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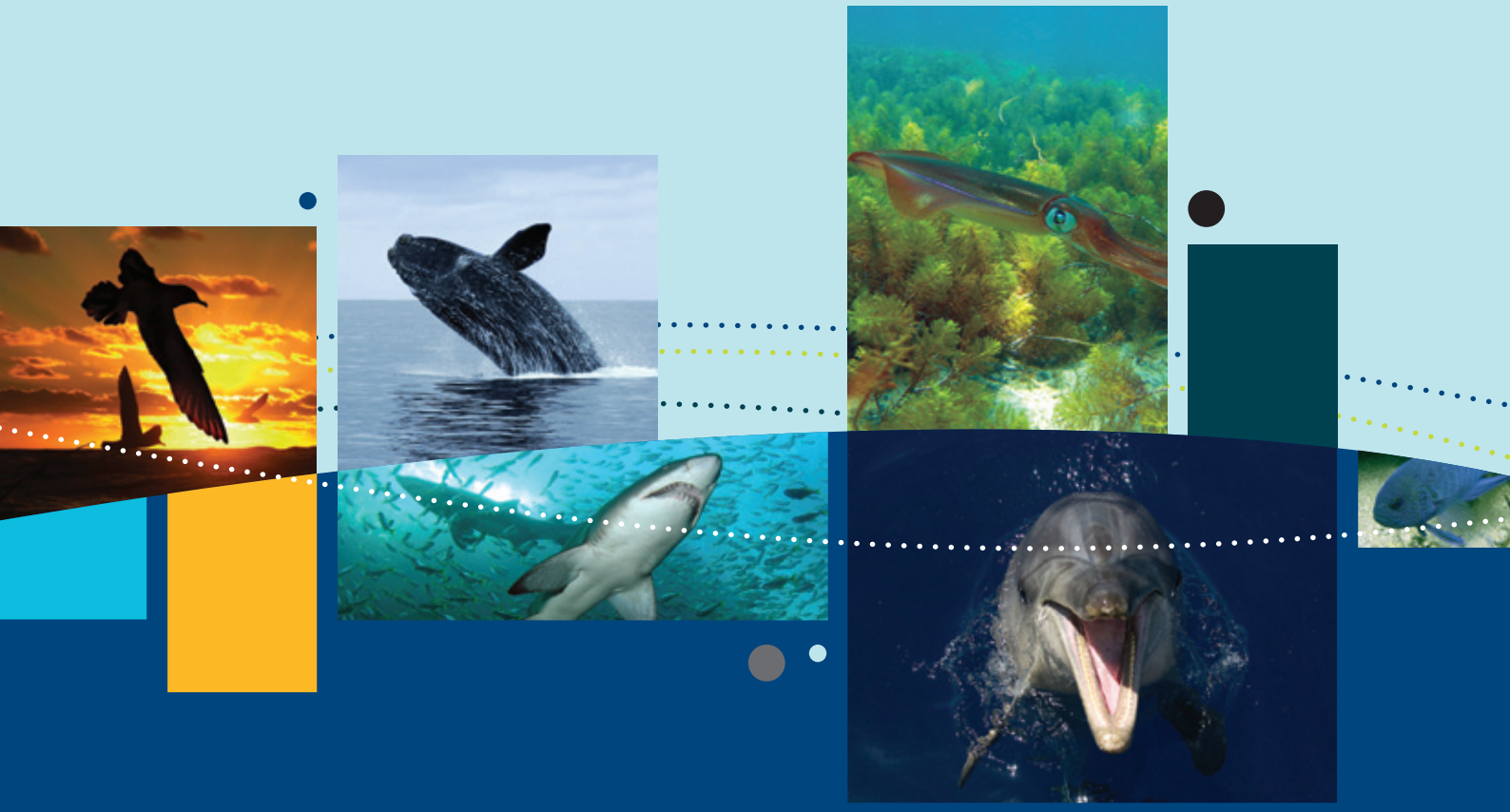

Marine bioregional plan for the South-west Marine Region

prepared under the *Environment Protection and Biodiversity Conservation Act 1999*

Images:
Flesh footed shearwater – Richard Freeman, Southern right whale – Dave Watts, Grey nurse shark – David Harasti, Southern calamari squid – Anthony King, Dolphin – Richard Freeman, Southern blue devil – MLSSA/Antony King, Marine life – CSIRO, Capes seagrass – Marine Futures WA, Blue whale – DSEWPAC, Australian Sea Lion – Glen Cowan, Tern common – Richard Freeman

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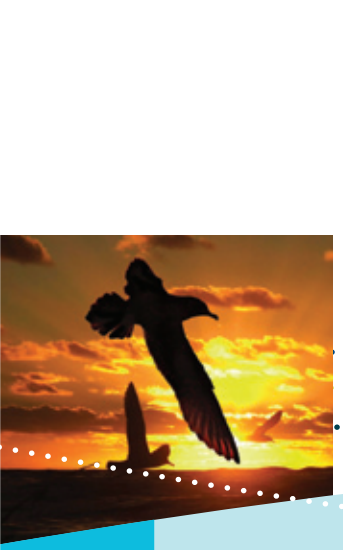

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MINISTERIAL FOREWORD

South-west Marine Bioregional Plan

For generations, Australians have enjoyed a unique relationship with the sea. Our oceans play a massive role in Australian life – they provide us with fish to eat, a place to fish, business and tourism opportunities and a place for families to enjoy.

Australians know, better than anyone, how important it is that our oceans remain healthy and sustainable.

Right now, our iconic marine environment is coming under more and more pressure from industry, from pollution and, increasingly, from climate change.

That is why the Australian Government has committed to creating a network of Commonwealth marine reserves around the country. We will protect our precious ecosystems in our oceans as we have done on land with our national parks.

The South-west Marine Region extends from the eastern end of Kangaroo Island in South Australia to Shark Bay in Western Australia. The vast waters of the South-west Marine Region are renowned for some of the most diverse temperate marine ecosystems on earth.

The area is of global significance as a breeding and feeding ground for a number of protected marine species such as southern right whales, blue whales and the Australian sea lion.

Features in the South-west Marine Region include the Perth Canyon – an underwater area bigger than the Grand Canyon and the Diamantina Fracture Zone – a large underwater mountain chain which includes Australia's deepest water.

These plans have been developed under the *Environment Protection and Biodiversity Conservation Act 1999* and backed by the best available science.

During the statutory consultation period, submissions were received from a wide range of stakeholders in the South-west Marine Region. The comments and information provided by communities and industries have informed the finalisation of the plan.

Our oceans contain a diversity of species and ecosystems which deserve protection. In this South-west Marine Bioregional Plan, you will find information about this extraordinary array of marine life and ecosystems.

Tony Burke
Minister for the Environment

CONTENTS

1 THE SOUTH-WEST MARINE BIOREGIONAL PLAN

1.1 Introduction to Marine Bioregional Planning

Australia has one of the largest marine jurisdictions of any nation in the world. Australian waters cover 14.7 million square kilometres, including waters around the external territories of Cocos (Keeling), Christmas, Heard, McDonald and Norfolk Islands as well as waters adjacent to Australia's Antarctic Territory. Within that area, Commonwealth waters surrounding the Australian continent and Tasmania cover 7.4 million square kilometres. The biodiversity of Australia's vast marine jurisdiction has been recognised as globally significant. Australia's oceans provide a home to a diverse array of marine species including marine mammals and reptiles, more than 4,000 species of fish and tens of thousands of species of invertebrates, plants and micro-organisms. Many of Australia's marine species are endemic, and therefore occur nowhere else in the world. Others utilise Australian waters as part of their global migrations.

As well as being home to an amazing diversity of marine environments, Australia's oceans support a range of marine industries, providing a significant contribution to the national economy. These industries include commercial fishing and aquaculture, petroleum and mineral exploration and production, shipping, ports, recreational and charter fishing, and tourism.

With 80 per cent of Australia's population living in the coastal zone, the marine environment has important social and cultural values, including recreational opportunities, amenity, cultural heritage, conservation and scientific significance. Many Aboriginal and Torres Strait Islander peoples have a close, long-standing relationship with coastal and marine environments and continue to rely on these environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies.

Marine bioregional planning is about improving the way Australia's marine environment is managed and helping our oceans remain healthy and productive. Marine bioregional plans have been prepared under section 176 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the South-west, North-west, North and Temperate East marine regions in Commonwealth waters around Australia (Figure 1.1) and relate to a number of matters of national environmental significance (Box 1.1).

A draft marine bioregional plan was released for the South-west Marine Region in May 2011 for a 90 day statutory consultation period. This final plan has been informed by comments received from a range of stakeholders including Government agencies, industry, recreational and conservation organisations and members of the public. The Australian Government will work with stakeholders to achieve the objectives of the plan.

The preparation of marine bioregional plans represents an important step towards a genuine “ecosystem approach” (Box 1.2) to biodiversity conservation and marine resource management. The plans provide a basis for the recognition and valuation of the many essential and largely irreplaceable ecosystem services provided by the Australian marine environment, including food production, recycling of nutrients and waste, climate stabilisation and recreation.

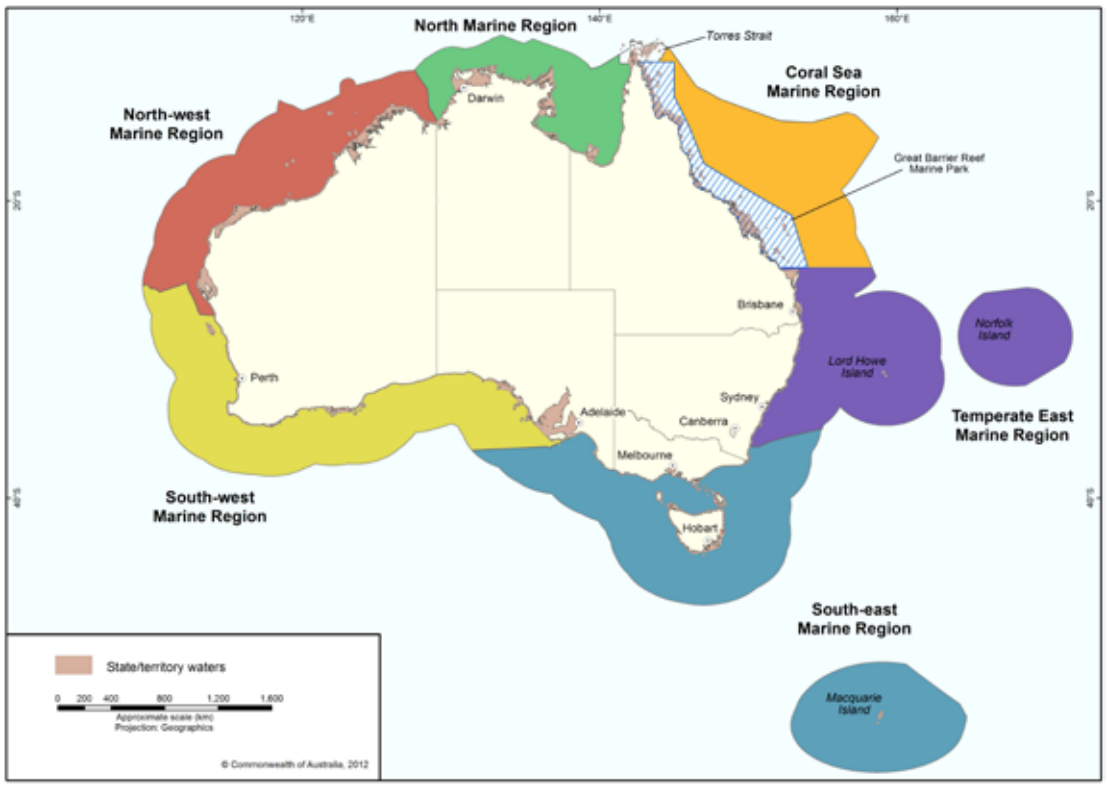


Figure 1.1: Australia’s Marine Regions

Box 1.1 Matters of national environmental significance

Under the EPBC Act actions that have or are likely to have a significant impact on matters of national environmental significance require approval by the environment minister. There are currently eight matters of national environmental significance protected under the EPBC Act:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species (except those listed as extinct or conservation dependent) and ecological communities (except those listed as vulnerable)
- migratory species protected under international agreements
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- nuclear actions, including uranium mines.

Box 1.2 The ecosystem approach

What is it?

The ecosystem approach is one of the most important principles of sustainable environmental management. Essentially, it recognises that all elements of an ecosystem are interconnected and requires that the effects of actions on the different elements of an ecosystem be taken into consideration in decision-making.

Why do we do it?

Ecosystems are complex and interconnected—what affects one species or habitat will have cascading and possibly unpredictable implications for other species or habitats. In addition, different activities within a marine environment may affect different parts of the interconnected whole or amplify the impacts on particular parts of the natural system.

We wish to prevent problems rather than react to them. This is why we want to address the drivers of biodiversity loss, rather than their symptoms. A focus on building and maintaining the resilience of ecosystems is more efficient and effective than trying to address problems after they have occurred.

1.2 Goal and objectives of the plan

The South-west Marine Bioregional Plan aims to strengthen the operation of the EPBC Act in the region to help ensure that the marine environment remains healthy and resilient. The plan will be used by government and industry to improve the way the marine environment is managed and protected.

Consistent with the objectives of the EPBC Act, and in the context of the principles for ecologically sustainable development as defined in the Act, the plan sets the following objectives for the region:

- conserving biodiversity and maintaining ecosystem health
- ensuring the recovery and protection of threatened species
- improving understanding of the region's biodiversity and ecosystems and the pressures they face.

The marine bioregional plan will contribute to these objectives by:

- supporting strategic, consistent and informed decision-making under Commonwealth environment legislation in relation to Commonwealth marine areas
- supporting efficient administration of the EPBC Act to promote the conservation and ecologically sustainable use of the marine environment and its resources
- providing a framework for strategic intervention and investment by government to meet its policy objectives and statutory responsibilities.

The South-west Marine Bioregional Plan describes the marine environment and conservation values of the region, identifies and characterises the pressures affecting these conservation values, identifies regional priorities and outlines strategies to address them, and provides advice to decision-makers and people planning to undertake activities in the South-west Marine Region in relation to some of the region's conservation values.

1.3 Application of the plan

This plan is for the South-west Marine Region, which covers the Commonwealth marine area (Box 1.3) extending from the eastern end of Kangaroo Island in South Australia to the waters off Shark Bay in Western Australia (Figure 1.2). The plan does not cover state or territory waters but, where relevant, does include information about inshore environments and the way they interact with species and habitats of the Commonwealth marine area.

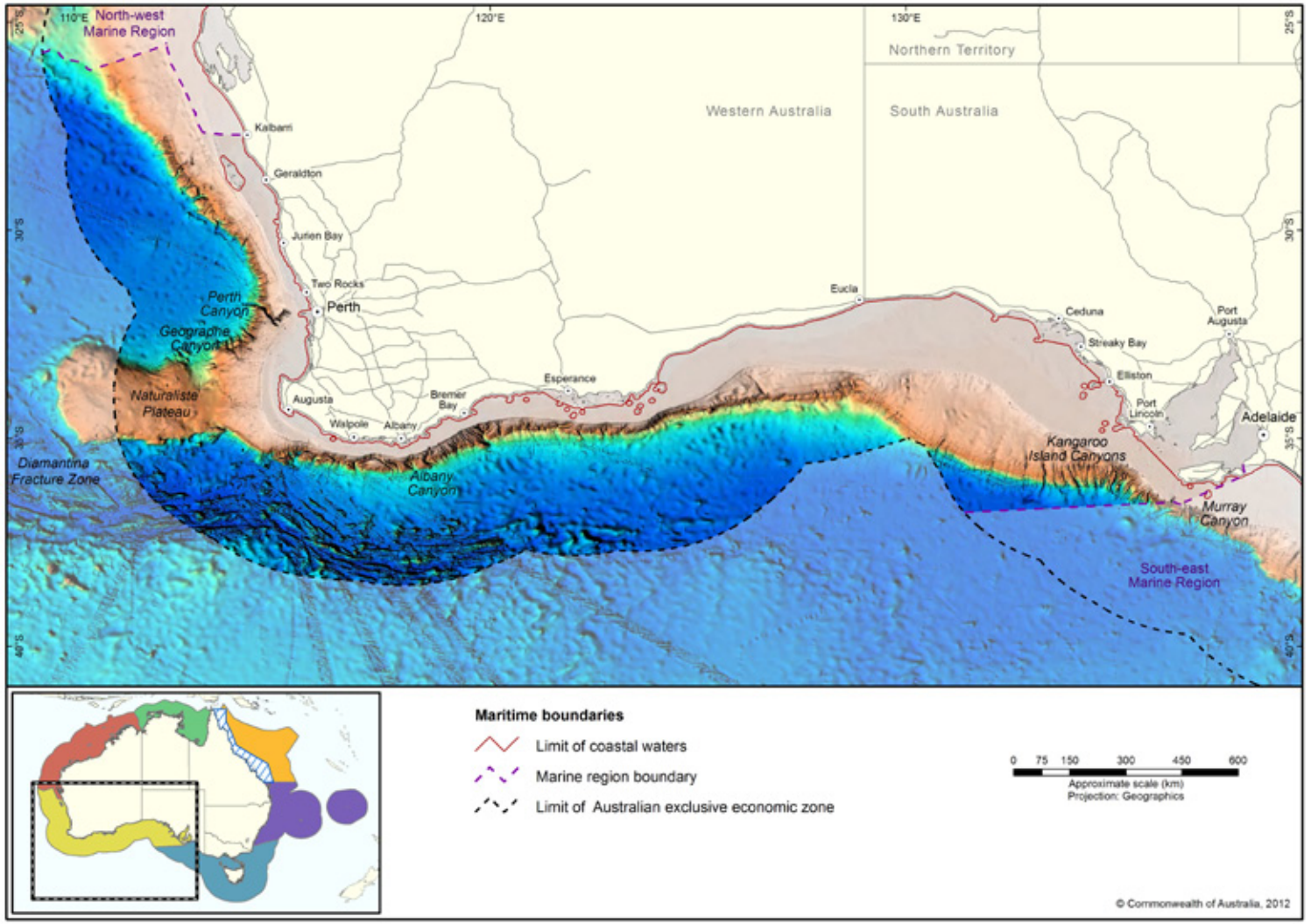


Figure 1.2: The South-west Marine Region

Under section 176 of the EPBC Act, once a bioregional plan has been made, the minister responsible for the environment must have regard to it when making any decision under the Act to which this plan is relevant. The plan does not alter the scope of the minister's statutory responsibilities or narrow the matters the minister is required to take into account or may wish to take into account in making decisions. The EPBC Act provides that this plan is not a legislative instrument. This plan will commence six weeks after it is approved by the minister.

Box 1.3 Commonwealth marine areas

The Australian Government is responsible for the Commonwealth marine area (also known as Commonwealth waters) as defined in section 24 of the EPBC Act (glossary **www.environment.gov.au/marineplans**). The Commonwealth marine area extends beyond the outer edge of state/territory waters, generally some 3 nautical miles (or 5.5 kilometres) from the coast, to the boundary of Australia's exclusive economic zone, generally around 200 nautical miles (or 370 kilometres) from shore (Figure 1.3). In this plan, the Commonwealth marine environment refers to the environment in a Commonwealth marine area.

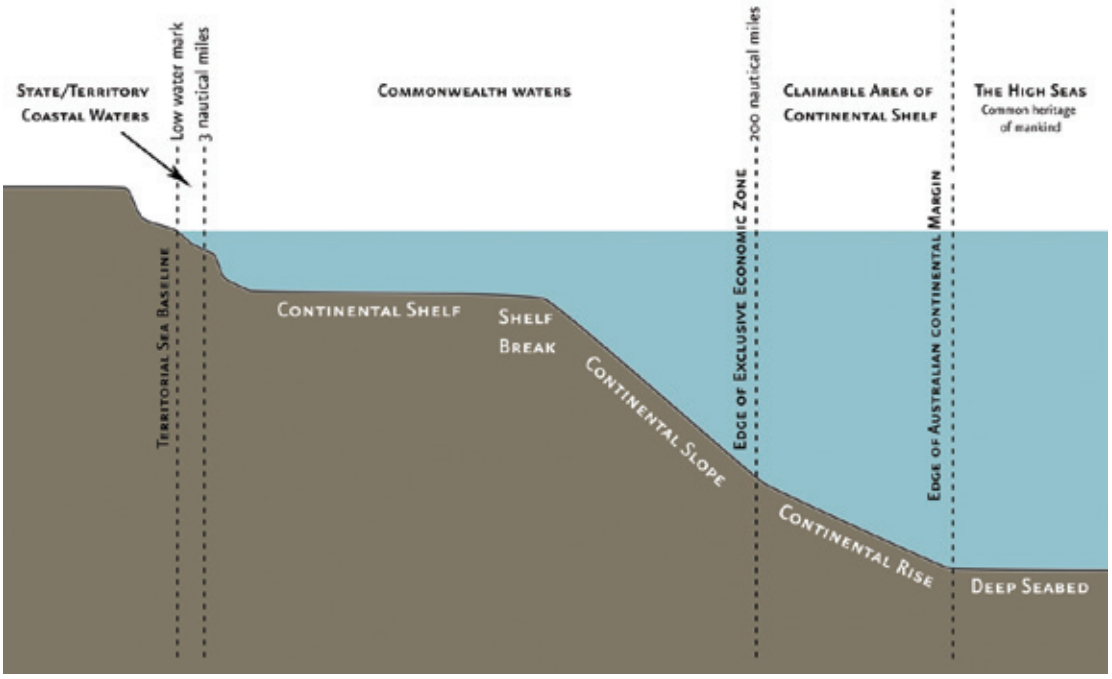


Figure 1.3: Australia's maritime zones

1.4 Key elements of the plan and supporting information

There were five key steps in the development of this marine bioregional plan.

1. Characterisation of the marine region

Currently available scientific and other information were used to describe the bio-physical environment and socio-economic characteristics of the marine region and its conservation values, including key ecological features, protected places and species and species groups protected by the EPBC Act. This information was combined in a Bioregional Profile for the region.

2. Regional analysis of the conservation values

The pressures potentially affecting conservation values were identified and characterised against a scale *of concern* in relation to their impacts on the values. The regional pressure analysis was informed by peer reviewed scientific literature and its findings subject to external review by experts in the relevant fields. The outcomes of the regional pressure analysis are described in Schedule 1 and informed both the identification of regional priorities (Part 4) and regional advice on matters of national environmental significance (Schedule 2).

3. Development of regional priorities

The regional pressure analysis assisted in the identification of conservation values that were, or potentially were, adversely affected by multiple pressures, as well as pressures that were impacting on multiple conservation values. Where warranted by the level *of concern*, these conservation values or pressures have been identified as regional priorities and consideration given to the strategies required to address them (Part 4).

4. Development of regional advice

The regional pressure analysis has also informed the development of regional advice in relation to matters of national environmental significance. This advice has been developed to assist people planning to undertake activities in Commonwealth marine areas to better understand and comply with their obligations under the EPBC Act, including helping them to decide whether to refer their proposed activity and determine what information would most usefully accompany any referral.

5. Public consultation on the draft marine bioregional plan

This marine bioregional plan was released in draft form for a 90 day public consultation period. The comments received have been taken into account in finalising this plan.

The plan is made up of a number of parts and is supported by a suite of information resources.

The plan

Part 1 (this part) of the plan provides context about marine bioregional plans. Part 2 of the plan describes the conservation values of the South-west Marine Region. Part 3 presents a summary of the analysis of pressures affecting conservation values in the region undertaken to inform the development of regional priorities. Part 4 introduces the regional priorities for the region and outlines strategies and actions to address them.

Schedules

Schedule 1 of the plan presents a full description of the pressures on the conservation values of the South-west Marine Region that have been assessed as being *of concern* or *of potential concern*. Schedule 2 provides specific advice on matters of national environmental significance in the region. This regional advice will assist people who plan to undertake activities in, or potentially impacting on, the Commonwealth marine environment to better understand and meet their obligations under the EPBC Act. It will also assist in deciding whether a proposed action should be referred to the minister for assessment, and identify any information that is likely to be important as part of the referral.

Glossary

A glossary of terms used in this plan and relevant to marine bioregional planning is located at **www.environment.gov.au/marineplans**.

Conservation values report cards

The conservation values report cards contain comprehensive information about the conservation values of the South-west Marine Region. Conservation values include species and places protected under the EPBC Act and key ecological features. There are three types of conservation values report cards:

- protected species groups
- Commonwealth marine environment (including key ecological features)
- protected places.

The report cards support the information provided in this plan and are available at **www.environment.gov.au/marineplans/south-west**. They include:

- a description of the conservation values of the region
- an overview of the vulnerabilities and pressures on the conservation values (*of concern* and *of potential concern*)
- a list of relevant protection measures
- references.

Conservation Values Atlas

The Department of Sustainability, Environment, Water, Population and Communities, as the Australian Government department responsible for administering the EPBC Act, maintains a suite of interactive tools that allow users to search, find and generate reports on information and data describing matters of national environmental significance and other conservation values in the marine environment.

The Conservation Values Atlas is designed to provide a visual representation of the conservation values in each marine region. It shows the location and spatial extent of conservation values (where sufficient information exists) and is available at **www.environment.gov.au/cva**.

Other resources

A number of important reference documents for the South-west Marine Region are available at **www.environment.gov.au/marineplans/south-west**.

1.5 Who will use the plan?

People who have responsibility for, or interest in, management of marine-based activities, environment protection and marine science

The South-west Marine Bioregional Plan is an important document for individuals and organisations with an interest in the region and the way national environmental law is administered within Commonwealth waters. The plan provides information that enables people to better understand the Australian Government's marine environment protection and biodiversity conservation responsibilities, objectives and priorities in the region.

People planning to undertake activities in Commonwealth waters, or planning to undertake activities that are likely to have a significant impact on the Commonwealth marine environment

The plan is not a legislative instrument and therefore does not alter the EPBC Act referrals process. People planning to undertake activities within the South-west Marine Region can use the plan and supporting information to help decide whether their proposal should be referred in accordance with the EPBC Act.

The minister and department administering the EPBC Act

The minister must have regard to the South-west Marine Bioregional Plan in making any decision under the EPBC Act to which the plan is relevant.

Other government agencies

The requirement to have regard to the South-west Marine Bioregional Plan in making decisions applies only to the Commonwealth minister administering the EPBC Act. However, the plan provides comprehensive information about the region that assists government decision-making relevant to the Commonwealth marine environment. The plan is underpinned by an ecosystem approach (Box 1.2). This approach requires government decision-makers to consider issues across jurisdictional, sectoral and disciplinary boundaries, so that actions are not considered in isolation from one another. The information provided in the plan assists decision-makers in the Australian Government and other jurisdictions to collaborate more effectively across jurisdictional and sectoral boundaries.

2 THE SOUTH-WEST MARINE REGION AND ITS CONSERVATION VALUES

The South-west Marine Region comprises Commonwealth waters from the eastern end of Kangaroo Island in South Australia to Shark Bay in Western Australia (Figure 1.2). The region spans approximately 1.3 million square kilometres of temperate and subtropical waters and abuts the coastal waters of South Australia and Western Australia.

The main physical features of the region are:

- a narrow continental shelf on the west coast from the subtropics to temperate waters off south-west Western Australia
- a wide continental shelf dominated by sandy carbonate sediments of marine origin (i.e. crushed shells from snails and other small animals and calcareous algae) in the Great Australian Bight
- high wave energy on the continental shelf around the whole region
- a steep, muddy continental slope which include many canyons; the most significant being the Perth Canyon, the Albany canyon group and the canyons in the vicinity of Kangaroo Island
- large tracts of poorly understood abyssal plains at depths greater than 4000 m
- the Diamantina Fracture Zone, a rugged area of steep mountains and troughs off south-west Australia at depths greater than 4000 m
- the Naturaliste Plateau, an extension of Australia's continental mass that provides deep-water habitat at depths of 2000–5000 m
- islands and reefs in both subtropical (Houtman Abrolhos Islands) and temperate waters (e.g. Recherche Archipelago)
- complex and unusual oceanographic patterns, driven largely by the Leeuwin Current and its associated currents, that have a significant influence on biodiversity distribution and abundance.

The remainder of this chapter describes the conservation values of the region, including the Commonwealth marine environment and its protected species and places.

2.1 Identification of conservation values

A range of conservation values have been identified in the South-west Marine Region. Conservation values are defined as those elements of the region that are:

- key ecological features of the Commonwealth marine area
- species listed under Part 13 of the EPBC Act that live in the Commonwealth marine area or for which the Commonwealth marine area is necessary for a part of the life cycle.
- protected places including marine reserves, heritage places and historic shipwrecks in the Commonwealth marine area.

2.2 Conservation values—the Commonwealth marine environment

Biodiversity

By global standards, the marine environment of the South-west Marine Region has high biodiversity and large numbers of species native to the region (known as endemism). Particular hotspots for biodiversity are the Houtman Abrolhos Islands, the overlap between tropical and temperate fauna along the west coast, the Recherche Archipelago and the soft sediment ecosystems in the Great Australian Bight.

Several factors combine to contribute to the high level of biodiversity and endemism in the region. These include a long and stable period of geological isolation, a persistent high-energy environment, warm-water intrusion via the Leeuwin Current and areas where cold, nutrient-rich, deep ocean waters rise to the surface in the east of the region. The low-nutrient environment of the South-west Marine Region results in clear waters and high levels of light penetration, giving rise to a continental shelf characterised by high diversity of seagrass and algal species and benthic communities. These, in turn, provide habitats for a large variety of species and function as nurseries for a range of fish and invertebrates, which move further offshore in their adult stages.

The region is increasingly recognised as an area of global conservation significance for species of rare and endangered marine mammals and seabirds. The endangered southern right whale migrates through the region to important calving areas in coastal waters of South Australia and Western Australia. The region is also critical for Australia's only endemic pinniped, the vulnerable Australian sea lion, as its range is virtually constrained to the South-west Marine Region. The region is also known to be particularly important for six species of seabird – the Australian lesser noddy, common noddy, flesh-footed shearwater, wedgetailed shearwater, bridled tern, and roseate tern. All of these species have substantial proportions of their Australian nesting population breeding in areas immediately adjacent to the region

and are known to feed in the waters of the region. The south-west corner of the region is also an important area for beaked whales. Other protected species known to occur in the region include white shark, humpback whale and several species of albatross.

The biological productivity of the South-west Marine Region is low by global standards and in comparison with other Australian marine regions because of the low-nutrient tropical waters carried south by the Leeuwin Current and its effect in suppressing upwelling of nutrients from deeper cold waters and the absence of significant rivers contributing nutrients into the marine environment through run-off. Small seasonal upwellings occur regularly at known locations and, because of the overall nutrient-poor nature of the region's waters, these hotspots of productivity have a disproportionate influence on the region's ecosystems, which is the reason that they are identified as key ecological features (see below). The main areas of relatively higher seasonal productivity in the region are the Perth Canyon, Albany canyon group, Kangaroo Island canyons and pool, Cape Mentelle and eddy fields that spin off the Leeuwin Current along the west and south coasts of Western Australia.

The most significant known influence on ecosystem structure and function in the South-west Marine Region is the Leeuwin Current. The current originates in the warm, low-saline waters of the Indonesian archipelago, and brings warm waters south along the west coast of Australia before rounding capes Leeuwin and Mentelle and flowing east across the south coast. The current is stronger in winter than in summer and has three main influences on the south-west region:

- suppressing upwelling and therefore contributing to the low productivity of the region, and consequently the relatively small fisheries on the west coast
- maintaining warm-water communities much further south than they would normally occur—for example, corals and coral reef fish as far south as Rottnest Island
- driving inter annual variability in settlement of western rock lobster, which is a significant component of benthic communities on the west coast and a valuable fishery species.

Associated with the Leeuwin Current are fields of eddies that form at predictable locations in the region. These eddies can be either upwelling or downwelling; upwelling eddies enhance local biological productivity where they form, and downwelling eddies concentrate and transport communities away from the coast.

Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment in the South-west Marine Region that, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity.

