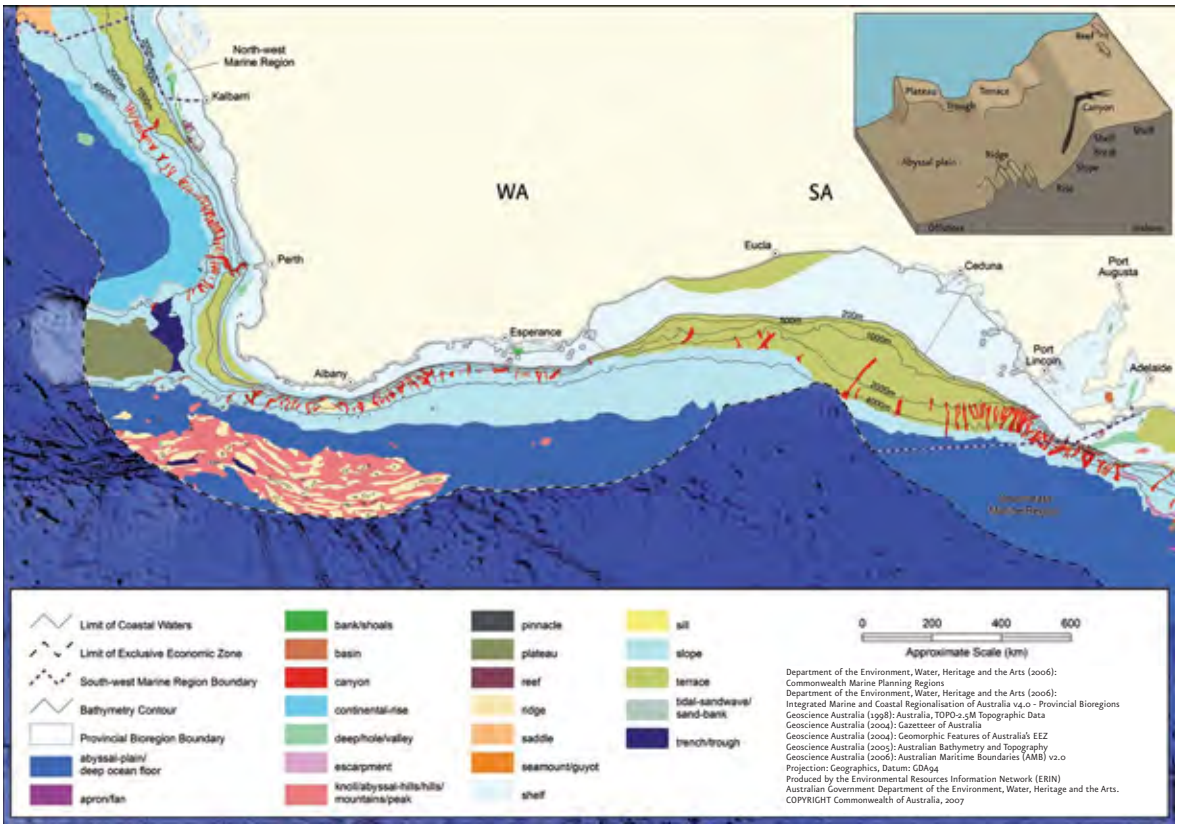
(b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

zooplankton

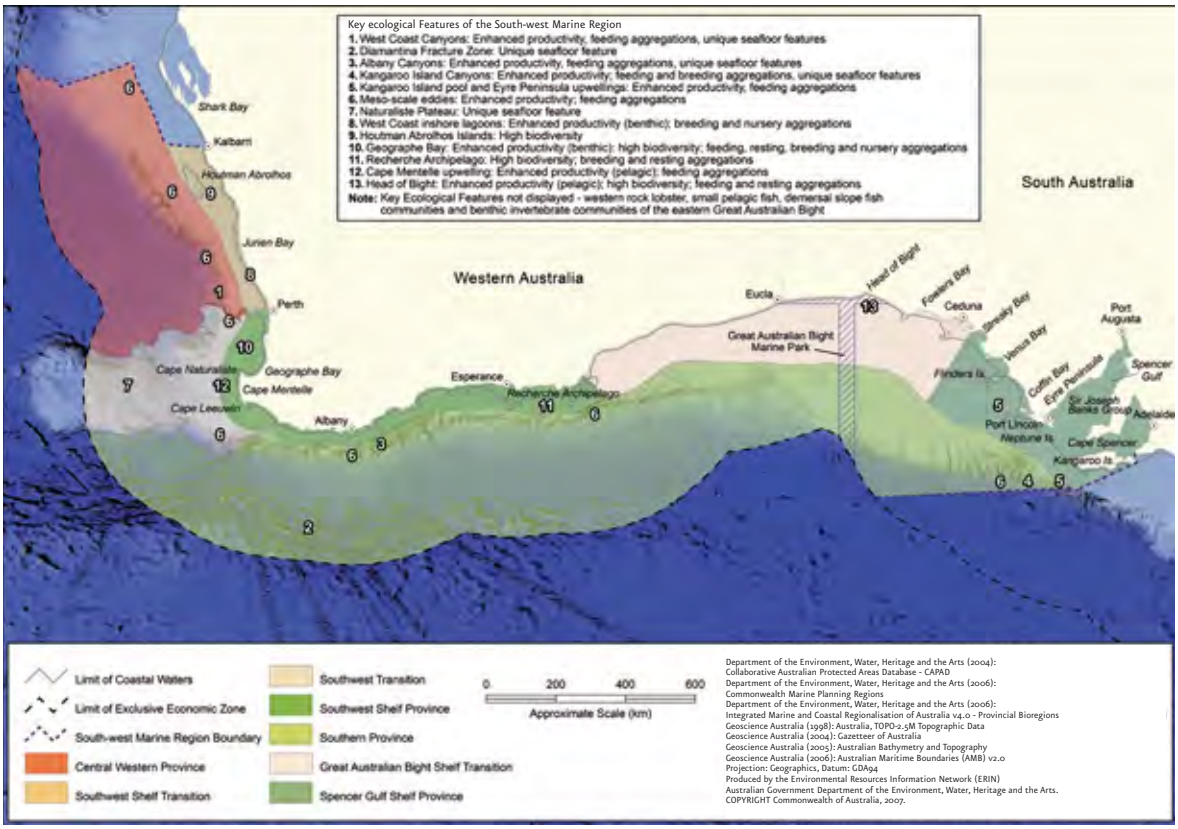
Animal component of the plankton community.

Maps

Geomorphic (seafloor) features of the South-west Marine Region



Key ecological features of the South-west Marine Region



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