The criteria used to identify KEFs in the region are:

- a species, group of species or community with a regionally important ecological role, where there is specific knowledge about why the species or species group is important to the ecology of the region, and the spatial and temporal occurrence of the species or species group is known
- a species, group of species or community that is nationally or regionally important for biodiversity, where there is specific knowledge about why the species or species group is regionally or nationally important for biodiversity, and the spatial and temporal occurrence of the species or species group is known
- an area or habitat that is nationally or regionally important for
  - enhanced or high biological productivity
  - aggregations of marine life
  - biodiversity and endemism
- unique seafloor feature with ecological properties of regional significance.

KEFs were first described in the bioregional profile for each region and have since been modified as a result of further analysis and review by scientific experts.

Sixteen key ecological features have been identified in the South-west Marine Region (Figure 2.1 and Table 2.1). Further information on the KEFs can be found in the Commonwealth marine environment report card: **www.environment.gov.au/marineplans/south-west**. Understanding of KEFs may evolve as new scientific information emerges.

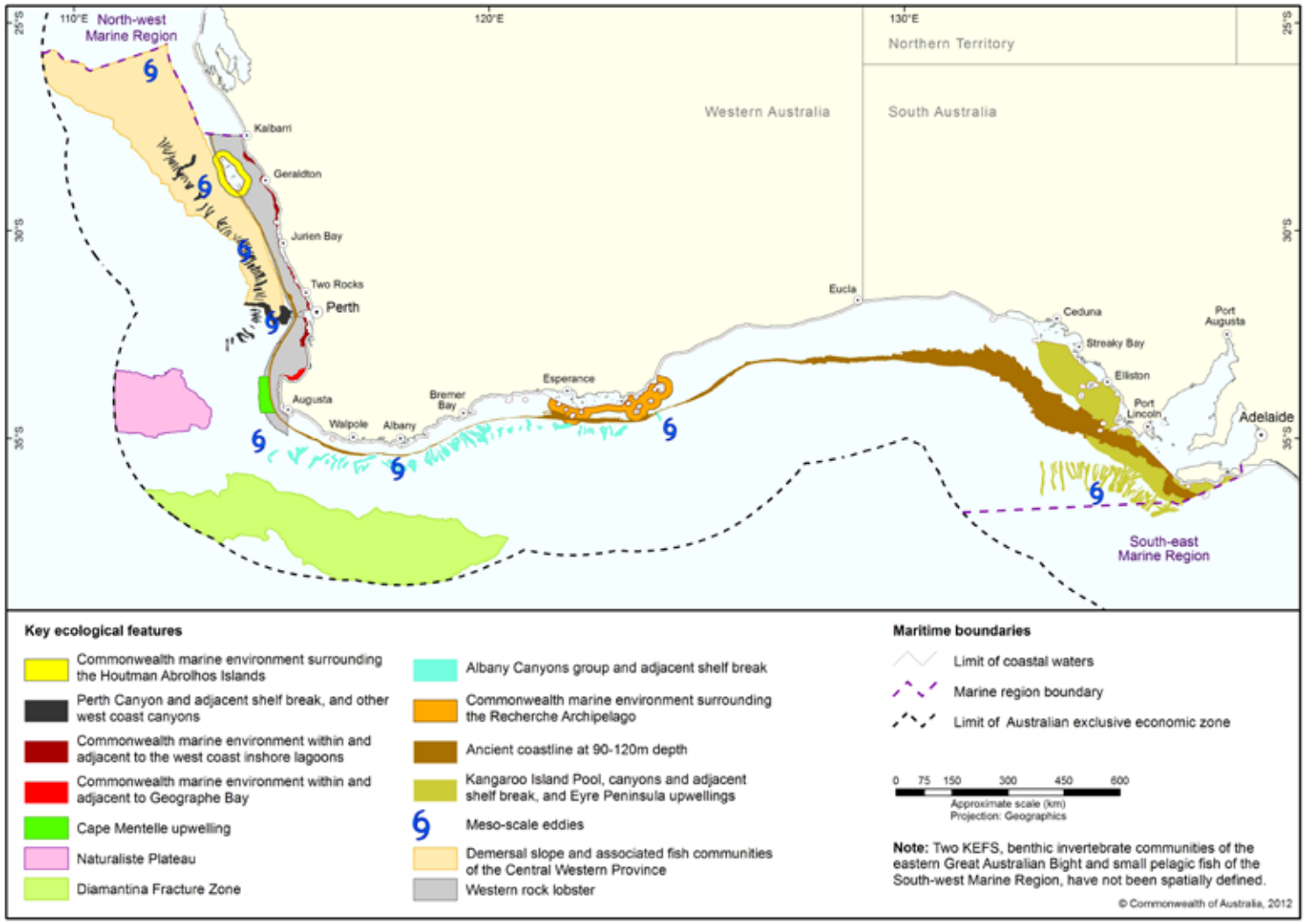


Figure 2.1: Key ecological features in the South-west Marine Region

Table 2.1: Key ecological features of the South-west Marine Region

Feature	Values	Description
Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break)	High levels of biodiversity and endemism	The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean. They support more than one million pairs of breeding seabirds.
Perth Canyon and adjacent shelf break, and other west-coast canyons	High biological productivity and aggregations of marine life, and unique seafloor features with ecological properties of regional significance	The Perth Canyon is the largest known undersea canyon in Australian waters. Deep ocean currents rise to the surface, creating 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.
Commonwealth marine environment within and adjacent to the west-coast inshore lagoons	High productivity and aggregations of marine life	These lagoons are important for benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fishery species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.
Commonwealth marine environment within and adjacent to Geographe Bay	High productivity and aggregations of marine life, and high levels of biodiversity and endemism	Geographe Bay is known for its extensive beds of tropical and temperate seagrass that support a diversity of species, many of them not found anywhere else. The bay provides important nursery habitat for many species. It is also an important migratory area for humpback whales.

Feature	Values	Description
Cape Mentelle upwelling	High productivity and aggregations of marine life	The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks.
Naturaliste Plateau	Unique seafloor feature with ecological properties of regional significance	The Naturaliste Plateau is Australia's deepest temperate marginal plateau. The combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism.
Diamantina Fracture Zone	Unique seafloor feature with ecological properties of regional significance	The Diamantina Fracture Zone is a rugged, deep-water environment of seamounts and numerous closely spaced troughs and ridges. Very little is known about the ecology of this remote, deep-water feature, but marine experts suggest that its size and physical complexity mean that it is likely to support deep-water communities characterised by high species diversity, with many species found nowhere else.
Albany canyon group and adjacent shelf break	High productivity and aggregations of marine life, and unique seafloor feature with ecological properties of regional significance	The Albany canyon group is thought to be associated with small, periodic subsurface upwelling events, which may drive localised regions of high productivity. The canyons are known to be a feeding area for sperm whale and sites of orange roughy aggregations. Anecdotal evidence also indicates that this area supports fish aggregations that attract large predatory fish and sharks.
The Commonwealth marine environment surrounding the Recherche Archipelago	Aggregations of marine life and high levels of biodiversity and endemism	The Recherche Archipelago is the most extensive area of reef in the South-west Marine Region. 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 macroalgae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals.

Feature	Values	Description
Ancient coastline between 90 and 120 m depth	Relatively high productivity and aggregations of marine life, and high levels of biodiversity and endemism	Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment, such as in the western Great Australian Bight, where the sea floor is dominated by sponge communities of significant biodiversity and structural complexity.
Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings	High productivity and aggregations of marine life, and the canyons and adjacent shelf break are unique seafloor features with ecological properties of regional significance	The Kangaroo Island canyons are known for their seasonal upwellings of deep ocean waters that support aggregations of krill, small pelagic fish and squid, which, in turn, attract marine mammals (e.g. pygmy blue whales, sperm whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds.
Meso-scale eddies (several locations)	High productivity and aggregations of marine life	Driven by interactions between currents and bathymetry, persistent meso-scale eddies form in predictable locations within the meanders of the Leeuwin Current. They are important transporters of nutrients and plankton communities and are likely to attract a range of organisms from the higher trophic levels, such as marine mammals, seabirds, tuna and billfish. The eddies play a critical role in determining species distribution, as they influence the southerly range boundaries of tropical and subtropical species, the transport of coastal phytoplankton communities offshore and recruitment to fisheries.

Feature	Values	Description
Demersal slope and associated fish communities of the Central Western Province	Species groups that are nationally or regionally important to biodiversity	The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits.
Western rock lobster	A species that plays a regionally important ecological role	This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles.
Benthic invertebrate communities of the eastern Great Australian Bight	A species group or community that is nationally or regionally important to biodiversity	The benthic invertebrate communities found on the shelf of the Great Australian Bight, particularly sponges, ascidians and bryozoans, have been described as among the world's most diverse soft-sediment ecosystems.
Small pelagic fish	A species group that has a regionally important ecological role	This species group is considered important for ecological functioning and integrity, providing critical links between primary production and higher predators. Collectively, they are an important prey item for a diverse range of species, including tuna, whales, dolphins, seals, sea lions and numerous seabirds.

2.3 Conservation values—protected species

The South-west Marine Region is an important area for protected species. Species listed under the EPBC Act are commonly referred to as protected species and can be listed as threatened species (critically endangered, endangered, vulnerable, conservation dependent), migratory species, cetaceans and marine species (see glossary for a full definition). An individual species may be listed under more than one category.

Threatened species are, in broad terms, those species that have been identified as being in danger of becoming extinct. Species may be listed in the following categories:

- conservation dependent
- vulnerable
- endangered
- critically endangered
- extinct in the wild
- extinct.

(see the glossary for further explanation of these categories **www.environment.gov.au/marineplans/south-west**).

Migratory species are those species that are listed under:

- the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS or Bonn Convention)
- the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA)
- the *Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment 1986* (CAMBA)
- the *Agreement between the Government of Australia and the Government of the Republic Of Korea on the Protection of Migratory Birds 2007* (ROKAMBA)
- any other international agreement, or instrument made under other international agreements approved by the environment minister.

Further information on the CMS, JAMBA, CAMBA and ROKAMBA is provided at **www.environment.gov.au/biodiversity/migratory/index.html**

Cetaceans (whales, dolphins and porpoises) are all protected under the EPBC Act in the Australian Whale Sanctuary and, to some extent, beyond its outer limits.

Marine species belong to taxa that the Australian Government has recognised as requiring protection to ensure their long-term conservation (in accordance with sections 248–250 of the EPBC Act). (Refer to Table A in Schedule 2 for listed marine species in the region).

The list of protected species established under the EPBC Act is updated periodically. This plan refers to lists of protected species in the region, current at May 2012. Species groups identified as conservation values in the South-west Marine Region are:

- bony fishes
- cetaceans
- pinnipeds
- marine reptiles
- seabirds
- sharks.

Report cards describe the protected species (as of May 2012) and include detailed information about species distribution and ecology in the South-west Marine Region.

Biologically important areas have been identified for some of the region's protected species. These are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour such as breeding, foraging, resting or migration. They have been identified using expert scientific knowledge about species' distribution, abundance and behaviour in the region. The presence of the observed behavior is assumed to indicate that the habitat required for the behaviour is also present. The selection of species for which biologically important areas have been identified was informed by the availability of scientific information, the conservation status of listed species and the importance of the region for the species. The range of species for which biologically important areas are identified will continue to expand as reliable spatial and scientific information becomes available.

The process for identifying biologically important areas involves mapping proposed areas digitally, based on expert advice and published literature, then obtaining independent scientific review of the maps and descriptions of the proposed areas.

Biologically important area maps and descriptions are available in the South-west Marine Region Conservation Values Atlas (**www.environment.gov.au/marineplans/cva**).

2.4 Conservation values—protected places

Protected places are those places protected under the EPBC Act as matters of national environmental significance—places listed as World Heritage, National Heritage, or wetlands of international importance. Protected places may also include Commonwealth marine reserves and places deemed to have heritage value in the Commonwealth marine environment such as places on the Commonwealth heritage list or shipwrecks under the *Historic Shipwrecks Act 1976*.

Protected places in the region are shown in Figure 2.2 and described in Table 2.2.

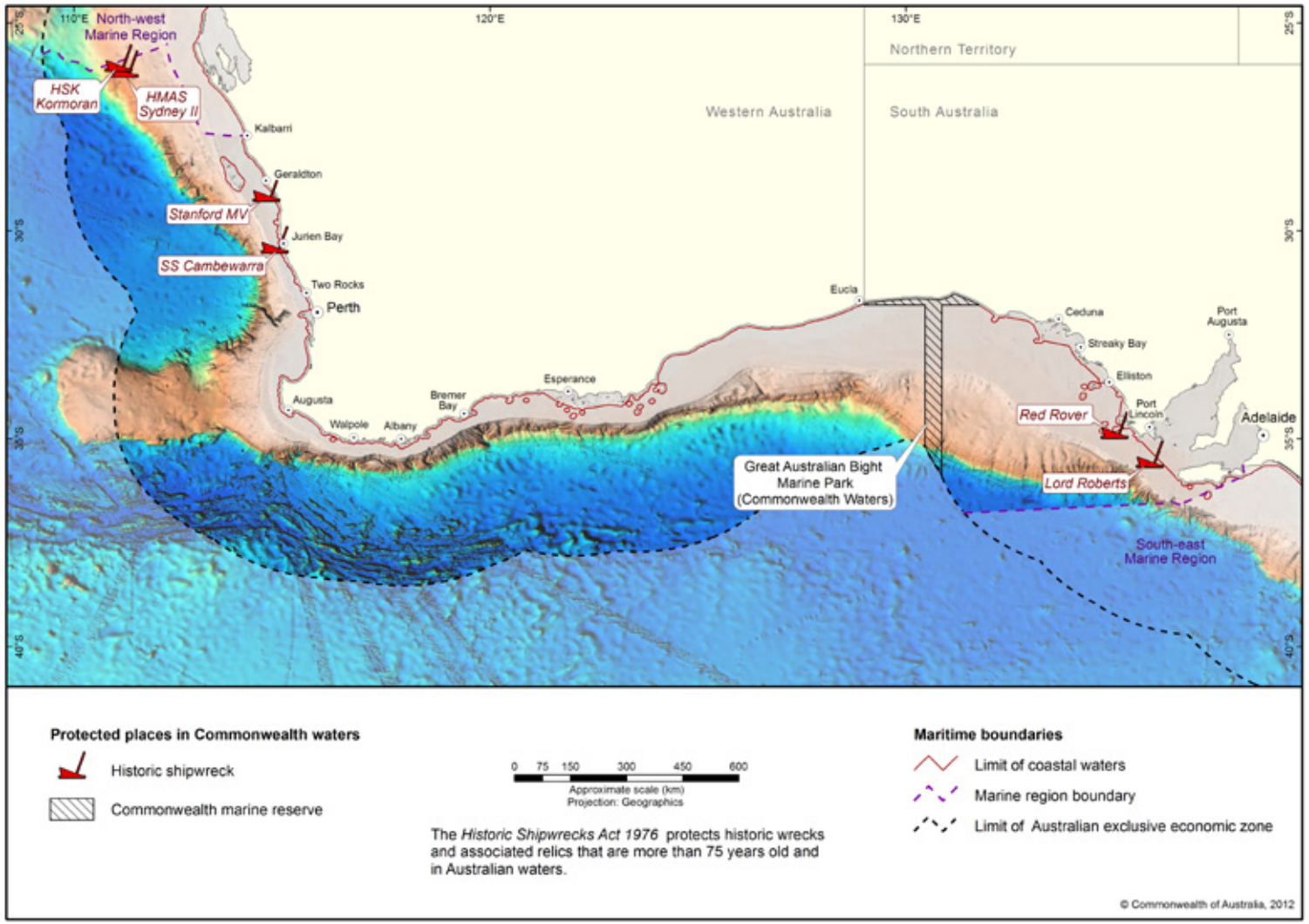


Figure 2.2: Protected places in the South-west Marine Region as of May 2012

Table 2.2: Protected places in the South-west Marine Region as of May 2012

Protected place	Protection measure
Great Australian Bight Marine Park	Commonwealth marine reserve
HMAS Sydney II	National Heritage List Commonwealth Heritage List Historic Shipwreck
HSK Kormoran	National Heritage List Commonwealth Heritage List Historic Shipwreck
Lord Roberts	Historic Shipwreck
MV Stanford	Historic Shipwreck
Red Rover	Historic Shipwreck
SS Cambewarra	Historic Shipwreck

Commonwealth marine reserves are relevant in EPBC Act decision making on referred matters and explicitly referenced in the *EPBC Act Policy statement 1.1 Significant Impact Guidelines*.

3 PRESSURES AFFECTING CONSERVATION VALUES

3.1 Analysis of pressures on conservation values

The pressure analysis assessed present and emerging pressures affecting conservation values in the South-west Marine Region and the effectiveness of mitigation and management arrangements that are currently in place to address these pressures. The analysis enabled pressures to be categorised in terms of their relative importance or concern, and has informed the identification of regional conservation priorities and the development of regional advice. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values.

The analysis considered pressures affecting all key ecological features and protected places and a number of species belonging to the species groups: cetaceans; pinnipeds; seabirds; marine reptiles; bony fishes; and sharks. Considerations used for selecting the species for analysis were specific to the biological characteristics of the species groups, but broadly centred on the relative significance of the region to the conservation of the particular species. In assessing the significance of the region for a species' conservation, key considerations included the species' conservation status, distribution, population structure within the region and life history characteristics, and the potential for the population(s) in the region to be genetically distinct from populations elsewhere. Table 3.1 lists and provides an explanation of the species selected for inclusion in the pressure analysis for the South-west Marine Region.

A range of pressures from a range of sources was considered in the pressure analysis. Table S1.1 in Schedule 1 provides a list of the type and source of pressures available for inclusion in the analysis. Not every type and source of pressure in this list was assessed against every conservation value. Only those pressures relevant to the conservation value being analysed were considered.

The analysis included a review of scientific and expert literature, and was informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion. The pressure analysis considered, for each selected conservation value, information derived from available reports and research about:

- the spatial location and intensity of the pressure(s), both current and anticipated
- the location of the conservation value—that is, its distribution and the location of areas important to it
- current understanding of impacts (at relevant scales) resulting from the interaction between the pressure(s) and the conservation value
- the effectiveness of current management and impact mitigation measures.

Table 3.1: Protected species selected for the pressure analysis

Species group	Group-specific criteria for selection	Species selected for detailed pressure analysis
Bony fishes	Species protected under the EPBC Act known to occur in the Commonwealth marine environment	**Günther's pipehorse** **Orange roughy** **Southern bluefin tuna**
Cetaceans	Species that have important feeding, breeding or migratory areas within the region	**Blue whale** **Humpback whale** **Southern right whale** **Sperm whale**
Marine reptiles	Species that have presumed feeding areas within the region (no nesting areas are known to exist in the South-west Marine Region)	**Green turtle** **Leatherback turtle** **Loggerhead turtle**
Pinnipeds	Species that have important feeding, breeding or haul-out areas within the region	**Australian sea lion** **New Zealand fur seal**

Species group	Group-specific criteria for selection	Species selected for detailed pressure analysis
Seabirds	Species that breed only in the region, species with a high proportion of the Australian population breeding in the region and species that have identified biologically important areas in the region	**Indian yellow-nosed albatross** **Great-winged petrel** **Soft-plumaged petrel** **White-faced storm petrel** **Flesh-footed shearwater** **Little shearwater** **Short-tailed shearwater** **Wedge-tailed shearwater** **Bridled tern** **Caspian tern** **Fairy tern** **Roseate tern** **Sooty tern** **Australian lesser noddy** **Common (brown) noddy** **Pacific gull** **Little penguin** **Black-faced cormorant**
Sharks	Species protected under the EPBC Act that have, or are presumed to have, important feeding, breeding or nursery areas within the region	**Grey nurse shark** **Longfin mako** **Shortfin mako** **Porbeagle shark** **School shark** **White shark**

3.2 Outcome of pressure analysis

Human pressures on marine ecosystems and biodiversity in the South-west Marine Region are, by global standards, low. This is partly due to the relatively low levels of marine resource use and coastal population pressure across the region (exceptions being in proximity to the large urban centres), and partly due to Australia's generally sound management of the marine environment.

A number of sources of pressures nevertheless exist in the region, which is next to one of the fastest growing economies in Australia. The main drivers and sources of pressure on conservation values in the South-west Marine Region are:

- climate change and associated large-scale effects, including shifts in major currents, rising sea levels, ocean acidification, and changes in the variability and extremes of climatic features (e.g. sea temperature, winds, and storm frequency and intensity)
- harvesting of living resources
- fast urban and industrial development in areas adjacent to the region
- increases in shipping and port activities
- growth in marine industries and infrastructure
- defence training activities within the Western Australian training exercise area off Perth
- emergence of offshore renewable energy industries.

The findings of the pressure analysis are presented in Schedule 1 of the plan and in the South-west Marine Region conservation values report cards (**www.environment.gov.au/marineplans/south-west**).

4 REGIONAL PRIORITIES, STRATEGIES AND ACTIONS

4.1 Regional priorities

Regional priorities are key areas of focus that have been identified to inform decision-making about marine conservation and planning, as well as industry development and other human activities. The regional priorities provide context for implementing the government's statutory responsibilities, such as recovery planning for threatened species and the development and implementation of threat abatement measures. They also point to where future government initiatives and future investments in marine conservation, including in research and monitoring, would be best directed.

The identification of regional priorities for the South-west Marine Region has been guided by the outcomes of the pressure analysis. In identifying regional priorities, consideration has been given to the following:

- conservation values that are subject to
  - a pressure considered *of concern* for the conservation value, and
  - pressures that together are likely to result in cumulative impacts on the value, and/or
  - pressure(s) that are likely to increase substantially in intensity and extent over the next 5–10 years
- pressures that are considered *of concern* for multiple conservation values
- areas where better knowledge would improve the government's capacity to meet conservation and ecologically sustainable use objectives
- Australian Government policy priorities for the marine region.

Only a subset of conservation values and pressures assessed as being *of concern* or *of potential concern* have been identified as regional priorities. Generally, when a pressure affects multiple values and its effects are *of concern* for at least some of these values, then the pressure is identified as a regional priority. Similarly, if a conservation value is, or is likely to be, affected detrimentally by multiple pressures, and at least one of the pressures has been assessed as *of concern*, it is considered to be a regional priority. Other key considerations in determining pressure-based regional priorities included issues of scale, legislative responsibility, conservation status, effectiveness of existing management arrangements, and level of uncertainty about distribution, abundance and status of conservation values and the pressures acting on them.

South-west Marine Region priorities

This plan identifies 23 regional priorities: 18 conservation values and 5 pressures, which are further discussed in Table 4.1 and 4.2 respectively. The strategies and actions to address these priorities are detailed in Section 4.2.

Building on the identification of regional priorities, available information and existing administrative guidelines, this plan provides advice to assist decision-makers, marine industries and other users to understand and meet the obligations that exist with respect to these priorities under the EPBC Act (see Schedule 2).

Table 4.1: Conservation values of regional priority for the South-west Marine Region

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
1	**Blue whale** (EPBC Act listed as endangered, migratory and cetacean)	Aggregates to feed in two important areas (Perth Canyon and Eastern Great Australian Bight Upwelling / Kangaroo Island canyons) High degree of uncertainty about population levels, structure and recovery rates. In the South-west Marine Region, the pressures assessed as *of potential concern* for blue whales are changes in sea temperature, changes in oceanography, ocean acidification, marine debris, noise pollution, oil pollution and collisions with vessels. The conservation status of blue whales, the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Action 2, 3 Strategy B, Action 1 Strategy D, Action 3, 8 Strategy G, Action 1
2	**Southern right whale** (EPBC Act listed as endangered, migratory and cetacean)	Uses sites in coastal waters adjacent to the region seasonally for calving. It is thought that the species is recovering due to observed recolonisation of historic calving sites; however, uncertainty about population levels, population structure and recovery rates remain high. In the South-west Marine Region, the pressures assessed as *of potential concern* for southern right whales are changes in oceanography, ocean acidification, marine debris, noise pollution, physical habitat modification, oil pollution, collisions with vessels and collision/entanglement with infrastructure. The conservation status of southern right whales, the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Action 2, 3 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Action 3, 8 Strategy E, Action 3 Strategy G, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
3	**Humpback whale** (EPBC Act listed as vulnerable, migratory and cetacean)	Migrates through the region. In the South-west Marine Region, the pressures assessed as *of potential concern* for humpback whales are changes in oceanography, ocean acidification, marine debris, noise pollution, bycatch and oil pollution. Some pressures, such as interaction with fishing gear and associated bycatch mortality, are expected to increase as the species recovers. The conservation status of humpback whales, the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation.	Strategy A, Action 3 Strategy B, Action 1 Strategy D, Action 3, 8 Strategy G, Action 1
4	**Australian sea lion** (EPBC Act listed as vulnerable and marine)	Is almost exclusively confined to the region. Species has biological characteristics that are unique among pinnipeds and marine mammals. There is documented lack of recovery and population decline for some breeding colonies. In the South-west Marine Region, the pressures assessed as *of concern* for Australian sea lions are changes in sea temperature, marine debris and bycatch. The pressures assessed as *of potential concern* for Australian sea lions are sea level rise, changes in oceanography, ocean acidification, noise pollution, human presence at sensitive sites, extraction of living resources, oil pollution and collision/ entanglement with infrastructure. The conservation status of Australian sea lions, the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation.	Strategy A, Action 2, 3 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Action 1, 4, 7, 8 Strategy E, Action 1, 2

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
5	**Australian lesser noddy** (EPBC Act listed as vulnerable and marine)	Has a restricted distributional range and is dependent on one type of habitat (mangrove forests) for nesting, and the Australian breeding population at the Houtman Abrolhos Islands is of global significance. In the South-west Marine Region, the pressures assessed as *of concern* for Australian lesser noddys are sea level rise, changes in sea temperature and changes in oceanography. The pressures assessed as *of potential concern* are ocean acidification, chemical pollution/contaminants, light pollution, physical habitat modification, nuisance species, extraction of living resources and oil pollution. The conservation status of Australian lesser noddys, its restricted range and the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation.	Strategy A, Action 2, 3 Strategy B, Action 1 Strategy C, Action 3
6	**Flesh-footed shearwater, short-tailed shearwater, roseate tern, common noddy and bridled tern** (EPBC Act listed as migratory and marine)	Nests adjacent to the region for a significant proportion of their Australian population, so the region is significant to their conservation. In the South-west Marine Region, the pressures assessed as *of concern* (for some species) are sea level rise, changes in sea temperature and changes in oceanography. For some of these species, changes in distribution and/or prey availability have been recorded from the region and have been attributed to climate change. *Of potential concern* (for some species) are ocean acidification, chemical pollution/ contaminants, marine debris, light pollution, nuisance species, extraction of living resources, bycatch, oil pollution and disease. The significance of the South-west Marine Region to the ecology of the species, and the increasing pressures facing them in the region make the species group a priority for conservation.	Strategy A, Action 3 Strategy B, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
7	**Little penguin** (EPBC Act listed as marine)	Range in Australian waters is about half within the region. The population breeding in the Perth region is the largest in Western Australia (around 700 pairs) and geographically isolated from the south coast populations. Highly dependent on small pelagic fish as a food source. In the South-west Marine Region, the pressures assessed as *of concern* are sea level rise, changes in sea temperature, and changes in oceanography. *Of potential concern* are ocean acidification, chemical pollution/contaminants, marine debris, physical habitat modification, extraction of living resources, oil pollution, collisions with vessels and disease. The restricted range in the region, its remoteness from the rest of the Australian population and the multiple increasing pressures affecting the species in the region make the species a regional priority for conservation.	Strategy A, Action 3 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Action 8
8	**Sooty tern and little shearwater** (EPBC Act listed as marine)	Important nesting populations of sooty tern (72 per cent of the Australian population) and little shearwater (58 per cent of the Australian population) are supported by biologically important feeding areas in the region. With the exception of colonies at Norfolk and Lord Howe Islands, little shearwater occur only in the South-west Marine Region, and this population is considered a subspecies (tunneyi). In the South-west Marine Region, the pressures assessed as *of concern* are sea level rise, changes in sea temperature and changes in oceanography. *Of potential concern* are ocean acidification, light pollution (little shearwater), extraction of living resources (sooty tern) and oil pollution. The significance of the region to their ecology and their potential vulnerability to climate change and its effects make the species' a regional priority for conservation.	Strategy A, Action 3 Strategy B, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
9	**White shark** (EPBC Act listed as vulnerable and migratory)	Important foraging areas and areas that white shark appears to occur with high frequency are in the region. There is a high level of uncertainty about the species' population numbers, structure and recovery. In the South-west Marine Region, the pressure assessed as *of concern* is bycatch. *Of potential concern* are changes in sea temperature, change in oceanography, ocean acidification, marine debris and collision/entanglement with infrastructure. Any wholesale shift in the productivity and trophic regimes of the region's ecosystem in response to climate change has the potential to significantly affect large top predators, such as sharks. The conservation status of white shark, the significance of the South-west Marine Region to their recovery and the pressures facing them in the region make the species a priority for conservation.	Strategy A, Action 2, 3, 7 Strategy B, Action 1 Strategy C, Action 1 Strategy D, Action 1, 4 Strategy G, Action 1
10	**School shark** (EPBC Act listed as conservation dependent)	Location and extent of biologically important areas are uncertain in the region. In the South-west Marine Region, the pressure assessed as *of concern* is bycatch. *Of potential concern* are sea level rise, changes in sea temperature, changes in oceanography, ocean acidification, marine debris and physical habitat modification. As for other shark species, any wholesale shift in the productivity and trophic regimes of the region's ecosystem in response to climate change has the potential to significantly affect large top predators. The population decline, the significance of the region and the pressures facing them in the region make the species a priority for conservation.	Strategy A, Action 3 Strategy B, Action 1 Strategy C, Action 1 Strategy D, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
11	**Commonwealth marine environment surrounding the Houtman Abrolhos Islands** (Key ecological feature)	Supports high and unique biodiversity. Provides important habitat for a range of species, including threatened species. In the South-west Marine Region, the pressures assessed as *of concern* are sea level rise, changes in sea temperature and changes in oceanography. In particular, climate-related effects on species distribution and reproductive success and the region's productivity and trophic processes are *of concern*. *Of potential concern* are ocean acidification, chemical pollution/contaminants, nutrient pollution, physical habitat modification, extraction of living resources, bycatch and oil pollution. Pressures are either not well understood or expected to increase. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy C, Action 3 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
12	**Perth Canyon and adjacent shelf break, and other west coast canyons** (Key ecological feature)	Supports one of the largest known feeding aggregations of endangered blue whales in Australia. Unique geomorphology gives rise to ecologically important events of localised productivity. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. Climate-related effects on species distribution and reproductive success and on the region's productivity and trophic processes are *of concern*. *Of potential concern* are ocean acidification, chemical pollution/contaminants, noise pollution, extraction of living resources, bycatch, oil pollution and collisions with vessels. Pressures are either not well understood or expected to increase. The Perth Canyon is located offshore from the largest urban centre in Western Australia, and a number of human activities take place in this area, with multiple pressures potentially resulting in cumulative effects on its biodiversity. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
13	**Commonwealth marine environment within and adjacent to the west coast inshore lagoons** (Key ecological feature)	Regionally important for enhanced benthic productivity and for aggregations of marine life. Includes ecosystems important for benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species. 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, abalone and many other reef species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. *Of potential concern* are sea level rise, ocean acidification, chemical pollution/ contaminants, nutrient pollution, changes in turbidity, physical habitat modification, extraction of living resources, bycatch, oil pollution and invasive species. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
14	**Commonwealth marine environment within and adjacent to Geographe Bay** (Key ecological feature)	Includes extensive seagrass beds, extending into relatively deep waters (up to 40–50 m in depth). Provides important habitat for a range of species, including nursery habitat for a number of commercially and economically valuable fish species. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. Climate-related effects on species distribution and reproductive success and on the region's productivity and trophic processes are *of concern*, with flow-on effects for the surrounding marine ecosystem. *Of potential concern* are sea level rise, ocean acidification, chemical pollution/ contaminants, nutrient pollution, changes in turbidity, noise pollution, physical habitat modification, extraction of living resources, oil pollution and invasive species. Pressures are expected to increase. In particular, pressures that might affect seagrass communities are *of potential concern*. One of the few areas in the south-west where agricultural run-off has the potential to affect the marine environment because of the intensity of land use and the presence of watercourses that discharge into the bay. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy C, Action 3 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
15	**Commonwealth marine environment surrounding the Recherche Archipelago** (Key ecological feature)	Supports a high level of biodiversity, including high numbers of endemic species. Provides important habitat for a range of species, including threatened species. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. In particular, climate-related effects on species distribution and reproductive success and on the region's productivity and trophic processes are *of concern*. *Of potential concern* are sea level rise, ocean acidification, chemical pollution/ contaminants, nutrient pollution, extraction of living resources, bycatch, oil pollution and invasive species. Pressures are either not well understood or expected to increase. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity and endemism. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
16	**Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings** (Key ecological feature)	Supports regionally important processes of biological productivity and is inhabited by benthic communities that are species rich by national and global standards. Provides important habitat for a range of species, including threatened species. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. Climate-related effects on species distribution and reproductive success and on the region's productivity and trophic processes are *of concern*. *Of potential concern* are ocean acidification, noise pollution, extraction of living resources, bycatch and oil pollution. Pressures are either not well understood or expected to increase. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1 Strategy F, Action 1

	Conservation values	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
17	**Western rock lobster** (Key ecological feature)	Is a top benthic predator in its adult stage, which is likely to play an important role in community structure. The species has experienced significant decline in larval settlement in recent years. Its ecological role in unexploited conditions is not fully understood, as there are no areas in the region where the species is not fished. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. *Of potential concern* are sea level rise, ocean acidification, changes in turbidity, physical habitat modification, extraction of living resources and oil pollution. Management measures have been implemented by state agencies and industry to address regional priorities and to mitigate the effects of pressures on conservation values such as Western rock lobster. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4, 5 Strategy B, Action 1
18	**Small pelagic fish** (Key ecological feature)	Thought to play an important role in the region's ecosystems. While small pelagic fish are currently underexploited in the region, the volume harvested has increased in recent years and these species are inherently vulnerable to overfishing because they occur in aggregations. In the past, small pelagic fish have experienced severe declines in the region in response to introduced pathogens. In the South-west Marine Region, the pressures assessed as *of concern* are changes in sea temperature and changes in oceanography. *Of potential concern* are ocean acidification and disease. This key ecological feature has been identified as a regional priority on the basis of its important contribution to the region's biodiversity. Its selection also acknowledges the need to prioritise research to further understand the ecological functioning of this feature.	Strategy A, Action 3, 4 Strategy B, Action 1

Table 4.2: Pressures of regional priority for the South-west Marine Region

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
19	**Climate change**	Climate change-related pressures including changes in sea temperature, ocean acidification, sea level rise are predicted to increase in the South-west Marine Region, with the potential to impact most conservation values to varying extents. Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases is listed as a key threatening process under the EPBC Act. Potential for significant and large-scale changes to marine ecosystems. Potential detrimental effects on a number of protected species through the loss and modification (e.g. increased turbidity) of coastal and inshore habitats by sea level rise. changes in sea temperature likely to affect the distributional range of species, resulting in changes to species composition of ecosystems. changes in the oceanography of the region may affect ecosystem productivity, larval dispersal, species distribution and breeding patterns. Predicted that, if concentration of atmospheric CO_2 continues to increase at the current rate, the ocean will become corrosive to the shells of many marine organisms by 2100. The response of marine organisms to increased ocean acidity is poorly understood. In the South-west, climate change is assessed as *of concern* for Australian sea lions, Australian lesser noddys, flesh-footed shearwater, short-tailed shearwater, roseate tern, common noddy, bridled tern, little penguin, sooty tern, little shearwater, wedge-tailed shearwater, caspian tern and fairy tern. It is also *of concern* for ten key ecological features of the South-west Marine Region. Climate change is assessed as *of potential concern* for all other conservation values (species) and key ecological features. Climate change has been identified as a priority because of the extent of predicted impacts on conservation values in the region, particularly the cumulative nature of these impacts.	Strategy A, Action 3 Strategy B, Action 2 Strategy C, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
20	**Marine debris**	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act. In the South-west, interactions with marine debris are assessed as *of concern* for Australian sea lions. Interactions with marine debris are assessed as *of potential concern* for 4 cetaceans, New Zealand fur seal, Indian yellow-nosed albatross, flesh-footed shearwater, wedge-tailed shearwater, little penguin, leatherback turtle, loggerhead turtle, school shark, and the white shark. Marine debris is a priority for conservation efforts in the South-west Marine Region because it is considered *of concern* or *of potential concern* for multiple conservation values, because of the vulnerability of the region to the pressure and because it is listed under the EPBC Act as a key threatening process. Marine debris has been identified as a priority because of its interaction with a range of conservation values across the region, and its status as an Australian Government policy priority.	Strategy E, Action 8
21	**Noise pollution**	Three key ecological features have been identified, as they are located in areas of high prospectivity for oil and gas resources and the use of seismic surveys is expected to increase. One of these features, the Perth Canyon, is also located in a Royal Australian Navy training area, where active sonar is used, and in front of the ports of Fremantle and Kwinana, where shipping traffic is expected to increase. Noise pollution is *of potential concern* for 4 cetaceans, Australian sea lions, green turtles, leatherback turtles, loggerhead turtles and southern bluefin tuna. It is also *of potential concern* for 5 KEFs: Perth Canyon and adjacent shelf break, and other west coast canyons, Commonwealth marine environment within and adjacent to Geographe Bay, Albany Canyon group and adjacent shelf break, Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings, and demersal slope and associated fish communities of the Central Western Province. Noise pollution has been identified as a priority because it is likely to increase substantially in intensity and extent over the next 5–10 years in the region.	Strategy A, Action 1, 6 Strategy C, Action 3 Strategy D, Action 5, 7

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
22	**Extraction of living resources**	Future increase in fishing pressure on small pelagic fishes is assessed as being *of potential concern*. The effect of this pressure on the functioning of species and ecosystems reliant on overfished species has been assessed as *of concern* or *of potential concern* due to its interactions with a number of protected species, including in relation to prey depletion. Recreational fishing in the region has variable effort with seasonal and localised peaks; a recent. report suggests that effort has reduced in some areas. Extraction of living resources is *of concern* for southern bluefin tuna. Extraction of living resources is *of potential concern* for Australian sea lions, short-tailed shearwater, wedge-tailed shearwater, roseate tern, sooty tern, Australian lesser noddy, common noddy and little penguin. It is also *of potential concern* for 9 KEFs: Commonwealth marine environment surrounding the Houtman Abrolhos Islands, Perth Canyon and adjacent shelf break, and other west coast canyons, Commonwealth marine environment within and adjacent to the west coast inshore lagoons, Commonwealth marine environment within and adjacent to Geographe Bay, Commonwealth marine environment surrounding the Recherche Archipelago, Ancient coastline between 90 and 120 m depth, Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings, Demersal slope and associated fish communities of the Central Western Province and Western rock lobster. Extraction of living resources has been identified as a priority because of its interaction with a range of conservation values across the region.	Strategy D, Action 2, 3, 4

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
23	**Bycatch**	Data on bycatch mortality is poor for many species. Some species are subject to bycatch mortality from multiple fisheries. The *Threat Abatement Plan for the Incidental Catch (or Bycatch) of Seabirds during Oceanic Longline Fishing Operations (2006)* appears to be effective in mitigating impacts on seabirds. The effectiveness of bycatch mitigation measures for other species is less clear. Bycatch is *of concern* for Australian sea lions, school sharks and white sharks. Bycatch is *of potential concern* for humpback whales, southern right whales, sperm whales, Indian yellow-nosed albatross, soft-plumaged petrels, flesh-footed shearwaters, green turtles, leatherback turtles, loggerhead turtles, Günther's pipehorse, and orange roughy. It is also *of potential concern* for 8KEFs: Commonwealth marine environment surrounding the Houtman Abrolhos Islands, Perth Canyon and adjacent shelf break, and other west coast canyons, Commonwealth marine environment within and adjacent to the west coast inshore lagoons, Cape Mentelle upwelling, Albany Canyon group and adjacent shelf break, Commonwealth marine environment surrounding the Recherche Archipelago, Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings and Demersal slope and associated fish communities of the Central Western Province. Bycatch has been identified as a priority because of its interaction with a range of conservation values across the region.	Strategy D, Action 1, 2, 3

EPBC Act = *Environment Protection and Biodiversity Act 1999*

4.2 Strategies and actions

The South-west Marine Bioregional Plan includes seven strategies to address its priorities:

Strategy A: Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision-making.

Strategy B: Establish and manage a Commonwealth marine reserve network in the South-west Marine Region as part of a national representative system of marine protected areas.

Strategy C: Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act.

Strategy D: Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species.

Strategy E: Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government and state and territory agencies with responsibilities for the marine environment.

Strategy F: Improve monitoring, evaluation and reporting on ecosystem health in the marine environment.

Strategy G: Participate in international efforts to manage conservation values and pressures of regional priority.

Within each strategy, actions have been designed to address one or more of the regional priorities. A few actions are not linked directly to regional priorities but have been included as enabling actions—that is, they provide the necessary foundation and/or mechanisms for addressing the regional priorities in a coordinated, effective and efficient way.

Actions under the strategies are classified in terms of their implementation timeframe:

- **Immediate actions** are those expected to be implemented within 6–12 months (these usually relate to priorities where the level of concern is high and management responses are either under way or expected to begin in the near future).
- **Short-term actions** are those expected to be implemented within 2 years.
- **Medium-term actions** are those expected to be implemented within 3–5 years.
- **Long-term actions** are those expected to be implemented within 8–10 years, and usually relate to research into ecological effects that involves observational studies requiring long timeframes.
- **Ongoing actions** commonly cover routine administrative decision-making under the EPBC Act (e.g. administration of the fisheries assessment provisions).

The actions identified to address the South-west Marine Region's priorities are listed under each strategy (in no particular order) below:

Strategy A:
Increase collaboration with relevant research organisations to inform and influence research priorities and to increase the uptake of research findings to inform management and administrative decision making

1. Improve existing mechanisms and establish new mechanisms to facilitate the uptake of marine research findings so that they can inform administrative and management decisions (short term).
2. Support research undertaken through relevant recovery plans for Australian sea lion, blue whale, southern right whale, white shark and Australian lesser noddy (regional priority 4—short term; regional priorities 1, 2, 5, 9—medium to long term).
3. Support research to improve information on the impacts of climate change on protected species and key ecological features; in particular, their vulnerability and adaptive capacity to predicted changes (regional priorities 1–19—medium to long term).
4. Improve knowledge of the processes driving biodiversity and ecosystem functioning of priority key ecological features of the South-west Marine Region (regional priorities 11, 12, 13, 14, 15, 16, 17, 18—medium to long term).
5. Support further research investigating the ecological role of western rock lobster, particularly in the deeper waters of the Commonwealth marine environment, through establishing suitable sites for ongoing environmental monitoring (regional priority 17—medium to long term).
6. Improve knowledge on the pressures of marine debris, noise pollution, extraction of living resources and bycatch in the South-west Marine region (regional priorities 20-23 — short to medium term).
7. Improve information on biologically important areas for protected species and species considered under pressure within the South-west Marine Region, with priority given to:
   - white shark (regional priority 9 — short to medium term)
   - school shark (regional priority 10 — short to medium term).

Strategy B:
Establish and manage a south-west Commonwealth marine reserve network in the South-west Marine Region as part of the national representative system of marine protected areas

1. Ensure that management arrangements for marine reserves contribute to the protection and conservation of the region's biodiversity and ecosystem function and integrity (regional priorities 11, 12, 13, 14, 15, 16, 17, 18—medium to long term).

2. Ensure that management arrangements for the reserves minimise, where appropriate, the risk and impacts of pressures rated as being *of concern* or *of potential concern* in the South-west Marine Region (medium to long term).

Strategy C:
Provide relevant, accessible and evidence-based information to support decision-making with respect to development proposals that come under the jurisdiction of the EPBC Act

1. Improve access to information, particularly spatial data, on the region's key ecological features and protected species and the pressures on them (short to medium term).

2. Assess the need for—and, if appropriate promote—strategic assessments under the EPBC Act of coastal and inshore marine environments adjacent to the region that are expected to experience rapid change and have the potential to increase pressure on the Commonwealth marine environment (regional priorities 2, 4, 5, 7, 11, 14—short to medium term).

3. Provide regional advice to assist in assessing and determining the significance of potential impacts on the region's conservation values to the extent that they are (or are components of) matters of national environmental significance (Schedule 2) (immediate).

4. Evaluate the role of the plan and its supporting information resources in streamlining decision making under the EPBC Act at all levels (i.e. the environment minister, the environment department, or persons proposing to take actions likely to impact on matters of national environmental significance in the South-west Marine Region) in support of a balance between conservation and sustainable development of industries (short to medium term).

Strategy D:
Increase collaboration with relevant industries to improve understanding of the impacts of anthropogenic disturbance and address the cumulative effects on the region's key ecological features and protected species

1. Collaborate with relevant fisheries management organisations and industry to support research, information exchange and the development of improved management initiatives to address bycatch of protected species— particularly school shark, white shark and Australian sea lion. Focus on improving information on the cumulative effects of bycatch across multiple fisheries and the establishment of ongoing monitoring indicators (regional priorities 4, 9, 10, 23—immediate).

2. Collaborate with relevant fisheries management organisations to support research into the impacts of the extraction of living marine resources on key ecological features and protected species, and develop improved management initiatives where appropriate (regional priorities 22—ongoing).

3. Collaborate with relevant fisheries management organisations to improve current fisheries interaction data sets for cetaceans in the region (regional priorities 1, 2, 3, 22, 23—short term).

4. Collaborate with relevant fisheries management organisations to improve information on interactions between protected species—particularly white shark and Australian sea lion—and aquaculture infrastructure, focusing on obtaining mortality rates and establishing ongoing monitoring indicators (regional priorities 4, 9, 22—medium to long term).

5. Collaborate with industry and research organisations to improve mechanisms for data collection, management and reporting of interactions between industries and biodiversity (short to medium term).

6. Pursue, where feasible, collaborative agreements authorising the shared use of industry-gathered marine information, particularly spatial data (short to medium term).

7. Collaborate with industry to improve understanding of the effects of increased noise on Australian sea lion (regional priority 4, 21—short to medium term).

8. Collaborate with relevant agencies to improve compliance in the reporting of vessel collisions with large whales and other marine fauna and seek to use the improved data sets in the development of improved mitigation measures, particularly in biologically important areas (regional priorities 1, 2, 3, 4, 7—short to long term).

Strategy E:
Develop targeted collaborative programs to coordinate species recovery and environmental protection efforts across Australian Government, state and territory agencies and coastal communities with responsibilities for the marine environment

1. Collaborate with relevant government agencies and coastal communities to implement mitigation measures to address the key pressures on Australian sea lion and assess their effectiveness in reducing the risk to the species' recovery (regional priority 4—immediate)

2. Foster research and monitoring in relation to Australian sea lion to assess and monitor population and recovery rates and increase the ability to support the species' recovery through better knowledge of ecology, genetics and population dynamics (regional priority 4—short term).

3. Collaborate with the South Australian and Western Australian governments and coastal communities to develop protection measures to limit disturbances during the southern right whale calving season, focusing on areas in proximity to inhabited areas or areas where sources of disturbance exist or are emerging (regional priority 2—short term).

4. Increase information on the sources and impacts of marine debris on the region's marine life and ecosystems, including by supporting monitoring of marine debris loads at selected locations in and adjacent to the South-west Marine Region (regional priority 20—short to medium term).

Strategy F:
Improve monitoring, evaluation and reporting on ecosystem health in the marine environment

1. Collate information on the ecosystem components, functioning, pressures and potential cumulative impacts on priority key ecological features in the region and develop effective ecological indicators that will facilitate future monitoring, evaluation and reporting of marine ecosystem health (medium to long term).

Key ecological features to be investigated are:

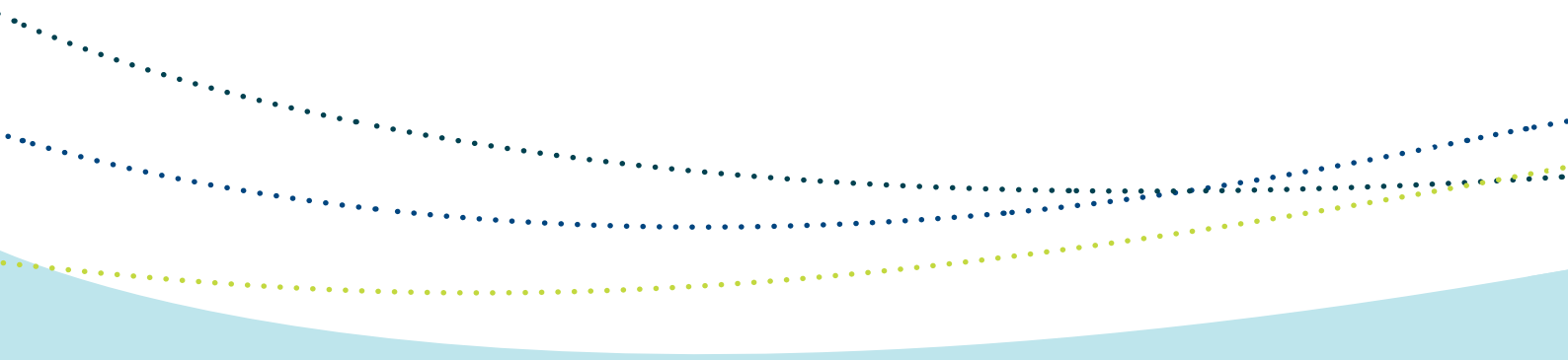
- the Commonwealth marine environment surrounding the Houtman Abrolhos Islands (regional priority 11)
- the Perth Canyon, focusing on better understanding the potential for cumulative impacts arising from multiple and concurrent pressures (regional priority 12)
- the Commonwealth marine environment within and adjacent to the west coast inshore lagoons (regional priority 13)
- the Commonwealth marine environment of Geographe Bay, focusing on understanding changes in the extent of seagrass beds in this area (regional priority 14)
- the Commonwealth marine environment surrounding the Recherche Archipelago (regional priority 15)
- the Kangaroo Island Pool, canyons and adjacent shelf break ecosystems, including the upwelling systems off the Eyre Peninsula (regional priority 16).

2. Assess potential for bioaccumulation of contaminants in key species and evaluate their potential to indicate trends in environmental health.

Strategy G:
Participate in international efforts to manage conservation values and pressures of regional priority

1. Collaborate with government and non-government organisations through regional and international initiatives to protect conservation values and address pressures of regional priority (regional priority 1, 2, 3, 9—ongoing).

The Australian Government will work towards implementing these strategies and actions in order to address the regional priorities for conservation effort identified for the South-west Marine Region.



SCHEDULE 1

Analysis of pressures affecting conservation values of the South-west Marine Region

SCHEDULE 1 ANALYSIS OF PRESSURES AFFECTING CONSERVATION VALUES OF THE SOUTH-WEST MARINE REGION

This schedule summarises the methods and findings of the regional pressure analysis undertaken for the South-west Marine Region.

S1.1 How are the pressures on conservation values analysed?

The pressure analysis process considered the impact of pressures on a region's conservation values, with a focused evaluation of the effectiveness of current mitigation and management arrangements in place to respond to those pressures. For the purpose of this plan, pressures are defined broadly as human-driven processes and events that do or can detrimentally affect the region's conservation values. Table S1.1 lists the type and source of pressures available for inclusion in the analysis. Only those pressures relevant to the conservation value being analysed were considered.

The analysis enabled pressures to be categorised in terms of their relative importance and has contributed to identification of regional priorities for the South-west Marine Region. Regional priorities are described in section 4.1 of the plan. The conservation values selected for the pressure analysis are discussed in Part 3 of the plan.

Table S1.1: Pressures and sources of pressures available for selection in the South-west Marine Region pressure analysis

Pressure	Source
Sea level rise	Climate change
Changes in sea temperature	Climate change
	Urban development
Changes in oceanography	Climate change
Ocean acidification	Climate change
Changes in terrestrial sand temperature	Climate change
Chemical pollution/contaminants	Agricultural activities
	Aquaculture operations
	Onshore and offshore mining operations
	Renewable energy operations
	Shipping
	Urban development (urban and/or industrial infrastructure)
	Vessels (other)
Nutrient pollution	Agricultural activities
	Aquaculture operations
	Urban development
Changes in turbidity	Climate change (changes in rainfall, storm frequency)
	Dredging (spoil dumping)
	Land-based activities
	Onshore and offshore mining operations
Marine debris[1]	Aquaculture infrastructure
	Fishing boats
	Land-based activities
	Oil rigs
	Renewable energy infrastructure
	Shipping
	Urban development
	Vessels (other)

Pressure	Source
Noise pollution	Aquaculture infrastructure
	Defence/surveillance activities
	Onshore and offshore construction
	Onshore and offshore mining operations
	Renewable energy infrastructure
	Seismic exploration
	Shipping
	Urban development
	Vessels (other)
Light pollution	Fishing boats
	Land-based activities
	Oil and gas infrastructure
	Onshore and offshore activities
	Onshore and offshore mining operations
	Renewable energy infrastructure
	Vessels (other)
Physical habitat modification	Climate change (changes in storm frequency etc.)
	Defence/surveillance activities
	Dredging (and/or dredge spoil)
	Fishing gear (active and derelict)
	Offshore construction and installation of infrastructure
	Offshore mining operations
	Onshore construction
	Ship grounding
	Shipping (anchorage)
	Telecommunications cables
	Tourism (diving, snorkelling)
	Urban/coastal development

Pressure	Source
Human presence at sensitive sites	Aircraft
	Aquaculture operations
	Defence/surveillance activities
	Recreational and charter fishing (burleying)
	Research
	Seismic exploration operations
	Tourism
Nuisance species[2]	Aquaculture operations
Extraction of living resources[3]	Commercial fishing (domestic or non-domestic)
	Commercial fishing – prey depletion
	Commercial, recreational and charter fishing – fisheries discards
	Indigenous harvest
	IUU fishing (domestic or non-domestic)
	Recreational and charter fishing
Bycatch[4]	Commercial fishing
	IUU fishing (domestic or non-domestic)
	Recreational and charter fishing
Oil pollution	Oil rigs
	Onshore and offshore mining operations
	Shipping
	Vessels (other)
Collision with vessels	Fishing
	Shipping
	Tourism
Collision/entanglement with infrastructure	Aquaculture infrastructure
	Oil and gas infrastructure
	Renewable energy infrastructure

Pressure	Source
Disease	Aquaculture operations
	Fishing
	Shipping
	Tourism
Invasive species	Aquaculture operations
	Fishing vessels
	IUU fishing and illegal immigration vessels
	Land-based activities
	Shipping
	Tourism
	Vessels (other)
Changes in hydrological regimes	Aquaculture infrastructure
	Climate change (e.g. changes in rainfall, storm frequency)
	Land-based activities
	Renewable energy infrastructure

IUU = illegal, unreported and unregulated

1 Marine debris is defined in the *Threat Abatement Plan for the impacts of marine debris on vertebrate marine life May 2009* (**www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris.html**) and refers to 'land-sourced plastic garbage, fishing gear from recreational and commercial fishing abandoned into the sea, and ship-sourced, solid non-biodegradable floating materials disposed of at sea'. In concordance with International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), plastic material is defined as bags, bottles, strapping bands, sheeting synthetic ropes, synthetic fishing nets, floats, fiberglass, piping, insulation, paints and adhesives.

2 Nuisance species are opportunistic native species (e.g. seagulls) whose populations boom when humans modify the ecosystem by increasing food supply.

3 Extraction of living resources includes the removal of target and byproduct species.

4 Bycatch includes all non-targeted catch from fishing operations, including by-product, discards and gear interactions. By-product refers to the unintended catch that may be kept or sold by the fisher. Discards refer to the product that is returned to the sea. Gear interactions refer to all species and habitat affected by the fishing gear.

Levels of concern for the interactions between pressures and conservation values

Based on a review of scientific and expert literature, and informed by the findings of relevant environmental and impact assessment studies, risk assessments and expert opinion, the interaction between selected conservation values and each pressure was assigned a level of concern. The levels of concern are:

- *of concern*
- *of potential concern*
- *of less concern*
- *not of concern.*

A pressure is *of concern* for a conservation value when:

- there is evidence that it interacts with the conservation value within the region and there are reasonable grounds to expect that it may result in a **substantial impact** (Box S2.1), and
- there are no management measures in place to mitigate the impact(s), or there is inadequate or inconclusive evidence of the effectiveness of management measures within the region.

A pressure is *of potential concern* for a conservation value when:

- there is evidence that the conservation value is vulnerable to the type of pressure, although there is limited evidence of a **substantial impac**t within the region, and
- the pressure is widespread or likely to increase within the region, and
- there are no management measures in place to mitigate potential or future impacts, or there is inadequate or inconclusive evidence of the effectiveness of management measures.

A pressure is *of less concern* for a conservation value either when:

- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that the impacts are unlikely to be substantial, or
- there is evidence of interaction with the conservation value within the region and there are reasonable grounds to expect that current management measures in place are effective in minimising or mitigating the impact.

A pressure is *not of concern for a conservation value* when:

- the pressure is rare or absent from the region, or
- there are reasonable grounds to expect that the impacts are minimal or the pressure does not interact with the conservation value, or
- there is evidence that the pressure is managed effectively through routine management measures.

In some instances, where a pressure operating outside of the region is having a substantial impact on a region's conservation value, consideration has been given to it.

Only those interactions between conservation values and pressures assessed as being *of concern* and *of potential concern* are described in this Schedule. Further information on the findings of the pressure analyses can be found in the conservation value report cards (**www.environment.gov.au/marineplans/south-west**).

Box S2.1 What is a substantial impact?

A pressure was considered likely to cause a substantial impact on a conservation value if there was a reasonable possibility that it would have any of the following effects:

- introduction of a known or potential pest or invasive species
- extensive modification, destruction, fragmentation, isolation or disturbance of habitat, which results in changes to community composition and/or trophic relationships and/ or ecosystem services
- modification, destruction, fragmentation, isolation or decline in availability of quality habitat important for a species of conservation value, to the extent that the species' conservation status is affected or its recovery is hindered
- substantial change in air or water quality, which may adversely impact biodiversity, ecological function or integrity, social amenity or human health
- introduction of persistent organic chemicals, heavy metals or potentially harmful chemicals, which adversely impact on biodiversity, ecosystem function or integrity, social amenity or human health
- change in community dynamics or structure that results in adverse impacts on biodiversity, ecological function or integrity, social amenity or human health
- increase in mortality of conservation values to an extent that may affect their conservation status or hinder recovery
- reduction in the area of occupancy of a species of conservation value, which may affect its conservation status or hinder recovery
- fragmentation of populations of conservation value
- reduced breeding success of a species or population of conservation value
- extensive or prolonged disturbance that affects the conservation status of a species or population of conservation value.

Note that the criteria above for defining substantial impact have been informed by *EPBC Act Policy Statement 1.1 – Significant Impact Guidelines*.

S1.2 Findings of the analysis

A summary of the pressure analysis findings on the key ecological features and historic shipwrecks of the South-west Marine Region is presented in Table S1.2. A summary of the pressure analysis findings on selected protected species in the South-west Marine Region is presented in Table S1.3.

A more detailed overview of the pressures assessed as *of concern* and *of potential concern* for these conservation values is presented in Tables S1.4–S1.15:

- Key ecological features of the South-west Marine Region
  - Pressures *of concern*—Table S1.4
  - Pressures *of potential concern*—Table S1.5.
- Selected bony fish species
  - Pressures *of concern*—Table S1.6
  - Pressures *of potential concern*—Table S1.7
- Selected cetacean species
  - Pressures *of potential concern*—Table S1.8
- Selected marine reptile species
  - Pressures *of potential concern*—Table S1.9
- Selected pinniped species
  - Pressures *of concern*—Table S1.10
  - Pressures *of potential concern*—Table S1.11
- Selected seabird species
  - Pressures *of concern*—Table S1.12
  - Pressures *of potential concern*—Table S1.13
- Selected shark species
  - Pressures *of concern*—Table S1.14
  - Pressures *of potential concern*—Table S1.15

Further information on the pressure analyses and their findings are provided in the conservation values report cards.

Table S1.2: Summary of pressures on key ecological features and historic shipwrecks of the South-west Marine Region

Key ecological feature	Pressure[5]								
	Sea level rise	Changes in sea temperature	Change in oceanography	Ocean acidification	Chemical pollution / contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution
1. Commonwealth marine environment surrounding the Houtman Abrolhos Islands									
2. Perth Canyon and adjacent shelf break, and other west coast canyons									
3. Commonwealth marine environment within and adjacent to the west coast inshore lagoons									
4. Commonwealth marine environment within and adjacent to Geographe Bay									
5. Cape Mentelle upwelling									
6. Naturaliste Plateau									
7. Diamantina Fracture Zone									
8. Albany Canyon group and adjacent shelf break									
9. Commonwealth marine environment surrounding the Recherche Archipelago									
10. Ancient coastline between 90 and 120 m depth									
11. Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings									

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.2 continued: Summary of pressures on key ecological features and historic shipwrecks of the South-west Marine Region

Key ecological feature	Pressure[5]										
	Light pollution	Physical habitat modification	Human presence at sensitive sites	Nuisance species	Extraction of living resources	Bycatch	Oil pollution	Collisions with vessels	Collision/ entanglement with infrastructure	Disease	Invasive species
1. Commonwealth marine environment surrounding the Houtman Abrolhos Islands											
2. Perth Canyon and adjacent shelf break, and other west coast canyons											
3. Commonwealth marine environment within and adjacent to the west coast inshore lagoons											
4. Commonwealth marine environment within and adjacent to Geographe Bay											
5. Cape Mentelle upwelling											
6. Naturaliste Plateau											
7. Diamantina Fracture Zone											
8. Albany Canyon group and adjacent shelf break											
9. Commonwealth marine environment surrounding the Recherche Archipelago											
10. Ancient coastline between 90 and 120 m depth											
11. Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings											

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.2 continued: Summary of pressures on key ecological features and historic shipwrecks of the South-west Marine Region

Key ecological feature	Pressure[5]									
	Sea level rise	Changes in sea temperature	Change in oceanography	Ocean acidification	Chemical pollution / contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
12. Meso-scale eddies (several locations)										
13. Demersal slope and associated fish communities of the Central Western Province										
14. Western rock lobster										
15. Benthic invertebrate communities of the eastern Great Australian Bight										
16. Small pelagic fish of the south-west marine region										
Historic shipwrecks										
HMAS Sydney II										
HSK Kormoran										
MV Stanford										
SS Cambewarra										
Lord Roberts										
Red Rover										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.2 continued: Summary of pressures on key ecological features and historic shipwrecks of the South-west Marine Region

Key ecological feature	Pressure[5]									
	Physical habitat modification	Human presence at sensitive sites	Nuisance species	Extraction of living resources	Bycatch	Oil pollution	Collisions with vessels	Collision/ entanglement with infrastructure	Disease	Invasive species
12. Meso-scale eddies (several locations)										
13. Demersal slope and associated fish communities of the Central Western Province										
14. Western rock lobster										
15. Benthic invertebrate communities of the eastern Great Australian Bight										
16. Small pelagic fish of the south-west marine region										
Historic shipwrecks										
HMAS Sydney II										
HSK Kormoran										
MV Stanford										
SS Cambewarra										
Lord Roberts										
Red Rover										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards

Table S1.3: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Sea level rise	Changes in sea temperature	Change in oceanography	Ocean acidification	Chemical pollution / contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Bony fishes	Günther's pipehorse										
	Orange roughy										
	Southern bluefin tuna										
Cetaceans	Blue whale										
	Humpback whale										
	Southern right whale										
	Sperm whale										
Marine reptiles	Green turtle										
	Leatherback turtle										
	Loggerhead turtle										
Pinnipeds	Australian sea lion										
	New Zealand fur seal										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.3 continued: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Physical habitat modification	Human presence at sensitive sites	Nuisance species	Extraction of living resources	Bycatch	Oil pollution	Collisions with vessels	Collision/ entanglement with infrastructure	Disease	Invasive species
Bony fishes	Günther's pipehorse										
	Orange roughy										
	Southern bluefin tuna										
Cetaceans	Blue whale										
	Humpback whale										
	Southern right whale										
	Sperm whale										
Marine reptiles	Green turtle										
	Leatherback turtle										
	Loggerhead turtle										
Pinnipeds	Australian sea lion										
	New Zealand fur seal										

Legend: of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.3 continued: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Sea level rise	Changes in sea temperature	Change in oceanography	Ocean acidification	Chemical pollution / contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Seabirds	Indian yellow-nosed albatross										
	Great-winged petrel										
	Soft-plumaged petrel										
	White-faced storm petrel										
	Flesh-footed shearwater										
	Little shearwater										
	Short-tailed shearwater										
	Wedge-tailed shearwater										
	Bridled tern										
	Caspian tern										
	Fairy tern										
	Roseate tern										
	Sooty tern										
	Australian lesser noddy										
	Common (brown) noddy										
	Pacific gull										
	Little penguin										
	Black-faced cormorant										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.3 continued: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Physical habitat modification	Human presence at sensitive sites	Nuisance species	Extraction of living resources	Bycatch	Oil pollution	Collisions with vessels	Collision/ entanglement with infrastructure	Disease	Invasive species
Seabirds	Indian yellow-nosed albatross										
	Great-winged petrel										
	Soft-plumaged petrel										
	White-faced storm petrel										
	Flesh-footed shearwater										
	Little shearwater										
	Short-tailed shearwater										
	Wedge-tailed shearwater										
	Bridled tern										
	Caspian tern										
	Fairy tern										
	Roseate tern										
	Sooty tern										
	Australian lesser noddy										
	Common (brown) noddy										
	Pacific gull										
	Little penguin										
	Black-faced cormorant										

Legend of concern; of potential concern; of less or no concern

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Table S1.3 continued: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Sea level rise	Changes in sea temperature	Change in oceanography	Ocean acidification	Chemical pollution / contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Sharks	Grey nurse shark										
	Longfin mako shark										
	Shortfin mako shark										
	Porbeagle shark										
	School shark										
	White shark										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.3 continued: Summary of pressures on selected protected species in the South-west Marine Region

Species group	Protected species	Pressure[5]									
		Physical habitat modification	Human presence at sensitive sites	Nuisance species	Extraction of living resources	Bycatch	Oil pollution	Collisions with vessels	Collision/ entanglement with infrastructure	Disease	Invasive species
Sharks	Grey nurse shark										
	Longfin mako shark										
	Shortfin mako shark										
	Porbeagle shark										
	School shark										
	White shark										

Legend of concern; of potential concern; of less or no concern

5 Some pressures considered in this analysis are made up of more than one category but are presented in this summary table under one heading. For example, some conservation values were assessed against the pressures of *bycatch from commercial fishing* and *bycatch from recreational fishing*; however these categories are presented in the summary table under bycatch. Where the ratings for a conservation value differ across the pressures in a category, the highest rating has been listed in the table. For example, *if bycatch from commercial fishing* is rated *of potential concern* and *bycatch from recreational fishing* is rated *of less concern*, the pressure of *bycatch* will be rated *of potential concern* for the conservation value in the table. More information about the pressure analyses for key ecological features and protected places can be found in the report cards.

Table S1.4: Pressures *of concern* to key ecological features of the South-west Marine Region

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Sea level rise (climate change)	CME off Houtman Abrolhos Islands	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1 m by 2100, relative to 2000 levels (Climate Commission 2011). The Houtman Abrolhos Islands are low-lying islands with an average altitude of 3 m above sea level. Many species of seabirds breed on the islands, which are considered of national and global significance as habitat for many migratory seabird species (Surman & Nicholson 2006). As many seabirds are ground nesting, the loss of habitat associated with sea level rise could result in reduced reproductive success, as well as displacement of populations from their breeding area. Because of the diversity and numbers breeding on the island, seabirds are key components of the marine ecosystem surrounding the Houtman Abrolhos Islands, including the Commonwealth marine environment, where most foraging grounds occur. The broader ecological implications for this key ecological feature of the effects of sea level rise on seabirds are uncertain.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Changes in sea temperature (climate change)	Cape Mentelle upwelling CME off Geographe Bay CME off Houtman Abrolhos Islands CME off Recherche Archipelago Kangaroo Island canyons and associated ecosystems Meso-scale eddies Perth Canyon and associated ecosystems Small pelagics West-coast inshore lagoons Western rock lobster	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). The south-west of Western Australia in particular is one of three hotspots in the Indian Ocean where rising temperature trends exceed the Indian Ocean basin average (Feng et al. 2009). All key ecological features considered important for the region's primary productivity and biological production are at risk from climate change. Changes in sea temperature and oceanographic processes have been implicated in the region in shifts in distribution of marine species, changes to prey variability (including positive changes for some species, such as bridled tern) and effects on reproductive time and success (Dunlop 2009; Gaughan et al. 2002; Surman & Nicholson 2009). The overall implications for ecosystem processes in the region are not known.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Change in oceanography (climate change)	Cape Mentelle upwelling CME off Geographe Bay CME off Houtman Abrolhos Islands CME off Recherche Archipelago Kangaroo Island canyons and associated ecosystems Meso-scale eddies Perth Canyon and associated ecosystems Small pelagics West-coast inshore lagoons Western rock lobster	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). The Leeuwin Current is the basis of much of the region's biological productivity, and its strength and seasonal/climatic variability are a primary driver for the intensity, timing and locations of productivity events in the region, from the waters off Geraldton to the Great Australian Bight (Pattiaratchi 2007). The long-term implications for the region's ecosystems and its key ecological features are uncertain. This pressure is considered *of concern* for those key ecological features important for the region's productivity and for which the Leeuwin Current is considered a primary ecological driver.

CME = Commonwealth marine environment

Table S1.5: Pressures *of potential concern* to key ecological features of the South-west Marine Region

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Sea level rise (climate change)	West-coast inshore lagoons CME off Geographe Bay CME off Recherche Archipelago Western rock lobster	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1 m by 2100, relative to 2000 levels (Climate Commission 2011). One of the anticipated effects of sea level rise is the increase in coastal erosion processes, which might be accompanied by an increase in sediment loads in the water column, particularly in inshore environments, and a possible loss of seagrass beds (Hobday et al. 2006).
Changes in sea temperature (climate change)	Naturaliste Plateau Diamantina Fracture Zone Albany canyon group Ancient coastline (GAB) Demersal fish communities Benthic communities (east GAB)	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). The implications of changes to the region's sea temperatures and oceanography for deeper ocean environments are uncertain, although sea-water warming at depth is expected to have significant implications for benthic and demersal fish.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Change in oceanography (climate change)	Naturaliste Plateau Diamantina Fracture Zone Albany canyon group Ancient coastline (GAB) Demersal fish communities Benthic communities (east GAB)	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). The Leeuwin Current is the basis of much of the region's biological productivity, and its strength and seasonal/climatic variability are a primary driver for the intensity, timing and locations of productivity events in the region, from the waters off Geraldton to the Great Australian Bight (Pattiaratchi 2007). Numerous water bodies and currents converge at the Naturaliste Plateau, including the subtropical convergence front. These complex water dynamics are likely to experience considerable changes if there are significant changes to ocean circulation in the region, with flow-on effects for the entire ecosystem.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Ocean acidification (climate change)	All features	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). Projected changes in Australian waters by 2070 include a decline in pH of 0.2 units (Lawrence et al. 2007). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities. Research on the impact of ocean acidification on Antarctic krill has found that increased levels of CO_2 kill their embryos (Kawaguchi et al. 2010). Krill are an important part of the food chain because they feed on phytoplankton and zooplankton, and are a key food source for many species that occur in Australian waters. Consequently, acidification impacts have the potential to affect species further up the food chain. Ocean acidification will also reduce coral growth rates (Anthony & Marshall 2009), making reefs, including those occurring in waters surrounding the Abrolhos Islands, more susceptible to erosion and disturbance from storms. The potential effects of increased acidity on the region's biodiversity also include changes to growth and population dynamics of some shell-forming organisms, impacts on the reproductive and metabolic functions of a number of fish and invertebrate species, and sensitivity of some early-life stages to acidification (Orr et al. 2009).

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Chemical pollution/ contaminants	CME off Houtman Abrolhos Islands Perth Canyon and associated ecosystems West coast inshore lagoons CME off Geographe Bay CME off Recherche Archipelago	Introduction of chemical pollution into the marine environment is usually localised and associated with shipping and ports operations, particularly dredging; industrial development in the coastal zone; and proximity to urban centres and estuaries in areas with intense industrial and agricultural development. This pressure is *of potential concern* for key ecological features that are close to coastal areas experiencing industrial developments, intense land use and/or large ports. There are potential contamination impacts from historical sea dumping in the Perth Canyon, although the likelihood is low.
Nutrient pollution	CME off Houtman Abrolhos Islands West coast inshore lagoons CME off Geographe Bay CME off Recherche Archipelago	The South-west Region waters are generally low in nutrients; any significant increase in nutrient loads in the water column has potential detrimental effects for biodiversity. Increases in nutrients may arise from run-off from agricultural production (e.g. in Geographe Bay) and discharge of sewerage into the ocean. Aquaculture development in the Houtman Abrolhos Islands and, potentially (in the future), in the Recherche Archipelago, might result in significant although highly localised increase in nutrients, with potential impacts on adjacent rich ecological communities.
Changes in turbidity	West coast inshore lagoons CME off Geographe Bay Western rock lobster	Changes in turbidity in the region can be associated primarily with increased coastal erosion (due to sea level rise). Increased run-off, which is the cause of turbidity changes in other parts of Australia, is not likely to be a significant source of pressure in the south-west due to the absence of large rivers and the anticipated dramatic decrease in rainfall predicted for the south-west corner of Australia (Hennessy et al. 2006). Key ecological features that are particularly vulnerable to increased turbidity are those that have extensive and important seagrass beds (Geographe Bay; west-coast inshore lagoons) or that have an ecological reliance on this type of habitat (western rock lobster).

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Noise pollution	Perth Canyon and associated ecosystems CME off Geographe Bay Albany canyon group Kangaroo Island canyons and associated ecosystems Demersal fish communities	All sources of man-made noise in the region—shipping, marine infrastructure construction and operation involving underwater blasting and pile driving, defence naval exercises and seismic surveys—are predicted to increase (Clifton et al. 2007). Many marine organisms use sound for a number of biological functions, including navigation, social communication and location of prey. The effects of seismic activities on large whales have received the most attention in the region; however, there have also been experimental studies into the effects of seismic surveys on fish (Popper et al. 2002; McCauley et al. 2003). Although extrapolation from experimental studies to wild populations is problematic, the evidence available to date justifies a precautionary approach. The Royal Australian Navy's Western Australia exercise area is located off Perth, and its operation involves noise-generating activities, including firing of live ammunition, shipping exercises and use of active sonar. Guidelines under the EPBC Act are in place to mitigate the effect of noise generated by seismic surveys on whales; similarly, the Royal Australian Navy implements operational procedures to minimise environmental impacts.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Physical habitat modification	CME off Houtman Abrolhos Islands West coast inshore lagoons CME off Geographe Bay Ancient coastline (GAB) Demersal fish communities Western rock lobster Benthic communities (east GAB)	Coastal, urban and industrial development and port activities can result in loss or significant degradation of areas of important habitat. *Of potential concern* are those features occurring on the west-coast continental shelf, where the rate of development is higher (Clifton et al. 2007). Inshore habitats, such as the *seagrass* beds and limestone reefs of the west coast and Geographe Bay, are important breeding and nursing areas for a range of fish and shark species and for western rock lobster. Loss and disturbance of mangrove habitat in the Houtman Abrolhos Islands due to climatic changes and/or further future development would have significant impacts on the year-round resident seabird populations of Australian lesser noddy. In the region, disturbance and physical changes to benthic habitats result from bottom trawling, although the extent of trawling varies broadly among the fisheries in the region. Sponges, bryozoans and sea squirts are particularly vulnerable to trawling impacts (Currie et al. 2009). Bottom trawling occurs on the west-coast shelf edge and slope, and loss or modification of the benthic community is likely (20 out of 48 habitat types occurring within the fishery area are at risk; Wayte et al. 2007). Similarly, in the Great Australian Bight, trawling covers limited ground relative to the fishery area but is concentrated on the diverse habitats of the shelf edge and upper slope. Effects of benthic habitat loss on demersal communities and associated ecosystems are not certain. The effects of demersal gillnet deployment over the species-rich benthic communities of this area have not been investigated. The habitats associated with the ancient coastline of the Great Australian Bight at depths of 80–100 m, although generally not suited to trawling, might also be subject to habitat loss and modification through the impacts of fishing gear. Other sources of benthic habitat loss or modification at more localised scales are dredging, construction of infrastructure, and laying of underwater pipelines and cables. The implications of benthic habitat loss on the region's species and ecosystems are not adequately understood.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Extraction of living resources	CME off Houtman Abrolhos Islands Perth Canyon and associated ecosystems West coast inshore lagoons CME off Geographe Bay CME off Recherche Archipelago Ancient coastline (GAB) Kangaroo Island canyons and associated ecosystems Demersal fish communities Western rock lobster	Understanding of ecosystem effects of fishing is very limited. Evidence of reliance of species on targeted stocks include research on the feeding ecology of seabirds foraging around the Houtman Abrolhos Islands, which indicates that a number of species, including the threatened Australian lesser noddy, are reliant on the availability of specific species of small pelagic fish (Gaughan et al. 2002). Some seabird species that inhabit the region are also known to depend on large pelagic predators, such as tunas, for driving prey fish to the surface, and some species, such as sooty tern, are thought to be totally reliant on this method of feeding (Dunlop 2008; Jaquemet et al. 2007). There are also some concerns, underpinned by high levels of uncertainty, about competition for resources between Australian sea lion and fisheries (DEWHA 2010). Based on the latest fisheries status reports from the Australian Government, Western Australia and South Australia (respectively, considering the 2009, 2008–09 and 2006 stock status reports), 10 stocks in the region are assessed as 'overfished.' 16 stocks have an uncertain status, including dhufish, for which substantial declines have been reported (Fletcher & Santoro 2009; Linnane et al. 2010a, 2010b; Wilson et al. 2010). Recent management changes have been implemented to facilitate stock recovery for dhufish and other west coast demersal finfish (DoF 2011a, DoF 2011b). In light of limited understanding about the ecosystem effects of extraction of living resources for the key ecological features of the region, the pressure is considered *of potential concern*.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Bycatch	CME off Houtman Abrolhos Islands Perth Canyon and associated ecosystems West coast inshore lagoons Cape Mentelle upwelling Albany canyon group CME off Recherche Archipelago Kangaroo Island canyons and associated ecosystems Demersal fish communities	There is a general lack of evidence to demonstrate the performance of bycatch mitigation measures (Bensley et al. 2010). In relation to bycatch of non-protected species, Phillips et al. (2010) indicate that current levels of independent observers preclude a cumulative assessment of the catch of non-target species, but recommend that such assessment is important to understand more broadly the environmental effects of fishing and to underpin an ecosystem approach to fisheries management (Phillips et al. 2010). In the absence of an integrated assessment of the cumulative ecosystem effects of current catch rates for a number of non-target species, this pressure is *of potential concern*.

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Oil pollution	CME off Houtman Abrolhos Islands Perth Canyon and associated ecosystems West coast inshore lagoons CME off Geographe Bay Cape Mentelle upwelling Kangaroo Island canyons and associated ecosystems CME off Recherche Archipelago Western rock lobster	Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas, could be severe. A number of the key ecological features of the region have characteristics that make their ecosystems and communities vulnerable to the effects of an oil spill, for example, features that include localised areas of high productivity, which attract large aggregations of marine life. The intensity and distribution of activities implicated in oil spills—such as oil production and transport—are likely to increase in the region.
Collisions with vessels	Perth Canyon and associated ecosystems	The Perth Canyon is an important habitat for a number of large whale species; its proximity to the Fremantle and Kwinana ports and its overlap with the Royal Australian Navy's Western Australia exercise area make the potential effects of ship strikes in this area *of potential concern*, particularly in light of anticipated increases in shipping traffic (Clifton et al. 2007). Although vessel collision across the region is unlikely to be as serious a problem as in some other parts of the world, there is the possibility that events that occur well offshore are not detected (Kemper 2008) or that ship-related deaths go unrecognised (Laist et al. 2001).

Key ecological features assessed = 16		
Pressure	**Features**	**Rationale**
Disease	Small pelagic fish	Two mortality events substantially reduced pilchard stocks off South Australia and Western Australia in 1995 and 1998 (Ward et al. 2001). The two events resulted in the loss of 10–15per cent of the stock over an extensive area, stretching from the Great Australian Bight to the tropical coast of Western Australia. The mortality was attributed to a herpes virus, which might have been introduced, although this was not conclusively demonstrated.
Invasive species	CME off Geographe Bay CME off Recherche Archipelago West coast inshore lagoons	Temperate southern Australian habitats are considered to be at great risk globally from introduced marine species because of their biogeographic isolation from other temperate marine habitats of the world. Species native to the east coast of Australia also present a risk, as they have evolved independently of those on the west coast and may become invasive if introduced in favourable conditions to the south-west marine environment. Marine pests can be introduced through ballast water exchange or via biofouling (the accumulation of microorganisms, algae and animals on objects in water). Vessels at high risk for introducing species include those that are slow moving, have spaces where marine species can settle, come in close contact with the sea bottom and remain in a single area for extended periods. Inshore areas, and particularly ports and sites where infrastructure development and maintenance take place, have the highest risk of marine pests becoming established. No marine pests have been recorded in the South-west Marine Region. Four marine pest species occur in the environment of four ports adjacent to the region (Fremantle, Bunbury, Albany and Port Adelaide). Pest species established in the neighbouring South-east Marine Region and capable of spreading into the deeper environments of the Commonwealth marine area include Northern Pacific seastar, New Zealand screw shell and Japanese kelp.

CME = Commonwealth marine environment; GAB = Great Australian Bight

Table S1.6: Pressures *of concern* to selected bony fish species in the South-west Marine Region

Species assessed = 3		
Pressure	**Species**	**Rationale**
Extraction of living resources	Southern bluefin tuna	Juvenile southern bluefin tuna are harvested in the Great Australian Bight by Australian purse seine fishing vessels. Southern bluefin tuna was listed in 2010 as conservation dependent under the EPBC Act because of the decline in the size of the spawning stock since the 1990s. The fishery is managed globally by the international Commission for the Conservation of Southern Bluefin Tuna, which has already established measures to ensure rebuilding of the spawning stock. The Commission will continue to assess the effectiveness of its management measures and implement further measures as required. Until evidence of the effectiveness of management is conclusive, the pressure remains *of concern* for this species.

Table S1.7: Pressures *of potential concern* to selected bony fish species in the South-west Marine Region

Species assessed = 3		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Günther's pipehorse Orange roughy Southern bluefin tuna	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). Modelling studies predict that the temperature of Australia's oceans at a depth of 500 m will increase by up to 1 °C by 2070 (Hobday et al. 2006). The south-west of Western Australia is one of three hotspots in the Indian Ocean where rising temperature trends exceed the Indian Ocean basin average (Feng et al. 2009). There is a high level of agreement from different data sets that warming is affecting the distributional ranges and growth of temperate marine fishes (Booth et al. 2009). Orange roughy mostly occur at depths between 700 m and 1000 m, but are known to inhabit waters as shallow as 180 m (Kailola et al. 1993). Sea water warming at depth is expected to have implications for benthic and demersal fish (such as orange roughy). The temperature of the ocean strongly influences the distribution of pelagic fish species, including southern bluefin tuna (Reddy et al. 1995).
Change in oceanography (climate change)	Günther's pipehorse Orange roughy Southern bluefin tuna	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). The weakening of the Leeuwin Current is likely to have implications for the productivity of the region, with uncertain and yet potentially significant effects on a broad range of species (Feng et al. 2009). Günther's pipehorse has a diet of small crustaceans and larval fish; the species might be affected by climate-related changes to the region's productivity and trophic processes. While it appears more common in waters off Albany, there is uncertainty about the species' distribution in the region and its use of the region's habitats. Orange roughy might also be affected by the climate-related effects on the region's productivity and trophic dynamics. Changes in productivity are likely also to affect the pelagic ecosystems and the harvested species at the top of the food chain. The impact of climate change on the winter southern bluefin tuna feeding grounds in the southern ocean may be significant (Sarmiento et al. 2004 cited in Hobday et al. 2008).

Species assessed = 3		
Pressure	**Species**	**Rationale**
Ocean acidification (climate change)	Günther's pipehorse Orange roughy	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities. The potential effects of increased ocean acidity on shark and fish species are not well understood. It is believed that for some invertebrates and fish, accumulation of CO_2 in the body may result in morphological changes, and impact metabolic state, physical activity and reproduction (Orr et al. 2009). Effects on phytoplankton and zooplankton are also likely to disrupt trophic dynamics and affect fish species and communities.
Noise pollution	Southern bluefin tuna	Research on the effects of noise disturbance on fish is limited and mostly confined to physiological impacts. Behavioural responses observed to date range from no overt response to substantial avoidance movements that may displace fish from their normal location (Popper & Hastings 2009; Popper et al. 2002). Two to four year old southern bluefin tuna are known to feed regularly during spring and summer in the waters off the Great Australian Bight; during this time, they grow at a faster rate than winter, presumably due to a combination of warmer waters and abundant food. Sustained noise disturbance off the waters of the Great Australian Bight during their feeding season has the potential, to impact on growth and, indirectly, survivorship on those year classes exposed to the disturbance (Davies 2011, press. comm.). There are management measures designed to ensure that mobile marine life has the opportunity to move away before the source reaches full power, such as "soft start" (ramp up) of the source, as established in the *Offshore Petroleum and Greenhouse Gas Storage Act 2006*.

Species assessed = 3		
Pressure	**Species**	**Rationale**
Extraction of living resources	Orange roughy	Orange roughy (listed as conservation dependent under the EPBC Act because of the dramatic stock decline in many parts of the south-east marine region) is harvested in the south-west under a conservative total allowable catch aimed at better understanding stock levels and structure. Bycatch mitigation measures are in place as part of the Orange Roughy Conservation Program, but some level of bycatch remains unavoidable through the operation of fisheries (AFMA 2006). There remains uncertainty about the response of the species to management measures.
Bycatch	Günther's pipehorse	Günther's pipehorse is caught accidentally in trawl nets. Due to the level of uncertainty about the population levels, it is difficult to assess the impacts of bycatch mortality.

Table S1.8: Pressures *of potential concern* to selected cetaceans in the South-west Marine Region

Species assessed = 4		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Blue whale	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). Changes in sea surface temperature are likely to result in changes to zooplankton communities, with implications for dependent species, such as the blue whale (Richardson et al. 2009). The blue whale is the only one of the baleen whales assessed that feeds in the region.
Change in oceanography (climate change)	Blue whale Humpback whale Southern right whale Sperm whale	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). The weakening of the Leeuwin Current is likely to result in changes to prey availability, affecting distribution, abundance and migration patterns of a range of species, as well as suitability of feeding and calving habitat (DEH 2005; Learmonth et al. 2006).
Ocean acidification (climate change)	Blue whale Humpback whale Southern right whale Sperm whale	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities. Recent research points to potentially significant impacts on Antarctic krill (Kawaguchi et al. 2010), which are a key food source for many whale species that visit Australian waters.

Species assessed = 4		
Pressure	**Species**	**Rationale**
Marine debris	Blue whale Humpback whale Southern right whale Sperm whale	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). The marine debris threat abatement plan lists a number of cetaceans, including southern right whale, blue whale and humpback whale, as threatened species under the EPBC Act that are known to be adversely affected by ingestion of, or entanglement in, harmful marine debris (DEWHA 2009a). Based on recorded strandings and sightings, the ingestion of marine debris causes most deaths in sperm whales, while entanglement is recorded most often in humpback whales (Ceccarelli 2009). There is limited information about the distribution and quantity of marine debris in the region. Deaths of southern right whales in the region involving entanglement, most commonly in discarded fishing gear, appear to be increasing relative to the number of carcasses reported (Kemper et al. 2008).
Noise pollution	Blue whale Humpback whale Southern right whale Sperm whale	There is growing concern that man-made noise impacts marine life, particularly cetaceans, because it may result in physical and/or behavioural effects on these species (DEWHA 2008). All sources of man-made noise in the region—shipping, marine infrastructure construction and operation, and seismic surveys—are predicted to increase (Clifton et al. 2007). Guidelines under the EPBC Act are in place to mitigate the effect of noise generated by seismic surveys on whales; similarly, the Royal Australian Navy implements operational procedures to minimise environmental impacts; no management measures are in place with respect to shipping-related noise disturbance in the region.

Species assessed = 4		
Pressure	**Species**	**Rationale**
Physical habitat modification	Southern right whale	Inshore habitat degradation is considered a threat to the recovery of southern right whale because this species uses inshore areas for calving, some of which are close to populated centres (DEH 2005). Swimming further to avoid degraded habitat might compromise reproductive success. This threat is greater for the small proportion of southern right whales that calve east of Adelaide, because of the higher population density and use of coastal areas along the south-east of Australia. However, coastal and inshore habitat degradation is also *of potential concern* in the South-west Region, due to the anticipated expansion of coastal infrastructure and urban development (Clifton et al. 2007).
Bycatch	Humpback whale Southern right whale Sperm whale	Southern right whales may be particularly vulnerable to entanglement in the ropes and lines associated with trapping crustaceans in coastal waters (Kemper 2008). The likelihood of entanglement may increase as the southern right whale population recovers. There have also been reports of sperm and humpback whales being entangled in fishing gear (Kemper et al. 2008), and interactions are likely to increase as the populations of these species recover.
Oil pollution	Blue whale Humpback whale Southern right whale Sperm whale	Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas, could be severe. Baleen whales are particularly vulnerable to oil pollution as the oil is likely to stick to the baleen plates while whales filter-feed on plankton and krill near oil slicks (AMSA 2010). Where an oil spill coincides with calving and nursing events, it may affect breeding success (DEH 2005). The intensity and distribution of activities implicated in oil spills—such as oil production and transport—are likely to increase in the region.

Species assessed = 4		
Pressure	**Species**	**Rationale**
Collision with vessels	Blue whale Southern right whale	Fatal ship strikes have been recorded in the region, involving southern right and blue whales (Kemper et al. 2008). The relative importance of this source of mortality is unknown, but it is not likely to impact the species at the population level; however, it is possible that a number of events are undetected (Kemper 2008). A review of ship strike records around the world (but not including Australia) found that, in some areas and for small populations, ship strikes are a significant source of mortality (Laist et al. 2001). Shipping traffic, particularly of large vessels, is expected to increase (Clifton et al. 2007), and shipping routes in the region overlap with some biologically important areas for these species.
Collision or entanglement with infrastructure	Southern right whale	Interactions between southern right whales and fish farm cages have been reported (Kemper et al. 2008). The species is particularly vulnerable to entanglement because the whales spend about half of each year in coastal waters, where human activities are more intense (Kemper et al. 2008). The relative importance of this source of mortality is not known, but it is not likely to be significant; however, marine aquaculture and renewable energy infrastructure in the region are predicted to increase.

Table S1.9: Pressures *of potential concern* to selected marine reptile species in the South-west Marine Region

Species assessed = 3		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Green turtle Leatherback turtle Loggerhead turtle	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). The south-west of Western Australia is one of three hotspots in the Indian Ocean where rising temperature trends exceed the Indian Ocean basin average (Feng et al. 2009). A reduction is expected in loggerhead turtle breeding capacity associated with a decrease in ocean productivity and prey abundance (e.g. in benthic invertebrates) due to warming in foraging areas (Chaloupka et al. 2008). Seagrasses are highly vulnerable to a changing climate, as temperature is a critical factor determining growth (Connolly 2009); any large-scale changes to seagrass extent and distribution are likely to have detrimental effects for all turtles foraging in the south-west.
Change in oceanography (climate change)	Green turtle Leatherback turtle Loggerhead turtle	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). Changes in oceanographic patterns are *of potential concern* to marine turtles in the region, through changes to the dispersal of hatchlings, and migration and feeding patterns. The weakening of the Leeuwin Current may also affect migratory pathways for adult breeding marine turtles and distribution of hatchlings. In addition, leatherback turtle is known to drift and feed in the Leeuwin Current and associated currents, and is therefore vulnerable to changes in oceanography.
Ocean acidification (climate change)	Green turtle Leatherback turtle Loggerhead turtle	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities.

Species assessed = 3		
Pressure	**Species**	**Rationale**
Marine debris	Leatherback turtle Loggerhead turtle	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). The loggerhead and leatherback turtles are known to be adversely affected by marine debris. Ingestion of debris is common for loggerhead and leatherback turtles, which might confuse the debris with prey (e.g. jellyfish). A worldwide study assessing autopsy records of 408 leatherback turtles from 1885 to 2007 identified plastic in the digestive tract in 34 per cent of cases (Mrosovsky et al. 2009). Entanglement in discarded monofilament line and fishing nets may impede mobility and reduce the turtle's ability to forage or avoid predators, or result in infection or asphyxiation (DEWHA 2009a). In the absence of region-specific data on mortality rates linked to debris, this pressure is *of potential concern* for the two species foraging in the south-west that are listed as endangered.
Noise pollution	Green turtle Leatherback turtle Loggerhead turtle	Marine turtles do not breed in coastal areas adjacent to the region, but they are thought to feed in some areas along the mid-west coast of Western Australia, where both shipping and petroleum exploration are expected to increase. McCauley et al. (2000, cited in Limpus 2008) document the circumstances in which turtles will change behaviour as a result of seismic surveys. The response of turtles to sound varies with different frequencies and intensities. Turtle hearing is most sensitive in the frequency range of about 200–700 Hz, which has the potential to overlap with the frequencies produced by seismic air guns (DIR 2007). Potential sources of noise pollution in the region include seismic surveys, use of active sonar in navy exercises, explosives, shipping, dredging, pile driving and blasting, and fishing (commercial and recreational vessels).

Species assessed = 3		
Pressure	**Species**	**Rationale**
Bycatch	Leatherback turtle Loggerhead turtle	Bycatch associated with commercial fisheries operating in the region is *of potential concern* to marine turtles listed as endangered. Leatherback turtle is considered the most affected by fishing gear (Phillips et al. 2010) and catch of this species has been recorded in the scientific monitoring of pelagic longline fishing off Western Australia (the turtles caught were released alive(Ward & Curran 2004). However, all marine turtle species are vulnerable to bycatch in trawl, pelagic longline and pot fisheries (DEWHA 2007). Interactions with fisheries may increase as a result of possible changes to the turtles' distributions as climate change progresses.
Collisions with vessels	Green turtle Leatherback turtle Loggerhead turtle	Marine turtles are at risk from commercial vessels such as fishing, construction, standby and work boats, in addition to recreational boats. They are vulnerable to boat strikes when at the surface to breathe and rest between dives (EA 2003). This is an issue in waters adjacent to large urban populations (EA 2002), where there are many boats and other pleasure craft, and near marine construction projects, such as harbour development and dredging programs, where large numbers of work-related vessels may be present. Coastal and offshore development associated with strong economic growth throughout Western Australia is expected to continue at a rapid pace. Interactions between marine turtles and increasing numbers of commercial and recreational vessels are expected to grow.

Table S1.10: Pressures *of concern* to selected pinnipeds in the South-west Marine Region

Species assessed = 2		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Australian sea lion	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). There is a demonstrated link between higher sea surface temperatures and lower rates of pup survival for Australian sea lion (Goldsworthy et al. 2004).
Marine debris	Australian sea lion	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). A high level of entanglement in discarded or lost fishing gear and other marine debris has been reported, and it is estimated that between 0.– 1.3 per cent of the population becomes entangled in these materials (Page et al. 2004; Shaughnessy et al. 2003). Typical items entangling sea lions include bait box straps, trawl netting, monofilament netting, lobster-pot float ropes, and fishing line and hooks (Page et al. 2004). A study at Kangaroo Island identified monofilament netting as the most prevalent material found entangled on Australian sea lions; however, it was unclear if the sea lions became entangled in active fishing gear and broke free, or became entangled in the net after it had become debris (Page et al. 2004). There is limited information about the distribution and quantity of marine debris in the region.
Bycatch	Australian sea lion	There is evidence of deaths from interactions with the demersal gillnet and rock lobster fisheries. Interaction with the demersal gillnet fishery off waters of South Australia is considered the key impediment to recovery of the species (Goldsworthy et al. 2010; Hamer et al. 2010). Mitigation measures for lobster pots have shown some effectiveness in reducing deaths. Mitigation measures for the gillnet fishery are in place, through the Australian Sea Lion Management Strategy (AFMA 2010), but the extent of their effectiveness is not yet fully understood. The pressure remains *of concern* until evidence of management effectiveness is conclusive.

Table S1.11: Pressures *of potential concern* to selected pinnipeds in the South-west Marine Region

Species assessed = 2		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Australian sea lion New Zealand fur seal	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1 m by 2100, relative to 2000 levels (Climate Commission 2011). Many breeding colonies of Australian sea lion occur in highly exposed, rocky shores, where breeding and nursing often take place on small ledges. Sea level rise, accompanied by an increase in intensity and frequency of severe storms, is likely to impact pup survival rates. Global sea levels have risen approximately 20 cm between 1870 and 2008. Sea levels are currently rising at near the upper end of current projections and will continue to rise in response to increasing concentrations of greenhouse gases.
Changes in sea temperature (climate change)	New Zealand fur seal	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). Changes in sea temperature are likely to have implications for the productivity of the region, with effects on a broad range of species (Feng et al. 2009). Impacts have been recorded for the Australian sea lion and it is likely that other pinniped species inhabiting the region, such as the New Zealand fur seal, may also be affected.
Change in oceanography (climate change)	Australian sea lion New Zealand fur seal	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence. The weakening of the Leeuwin Current is likely to have implications for the productivity of the region, with effects on a broad range of species (Feng et al. 2009). Pinnipeds are important predators in the region, and they are likely to be affected by changes in productivity and shifts in trophic processes and structure.

Species assessed = 2		
Pressure	**Species**	**Rationale**
Ocean acidification (climate change)	Australian sea lion New Zealand fur seal	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities.
Marine debris	New Zealand fur seal	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). A recent study, with an observational component at Kangaroo Island, estimated that approximately 295 New Zealand fur seals die each year in southern Australia from entanglement, mostly in discarded or lost fishing gear, although, it was unclear if the seals became entangled in active fishing gear and broke free, or became entangled in the net after it had become debris (Page et al. 2004). As the species is recovering fast it is unlikely that debris-associated mortality has population-level impacts. However, the significance of any increase of this source of mortality for the species is not known.
Noise pollution	Australian sea lion	There has been no assessment of the impact of noise on Australian pinnipeds. Studies from elsewhere and on similar species indicate that they may be impacted by seismic surveys and other sources of noise, such as shipping or construction (Gordon et al. 2003). All sources of man-made noise in the region—shipping, marine infrastructure construction and operation, and seismic surveys—are predicted to increase (Clifton et al. 2007). In view of the predicted increase in seismic surveying, construction activities (including blasting) and shipping noise in the region, and given the conservation status of Australian sea lion, noise pollution is *of potential concern* for this species. There are currently no management measures specifically aimed at assessing and mitigating effects of noise on pinnipeds.

Species assessed = 2		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites	Australian sea lion	Both Australian sea lions and New Zealand fur seals may be disturbed by tourism and recreational activities, particularly during breeding seasons (DAFF 2007; McKenzie et al. 2005). Tourism and disturbance at colonies can lead to disruption of breeding behaviour and site abandonment, although most colonies are on offshore islands and are relatively inaccessible (Goldsworthy & Gales 2008). Human presence at sensitive sites has been assessed as *of potential concern* for Australian sea lion because of its conservation status, lack of recovery and lack of monitoring information to assess the effectiveness of current mitigation practices.
Extraction of living resources	Australian sea lion	This pressure is considered here in terms of the effects of harvest of prey species important to the Australian sea lion. Little is known about competition between fisheries and Australian sea lions, either directly for the same stocks or indirectly through changes to ecosystem structure. However, as outlined in the Australian sea lion recovery plan - technical issues paper, it is likely that the amount of available prey has been affected by commercial fishing operations (DEWHA 2010). In light of the limited understanding of the implications of competition for prey species and given the conservation status of the Australian sea lion, this pressure is rated as *of potential concern*.

Species assessed = 2		
Pressure	**Species**	**Rationale**
Oil pollution	Australian sea lion New Zealand fur seal	Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas, could be severe. The one major oil spill that affected seal colonies in Australia occurred in 1991 off the Recherche Archipelago, when the bulk carrier *Sanko Harvest* was wrecked and spilled 700 tonnes of heavy fuel oil.[2] Pups were contaminated at two colonies, but prompt action enabled them to be captured, restrained in holding pens and cleaned (Gales 1991; Shaughnessy 1999). New Zealand fur seals are known to be vulnerable to oil spills because of their dependence on their thick fur for thermoregulation (Gales 1991). The intensity and distribution of activities implicated in oil spills – such as oil production and transport – are likely to increase in the region.
Collision or entanglement with infrastructure	Australian sea lion	Seals and Australian sea lions are known to interact with the infrastructure of tuna farms near Port Lincoln, in the South Australian waters adjacent to the region. However, the current levels of impact are unknown, as there are no formal observer programs to assess and monitor interactions (McKenzie et al. 2005). Offshore aquaculture is expected to increase in the region (Clifton et al. 2007), including in areas important for the Australian sea lion.

2 **www.amsa.gov.au/marine_environment_protection/major_oil_spills_in_australia/Sanko_Harvest/index.asp**

Table S1.12: Pressures *of concern* to selected seabirds in the South-west Marine Region

Species assessed = 18		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Little shearwater Wedge-tailed shearwater Bridled tern Caspian tern Roseate tern Sooty tern Australian lesser noddy Common (brown) noddy Little penguin	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 to 1m by 2100, relative to 2000 levels (Climate Commission 2011). The Houtman Abrolhos Islands (particularly leeward islands, including Pelsaert Island) are low-lying islands, averaging 3 m above sea level. Seabird species nesting on these islands (and other low-lying coastal sites and islands in the region) will be impacted by loss of habitat and increased effects of storms (compounded by the predicted increase in frequency and intensity of storms). There is evidence of little penguin colonies shrinking in South Australia as a result of increased storm-related impacts. The distribution and abundance of mangrove stands on the Houtman Abrolhos Islands (a roosting site for some species) will change with sea level rise, but ultimate consequences for this habitat are unknown.

Species assessed = 18		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Little shearwater Short-tailed shearwater Wedge-tailed shearwater Caspian tern Fairy tern Roseate tern Sooty tern Australian lesser noddy Common (brown) noddy Pacific gull Little penguin	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). The south-west of Western Australia is one of three hotspots in the Indian Ocean where rising temperature trends exceed the Indian Ocean basin average (Feng et al. 2009). Observed shifts in distributional range may be signalling a southward redistribution of northern and western coast metapopulations of tropical seabird species, driven by changes in the frequency, duration and intensity of the El Niño/ La Niña – Southern Oscillation and rising background sea temperatures. There is evidence of changes in the timing of breeding for some species (Gaughan et al. 2002; Surman & Nicholson 2009). There is also evidence from the region of latitudinal shifts in distribution, and these have been attributed to climate-related changes (Dunlop 2009). Reduced reproductive success has been recorded for some species breeding on the Houtman Abrolhos Islands (Gaughan et al. 2002; Surman & Nicholson 2006, 2009). There is uncertainty about the availability and condition of frontier habitats, and the potential implications for cool temperate species (Dunlop 2009).

Species assessed = 18		
Pressure	**Species**	**Rationale**
Change in oceanography (climate change)	Little shearwater Short-tailed shearwater Wedge-tailed shearwater Caspian tern Fairy tern Roseate tern Sooty tern Australian lesser noddy Common (brown) noddy Pacific gull Little penguin	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). Changes in oceanographic patterns are *of concern* to a number of seabirds in the region, with implications for the timing of breeding, reproductive success and species distribution. Observed changes might be signalling a southward redistribution of northern and western coast metapopulations of tropical species, driven by changes in the frequency, duration and intensity of the El Niño/La Niña – Southern Oscillation and rising background sea temperatures.

Table S1.13: Pressures *of potential concern* to selected seabirds in the South-west Marine Region

Species assessed = 18		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Great-winged petrel White-faced storm petrel Flesh-footed shearwater Short-tailed shearwater Fairy tern Black-faced cormorant	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1 m by 2100, relative to 2000 levels (Climate Commission 2011). Loss of nesting and breeding habitat for protected seabirds associated with sea level rise could result in reduced reproductive success, as well as displacement of populations from their breeding area. While no evidence of impact exists at present, all ground-nesting birds are at risk from increasing sea levels.
Changes in sea temperature (climate change)	Indian yellow-nosed albatross Great-winged petrel Soft-plumaged petrel White-faced storm petrel Flesh-footed shearwater Black-faced cormorant	Sea surface temperatures around Australia are expected to increase by 1–2 °C by 2030 and 2–3 °C by 2070 (Hobday et al. 2006). The south-west of Western Australia is one of three hotspots in the Indian Ocean where rising temperature trends exceed the Indian Ocean basin average (Feng et al. 2009). Changes in sea surface temperature are likely to have implications for the productivity of the region, with effects on a broad range of species (Feng et al. 2009), including pelagic foragers such as albatrosses and petrels (Baker et al. 2002). For a number of species, there is no long-term monitoring data at present to assess population effects resulting from climate-related changes.

Species assessed = 18		
Pressure	**Species**	**Rationale**
Change in oceanography (climate change)	Indian yellow-nosed albatross Great-winged petrel Soft-plumaged petrel White-faced storm petrel Flesh-footed shearwater Black-faced cormorant	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence. The weakening of the Leeuwin Current is likely to have implications for the productivity of the region, with uncertain and yet potentially significant effects on a broad range of species (Feng et al. 2009). There is uncertainty about the impact of changes in the strength of the Leeuwin Current and other oceanographic processes on many foraging and/or breeding seabirds in the south-west. Changes in productivity may influence prey availability, availability of suitable habitats.
Ocean acidification (climate change)	All species	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities. Seabirds might be affected by large-scale changes in the relative abundance of parts of the food chain.

Species assessed = 18		
Pressure	**Species**	**Rationale**
Chemical pollution or contaminants	Flesh-footed shearwater Caspian tern Australian lesser noddy Pacific gull Little penguin	Seabird populations that live in proximity to industrialised sites, such as the Perth metropolitan waters or King George Sound, are at risk of bioaccumulation of heavy metals, particularly from major dredging projects. Dredging activities have the potential to release heavy metals deposited over time in the sediment e.g. mercury, lead, into the pelagic food chain. This may pose a risk to seabirds and other predator species foraging in the area. Dredging guidelines (DEWHA 2009b) are in place to mitigate environmental impacts. Effectiveness of management in reducing contamination and bioaccumulation in seabirds species at industrialised sites of the region has not been assessed.
Marine debris	Indian yellow-nosed albatross Flesh-footed shearwater Bridled tern Little penguin	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). The Indian yellow-nosed albatross is one of the species known to be adversely affected by marine debris. Impacts on this species, particularly within the area of the South-west Region where the species forages at high density, are not known. Impacts on little penguins and flesh-footed shearwaters in the region have been recorded. Given the isolation of the south-west little penguin populations, impacts might be substantial if the pressure increases. The observed association between bridled tern and flotsam aggregations in down-welling zones may make this species more susceptible to plastic ingestion and oiling than other pelagic species.

Species assessed = 18		
Pressure	**Species**	**Rationale**
Light pollution	Flesh-footed shearwater Little shearwater Wedge-tailed shearwater Bridled tern Australian lesser noddy	Bright lighting can disorient flying birds and subsequently cause their death through collision with infrastructure or starvation due to disruptions in the ability to forage at sea (Wiese et al. 2001). It has the potential to result in substantial impacts on some affected species that might be subject to other pressures. Lighting mainly affects fledging shearwaters at coastal towns and ports, but at present it is unlikely to be significant at the population level. Future development of offshore infrastructure (e.g. petroleum industry) in this region may increase the population effects of this impact for some species and at some locations. Wedge-tailed shearwaters aggregate in large numbers off Perth in preparation for migration. Any sea installation in this area would have the potential to impact on a large number of birds.
Physical habitat modification	Australian lesser noddy Little penguin	The little penguin population breeding in the Perth region is currently threatened by habitat degradation due to coastal development in one of its prey nurseries (whitebait), and possibly by changes in prey distribution and availability caused by the Dawesville Cut (Cannell 2004). The range of Australian lesser noddy is restricted to the Houtman Abrolhos Islands, where they nest solely in mature mangroves. Modification of this habitat may have severe consequences for Australian lesser noddy populations (Surman & Nicholson 2006).
Nuisance species	White-faced storm petrel Australian lesser noddy	Increasing populations of nuisance species, such as silver gull and pied cormorant, can affect species vulnerable to predation on eggs and chicks, and competition for nesting sites. For example, silver gulls are known to eat other seabird eggs and chicks, and may displace other nesting seabirds through competitive exclusion from nesting sites (Surman & Nicholson 2006). Pied cormorants can damage woody vegetation required by other species for nesting, through mechanical damage and toxic effects from guano. There is evidence of an increase in the number of silver gulls on some of the inhabited islands in the Houtman Abrolhos Islands (Dunlop 2004) and in the Port Lincoln area, where they may impact upon seabird species nesting on the Sir Joseph Banks Group (Surman & Nicholson 2006).

Species assessed = 18		
Pressure	**Species**	**Rationale**
Extraction of living resources	Short-tailed shearwater Wedge-tailed shearwater Roseate tern Sooty tern Australian lesser noddy Common (brown) noddy Little penguin	This pressure is considered here in terms of its effect on prey or associate species important to protected seabirds. Some seabirds are highly dependent on specific prey species (Gaughan et al. 2002) or on predatory fish driving bait fish to the surface, and there is concern that declines in the number of predatory fish may have implications for seabird prey availability. It is important to note that the effect of tuna fishing in the Indian Ocean is difficult to separate from the probable decline in the productivity of the eastern Indian Ocean off Western Australia due to the weakening Leeuwin Current. Potential increases in the catch of small pelagic fish might affect seabirds that rely on them as forage fish. Fisheries targeting small pelagic fish operate in the South-west Marine Region in areas where seasonal upwellings support seabirds—such as the Eyre Peninsula coastal ecosystems, where large assemblages of small pelagic fish attract short-tailed shearwaters and little penguins.
Bycatch	Indian yellow-nosed albatross Soft-plumaged petrel Flesh-footed shearwater	Interactions of seabirds with longline fisheries are managed under the *Threat Abatement Plan for the incidental catch of seabirds in longline fishing operations* (DEWR 2006). Rate of coverage of independent scientific monitoring of interactions in the Western Tuna and Billfish Fishery has been high and shown low levels of interactions (Ward & Curran 2004). A recent review of wildlife bycatch in Commonwealth fisheries recommends that seabird bycatch in trawl fisheries be assessed to determine whether they are impacting on protected seabirds populations (Bensley et al. 2010; Phillips et al. 2010).

Species assessed = 18		
Pressure	**Species**	**Rationale**
Oil pollution	All species	Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas, could be severe. Birds foraging at sea are highly vulnerable to oiling, which in some instances may have population-level implications—for example, at breeding times. The intensity and distribution of activities implicated in oil spills—such as oil production and transport—are likely to increase in the region.
Collision with vessels	Little penguin	Mortality of the little penguin breeding population near Perth may be increasing due to collisions with boats as a result of the rapidly increasing numbers of recreational craft. Due to the size and relative isolation of the population and the current lack of data with respect to the rate of interaction, this pressure is *of potential concern* for the species.
Disease	Flesh-footed shearwater Wedge-tailed shearwater Little penguin	Species that have specialised diets, relying on one or a few forage species, are particularly vulnerable to outbreaks of disease in the prey species. The introduction of pathogens in forage fish, such as the pilchards herpes virus outbreaks in 1995 and 1998, has the potential to impact seabird species feeding on small pelagic fish. In particular, species with a highly specific diet, such as little penguin, flesh-footed shearwater and wedge-tailed shearwater, are vulnerable to such outbreaks, and this pressure is *of potential concern* for these species.

Table S1.14: Pressures *of concern* to selected shark species in the South-west Marine Region

Species assessed = 6		
Pressure	**Species**	**Rationale**
Bycatch	School shark White shark	School shark was listed in 2009 as conservation dependent under the EPBC Act. A rebuilding strategy is in place and the species is currently not targeted (AFMA 2009); some incidental catch is unavoidable by fisheries in the region that target gummy shark. The effectiveness of reduction in bycatch allowable catch is as yet unknown as it is likely to take several years before increases in the stock can be detected. Bycatch mortality continues to be *of concern* for this species until evidence of management effectiveness is conclusive. White shark is listed as threatened under the EPBC Act and is protected in Australian waters; the species interacts with a range of commercial and, to a lesser degree, recreational fisheries only accidentally. Whether the species is recovering is unknown given the lack of data on the population size and structure; consequently, the effectiveness of management measures is not fully understood and bycatch mortality continues to be *of concern* for this species until evidence of management effectiveness is conclusive.

Table S1.15: Pressures *of potential concern* to selected shark species in the South-west Marine Region

Species assessed = 6		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	School shark	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 to 1m by 2100, relative to 2000 levels (Climate Commission 2011). Higher sea level rises could occur (Church et al. 2009). Sea level rise is expected to result in increased rates of coastal erosion and an associated increase in sediment loads and water turbidity. These effects have the potential to detrimentally affect many shark species that utilise inshore habitats, such as estuaries, rocky reefs and kelp forest, for breeding and nursing. These include commercially important species such as school shark (Hobday et al. 2007). School shark is thought to occur in high concentrations on the inner shelf in Commonwealth waters adjacent to the Head of Bight. School sharks appear to use this relatively sheltered area of mixed seagrass, sand and limestone reef as nursery and feeding grounds.
Changes in sea temperature (climate change)	Grey nurse shark Porbeagle shark School shark White shark Shortfin mako	Sea temperatures have warmed by 0.7 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). There is a high level of agreement from different data sets that warming is affecting the distributional ranges and growth of temperate marine fishes (Booth et al. 2009). With these temperature increases, the preferred habitat for a range of species, including sharks, is predicted to move southwards by an average of 3.5 degrees (~390 km) along the west coast of Australia (Hobday et al. 2009). Implications for species with habitats along the southern coast of the region are not understood.

Species assessed = 6		
Pressure	**Species**	**Rationale**
Change in oceanography (climate change)	Grey nurse shark Porbeagle shark School shark White shark	The strength of the Leeuwin Current has decreased slightly since the 1970s. This weakening is expected to continue, although this prediction currently has low confidence (Feng et al. 2009). Changes in the strength of the Leeuwin Current are *of potential concern* through changes in productivity, influencing the distribution and abundance of sharks. There are a number of productivity hotspots in the region that may be affected by climate-related changes, including the Western Eyre and Kangaroo Island upwelling. This upwelling of productivity supports Australia's largest population of sardines, which, in turn, supports large aggregations of predators, and changes to this productivity could have significant impacts on community structure and function (Hobday et al. 2009).
Ocean acidification (climate change)	Grey nurse shark Longfin mako shark Shortfin mako shark Porbeagle shark School shark White shark	Driven by increasing levels of atmospheric CO_2 and subsequent chemical changes in the ocean, acidification is already underway and detectible. Since pre-industrial times, acidification has lowered ocean pH by 0.1 units (Howard et al. 2009). Furthermore, climate models predict this trend will continue, with a further 0.2–0.3 unit decline by 2100 (Howard et al. 2009). There is a high level of uncertainty about the effects of ocean acidification on marine life. While some organisms might be able to adapt (Orr et al. 2009), anticipated changes to phytoplankton and zooplankton have the potential to detrimentally affect ecosystem processes and the structure of ecological communities. The potential effects of increased ocean acidity on shark and fish species are not well understood. It is believed that for some invertebrates and fish, accumulation of CO_2 in the body may result in morphological changes, and impact metabolic state, physical activity and reproduction (Orr et al. 2009). Effects on phytoplankton and zooplankton are also likely to disrupt trophic dynamics and affect fish species and communities.

Species assessed = 6		
Pressure	**Species**	**Rationale**
Marine debris	School shark White shark Grey nurse shark Shortfin mako Porbeagle	*Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris* was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). Entanglement of Australian sharks in derelict fishing gear has been observed on numerous occasions (Alderman et al. 1999; Sloan et al. 1998), although few published records exist and there is uncertainty about the significance of the pressure for the species' conservation. Marine debris is expected to increase as both marine- and land-based sources of debris increase in the region.
Physical habitat modification	School shark	Habitat degradation as a result of coastal development or climate-related increases in coastal and inshore erosion may affect this vulnerable species. Research surveys of school shark nursery areas in Tasmania and Victoria have indicated a decline in abundance of pups between the 1950s and 1990s (McLoughlin 2007). School sharks depend on inshore nursery areas as habitat for females giving birth and for juveniles. Coastal development and human activity in adjacent waters are likely to have increased pollution and environmental degradation around these areas, and may be affecting the recovery capability of the species (McLoughlin 2007).
Human presence at sensitive sites	White shark	In waters adjacent to the south-west marine region (Neptune Islands in South Australia) regular interactions occur with white sharks in response to burleying by shark-cage diving tourism operators. The islands support the largest aggregations of pinnipeds in Australian waters of which the majority reside at the North Neptune Islands (Shaughnessy & McKeown 2002) and white sharks commonly visit the area to feed. Increases in periods of residency and in the duration and the timing of visits by sharks to the area which are consistent with responses to burleying have been documented (Bruce & Bradford 2011b) and management of industry activities is under review to reduce the level of impact on shark behaviour.

Species assessed = 6		
Pressure	**Species**	**Rationale**
Bycatch	Grey nurse shark Shortfin mako shark Porbeagle shark	Grey nurse sharks are caught in gillnet fisheries along the west and south-west coast of Western Australia. Records from the mid-1990s indicated that grey nurse shark was commonly distributed across the area and the population was stable (the west coast population was not subjected to the severe fishery-related declines experienced by the east coast population and populations elsewhere in the world). Reporting of incidental catches, however, ceased in 1997 following listing of the species as vulnerable under the EPBC Act, and thus there is some uncertainty about the ongoing status of the west coast population (Chidlow et al. 2006). While it is likely that this population is stable, the pressure is *of potential concern*, given the intrinsic vulnerability of this species and the limited understanding of the west coast population levels and structure. Shortfin mako has been reported as bycatch in gillnet and longline fisheries in the region. Porbeagle shark is caught as bycatch in pelagic longline fisheries and gillnets in the region. The significance of bycatch mortality from the region for these species is unknown but it is not likely to be significant relative to the pressures experienced by the species elsewhere in the world.
Collision or entanglement with infrastructure	White shark	Collision or entanglement with infrastructure is *of potential concern* to white shark, particularly interactions with aquaculture ropes and nets, which may result in entanglement and drowning (Trinder 2006). White sharks are the only protected species of shark that have been recorded in and around tuna pens in South Australia. White sharks are known to become entangled in nets or to enter aquaculture cages in search of food, posing a risk to stock and cage operators. In 2001, Malcolm et al. (2001) estimated that interaction with aquaculture infrastructure resulted in up to 20 white shark deaths per year, the significance of which is not understood given the uncertainty about white shark population levels and structure. Releasing sharks after they have entered aquaculture cages has had some success (Galaz & De Maddalena 2004). Evidence of effectiveness of management is not conclusive and the interaction remains *of potential concern*.

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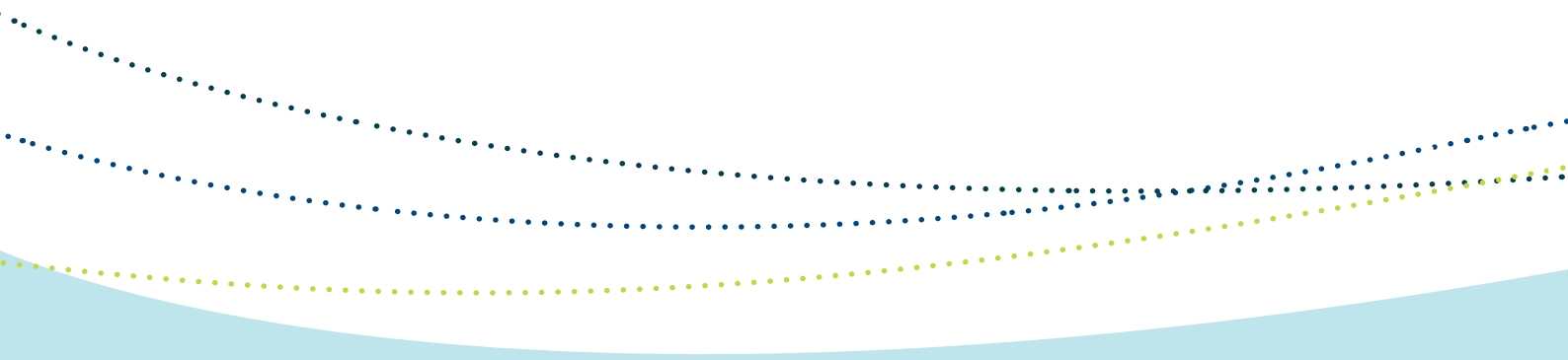

SCHEDULE 2

Regional advice on matters of national environmental significance

SCHEDULE 2 REGIONAL ADVICE ON MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

Introduction

Under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), an action requires approval from the environment minister if it has, will have or is likely to have a significant impact (see glossary **www.environment.gov.au/marineplans**) on a matter of national environmental significance. A person proposing to take an action that they think is, or may be, such an action must refer it to the minister for a decision as to whether further assessment and approval are required under the EPBC Act. Substantial penalties apply for taking such an action without approval.

There are currently eight matters of national environmental significance protected under the EPBC Act:

- world heritage properties
- national heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species (except those listed as extinct or conservation dependent) and ecological communities (except those listed as vulnerable)
- migratory species protected under international agreements
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- nuclear actions, including uranium mines.

This schedule to the South-west Marine Bioregional Plan has been prepared under the EPBC Act. It contains information about matters of national environmental significance within the South-west Marine Region and should be considered when deciding whether a proposed action needs to be referred to the environment minister for a decision.

Under section 176 of the EPBC Act, once a bioregional plan has been made, the environment minister must have regard to it when making any decision under the Act to which the plan is relevant. The minister will have regard to the information provided in Schedule 2 when making decisions about referrals, assessments and approvals, as well as other relevant decisions under the EPBC Act. However, this does not limit the information the minister may consider when making decisions.

The advice contained in this schedule is not comprehensive (i.e. it does not cover all matters of national environmental significance occurring in the South-west Marine Region) and should not be regarded as definitive in relation to those matters for which advice is provided. However, where advice is provided, this should be taken as an indication that the information is of sufficient quality to be taken into account in decision-making in relation to these matters of national environmental significance.

The regional advice should be read as supplementary to, and not as replacing, EPBC Act policy statements. In particular, the following policy statement is the key guidance document for determining whether a referral is required:

- *EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance.*

Depending on the type of action proposed, industry policy statements also provide important information:

- *EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales*
- *EPBC Act Policy Statement 2.2: Industry—offshore aquaculture*
- *EPBC Act Policy Statement 2.3: Wind farm industry.*

Other policy statements and guidelines may also be developed and provide important information. Further information and assistance can be obtained by contacting the referral business entry point through the department's community information unit on 1800 803 772 or by sending an email to **epbc.referrals@environment.gov.au**.

Schedule 2 does not provide advice for the assessment of the environmental performance of fisheries managed under Commonwealth legislation and state export fisheries. Guidelines for the strategic assessment of fisheries under Part 10 of the EPBC Act; assessments relating to impacts on protected marine species under Part 13; and assessments for the purpose of export approval under Part 13A are contained within the document Guidelines for the Ecologically Sustainable Management of Fisheries: **www.environment.gov.au/coasts/fisheries/publications/guidelines.html**.

Using the regional advice

This schedule is a guide and is not definitive. The regional advice provided in this Schedule is augmented by information provided in the conservation values report cards, which are available on the website of the Department of Sustainability, Environment, Water, Population and Communities at: **www.environment.gov.au/marineplans/south-west**.

The rating of risks in this schedule was developed to provide practical information on the kinds of actions which should be referred to determine if approval under the EPBC Act is needed. The ratings here are not designed to prioritise environmental risks. They relate to the risk of a proposed action needing to be referred under the EPBC Act. The highlighted advice provide further assistance in identifying types of activities that are at low risk of needing to be referred and those that are at higher risk of needing to be referred.

Considerations underpinning the rating of a risk include:

- pressure rating (of key ecological features and species, see Tables S1.2 and S1.3)
- conservation status (of species)
- presence of a biologically important area (for species; see Conservation Values Atlas)
- trends in pressures.

Commonwealth marine environment: Section 24 of the EPBC Act defines the Commonwealth marine area. It is the area that extends beyond the outer edge of State and Territory waters, generally 3 nautical miles (or 5.5 kilometres) from the coast, to the boundary of Australia's exclusive economic zone generally 200 nautical miles from shore (or 370 kilometres). Under the EPBC Act, the environment within the Commonwealth marine area is a matter of national significance.

Where sufficient information exists to aid decision-making, this schedule presents regional advice on the Commonwealth marine environment in relation to:

- key ecological features of the South-west Marine Region
- protected species that occur in the South-west Marine Region that are not otherwise matters of national environmental significance.

Some advice provided in this schedule refers to **biologically important areas**: These are areas that are particularly important for the conservation of protected species and where aggregations of individuals display biologically important behaviour, such as breeding, foraging, resting or migration. The presence of the observed behaviour is assumed to indicate that habitat required for the behaviour is also present. Regional advice has been developed for biologically important areas due to their relevance to a protected species. The advice focused on these areas should not be construed to mean that legislative obligations do not apply outside these areas. Biologically important areas are not protected matters and should not be confused with 'critical habitat' as defined in the EPBC Act.

A register of **critical habitat** is maintained under the EPBC Act. The register lists habitats considered critical to the survival of a listed threatened species or listed threatened ecological community. If a habitat occurs in or on a Commonwealth area and is listed in the register, it is an offence under the EPBC Act to take an action when it is known that the action significantly damages the critical habitat.

Species protected under the EPBC Act may be listed as threatened, migratory or marine species. Those protected species that are matters of national environmental significance are:

- threatened species (other than those categorised as extinct or conservation dependent)
- migratory species.

Species that are listed under the EPBC Act but are not matters of national environmental significance include those species that are listed as:

- marine (s. 248 of the EPBC Act)
- cetaceans (whales, dolphins and porpoises)
- threatened species listed as extinct or conservation dependent.

However, it is possible for listed marine species and cetaceans to also be matters of national environmental significance; that is, where they have been listed as a threatened species (other than in the conservation dependent category) or as migratory. For example, the humpback whale is listed as a cetacean but it is also a matter of national environmental significance because it is listed as vulnerable and migratory under the EPBC Act.

A number of terms related to protected species that are matters of national environmental significance have specific meaning under the EPBC Act, namely:

- **Population**: A population of a species is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to species that are categorised as critically endangered, endangered or vulnerable occurrences include but are not limited to:
  - a geographically distinct regional population or collection of local populations
  - a population or collection of local populations that occurs within a particular bioregion.
- **Important population:** This term relates to populations of threatened species that are categorised as vulnerable under the EPBC Act. An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or populations that are:
  - key source populations for either breeding or dispersal
  - necessary for maintaining genetic diversity
  - near the limit of the species' range.

This definition is consistent with that provided in EPBC Act *Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance (2009)*. In accordance with these guidelines, in determining the significance of an impact on a vulnerable species, consideration should be given to whether an important population is found in the area.

- **Ecologically significant proportion of a population:** This term applies to species listed as migratory. In accordance with *Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance*, for migratory listed species, consideration should be given to whether an ecologically significant proportion of a population is found in an area. Whether the species in an area represents an ecologically significant proportion of a population needs to be determined on a case-by-case basis, as different species have different life histories and populations. Some key factors that should be considered include the species' population status, genetic distinctiveness and species-specific behavioural patterns (for example, site fidelity and dispersal rates).

Schedule 2.1
The Commonwealth marine environment of the South-west Marine Region

The Commonwealth marine environments, including the South-west Marine Region, is a matter of national environmental significance under the EPBC Act. An action requires approval if it is taken:

- in a Commonwealth marine area, and the action has, will have or is likely to have a significant impact on the environment, or
- outside a Commonwealth marine area but within Australian jurisdiction and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area.[6]

The South-west Marine Region covers the Commonwealth waters from the eastern end of Kangaroo Island, South Australia, to offshore of Shark Bay, Western Australia, generally between 3 and 200 nautical miles from the coast.

The marine environment is made up of numerous habitats, biological communities and ecosystems. Determining whether a proposed action has the potential to cause a significant impact on the marine environment requires consideration of its individual and combined components at a scale relevant to the action.

The EPBC Act Policy Statement 1.1 outlines criteria to assist in determining the significance of impacts on the Commonwealth marine environment. Specifically, an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:

- result in a known or potential pest species becoming established in the Commonwealth marine area.
- modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that there will be an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area
- have a substantial adverse effect on a population of a marine species or cetacean, including its lifecycle (e.g. breeding, feeding, migration behaviour or life expectancy) and spatial distribution

6 Actions taken outside the Commonwealth marine area may impact on its environment through downstream effects—for example, by resulting in water quality changes that can spread offshore beyond 3 nautical miles or by adversely affecting species that are an important component of the Commonwealth marine environment, either throughout, or at specific stages of, their lifecycle. For example, seagrass beds are an important nursery habitat for a number of species, some of which move offshore in their adult stages. Reductions in seagrass beds—for example, as a result of dredging—depending on their extent, have the potential to impact on the population dynamics of a number of species that inhabit the Commonwealth marine area.

- result in a substantial change in air quality or water quality (including temperature) that may adversely impact on biodiversity, ecological integrity, social amenity or human health
- result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected
- have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of a historic shipwreck.

The regional advice in this schedule has been developed to assist the interpretation of some of these criteria within the context of the South-west Marine Region. The regional advice addresses:

S2.1.1: establishment of marine pest species

S2.1.2: adverse impacts on marine ecosystem functioning and integrity

S2.1.3: adverse effects on populations of a marine species or cetacean (excluding those listed as threatened or migratory)

S2.1.4: adverse impacts on heritage values

S2.1.5: actions in Commonwealth marine reserves.

S2.1.1 Establishment of marine pest species

Although the Commonwealth waters of the South-west Marine Region contain introduced marine species, none have yet established as invasive pest species[7].

The four marine pest species known to occur in the south-west are currently limited to port environments (Table S2.1). Of these, the invasive strain of the green alga Caulerpa is capable of invading benthic communities in depths up to 100 m. Near the region, this species is currently only found in Port Adelaide, and a number of measures to contain its spread have been put in place. Other species currently not recorded in the region but established in the neighbouring South-east Marine Region and capable of spreading into deeper water environments include Northern Pacific seastar, New Zealand screw shell and Japanese kelp. The National System for the Prevention and Management of Marine Pest Incursions, as part of its Emergency Marine Pest Plan, maintains a 'trigger list' comprising species that may become invasive if introduced.[8]

7 Introduced marine pests are marine plants or animals that are not native to Australia but have been introduced by human activities such as shipping and have become aggressive pests.

8 **www.marinepests.gov.au**

Table S2.1: Marine pests known to be established in or adjacent to the South-west Marine Region

Pest name	Location	Impact	Habitat
Aquarium caulerpa *Caulerpa taxifolia*	Port Adelaide	Overgrows native habitat and can establish vast beds on soft sediment, degrading fish habitat Tangles in nets and anchors	Up to 100 m depth Exposed and sheltered estuaries, coastal lagoons and bays Rock, sand, mud and seagrass beds
Asian date mussel *Musculista senhousia*	Port Adelaide Fremantle	Can form mats on soft sediments, smothering bottom communities and altering food availability	Prefers soft sediments but also fouls artificial hard surfaces Up to 20 m depth
European fan worm *Sabella spallanezanii*	Port Adelaide Albany Bunbury Fremantle	Forms dense colonies consuming vast amounts of food No known predators in Australia Fouls aquaculture structures, increasing cost for industry	Tubes attached to hard surfaces, artificial structures, rocks, shells and seagrass on soft sediments Sheltered waters, to 30 m depth
European green shore crab *Carcinus maenas*	Port Adelaide	Aggressive predator, out-competes natives for food and habitat	Prefers bays and estuaries, but found on all types of shores up to 60 m depth Tolerates temperatures up to 30 °C

The following types of actions have the potential to result in marine pests becoming established in the Commonwealth marine environment, thereby affecting the biodiversity values and/or ecological integrity of the Commonwealth marine environment:

- development of new ports or upgrades of existing port facilities that substantially increase shipping traffic
- construction of infrastructure or any other action involving the translocation into the region of marine equipment (e.g. dredges or platforms), from within or outside Australia.

There is a **low risk** of marine pests becoming established in the Commonwealth marine environment or affecting its biodiversity values and/or ecological integrity as a result of these actions when appropriate **mitigation measures are adopted**. Mitigation measures consistent with the National System for the Prevention and Management of Marine Pest Incursions, the Australian Ballast Water Management Requirements, the National Biofouling Management Guidelines for Commercial Vessels[9] and the *National Biofouling Management Guidelines for Recreational Vessels*[10] aim to reduce the risk that actions will result in the introduction of marine pests in port and inshore environments, such that they might significantly impact on the Commonwealth marine environment. Further information on responsibilities regarding the management of marine pest incursions is provided at **www.marinepests.gov.au**.

Temperate southern Australian habitats, including those of the South-west Marine Region, are considered to be at great risk globally from introduced marine species, because of their long (in geological terms) isolation from other temperate marine habitats of the world. In addition, the east coast of Australia has many species that have evolved independently of those on the west coast, because of the absence of, or limited, gene flow. In this situation, a number of species—whether from other temperate regions in the world or, in some cases, from the east of Australia—would not have natural controls and, given favourable environmental conditions, would be likely to become invasive if introduced in the south-west marine environment.

9 **www.marinepests.gov.au/__data/assets/pdf_file/0011/1109594/Biofouling_guidelines_commercial_vessels.pdf**

10 **www.marinepests.gov.au/__data/assets/pdf_file/0009/1109592/biofouling_guidelines_rec.pdf**

Marine pests can be introduced through ballast water exchange or via biofouling. High-risk vessels for the introduction of species include those that are slow moving, have spaces where marine species can settle, come in close contact with the sea bottom and remain in a single area for extended periods. This increases the likelihood that a species will become settled at a locality from where it is then introduced to new regions. Vessels in this category include dredges, supply boats, drilling rigs and some fishing boats. Other high-risk ships include some of the flag-of-convenience carriers that are low-cost operators with poorly maintained vessels, as well as small private recreational vessels from other parts of the world.

Inshore areas, particularly port areas and sites where infrastructure development and maintenance take place, have the highest risk of marine pests becoming established. Some introduced species have the potential to settle in or expand into deeper waters, including in the offshore Commonwealth marine environment.

S2.1.2 Adverse impacts on marine ecosystem functioning and integrity

The South-west Commonwealth marine environment report card provides an overview of key ecological features defined for the region and their relevance to ecosystem processes and structure. While the report card provides useful context, determining potential impacts of specific activities on the Commonwealth marine environment requires consideration of habitats and biodiversity at an appropriate subregional and local scale.

The regional advice below provides further guidance for considering impacts on areas and habitats that are defined as key ecological features in the South-west Marine Region by virtue of their regional importance for biodiversity and/or ecosystem functioning and integrity. The report card provides further information, including references to relevant scientific literature, on the region's key ecological features.

The advice below provides information of relevance to persons considering impacts on the Commonwealth marine environment. It is essential to note that provision of advice in relation to the key ecological features does not imply that they are the only habitats, areas, species or species groups that should be considered when determining the significance of potential impacts on the Commonwealth marine environment. It remains the responsibility of a person proposing to take an action to determine whether there is a real or not remote chance or possibility that the action is likely to result in a significant impact on the Commonwealth marine environment.

The South-west Marine Bioregional Plan recognises 12 areas and/or types of habitats and four species or species groups that are key ecological features in the region (Figure S2.1 and Section 2.1.3). Further information on these features is provided in the South-west Commonwealth marine environment report card (**www.environment.gov.au/marineplans/south-west**).

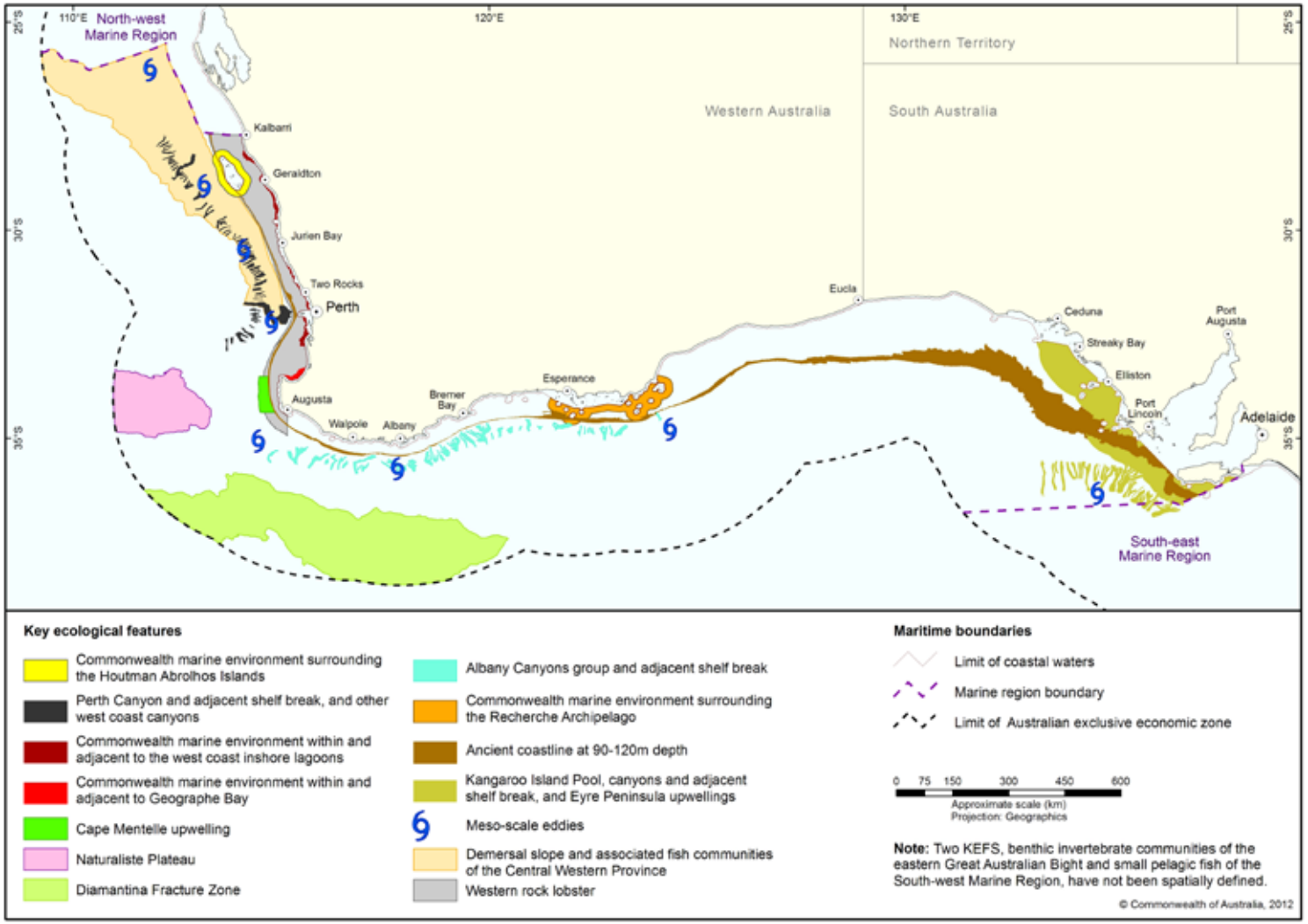

Figure S2.1: Key ecological features in the South-west Marine Region

In assessing the impacts of a proposed action on the Commonwealth marine environment and their significance, the relevance of the proposed action to the regional importance and vulnerabilities of the key ecological features described below should be considered.

Commonwealth marine environment surrounding the Houtman Abrolhos Islands: This key ecological feature is recognised for its biodiversity values, which apply to both its benthic and its pelagic habitats.

The Houtman Abrolhos Islands and surrounding reefs have been relatively well studied and are noted for their high species diversity. The islands represent the southern limit in Western Australia of many widespread Indo-Pacific tropical fish. 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. The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean. They support more than one million pairs of breeding seabirds, including sedentary and migratory species. Many of the islands' biodiversity features rely on the benthic and pelagic ecosystems in deeper, offshore waters—most notably, seabirds and rock lobster.

Potential pressures on ecosystem functioning and integrity of this key ecological feature include:

- commercial and recreational fishing, which may lead to overexploitation of important species (considered in Schedule 1)
- activities associated with coastal and marine infrastructure development, which have the potential to impact on water quality, and increase the risk of oil spill, chemical contamination and nutrient pollution
- onshore or offshore construction or dredging which results in habitat modification
- climate change.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat in the Commonwealth marine area around the Houtman Abrolhos Islands such that an adverse impact on marine ecosystem functioning or integrity results
- a substantial change in water quality (including temperature), which may adversely impact on biodiversity or ecological integrity of the Commonwealth marine area around the Houtman Abrolhos Islands
- persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the area around the Houtman Abrolhos Islands such that biodiversity or ecological integrity may be adversely affected

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising (e.g. port developments and drilling) in the Commonwealth marine area surrounding the Houtman Abrolhos Islands have a **risk** of significant impact on the Commonwealth marine environment.

Perth Canyon and adjacent shelf break, and other west coast canyons: This key ecological feature is recognised for its ecological functioning and integrity values (high productivity) and biodiversity values (aggregations of marine life; unique seafloor feature with ecological properties of regional significance). Values apply to both the benthic and the pelagic habitats of this feature.

The west coast system of canyons spans an extensive area (8744 km^2) of continental slope offshore from Kalbarri to south of Perth. The system includes Geographe Canyon, Busselton Canyon, Pelsaert Canyon, Geraldton Canyon, Wallaby Canyon, Houtman Canyon, Murchison Canyon and, most notably, the Perth Canyon. The Perth Canyon is prominent among the west coast canyons because of its size and ecological importance; however, the sheer abundance of canyons spread over a broad latitudinal range makes this feature important as a whole.

The west coast canyons are believed to be associated with small, periodic upwellings that locally enhance productivity and attract aggregations of marine life. In the Perth Canyon, the upwelling of deep ocean currents creates a nutrient-rich cold-water habitat that attracts 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. Cetacean species, predominately pygmy blue whales, aggregate in the canyon from November to May. The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs.

A number of human activities take place in, and potentially detrimentally affect, the environments of the Perth Canyon and other west coast canyons.

Potential pressures on ecosystem functioning and integrity of this key ecological feature include:

- noise-generating activities, which might affect large whales that use these habitats (these are considered in Schedule 2.5)
- bycatch and extraction of living resources , potentially leading to overexploitation of important species increased shipping traffic that might increase the likelihood of oil spill and chemical contamination and of ship strike for megafauna aggregating in the area (these are considered in Schedule 2.5)
- changes to oceanographic processes that are linked to localised productivity, and potential changes to community structure arising from shifts in marine species distribution as a result of climate change.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the area around the west coast canyons such that biodiversity or ecological integrity may be adversely affected have a **high risk** of significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. port developments that increase shipping and drilling) in the area around the west coast canyons have a **risk** of significant impact on the Commonwealth marine environment of the South-west Marine Region.

Commonwealth marine environment within and adjacent to the west coast inshore lagoons: This key ecological feature is recognised for its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values. Values apply to both the benthic and the pelagic habitats within the feature.

The chain of inshore lagoons that extends from south of Mandurah to Kalbarri is considered important for benthic productivity and recruitment for a range of marine species. The lagoons are formed by distinct ridges of limestone reef with extensive beds of macroalgae (principally Ecklonia spp.) and extend to a depth of 30 m. These inshore lagoons extend in places into the Commonwealth marine environment of the South-west Marine Region. Although macroalgae and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the inshore lagoon. The inshore lagoons are important areas for the recruitment of commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, and many other reef species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon. Seagrass meadows occur in more sheltered areas and in the inter-reef lagoons along exposed sections of the coast

Potential pressures on ecosystem functioning and integrity of this key ecological feature include:

- coastal and marine infrastructure development and associated changes in water quality (oil, chemical and nutrient pollution, turbidity)
- development of offshore aquaculture and other marine infrastructure, which might adversely affect benthic communities
- bycatch and extraction of living resources, potentially leading to overexploitation of important species
- sea level rise, changes in sea temperature, changes in oceanography and ocean acidification as a result of climate change
- invasive species.

Actions that irrespective of where they occur, have a real chance or possibility of resulting in:

- modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity of the west coast inshore lagoons results
- nutrient pollutants, persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the west coast inshore lagoons

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. port developments that increase shipping and drilling) in the west coast inshore lagoon habitats have a **risk** of significant impact on the Commonwealth marine environment of the South-west Marine Region.

Commonwealth marine environment within and adjacent to Geographe Bay: This key ecological feature is recognised for its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values. Values apply to both the benthic and the pelagic habitats within the feature.

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 migratory habitat for humpback whales.

Potential pressures on ecosystem functioning and integrity of this key ecological feature include:

- changes to water quality due to chemical and nutrient pollution or changes in turbidity
- physical habitat modification
- extraction of living resources
- noise pollution (considered in Schedule 2.5)
- oil pollution

- sea level rise, changes in sea temperature, changes in oceanography and ocean acidification as a result of climate change
- invasive species.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in:

- modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat (e.g. action resulting in a substantial reduction of the extent of seagrass meadows) such that an adverse impact on marine ecosystem functioning or integrity of Geographe Bay results
- a substantial change in water quality, which may adversely impact biodiversity, ecosystem functioning or integrity of Geographe Bay (e.g. changes in water quality that persistently affect light penetration across a substantial area)
- nutrient pollutants, persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in Geographe Bay

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill or other chemical pollution has a reasonable potential of arising (e.g. port developments that increase shipping and drilling) in Geographe Bay have a **risk** of significant impact on the Commonwealth marine environment of the South-west Marine Region.

Cape Mentelle upwelling: This feature is recognised because of its ecological functioning and integrity (high productivity) values.

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 onto the continental shelf, resulting 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. Climate change, through shifts in the strength of the Leeuwin Current, has the potential to alter the ecological values of this feature.

Potential pressures on ecosystem functioning and integrity of this key ecological feature include:

- bycatch
- changes in sea temperature, changes in oceanography and ocean acidification as a result of climate change
- oil spills, as a number of species aggregate in the area (although the likelihood of oil spills is currently low, there is potential for the likelihood to increase as shipping traffic—particularly of large vessels—increases around the south-west corner).

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in the area of the Cape Mentelle upwelling have a **risk** of significant impact on the Commonwealth marine environment of the South-west Marine Region.

Naturaliste Plateau: This feature is recognised for its biodiversity values (including a unique seafloor feature with ecological properties of regional significance), which apply to its benthic and demersal habitats.

The Naturaliste Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope. Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau. The Plateau features cliffs up to 1000 m high. It 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 subtropical convergence front. Although very little is 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.

Potential pressures include changes in sea temperature, change in oceanography and ocean acidification as a result of climate change. There are no other readily identifiable pressures on the habitat values of the Naturaliste Plateau, due to its remote location, in terms of both distance from shore and depth.

Generally, actions in or adjacent to the South-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Naturaliste Plateau because of the depth of this feature.

Diamantina Fracture Zone: This feature is recognised for its biodiversity values (including a unique seafloor feature with ecological properties of regional significance), which apply to its benthic and demersal habitats.

The Diamantina Fracture Zone is a rugged, deep-water environment composed of seamounts and numerous closely spaced troughs and ridges covering more than 100 000 km^2. Ridges can rise up to 4000 m from the seafloor; together with seamounts, these can affect water dynamics and flow, enhancing productivity. They may act as 'stepping stones' for species dispersal and migration across the region and the wider abyssal plain. Very little is known about the ecology of this remote deep-water feature. Marine experts note 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.

Potential pressures include changes in sea temperature, change in oceanography and ocean acidification as a result of climate change. There are no other readily identifiable pressures on the habitat values of the Diamantina Fracture Zone, due to its remote location, in terms of both distance from shore and depth.

Generally, actions in or adjacent to the South-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Diamantina Fracture Zone because of the depth of this feature.

Albany canyons group and adjacent shelf break: This feature is recognised because of its ecological functioning and integrity values (high productivity) and biodiversity values (aggregations of marine life; unique seafloor feature with ecological properties of regional significance), which apply to both its benthic and its pelagic habitats.

The Albany canyons group consists of 32 canyons that cut deeply into 700 km of steep continental slope. The canyon system extends from Broke Canyon in the west to the Albany, Vancouver, Wilyunup, Bremer and Malcolm canyons to the east. The canyons are believed to be associated with small periodic upwellings that enhance productivity and attract aggregations of marine life. In contrast to other canyon systems in the South-west Marine Region, the Albany canyons are immediately adjacent to, and interact with, a large section of continental shelf break. Anecdotal evidence indicates that this area supports fish aggregations that attract large predatory fish, sharks, and toothed, deep-diving whales such as sperm whale.

Existing pressures on the integrity of habitats in this key ecological feature include:

- bycatch
- changes in sea temperature, change in oceanography and ocean acidification as a result of climate change
- noise-generating activities which might affect large whales that use these habitats (these are considered in Schedule 2.5).

Generally, actions in or adjacent to the South-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Albany canyon group and adjacent shelf break.

Commonwealth marine environment surrounding the Recherche Archipelago: This key ecological feature is recognised because of its biodiversity values.

The Recherche Archipelago is the most extensive area of reef (35 203 km^2 of reef habitat) in the South-west Marine Region. 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 macroalgae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals. The islands are all nature reserves. Tourism development, including accommodation, is present on only one island (Woody Island).

Potential pressures on the biodiversity values of this key ecological feature include:

- extraction of living resources and bycatch
- severe oil spills, nutrient pollution and chemical pollution
- sea level rise, changes in sea temperature, change in oceanography and ocean acidification as a result of climate change
- invasive species.

Actions that, irrespective of where they take place, have a real chance or possibility of resulting in:

- a substantial change in water quality, which may adversely impact biodiversity, ecosystem functioning or integrity of the Commonwealth waters surrounding the Recherche Archipelago
- nutrient pollutants, persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the Commonwealth waters surrounding the Recherche Archipelago

have a **high risk** of a significant impact on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in the area of the Commonwealth waters surrounding the Recherche Archipelago have a **risk** of a significant impact on the Commonwealth marine environment of the South-west Marine Region.

Ancient coastline between 90 and 120 m depth: This key ecological feature is recognised because of its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values. Values apply to the benthic habitats of the feature and the associated demersal communities.

The continental shelf of the South-west Marine Region contains several terraces and steps, which reflect the gradual increase in sea level across the shelf that occurred over the past 12 000 years. The west coast inshore lagoons are an example of this. Some of these occur as escarpments, although their elevation and distinctness vary throughout the region. Where they are prominent, they create topographic complexity that may facilitate small, localised upwellings due to local acceleration of water movements; benthic biodiversity; and enhanced biological productivity. A prominent escarpment occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90–120 m. Experts suggest that, in places, this ancient coastline may support some demersal fish species travelling across the continental shelf to the upper continental slope—thereby supporting ecological connectivity. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment, such as in the western Great Australian Bight, where it is dominated by sponge communities of significant biodiversity and structural complexity. Large sponges up to one metre across—which is remarkable for any discrete colonial animal—have been recorded from this area; the large individuals at these depths are likely to be many decades old.

Potential pressures on the integrity of habitats of this key ecological feature include:

- physical habitat modification from activities such as bottom trawling (although this activity is limited by the morphology of the sea bed).
- sea level rise, changes in sea temperature, change in oceanography and ocean acidification as a result of climate change
- extraction of living resources.

Actions that have a real chance or possibility of resulting in modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that they cause an adverse impact on marine ecosystem functioning or integrity of the ancient coastline at 90–120 m depth off the Great Australian Bight have a **high risk** of significant impact on the Commonwealth marine environment.

Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings: This key ecological feature is recognised for its ecological functioning and integrity values (high productivity) and biodiversity values (aggregations of marine life; unique seafloor feature with ecological properties of regional significance). Values apply to the benthic and pelagic habitats of these features.

The Kangaroo Island canyons include a small group of steep-sided, narrow canyons that commence at the eastern end of the Ceduna Terrace, and continue to the Murray Canyons in the adjoining South-east Marine Region. The 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, 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 might spawn in this area, and there is empirical evidence that orange roughy eggs occur in high densities in the area. The shelf break adjacent to the canyons is known for high yields of giant crab and southern rock lobster. Very little is known about the connectivity between this extensive canyon system on the deep slope and the shelf. It is thought that blind canyons (that is, those that do not encroach onto the shelf, which is the case for the westernmost canyons of the feature) on the Eyre and Ceduna Terraces may act as conduits for deep-water upwelling, creating conditions that may be conducive to feeding and calving for whales.

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. These, in turn, attract marine mammals (e.g. toothed whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds. The variation in space, time and intensity of the upwellings (Kämpf et al. 2004; Kämpf 2010) provides a challenge for designating a protection zone around the entire feature.

Potential pressures on the ecological functioning and integrity of this key ecological feature include:

- oil spills affecting aggregations of species at upwellings
- extraction of living resources and bycatch
- changes in sea temperature, change in oceanography and ocean acidification as a result of climate change
- noise pollution for marine megafauna (considered in Schedule 2.5).

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in the area of the Kangaroo Island Pool, Kangaroo Island canyons and adjacent shelf break or the Eyre Peninsula upwellings have a **risk** of a significant impact on the Commonwealth marine environment.

Meso-scale eddies (several locations): Meso-scale eddies are a pelagic key ecological feature, which is recognised because of its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values.

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 mesoscale 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 (cold-core) eddies are considered to play an important role in lifting deep water, which can be cooler and richer in nutrients, towards the surface, where it can enhance production of plankton communities that attract aggregations of marine life. Warm-core (anticyclonic) mesoscale eddies are also important features of the South-west Marine Region because they are consistently associated with high phytoplankton biomass, transport coastal phytoplankton communities offshore, and support much larger communities of larger phytoplankton species than the surrounding waters. They therefore provide an important food source for mesozooplankton in otherwise oligotrophic waters.

Potential pressures include changes in sea temperature, change in oceanography and ocean acidification as a result of climate change.

> Generally, actions in or adjacent to the South-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the meso-scale eddies.

S2.1.3 Adverse impacts on populations of a marine species or cetacean (excluding those listed as threatened or migratory)[11]

An impact on the Commonwealth marine environment might be significant if there is a real chance or possibility that it will result in a substantial adverse effect on a population of a marine species, including its lifecycle and spatial distribution. The regional advice below provides further guidance that might assist in considering impacts on the Commonwealth marine environment of the South-west Marine Region and their significance, with respect to:

- protected marine species which are not considered matters of national environmental significance, including
  - cetaceans of known regional importance (that are not listed as threatened or migratory species under the EPBC Act)
  - listed marine species of known regional importance (that are not listed as threatened or migratory species under the EPBC Act)
- threatened species listed as conservation dependent that are of known regional importance
- species and/or communities that have been defined as key ecological features, as they are believed to play an important role in the South-west Marine Region's ecosystem structure and functioning and/or to have a particular relevance to its biodiversity and conservation.

It is essential to note that the provision of advice in relation to these species and communities does not imply that they are the only species and communities that should be considered in determining the significance of potential impacts on the Commonwealth marine environment. It remains the responsibility of a person proposing to take an action to determine whether the action will adversely and substantially affect any other marine species or community in a way that results in a significant impact on the Commonwealth marine environment.

11 Advice on the significance for species listed as threatened and/or migratory that are matters of national environmental significance is provided in Schedules 2.2 to 2.5. (Listed threatened species that are conservation dependent and are not, of themselves, matters of national environmental significance are discussed here.)

Protected species of known regional importance (not listed as threatened or migratory)

Fifty species protected under Part 13 of the EPBC Act (but not listed as threatened or migratory) are currently known to occur in the South-west Marine Region (Table A). The information currently available on many of these species is insufficient to provide separate regional advice. Sixteen species are of known importance in the context of the region's biodiversity and/or ecological functioning. These species are described below to assist in the interpretation of the significant impacts criteria of EPBC Act Policy Statement 1.1.

Strap-toothed beaked whale *(Mesoplodon layardii)*, also known as strap-toothed whale or Layard's beaked whale, is a cetacean and therefore protected under the Act. It is the most commonly encountered of the beaked whales, which are a little-known and rarely sighted group of whales. While there is uncertainty about the ecology of all beaked whales, the greater frequency of encounters with this species and their seasonality might indicate that this species may feed and breed in the region. The species is known mainly from strandings, which in the south-west are more common between January and April. The population status is unknown. There is some evidence from overseas of impacts on beaked whales from noise-generating activities and, in particular, sonar activities.

> Noise-generating activities, particularly the use of active sonar in the region between January and April, have a **risk** of a substantial adverse effect on a population of strap-toothed beaked whale.

Common dolphin *(Delphinus delphis)*, **bottlenose dolphin** *(Tursiops truncatus)* and spotted or **Indo-Pacific bottlenose dolphin** *(Tursiops aduncus)* are protected within the Australian Whale Sanctuary.[12] They are widespread and abundant in the South-west Marine Region and inhabit the continental shelf waters. Some populations in the south-west appear to be either permanently or seasonally resident in specific areas (Spencer Gulf, Bunbury, Swan River, Cockburn Sound). Dolphins with limited distribution might be more vulnerable to chemical contamination and oil spills and are known to suffer adverse effects through ingestion of, or entanglement in, marine debris. Dolphin watching is a fast-developing tourism industry sector, whose effects on the biology and ecology of dolphins are not well understood.

12 The Australian Whale Sanctuary was established under the EPBC Act to protect all whales and dolphins in Australian waters. The Australian Whale Sanctuary comprises the Commonwealth marine area and covers all of Australia's Exclusive Economic Zone which generally extends out to 200 nautical miles from the coast and includes the waters surrounding Australia's external territories such as Christmas, Cocos (Keeling), Norfolk, Heard and Macdonald Islands. Within the Australian Whale Sanctuary it is an offence to kill, injure or interfere with a cetacean. Severe penalties apply to anyone convicted of such offences. More information about the Australian Whale Sanctuary can be found at **www.environment.gov.au/coasts/species/cetaceans/conservation/sanctuary.html** All states and territories also protect whales and dolphins within their waters.

Actions that have a real chance or possibility of causing a chemical contamination, oil spill or increased sedimentation in areas occupied by bottlenose and common dolphins have a **risk** of a substantial adverse effect on populations of these species.

Actions that have a real chance or possibility of increasing localised vessel traffic, including small craft, in areas where common dolphins and/or bottlenose dolphins reside have a **risk** of substantial adverse impact on populations of these species.

Actions that have a real chance or possibility of increasing marine debris in areas occupied by bottlenose and common dolphins have a **risk** of a substantial adverse effect on populations of these species.

Long-snouted spinner dolphin *(Stenella longirostris)* is protected within the Australian Whale Sanctuary. It has a tropical and subtropical distribution and occurs in oceanic environments and over the continental slopes off the west coast of the region. It is commonly sighted around the Perth Canyon. The species has declined in the past as a result of interactions with fisheries in the Arafura Sea. No immediate threat is readily identifiable in the region.

The occurrence of long-snouted spinner dolphin in the region and its priority status in the context of the Action Plan for Small Whales and Dolphins should be considered in determining impacts of actions in the Commonwealth marine area off the west coast, and in the Perth Canyon in particular.

The seabird species described below are all listed marine species and protected under the EPBC Act.

- **Black-faced cormorant** *(Phalacrocorax fuscescens)*: This species is endemic to southern Australia, with a western population that is centred on Recherche Island, where a colony has persisted since 1889. This colony is separate and isolated from the eastern population. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas: **www.environment.gov.au/marineplans/cva**).

- **Fairy tern** *(Sternula nereis)*: This species forages mainly inshore and breeds mostly on islands. It is common around the Houtman Abrolhos Islands and around islands off the lower west coast of Western Australia. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas). Human disturbance at nesting sites might impact on the species by reducing reproductive success.
- **Sooty tern** *(Onychoprion fuscata)*: Seventy-two per cent of Australia's sooty tern breeding population nests in the region. It is found mostly at sea, in offshore pelagic environments. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas). The Australian population is considered secure, and no threats are readily identifiable.
- **Great-winged petrel** *(Pterodroma macroptera)*: While this species disperses across temperate Australian waters during the non-breeding season, the entire Australian breeding population nests in the region on islands of the Recherche Archipelago and off Albany. Biologically important areas are defined for this species (see **www.environment.gov.au/marineplans/cva**).
- **White-faced storm petrel** *(Pelagodroma marina)*: This species breeds and forages extensively in pelagic environments across the region in summer, and migrates to tropical latitudes in the non-breeding season. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas). A known threat is the predation of chicks and eggs by introduced pest species and nuisance (increaser[13]) species.
- **Little shearwater** *(Puffinus assimilis)*: With the exception of colonies at Norfolk and Lord Howe Islands, this species occurs only in the South-west Marine Region. The south-west population is considered a subspecies (tunneyi). Fifty-eight per cent of Australia's breeding population nests in the region. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas). The species is sedentary and is in the region throughout the year, and has a pelagic habit. A known threat is predation of chicks and eggs by introduced feral animals at nesting colonies.
- **Pacific gull** *(Chroicocephalus pacificus)*: There are stable (albeit small) populations of Pacific gull in the region, which are important because the species is being out-competed elsewhere by kelp gull. There might be two distinct populations in Western Australia, one on the south coast and another between Lancelin and Shark Bay. The latter is likely to consist of only a couple of hundred pairs. This species forages in inshore waters. Biologically important areas are defined for the species (see the South-west Conservation Values Atlas). Known threats include bioaccumulation at contaminated port sites, interaction with fisheries and competition with nuisance species (e.g. kelp gull). The species might be vulnerable to entanglement in marine infrastructure.

13 Nuisance species are opportunistic native species (e.g. seagulls) whose populations boom when humans modify the ecosystem by increasing food supply, for example.

- **Little penguin** *(Eudyptula minor)*: Although the species, which is endemic to Australasia, is distributed across temperate Australia and New Zealand, the geographic isolation of the south coast populations might render them vulnerable to local declines due to limited recolonisation from neighbouring colonies. Biologically important areas are defined for this species (see the South-west Conservation Values Atlas). Known threats in the region include increased mortality due to collision with vessels and loss of prey (whitebait) nursery habitat.

New Zealand fur seal *(Arctocephalus forsteri)*: This is a listed marine species that is protected under the EPBC Act. New Zealand fur seals breed in the region on rocky islands. There are 51 known breeding sites for this species in Australia, with most in adjacent state waters (30 in South Australia, including in the South-east Marine Region, and 17 in Western Australia). More than 80 per cent of Australia's population of New Zealand fur seals occurs off South Australia. The species is reported occasionally as far north as Perth. Biologically important areas are yet to be defined for this species. Potential pressures on this species include oil pollution, marine debris and pressures associated with climate change.

Actions that introduce a new source from which a severe oil spill has a reasonable potential to arise have a **risk** of substantially affecting a population of New Zealand fur seals.

Orange roughy *(Hoplostethus atlanticus)*, **southern bluefin tuna** *(Thunnus maccoyii)* and **school shark** *(Galeorhinus galeus)* are listed as threatened species in the conservation dependent category under the EPBC Act. Orange roughy is a high-value commercial species that is highly vulnerable to depletion because of its long-lived and late-maturing habit. It is a deep-water species, which is associated with pinnacles, seamounts and other features where prey aggregates. Important habitat occurs in the region. Biologically important areas are to be defined for this species. Extraction of living resources is *of potential concern* for the orange roughty but this pressure currently under active management. Southern bluefin tuna was listed in 2010 as conservation dependent under the EPBC Act. Biologically important areas are yet to be defined for this species. The species is highly migratory, generally accepted to be a single population, with juveniles in their first year of life moving into the South-west marine Region. Extraction of living resources is *of concern* to the southern bluefin tuna. The fishery is managed globally by the international Commission for the Conservation of Southern Bluefin Tuna, which has already established measures to ensure rebuilding of the spawning stock. The Commission will continue to assess the effectiveness of its management measures and implement further measures as required. Noise pollution is *of potential concern* for southern bluefin tuna as are changes in sea temperature and oceanography.

Important nursery habitat for school shark is found in the coastal waters of the South-west Marine Region, in sheltered embayments and estuaries. Biologically important areas are yet to be defined for this species. Bycatch is *of concern* to this species while physical habitat modification (such as seagrass habitat loss and degradation from coastal development) is *of potential concern*. Marine debris and sea level rise, changes in sea temperature and oceanography and ocean acidification are also *of potential concern* to the school shark.

Actions with a real chance or possibility of resulting in the modification, destruction and/or contraction of nursery and pupping habitat for school shark have a **risk** of a substantial adverse effect on populations of this species.

Species and communities defined as key ecological features for their biodiversity and/or ecosystem functioning values

Marine ecosystems comprise a large number of species, linked to each other through a complex web of interrelationships (assemblages). In most instances, we do not have the knowledge necessary to understand the role that each individual species plays in maintaining ecosystem structure, overall biological diversity and processes. Some of the species are known to play a particularly important role—for example, in controlling populations of other species by exerting predatory pressure. For their relevance in characterising and defining regional biodiversity, these key species may be defined as key ecological features.

The South-west Marine Bioregional Plan recognises one species and three species assemblages as key ecological features, because they are thought to play an important role in the region's ecological process and/or to have particular relevance for its biodiversity. These features were identified at a broad regional scale through discussions with scientists with knowledge of the South-west Marine Region. As more data become available, our understanding of the role of individual species and communities will become clearer. The report card on the Commonwealth marine environment is available at: **www.environment.gov.au/marineplans/south-west**.

In assessing the impacts of a proposed action on the Commonwealth marine environment and their significance, the potential implications of the proposed action to the regional importance and vulnerabilities of the key ecological features listed below should be considered.

Demersal slope and associated fish communities of the Central Western Province: This species assemblage is recognised because of its biodiversity (endemism) values.

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. In particular, demersal fish on the slope in this bioregion have high species diversity compared with other more intensively sampled oceanic regions of the world. Demersal fish communities occurring at depths greater than 400 m are characterised by a diverse assemblage, dominated by relatively small benthic species (grenadiers, dogfish and cucumber fish). Unlike other slope fish communities in Australia, many of these species display unique 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.

Pressures *of potential concern* on this feature include:

- changes in sea temperature and oceanography and ocean acidification
- noise pollution
- physical habitat modification
- extraction of living resources and bycatch
- noise-generating activities, such as seismic surveying, might have an adverse effect on demersal fish species (for example, experimental studies on pink snapper in Western Australia have demonstrated physiological damage after exposure to seismic surveying; McCauley et al. 2003).

Generally, most actions occurring within the Demersal slope and associated fish communities of the Central Western Province are unlikely to impact adversely on the biodiversity values of this key ecological feature.

Western rock lobster *(Panulirus cygnus)*: This species is recognised because of its presumed important ecological role as a major benthic predator species in the deeper communities of the west coast continental shelf.

Western rock lobster is the dominant large benthic invertebrate in this bioregion. It is also an important part of the food web on the inner shelf, particularly as a juvenile, when it is preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod and breaksea cod. Western rock lobsters 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. In recent years, larval settlement—which predicts catch levels 3–4 years in advance—has undergone substantial decline.

Pressures of concern include changes in sea temperature and oceanography (such as shifts in the strength of the Leeuwin Current) as a result of climate change. Pressures of potential concern include sea level rise, ocean acidification (due to climate change), changes in turbidity, physical habitat modification, extraction of living resources and oil pollution.

A detailed report *Western rock lobster in ecosystem processes of south-western Australia* is available at **<www.environment.gov.au/coasts/mbp/publications/south-west/index.html>**.

Actions that have a real chance or possibility of resulting in physical habitat modification (including increased turbidity) of the western rock lobster have a **high risk** of a significant on the Commonwealth marine environment.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising (e.g. drilling activities, oil rigs, increased shipping) affecting the western rock lobster have a **risk** of a significant impact on the Commonwealth marine environment of the South-west Marine Region.

Benthic invertebrate communities of the eastern Great Australian Bight: These communities are recognised for their biodiversity values.

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 more than 80 per cent of the shelf sediments. The high levels of biodiversity have been attributed to the unusual width of the continental shelf, the high degree of geographic isolation from similar habitats, and the opportunities for incursions by tropical species in the Leeuwin Current.

Pressures *of potential concern* on this feature include changes in sea temperature and oceanography and ocean acidification as a result of climate change and physical habitat modification (such as caused by damage to benthic communities from bottom trawling).

Generally, most actions occurring in Benthic invertebrate communities of the eastern Great Australian Bight are unlikely to impact adversely on the biodiversity values of this key ecological feature.

Small pelagic fish of the South-west Marine Region: This species group is recognised because of its important ecological role in the South-west Marine Region.

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 10 species: sardine, scaly mackerel, Australian anchovy, round herring, sandy sprat, blue sprat, jack mackerel, blue or slimy mackerel, red bait and saury. This group of fish supports Australia's largest fishery (by weight)—the South Australian Sardine Fishery—as well as a diverse range of large pelagic predatory fish (southern bluefin tuna, samson fish and kingfish), marine mammals (pygmy blue whales, southern right whales, dolphins, New Zealand fur seals and Australian sea lions), cephalopods (arrow squid) and seabirds (short-tailed shearwaters, crested terns, petrels and little penguins).

Pressures *of concern* for this key ecological feature include changes in sea temperature and oceanography as a result of climate change. Pressure of potential concern include :

- ocean acidification (due to climate change)
- disease (the introduction of a herpes virus in the late 1990s resulted in high levels of mortality among pilchards off Albany).

Actions which have a real chance or possibility of introducing pathogens to the small pelagic fish of the South-west Marine Region have a **high risk** of significant impact on the Commonwealth marine environment.

S2.1.4 Adverse impacts on heritage values

Historic shipwrecks

Five historic shipwrecks are located in the South-west Marine Region (Figure S2.2). The conservation values report card on protected places provides further information (See **www.environment.gov.au/marineplans/south-west**)

It is an offence under the *Historic Shipwreck Act 1976* to damage, destroy or interfere with a historic shipwreck without a permit.

The HMAS Sydney II and *HSK Kormoran* wrecks are also listed on the National Heritage List and Commonwealth Heritage List for their historic heritage values (Table S2.2). By virtue of their listing on the National Heritage List, these two shipwrecks are matters of national environmental significance. It is an offence under the *Historic Shipwreck Act 1976* to damage, destroy or interfere with a historic shipwreck without a permit.

Actions that have a real chance or possibility of resulting in substantial adverse impacts on the heritage values of the Commonwealth marine area, including damage to or destruction of a historic shipwreck, have a **high risk** of a significant impact on the Commonwealth marine environment.

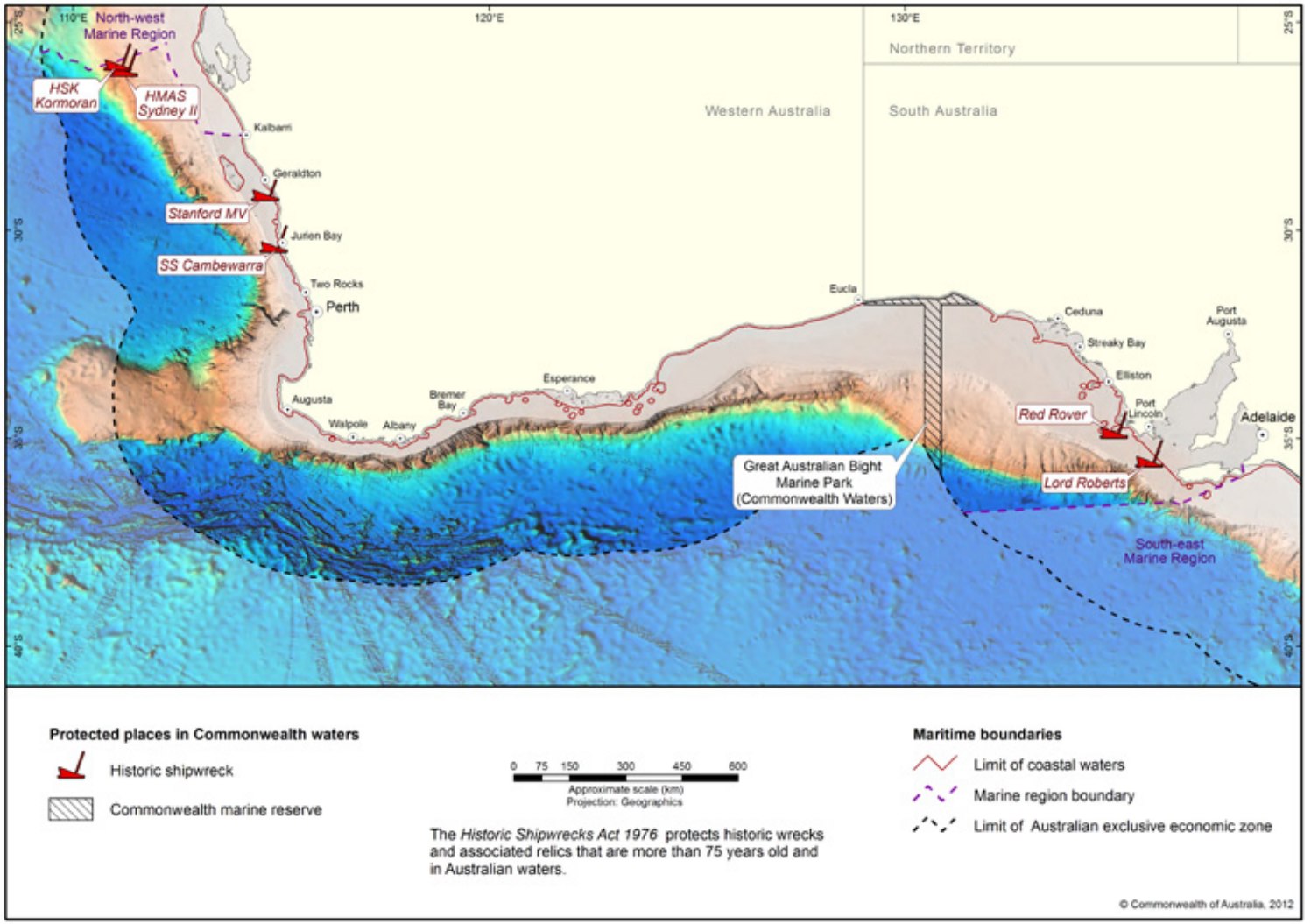

Figure S2.2: Heritage places in the South-west Marine Region as of May 2012

Table S2.2: Heritage places in the South-west Marine Region as of May 2012

Heritage Place	Shipwreck	Commonwealth Heritage List	National Heritage List
HMAS Sydney II	✓	✓	✓
HSK Kormoran	✓	✓	✓

S2.1.5 Actions in Commonwealth marine reserves

Commonwealth marine reserves (also called marine protected areas) in the South-west Marine Region are areas recognised as having high conservation value. Marine protected areas in the region (Figure S2.2) for which information is provided in this plan include:

- Great Australian Bight Marine Park (Commonwealth waters).

The Director of National Parks is the statutory authority directly responsible for managing all Commonwealth reserves (including marine protected areas) as specified by the EPBC Act. The Act requires all Commonwealth reserves (terrestrial and marine) to have a management plan. The Act prohibits some activities being carried out on or in a Commonwealth reserve unless they are expressly provided for by a management plan for the reserve or are approved in writing by the Director of National Parks when a management plan is not in operation. This includes actions that affect native species, commercial activities and mining operations.

People considering actions in or adjacent to the South-west Marine Region should check the Commonwealth environment department's web site **www.environment.gov.au/marinereserves** for the current list and location of Commonwealth marine reserves in the South-west Marine Region.

The Great Australian Bight Marine Park (Commonwealth waters)

The Great Australian Bight Marine Park stretches from 200 km west of Ceduna, South Australia, along the coast to the Western Australian border. The park, which includes a strip 20 nautical miles wide that extends to 200 nautical miles, covers a total area of around 19 700 km^2 (see Figure S2.2). It is made up of adjoining Commonwealth and South Australian protected areas. The Yalata Indigenous Protected Area lies adjacent to the park, creating one of the world's largest contiguous areas of land and sea managed for biodiversity conservation.

The state waters of the park consist of a Whale Sanctuary Zone and a Conservation Zone, while the Commonwealth waters are made up of a Marine Mammal Protection Zone and a Benthic Protection Zone. The park (both state and Commonwealth waters) was declared in 1998. It provides protection for important breeding and calving habitat for the endangered southern right whale, breeding colonies of the vulnerable Australian sea lion, and habitat for other species of conservation significance, such as white sharks, dolphins, albatrosses, petrels and other seabirds. It also protects parts of the world's most diverse soft-sediment ecosystems, which comprise the largest cool-water carbonate province in the world.

All activities within the boundaries of the Commonwealth waters of the park must comply with the Great Australian Bight Marine Park (Commonwealth Waters) Management Plan 2005–2012. Certain activities are prohibited within the park (Commonwealth waters). Some activities might be allowed subject to permit approval issued by the Director of National Parks.

Mining operations—including exploration activities such as seismic surveying—are prohibited in the park (Commonwealth waters) except with the approval of the Australian Governor-General and carried out in accordance with the management plan. For more information on the Great Australian Bight Marine Park, visit **www.environment.gov.au/coasts/mpa/gab**.

Actions in or near Commonwealth marine reserves have a **greater risk** of a significant impact on the Commonwealth marine environment.

Advice for preparing a referral with respect to impacts on the Commonwealth marine environment of the South-west Marine Region

The 'referral of proposed action form' is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on the Commonwealth marine environment of the South-west Marine Region, consideration of the following matters is recommended:

- For actions associated with physical habitat modification, for example dredging, independent dredge plume modelling undertaken to predict suspended sediment levels and the extent of sediment dispersal as a result of the proposed action would assist in assessing the action.

- For actions associated with physical habitat modification, for example the dumping of dredge spoils or other materials into the Commonwealth marine environment, requirements under the *Environment Protection (Sea Dumping) Act 1981* and the *National assessment guidelines for dredging 2009* apply. An application for a sea dumping permit should be submitted. Further information on sea dumping is available at **www.environment.gov.au/coasts/pollution/dumping/index.html**.
- For actions likely to release nutrients or pollutants into the Commonwealth marine environment, modelling of nutrient or pollutant dispersal and accumulation undertaken to determine potential impacts on marine ecosystems would assist in assessing the action.
- To mitigate the effects of an accidental hydrocarbon spill from a vessel, an approved shipboard oil pollution emergency plan should be in place. For actions relating to petroleum facilities and pipelines, an approved environment plan, containing an oil spill contingency plan, should be in place. Further information on responsibilities regarding the protection of the marine environment from oil spills is available on the National Offshore Petroleum Safety and Environmental Management Authority's website: **www.nopsema.gov.au/**.

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Schedule 2.2 Cetaceans of the South-west Marine Region

All cetaceans are protected under the EPBC Act in the Australian Whale Sanctuary[14]. Of the 45 cetacean species (whales, dolphins and porpoises) recorded in Australian waters, 33 are known to occur in the South-west Marine Region and a further 10 species may occur infrequently in the region. Please refer to the conservation values report card—cetaceans, for a complete list of cetaceans and additional information **www.environment.gov.au/marineplans/south-west**.

Eleven species of whale that occur in the South-west Marine Region are listed as threatened and/or migratory species under the EPBC Act. For the purpose of assisting decision-making, these species can be divided into three groups:

- four species (Table S2.3) with known biologically important areas in the South-west Marine Region
- five species that, although known to occur in the region, are less frequently encountered; there are currently no known biologically important areas in the region for these species
- two species that may infrequently occur in the region and are considered vagrant species in the south-west.

Cetaceans that occur in the South-west Marine Region but are not listed as threatened or migratory species under the EPBC Act are protected under the EPBC Act by virtue of the Australian Whale Sanctuary, and are considered in Schedule 2.1.

14 The Australian Whale Sanctuary was established under the EPBC Act to protect all whales and dolphins in Australian waters. The Australian Whale Sanctuary comprises the Commonwealth marine area and covers all of Australia's Exclusive Economic Zone which generally extends out to 200 nautical miles from the coast and includes the waters surrounding Australia's external territories such as Christmas, Cocos (Keeling), Norfolk, Heard and Macdonald Islands. Within the Australian Whale Sanctuary it is an offence to kill, injure or interfere with a cetacean. Severe penalties apply to anyone convicted of such offences. More information about the Australian Whale Sanctuary can be found at **www.environment.gov.au/coasts/species/cetaceans/conservation/sanctuary.html.**

Table S2.3: Cetaceans listed as threatened and/or migratory with known biologically important areas in the South-west Marine Region

Species	Listing status
Blue whale[15] *(Balaenoptera musculus)*	Endangered, migratory
Southern right whale *(Eubalaena australis)*	Endangered, migratory
Humpback whale *(Megaptera novaeangliae)*	Vulnerable, migratory
Sperm whale *(Physeter macrocephalus)*	Migratory

The following advice relates only to those species listed above for which it has been possible to identify biologically important areas.

Key considerations in relation to significant impacts on blue, southern right, humpback and sperm whales in the South-west Marine Region

Population status and ecological significance

Although there is not a population estimate available for **pygmy blue whale** in Australia, McCauley and Jenner (2010) used acoustic data to estimate abundance of the population of pygmy blue whales migrating south along the Western Australian coast. Their abundance estimate was based on acoustic data recorded in 2004 and provided an estimate of between 662 to1559 whales.

The Australian population of **southern right whales** has shown signs of a slow and steady recovery. However, the long-term recovery of the species is not yet assured as global numbers are probably at less than 10 per cent of pre-exploitation abundance (DEH 2005a). The continued recovery of this species and its expansion into suitable breeding habitats is of regional priority for the South-west Marine Region.

Humpback whales are showing strong signs of recovery in Australian waters, with populations growing at approximately 10 per cent per year (DEH 2005a). It is estimated that the Australian west coast population of humpback whale is 21 750 (Hedley et al. 2009).

15 The taxonomy of blue whale is unclear; however, it is generally accepted that there are two subspecies in the Southern Hemisphere: Antarctic blue whale and pygmy blue whale (DEWHA 2008). In general, Antarctic blue whale is found south of 60° S and pygmy blue whale is found north of 55° S (DEWHA 2008). As Antarctic blue whales feed predominantly in polar waters, it has been suggested that all blue whales sighted in Australian waters are pygmy blue whales (DEH 2005a). However, available acoustic information indicates that Antarctic blue whales are likely to occur infrequently in the South-west Marine Region. The information provided in this schedule is relevant to blue whale at the species level *(Balaenoptera musculus)*, unless stated otherwise.

Globally, it is estimated that there are approximately 300 000–450 000 **sperm whales** and that this species is slowly recovering. However, there are currently no estimates of the Australian sperm whale population size and therefore the proportion of the global population or recovery rate in Australia.

For the purpose of determining the significance of impacts of proposed actions on the endangered blue whale and southern right whale, it is known that populations of these species occur in the South-west Marine Region seasonally.

For the purpose of determining the significance of impacts of proposed actions on humpback whale, a vulnerable listed species, it should be assumed that the west coast population is an important population of the species.

For the purpose of determining the significance of impacts of proposed actions on sperm whale, a migratory listed species, it should be assumed that an ecologically significant proportion of the population occurs in the South-west Marine Region.

Definitions of 'important population' and 'ecologically significant population' are provided at the beginning of this schedule and are consistent with *EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance (2009).* In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as humpback whale, consideration should be given to whether an important population occurs in the area where the action is proposed; for listed migratory species, consideration should be given to whether an 'ecologically significant proportion of the population' occurs in the area where the action is proposed.

Species distribution and biologically important areas

Blue whales are broadly distributed across Australia's oceanic waters. However, much of the Australian continental shelf and coastal waters are not considered particularly important for the species. In the South-west Marine Region, pygmy blue whales aggregate at particular sites for foraging and during migration. Pygmy blue whales are known to migrate between warm water (low-latitude) breeding grounds and cold water (high-latitude) feeding grounds. The migratory habits of pygmy blue whales along the Western Australian coast are now reasonably well understood (see McCauley & Jenner 2010). On their northern migration pygmy blue whales come into the Perth Canyon in the period January to May, and then head up the coast passing Exmouth in the period April through to August before continuing north, with animals known to frequent Indonesian waters. Their southern migration down the Western Australian coast is from October to late December.

There are three locations in the South-west Marine Region where aggregations of pygmy blue whales are known to occur. These are:

- Geographe Bay, which is thought to be an important migratory habitat for pygmy blue whale from September to December, with cows and calves observed resting in the area
- the Perth Canyon, which is a seasonally important aggregation area, where pygmy blue whales feed on krill at depths of 200–300 m in the canyon from January to May (with feeding peaking in the area from March to May)
- Eastern Great Australian Bight upwelling and Kangaroo Island canyons, which are another important foraging habitat for pygmy blue whales between November and May (peaking in December).

Southern right whales occur seasonally in the South-west Marine Region. They stay in the region over winter and breed in Australian waters. Coastal locations regularly used by southern right whales for resting and calving are known, although few data exist about the offshore distribution of the species while in Australian waters.

In the coastal waters adjacent to the South-west Marine Region, there are three main calving areas for the Australian southern right whale population, where density of calving cows is high:

- Doubtful Island Bay
- Israelite Bay
- Head of Bight.

During the calving season, between May and November, female southern right whales that are either pregnant or with calf can be present in shallow protected waters along the entire south coast of the region and west up to approximately Two Rock, north of Perth.

Humpback whales also occur seasonally in the South-west Marine Region on migration between calving areas in the Kimberley and summer feeding areas in Antarctica. The exact timing of the migration period can vary from year to year, depending on water temperature, sea ice, predation risk, prey abundance and the location of the feeding ground (DEWHA 2009). In general, humpback whales are sighted in southern Australian waters off the west coast in May and migrate slowly up the coast. By October, the majority of whales have started their southward migration, and sightings are less frequent from November.

Humpback whales migrate through coastal areas between Esperance and Kalbarri. Along parts of their migratory route there are narrow corridors and bottlenecks resulting from physical barriers where the majority of the population passes close to shore (i.e. within 30 km of the coastline) (DEH 2005a).In the South-west Marine Region such narrow migratory corridors appear to be found in the following three areas:

- waters between the Houtman Abrolhos Islands and Geraldton
- waters from Geographe Bay to Rottnest Island
- waters to the east of Augusta.

Resting areas are used by cow-calf pairs and attendant males during the southern migration. Sheltered bays appear to be opportunistically used for resting during the southern migration. Although there is some debate amongst scientists about resting areas for the species in the South-west Marine Region, Geographe Bay is considered to be a resting area for the species because it offers protected, shallow coastal waters.

Sperm whales are poorly understood species which are generally found in deep water offshore, around seamounts and canyons. In the South-west Marine Region, scientists consider that the species is likely to forage along the shelf-break. Sperm whales have been observed foraging in waters over the Perth Canyon and over the Albany canyons group. They are also known to occur in waters along the shelf break of the eastern Great Australian Bight, and waters to the south of Kangaroo Island and are presumed to be foraging in these areas. They are not seasonal: they can be encountered at any time during the year. However, encounters in the feeding areas of the Albany canyons group and the Great Australian Bight appear more frequent in August–September.

Additional information on biologically important areas of whales can be found in the South-west Conservation Values Atlas.

Table S2.4: Advice on the risk of significant impact on blue whale, humpback whale, southern right whale and sperm whale

Species	Action in biologically important areas	Action outside biologically important areas	Temporal considerations[16]
Blue whale	**High risk** of significant impact, depending on the type of action (see 'Nature of the proposed action' below)	There is some uncertainty about species behaviour and/or the importance of other areas in the region (aside from biologically important areas identified above). Given the endangered status of the species, actions occurring outside and not affecting biologically important areas for the blue whale and, in the case of seismic surveying, undertaken in accordance with EPBC Act Policy Statement 2.1, have a **moderate risk** of significant impact on this species, when an activity is undertaken during the season of occurrence of the species in the region.	In the South-west Marine Region during July and August, the likelihood of encounter with blue whales is lower. Actions undertaken in the region during these months have a **low risk** of significant impact on this species.
Southern right whale	**High risk** of significant impact, depending on the type of action (see 'Nature of the proposed action' below)	There is some uncertainty about species behaviour and/or the importance of other areas in the region (aside from biologically important areas identified above). Given the endangered status of the species, actions occurring outside and not affecting biologically important areas for southern right whale and, in the case of seismic surveying, undertaken in accordance with EPBC Act Policy Statement 2.1, have a **moderate risk** of significant impact on this species, when an activity is undertaken during the season of occurrence of the species in the region.	In the South-west Marine Region from December to late March[17] there is a low likelihood of encounter with southern right whales. Generally, actions undertaken anywhere in the region during this period have a **low risk** of significant impact on the species.
Humpback whale	**High risk** of significant impact, depending on the type of action (see 'Nature of the proposed action' below)	Actions undertaken outside and not affecting[18] biologically important areas for humpback whale and, in the case of seismic surveying, undertaken in accordance with EPBC Act Policy Statement 2.1, have a **low risk** of significant impact on this species.	In the South-west Marine Region from early December to April[17], there is a low likelihood of encounter with humpback whales. Generally, actions undertaken anywhere in the region during this period have a **low risk** of significant impact on the species.
Sperm whale	**High risk** of significant impact, depending on the type of action (see 'Nature of the proposed action' below)	Actions undertaken at any time during the year and occurring outside and not affecting biologically important areas for sperm whale and, in the case of seismic surveying, undertaken in accordance with EPBC Act Policy Statement 2.1, have a **low risk** of significant impact on this species.	Sperm whales can be encountered in the region at any time during the year; however, encounters over the Albany canyons group and in the Great Australian Bight appear more frequent in August—September.

16 This advice does not apply to actions that inherently result in prolonged or enduring changes to the biologically important areas or the marine environment in general. Actions should also be conducted in accordance with EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales, where relevant.

17 This time period reflects a precautionary approach and is buffered by a month on either end of the known periods during which these species are found in these areas. The buffer has been used as there is a limited understanding of the migratory movements of either of these species or the seasonality of their occurrence in the region before or after they are sighted in known biologically important areas.

18 Actions that might affect a biologically important area, even when undertaken outside the area, include sound transmission that may result in behavioural reactions of whale species and/or prey, such that a physical impact is likely.

Nature of the proposed action

Human activities in coastal environments and offshore have the potential to result in significant impacts on cetaceans. An overview of the vulnerabilities and pressures on cetaceans in the South-west Marine Region is in the species group report card—cetaceans.

Human-induced noise (noise pollution) is a pressure of potential concern to all four species. Noise pollution has the potential to cause physical effects or damage to baleen whales and possibly to some large toothed whales (including sperm whale) if carried out in close proximity to these whales and involving sounds at frequencies used by whales (<500 Hz, Weir & Dolman 2007). Noise pollution may also lead to avoidance by whales of biologically important areas (breeding, calving, feeding and resting areas, and migration routes) and mask sounds that are vital for essential functions and behaviours, including navigating, identifying the location of prey and predators, announcing location and territory, establishing dominance, attracting mates, and maintaining group cohesion and social interaction. These effects may impede successful breeding, calving and other biologically important behaviours.

Research in the area of noise pollution and cetaceans is active worldwide (Southall et al. 2007; Weilgart 2007; Ellison et al. 2011). Strategy A Action 6 identifies a priority to "Improve knowledge on the pressures of marine debris, noise pollution, extraction of living resources and bycatch in the South-west Marine region …" In the meantime, based on the evidence available, a precautionary approach is prudent to balance the conservation values for cetaceans and the responsible development of Australia's oil and gas resources.

Sources of noise that have the potential to impact on whales include seismic surveys, shipping traffic, construction activities (e.g. pile driving or blasting) and defence training activities involving active sonar and/or live ammunitions.

EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales aims to limit the potential for physiological impacts from seismic surveys in Australian waters. This policy limits the amount of sound that may reach the whales by a variety of methods, such as shut-downs if a whale is seen within a certain distance. Less is known about the potential for behavioural impacts at distance from the noise source where the sound is too low to be physically damaging but is still audible. During biologically important periods such as calving, potential behavioural impacts are managed by avoidance of biologically important areas and their surroundings.

Sperm whales are mystecites (toothed whales) and have a higher hearing frequency than baleen whales. It is therefore thought that the impacts from seismic surveys may be less on sperm whales than on baleen whales. However, seismic surveys may still pose a threat to sperm whales, particularly in biologically important areas, where seismic noise may affect the abundance of prey species.

The Australian Defence Force's use of active sonar and live ammunition may impact on pygmy blue whales, particularly within the Western Australian exercise area off Perth, which covers the Perth Canyon. Noise from some types of military sonar has been linked elsewhere to strandings and deaths in some species of deep-diving beaked whales (Balcomb & Claridge 2001; D'Amico et al. 2009; Filadelfo et al. 2009); however, there is little empirical evidence to support this (Bradshaw et al. 2006). To date, there is no evidence of whale strandings linked to defence training activities within the Western Australian exercise area or elsewhere in Australian waters. The Australian Defence Force manages its use of sonar through its environmental management system and some specific navy procedures to minimise risks to cetaceans.

Collisions with vessels is *of potential concern* for blue whales and southern right whales.

Whales and dolphins are known to become entangled in certain types of fishing gear, particularly potbuoy lines and certain types of nets—bycatch is of potential concern for the humpback, southern right and sperm whale. Marine debris is a pressure of potential concern for all four species and collision and entanglement with infrastructure is of potential concern for the southern right whale.

Oil pollution is of potential concern for all four species of whales in the South-west Marine Region, but particularly for the southern right whale, which has calving grounds adjacent to the region. An oil spill may disrupt the breeding cycle, increase mortality and/or reduce calving.

Loss or degradation of habitat is a pressure of potential concern for southern right whale, because this species relies on shallow and sheltered habitats for calving.

Climate change related pressures are of potential concern to all four species.

People planning to undertake actions in biologically important areas for humpback, sperm, southern right and blue whales should carefully consider the potential for their action to have a significant impact on the species. Table S2.4 provides further information on spatial and temporal considerations. The following actions have a **high risk** of a significant impact on all four species of whale:

- actions that have a real chance or possibility of increasing relevant noise[19] above ambient levels within any of the biologically important areas for all four species of whale when the species is present. Examples of such actions are seismic surveys, defence training activities implementing active sonar and live ammunition, and actions resulting in a substantial increase in ship noise.

When the actions are undertaken in accordance with Part A and, where relevant, Part B of EPBC Act Policy Statement 2.1: Industry—interaction between offshore seismic surveys and whales, the risk of a significant impact to the species is **low**.

The following actions have a **high risk** of significant impact on the southern right whale:

- actions that have a real chance or possibility of increasing the rate of entanglement and potentially result in long-term decrease in the size of the population (e.g. construction of offshore aquaculture fish farms and marine-based renewable energy production plants)
- actions that have a real chance or possibility of modifying, destroying or isolating habitat. Examples of actions include urban development adjacent to, and coastal infrastructure in, southern right whale biologically important areas.

The following actions have a **high risk** of significant impact on the southern right whale and blue whale:

- actions that have a real chance or possibility of increasing the rate of ship strike within biologically important areas and potentially leading to reduced occupancy area and/or to long-term population decrease (e.g. construction of ports or expansion in port facilities, leading to greater shipping traffic).

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising within or affecting biologically important areas and potentially leading to reduced occupancy area and/or to long-term population decrease (e.g. construction of new oil or gas wells; construction of ports or expansion in port facilities, leading to greater shipping traffic) have a **risk** of a significant impact on all four species of whale.

19 Relevant noise is defined here as low-frequency sounds (below 200Hz) that are within the same range of frequencies used by some whales.

Advice for preparing a referral with respect to impacts on blue, southern right, humpback and sperm whale in the South-west Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on any of the four cetaceans considered here, the referral should include information on measures to avoid and reduce the likelihood of a significant impact on cetaceans. Consideration of the following matters is also recommended:

- If the action proposed is within a biologically important area, information about any alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- If the action involves undertaking a seismic survey, refer to EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales, which provides operating standards and mitigation strategies to reduce the potential for significant impacts and should be used when planning activities. For other noise-generating activities, the information contained in Policy Statement 2.1 may assist in understanding the effects of noise on cetaceans generally.
- If planning a seismic survey, and when the likelihood of encounter is moderate to high, the referral should specify the additional management measures that would be followed, as at Part B of Policy Statement 2.1.
- For seismic surveys and other noise-generating activities proposed to occur at times when there is a moderate to high likelihood of biologically important behaviours in the vicinity of the survey, acoustic propagation modelling may assist in assessing any change in noise levels within biologically important areas classified as 'calving', 'resting' and/or 'feeding (high density)'. It is recommended that early advice be sought from the Australian Government department responsible for the environment.
- If planning recreational and/or tourism operations, the *Australian national guidelines for whale and dolphin watching* (DEH 2005b) provide standards on approach distances and operating procedures.

- Referrals should be supported by scientifically credible information that places the proposal in the context of advice on existing pressures on cetaceans and the particular life history characteristics of the species. The species group report card—cetaceans provides additional information on the current understanding of the range of pressures on cetaceans addressed in this regional advice.
- For areas earmarked for long-term development involving noise-generating activities, passive acoustic monitoring programs (e.g. installation of sonobuoys) might assist in gaining the necessary understanding of the finer-scale spatial and temporal patterns of presence of some whales and improve the ability to assess and mitigate impacts. It is recommended that early advice be sought from the Australian Government department responsible for the environment.

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Schedule 2.3 Pinnipeds of the South-west Marine Region

Three species of pinniped inhabit the South-west Marine Region (the Australian sea lion, the Australian fur seal and the New Zealand fur seal). Another seven pinnipeds, which are listed marine species, have been recorded occasionally in the region and are considered as vagrant species (see species group report card—pinnipeds for a complete list and additional information **www.environment.gov.au/marineplans/south-west**).

Biologically important areas have been identified for the Australian sea lion and the following advice relates only to this species.

Information is provided on the pressures *of concern* or *of potential concern* for the New Zealand fur seal in Schedule 2.1.

Key considerations in relation to significant impacts on Australian sea lion

Population status and ecological significance

Australian sea lion is listed as vulnerable and, as such, is a matter of national environmental significance under the EPBC Act. The species occurs almost exclusively within the South-west Marine Region and is not showing signs of recovery. The estimated total population of Australian sea lion is approximately 14 700. Population genetic studies have indicated that there is little or no interchange of females between breeding colonies, even those separated by short distances. Males can travel long distances both for foraging and breeding, which contributes to some genetic dispersal across colonies. For conservation management purposes, since breeding females remain at one site, each colony should be viewed as a quasi-closed population.

For the purpose of determining the significance of impacts of proposed actions on Australian sea lion, any individual breeding colony should be regarded as an important population.

The definition of 'important population' is provided at the beginning of this schedule and is consistent with *EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance (2009).* In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as Australian sea lion, consideration should be given to whether an important population occurs in the area where the action is proposed.

Species distribution and biologically important areas

There are currently 76 known breeding locations for Australian sea lion, of which 48 occur in South Australia and 28 in Western Australia. Based on pup numbers, 86 per cent of the population is found in South Australia and 14 per cent in Western Australia. There are three distinct geographical areas for the species within the South-west Marine Region, where clusters of breeding colonies and haul-out sites occur. Biologically important areas for Australian sea lion in the South-west Marine Region include foraging areas for males and females, breeding colonies and haul-out sites.

Male Australian sea lions are known to move up to 200 km, including between different clusters of colonies, and may occur across the entire continental shelf. Female sea lions return to the same breeding site.

The distances that female sea lions will travel to forage vary substantially, so that foraging areas of females from small and more vulnerable colonies are not necessarily separated from foraging areas of females from larger and more robust colonies. Recent research suggests that even minor increases in the rate of mortality of female Australian sea lions raise the probability of extinction for a number of subcolonies (Goldsworthy et al. 2010).

Additional information on biologically important areas of the Australian sea lion can be found in the South-west Conservation Values Atlas.

Generally, an action undertaken beyond the continental shelf (offshore at depths greater than 200 m) will have a **low risk** of a significant impact on Australian sea lion, unless the action has the potential to modify biophysical conditions (e.g. ambient noise levels, or water quality in the adjacent continental shelf environment).

In planning for development in the South-west Marine Region, all attempts should be made to avoid biologically important areas for Australian sea lion, particularly waters surrounding breeding colonies and foraging areas used by female sea lions.

Nature of the proposed action

In determining whether an action undertaken in proximity to breeding colonies and haul-out sites and within the foraging range of female sea lions is likely to have a significant impact on the species, the types of action and the potential they have for impact on the species should be considered.

Australian sea lions are known to become entangled in ropes, nets and filaments associated with fishing gear and aquaculture cages, often with fatal consequences.

Although research into the vulnerability of Australian sea lions to noise disturbance has not been undertaken, studies of similar species in the Northern Hemisphere indicate that sea lions might be impacted by noise-generating activities (Gordon et al. 2003). Given the conservation status and lack of recovery of this species, development that substantially or persistently increases the level of noise in female foraging areas must be treated with precaution until there is more certainty about potential impacts on the species.

There are three pressures of concern to the Australian sea lion—changes in sea temperature, marine debris and bycatch from commercial fisheries.

Pressures of potential concern include sea level rise, changes in oceanography, ocean acidification, noise pollution, human presence at sensitive sites, extraction of living resources (prey depletion), and collision and entanglement with infrastructure. Australian sea lion is also likely to be detrimentally affected by changes in water quality, by oil and other chemical pollution and by severe modifications or destruction of the habitat on which their prey species rely. Unlike other species with seasonally defined breeding or migratory cycles, the timing of an action would not greatly affect the likelihood of significant impacts on Australian sea lion, as the species is not migratory and has a non–annual breeding cycle of 17–18 months, and colonies do not have synchronised breeding (i.e. breeding does not occur at the same time across the species range).

People planning to undertake actions in proximity of breeding colonies and haul-out sites and within the foraging range of female sea lions should carefully consider the potential for their action to have a significant impact on the species. In planning actions in proximity to a haul-out site, ascertaining the level of pupping potentially occurring at the site would assist in determining the impact of the proposed action.

The following types of action have a **high risk** of a significant impact on Australian sea lion:

- actions with a real chance or possibility of increasing the rate of collision within, or entanglement within, female foraging areas. Examples of such actions may be installation of infrastructure such as aquaculture sea cages, large renewable energy infrastructure
- actions with a real chance or possibility of increasing the ambient noise levels within female Australian sea lion foraging areas to a level that might result in site avoidance or other physiological or behavioural responses
- actions with a real chance or possibility of increasing human disturbance in biologically important areas (e.g. tourism developments).

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising within or affecting biologically important areas and potentially leading to reduced occupancy area and/or to long-term population decrease (e.g. construction of new oil or gas wells; construction of ports or expansion in port facilities, leading to greater shipping traffic) have a **risk** of a significant impact on Australian sea lions.

Advice for preparing a referral with respect to impacts on Australian sea lion in the South-west Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of a significant impact on Australian sea lion, consideration of the following matters is also recommended:

- Information about any alternative locations for the proposed action that would be outside the biologically important area for Australian sea lion and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- Independent scientific assessments of the likelihood, extent, nature and significance of any interaction between the proposed activity and Australian sea lions within the biologically important area should be considered.
- There should be assessment of the potential for a proposed action to interact with other activities and pressures on Australian sea lions or otherwise result in indirect cumulative impacts. The species group report card—pinnipeds provides information on the current understanding of the range of pressures on Australian sea lions in this region.
- Information on proposed mitigation of any significant impact on Australian sea lions, based on the advice provided above on risks of significant impacts on Australian sea lions, should be included in the referral. It is recommended that independent scientific assessments of any intended mitigation measures be included in a referral.

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Schedule 2.4 Seabirds of the South-west Marine Region

Forty-eight seabird species are known to occur in the South-west Marine Region.[20] Of these, 27 species are listed as threatened and/or migratory and, as such, are matters of national environmental significance protected under the EPBC Act. Regional advice for some seabird species not listed as threatened or migratory is included in the advice provided on the Commonwealth marine environment (Schedule 2.1).

Six species have substantial proportions of their Australian nesting population breeding in areas immediately adjacent to the South-west Marine Region and are known to feed within the Commonwealth waters of the South-west Marine Region (Table S2.5). For these species, the South-west Marine Region is considered important, as impacts within the region may affect the species' populations and behaviour. These species are considered in more detail in the advice below.

20 Sixty-two species of bird are known to occur in the South-west Marine Region. All birds that occur naturally in the region (including the airspace) are protected under the EPBC Act as listed marine species. Seabirds are those birds that rely on and have an ecological association with the marine environment. Thus not all of the birds that occur in the South-west Marine Region are seabirds (a complete list of all the birds known to occur in the region is provided in the report card on seabirds).

Table S2.5: Seabird species listed as threatened and/or migratory that have a large proportion of their Australian nesting population breeding in areas immediately adjacent to the South-west Marine Region

Common name	Australian nesting population breeding adjacent to the South-west Marine Region[21] (%)	Breeding season and habits
Australian lesser noddy[22] *(Anous tenuirostris melanops)*	100%	Late July – early December Sedentary
Common noddy[23] *(Anous stolidus)*	67%	Spring breeding on Houtman Abrolhos Islands Subtropical population disperses in non–breeding season
Flesh-footed shearwater *(Ardenna caneipes formerly known as Puffinus cameipes)*	72%	Late September – early May Migrates north during non–breeding season
Bridled tern[23] *(Onychoprion anaethetus)*	50%	Spring–summer Migrates north in non–breeding season
Roseate tern[23] *(Sterna dougallii)*	60%	Spring breeding population (November–January); autumn breeding population (April–June) Disperses in non–breeding season
Wedge-tailed shearwater *(Ardenna pacifica formerly known as Puffinus pacificus)*	71%	October–May Migrates north during non-breeding season

No specific regional advice is provided here for birds that fly over the Commonwealth marine area of the South-west Marine Region but do not feed within the marine environment. A complete list of birds that are known to overfly the South-west Marine Region is provided in the species group report card—seabirds (see **www.environment.gov.au/marineplans/south-west**).

21 From Surman & Nicholson 2006
22 Listed as vulnerable
23 Listed as migratory

Most actions would have **low risk** of a significant impact on those birds that only fly over the region, which are listed as threatened and/or migratory.

Key considerations in relation to significant impacts on six species of seabird in the South-west Marine Region

Population status and ecological significance

Each of the six species listed in Table S2.5 has a substantial proportion of its Australian breeding population nesting in coastal areas and/or islands adjacent to the South-west Marine Region.

Australian lesser noddy is listed as vulnerable. It has a very limited breeding range, concentrated on the Houtman Abrolhos Islands. Australian lesser noddies nest on three islands in the Houtman Abrolhos Islands: Pelsaert Island (21 867 pairs), Wooded Island (2477 pairs) and Morely Island (6972 pairs) (Surman & Nicholson 2007). In 2006, the breeding potential (nest numbers) was 68 000 pairs; however, approximately 31 000 pairs were recorded breeding on three islands in the Houtman Abrolhos Islands in 2006 (Surman & Nicholson 2007). Australian lesser noddy depends on the presence of mangrove forests for breeding. It also appears to rely heavily on one species of larval fish for foraging (Gaughan et al. 2002). The population levels fluctuate annually, reflecting variability in reproductive output, which, in turn, reflects varying availability of prey.

Common noddy breeds on two islands: Pelsaert Island (Houtman Abrolhos Islands) and Lancelin Island. Approximately 121 320 pairs were recorded on Pelsaert Island in 2006 (Surman & Nicholson 2007). A colony at Lancelin Island formed in 1991–92 and is now 1200 pairs (Dunlop 2005). The species feeds by hovering, surface-dipping or snatching prey from the top few centimetres of the sea surface (Surman & Wooller 2003).

About 104 000 pairs of **flesh-footed shearwaters** breed on islands between the South Australian border and Cape Leeuwin (Surman & Nicholson 2006). Flesh-footed shearwaters breed from late September to early May off south-western Western Australia (DSEWPaC 2010). Important breeding areas in the South-west Marine Region include the Recherche Archipelago to Cape Hamelin in Western Australia (including Sandy Island and Eclipse Island). Both flesh-footed shearwater and wedge-tailed shearwater nest in burrows. They forage by pursuit-plunging, some surface-seizing, and surface-plunging and pursuit-diving to 4 m (Marchant & Higgins 1990). Flesh-footed shearwaters are less gregarious than most other shearwaters. They forage singly, but congregate at food—for example, at swarms of euphausiids or small fish that are driven to the surface by predatory fish. They form rafts off breeding colonies before flying to colonies at or after sunset (Marchant & Higgins 1990).

Approximately 664 883 pairs of **wedge-tailed shearwaters** breed on seven of the Houtman Abrolhos Islands, Rottnest Island and Lancelin Island (Surman & Nicholson 2007). Wedge-tailed shearwaters return to breed in the region between mid-August and late May (Johnstone & Darnell 2008). They forage by contact-dipping, dipping, surface-seizing and subsurface pursuit (Burger 2001; Nicholson 2002). Large flocks have been observed feeding in association with tuna off Western Australia (Marchant & Higgins 1990). Wedge-tailed shearwaters occur mainly in offshore and pelagic waters. They concentrate at sources of food; in Australia, they are observed feeding along the junction between inshore and offshore water masses (Marchant & Higgins 1990). They are partially dependent on predatory fish, particularly tuna, to herd prey to the ocean's surface.

In Australia, it is estimated that there are 7218–13 370 nesting pairs of **roseate tern** (WBM Oceanics Australia & Claridge 1997). Large breeding colonies have been recorded at the Houtman Abrolhos Islands (Pelsaert Island—1700 pairs, Square Island—500 pairs, Jon Jim Island—964 pairs, Leo Island—627 pairs) (Surman & Nicholson 2007). Approximately 4210 pairs were recorded across 19 of the Houtman Abrolhos Islands in 2007 (Surman & Nicholson 2007), and the species has also been recorded at Safety Bay, Western Australia (less than 1000 pairs); Rottnest Island, Western Australia (less than 1000 pairs); and Lancelin Island, Western Australia (less than 200 pairs). Important autumn nesting occurs on Post Office Island, Newman Island and Long Island at the Houtman Abrolhos Islands. There are spring and autumn breeding subpopulations in south-western Australia, which have shifted south from the Houtman Abrolhos Islands during the period of historical records.

In Australia, it is estimated that there are 20 063–57 819 nesting pairs of **bridled tern** (WBM Oceanics Australia & Claridge 1997). Important breeding colonies in the south-west include Penguin Island, Lancelin Island, Fisherman Island and Beagle Island; and the Houtman Abrolhos Islands (Gun Island, Leo Island, Pelsaert Island, Little North Island) (DSEWPaC 2010). Approximately 2274 pairs bred on 90 islands at the Houtman Abrolhos Islands in 2006, significantly fewer than in 1999, when 6368 were recorded (Burbidge & Fuller 2004; Surman & Nicholson 2007).

For the purpose of determining the significance of impacts of proposed actions on the six species listed above, note that:

- the Australian lesser noddy population in the South-west Marine Region should be considered as an important population
- common noddy, flesh-footed shearwater, wedge-tailed shearwater, roseate tern and bridled tern breeding in the South-west Marine Region should be considered as constituting an ecologically significant proportion of these species' populations.

Definitions of 'important population' and 'ecologically significant population' are provided at the beginning of this schedule and are consistent with *EPBC Act Policy Statement 1.1: Significant impact guidelines—matters of national environmental significance (2009).* In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as Australian lesser noddy, consideration should be given to whether an important population occurs in the area where the action is proposed; for listed migratory species, consideration should be given to whether an ecologically significant proportion of a population may be impacted.

Species distribution and biologically important areas

The six species listed in Table S2.7 are primarily distributed across the west coast continental shelf, with two species—bridled tern and flesh-footed shearwater—stretching further south and east to the Recherche Archipelago.

Biologically important areas have been identified for all six species and pertain to:

- breeding colonies
- foraging
- foraging (in high numbers)[24]
- foraging (provisioning young)
- aggregation (pre-migration).

Further information on these areas is found in the South-west Conservation Values Atlas and in the species group report card—seabirds.

24 Foraging areas are typically more extensive areas where species may range broadly, whereas foraging (high numbers) are relatively discrete areas where the density of animals foraging is somewhat higher than in surrounding waters.

Flesh-footed shearwater is also known to breed in areas adjacent to the eastern part of the region, in the Spencer Gulf and some islands off the Eyre Peninsula. However, no data were available to define the foraging range of the species in this area at the time of publication. It should be considered that the species usually feeds in waters over the continental shelf and continental slope, and less frequently in inshore waters.

Generally, an action undertaken outside the biologically important areas defined for the six species has a **low risk** of a significant impact on these species.

People planning to take an action within a biologically important area of the six species listed in Table S2.5, when the species is present, should carefully consider the potential for their action to have a significant impact. Biologically important areas classified as breeding colonies, foraging (in high numbers), foraging (provisioning for young) and aggregation (pre-migration) are generally more sensitive to disturbance than other types of biologically important areas.

The risk of significant impact from actions undertaken within the biologically important areas for common noddy, flesh-footed shearwater, wedge-tailed shearwater, roseate tern and bridled tern but at a time outside their breeding seasons is likely to be lower, as these species migrate or disperse during the non-breeding season. This might not apply to actions that involve ongoing effects (e.g. permanent installation of lights, loss of breeding habitat). In light of observed changes in breeding times in response to climate-related shifts, surveys of breeding colonies can assist with verifying the presence of nesting birds.

The point above does not apply within areas that are also biologically important areas for Australian lesser noddy, as this species is vulnerable, sedentary and present in those areas at all times.

Nature of the proposed action

The species group report card—seabirds provides an overview of the vulnerabilities and pressures on protected seabirds in the South-west Marine Region. Anthropogenic activities in coastal environments and offshore have the potential to impact significantly on seabirds.

- Climate change is of concern, or of potential concern to all six species of bird.
- Chemical pollution is of potential concern for the Australian lesser noddy and the flesh-footed shearwater.
- Marine debris is of potential concern to the flesh-footed shearwater and the bridled tern.
- Light pollution is of potential concern for the flesh-footed shearwater, the wedge-tailed shearwater, the bridled tern and the Australian lesser noddy.
- Physical habitat modification is of potential concern to the Australian lesser noddy.
- Nuisance species is of potential concern to the Australian lesser noddy.
- Extraction of living resources (prey depletion) is of potential concern to the Australian lesser noddy, the common noddy, the wedge-tailed shearwater and the roseate tern.
- Bycatch is of potential concern to the flesh-footed shearwater.
- Oil pollution is of potential concern to all six species.
- Disease is of potential concern to the flesh-footed shearwater and the wedge-tailed shearwater.

Ground-nesting species, such as **common noddy, roseate tern, bridled tern, flesh-footed shearwater** and **wedge-tailed shearwater**, are susceptible to human disturbance during the breeding season. Pest species, such as fox, rats and silver gulls, can also substantially affect the reproductive success of ground-nesting seabirds.

Light pollution is a pressure of potential concern for seabirds. Coastal lighting in proximity to breeding colonies is believed to result in disorientation and mortality of **flesh-footed** and **wedge-tailed shearwater** fledglings. **Bridled tern** is vulnerable to offshore lighting, becoming disoriented during migration. Marine debris appears to be a threat, particularly for those seabirds, like **bridled tern**, that associate with flotsam aggregations for feeding; this behaviour also may make this species particularly vulnerable to oil slicks. Water quality issues—in particular, chemical pollution and heavy metal contaminants—have been reported to impact seabirds at ports.

The following actions have a **high risk** of a significant impact on one or more of the six species:

- actions with a real chance or possibility of introducing or increasing chemical pollution or contaminants to biologically important areas of the Australian lesser noddy and flesh-footed shearwater
- actions with a real chance or possibility of introducing or increasing lighting and flaring from both land-based (e.g. lighthouses, buildings) and offshore (e.g. boats, oil rigs) sources at and around breeding colonies for flesh-footed shearwater, wedge-tailed shearwater, bridled tern and Australian lesser noddy
- actions with a real chance or possibility of modifying habitat of the Australian lesser noddy such as construction of infrastructure or coastal development
- actions with a real chance or possibility of introducing or increasing nuisance species to biologically important areas of the Australian lesser noddy
- actions with a real chance or possibility of introducing disease to the flesh-footed and wedge-tailed shearwaters.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising within or affecting biologically important areas and potentially leading to reduced occupancy area and/or to long-term population decrease (e.g. construction of new oil or gas wells; construction of ports or expansion in port facilities, leading to greater shipping traffic) have a **risk** of a significant impact on Seabirds in the South-west Marine Region.

Advice for preparing a referral with respect to impacts on six species of seabirds of national environmental significance in the South-west Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk of significant impact on any of the six species of seabirds considered here, consideration of the following matters is also recommended:

- If the action is proposed within a biologically important area classified as either breeding colonies, foraging (in high numbers), foraging (provisioning young) and aggregation (pre-migration), information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered
- Referrals should include information on how it is proposed that the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to any seabirds. It is recommended that independent scientific assessments of any intended mitigation measures is sought before submitting a referral and that any such assessment is included in the referral.

Referrals should be supported by scientifically credible information that places the proposal in the context of the advice on existing pressures on the seabirds and the particular life history characteristics of the species. The species group report card—seabirds provides information on the current understanding of the range of pressures on seabirds addressed in this regional advice.

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Schedule 2.5 Sharks of the South-west Marine Region

Seven shark species listed under the EPBC Act are known to occur in the South-west Marine Region (Table S2.6). All of these species, except school shark, are listed as threatened or migratory under the EPBC Act. School shark is listed as conservation dependent and is considered in more detail in the advice on the Commonwealth marine environment (Schedule 2.1). Biologically important areas have been identified for the white shark and a pressure analysis has been undertaken for the grey nurse, the porbeagle, the shortfin mako, school shark and white shark.

Table S2.6: Shark species listed as threatened and/or migratory that are known to occur in the South-west Marine Region

Species	Listing status
Grey nurse shark *(Carcharias taurus)* (west coast population)	Vulnerable
Whale shark *(Rhincodon typus)*	Vulnerable, migratory
White shark *(Carcharodon carcharias)*	Vulnerable, migratory
School shark *(Galeorhinus galeus)*	Conservation dependent
Longfin mako shark *(Isurus paucus)*	Migratory
Porbeagle shark *(Lamna nasus)*	Migratory
Shortfin mako shark *(Isurus oxyrinchus)*	Migratory

Longfin and shortfin makos are highly mobile species with oceanic and pelagic habit, and are only occasionally found inshore. Longfin mako is a tropical species, and the South-west Marine Region is likely to be on the margin of its distribution. Porbeagle shark occurs prevalently, but not exclusively, on the continental shelf in the southern part of the region, and has been recorded to a depth of 370 m. All three species are highly migratory and wide ranging. There are no known biologically important areas for these species in the region.

The South-west Marine Region is on the margin of the distribution for whale sharks, and they are rarely encountered. Advice is provided on the school shark, listed as conservation dependent in, Schedule 2.1.

Generally, actions taken in the South-west Marine Region have a **low risk** of significant impact on longfin mako, shortfin mako, whale and porbeagle shark.

Key considerations in relation to significant impacts on grey nurse and white sharks in the South-west Marine Region

Population status and ecological significance

Grey nurse shark is one of Australia's most threatened marine species, with the east-coast population listed under the EPBC Act as critically endangered and the west coast population as vulnerable. The east- and west coast populations are considered separate on the basis of genetic studies that have identified higher levels of genetic diversity in the west coast population than in the eastern Australian population (McAuley et al. 2005). Based on catch data, abundance of grey nurse sharks appears to be higher and more stable in the west than on the east coast. However, the size of the west coast population is poorly understood. The species is inherently highly vulnerable to depletion, as it reproduces biennially and produces only two pups per cycle.

There is also uncertainty about the size of the current population of **white shark**. It is not known whether the population of white shark in Australian waters is recovering (DEWHA 2008). Due to the internationally threatened status of this species, the region may be significant for the conservation and management of white sharks not only in Australia, but possibly also in a global context.

Species distribution and biologically important areas

Grey nurse shark has a broad distribution. The species is primarily found in subtropical to cool temperate waters around continental land masses. It is known to occur prevalently on the continental shelf from the surf zone down to at least 190 m (Last & Stevens 2009; McAuley 2004) and occasionally ventures off the continental shelf to depths of at least 230 m (Otway et al. 2009). The area of occupancy of the west coast population is less well known than that of the east-coast population. Available records indicate that grey nurse sharks can be found on the west coast from the North West Shelf (in the North-west Marine Region) down to coastal waters near Cocklebiddy in the Great Australian Bight (Cavanagh et al. 2003; Chidlow et al. 2006).

No biologically important area has yet been identified for **grey nurse shark** in the South-west Marine Region. Grey nurse sharks on the east coast are known to aggregate around inshore rocky reefs or islands, near the bottom (at depths of 10–40 m), in or near deep sandy or gravel-filled gutters, or in rocky caves (Last & Stevens 2009). Grey nurse sharks have also been observed congregating in the mid-water column adjacent to, or above, pinnacles or wrecks, at depths of 5–15 m. Juveniles have been observed in small gutters and crevices in shallow, wave-exposed waters close to islands and/or inshore rocky reefs. Aggregation behaviour for the west coast population is not well understood. Recently, the first aggregation area on the west coast has been identified at Roebuck Bay off Broome in the North-west Marine Region.

A comprehensive study investigating the presence of grey nurse shark aggregations in the area between the North West Cape and Cape Leeuwin did not detect any aggregation, despite the study's focus on a number of sites where, based on catch and sighting records, there is greater likelihood of the species aggregating. Importantly, the study also concluded that single observations at potential sites are an ineffective means of searching for grey nurse shark aggregation sites, and surveys should be repeated at a greater temporal scale (Chidlow et al.2006).

Although aggregation sites for grey nurse shark have not been identified, it is possible that the species aggregates in the South-west Marine Region. For actions that are undertaken at sites where suitable habitat may support aggregations, appropriately designed site surveys can assist in determining the presence of grey nurse aggregations.

White shark is a highly mobile species that occurs throughout southern Australian waters and displays seasonal patterns of movement. White sharks are widely, but not evenly, distributed in Australian waters. The concentration of sharks appears higher in some areas (Bruce & Bradford 2008; Malcolm et al. 2001). Areas within the South-west Marine Region—for example, the waters of the Great Australian Bight—appear to be important for white shark, as available records of incidental catches in fisheries are highest in the region, irrespective of fishing effort (Malcolm, Bruce & Stevens 2001). White sharks in Australian waters mainly seem to occur between the coast and the 100 m depth contour (Bruce & Bradford 2008; Bruce et al. 2006).

Biologically important areas have been identified for **white shark** in the South-west Marine Region and include:

- key foraging areas where the sharks are known to forage regularly and in a targeted way (e.g. in proximity to pinniped colonies)
- the area off the Great Australian Bight where the concentration of individual sharks appears to be higher, with subadult and adult white sharks being observed moving from this area across their Australian range and then returning to it (Bruce et al. 2006; CMAR 2007).

White sharks are not known to form and defend territories and are only temporary residents of areas they inhabit. However, their ability to return on a highly seasonal or more regular basis to certain areas implies a degree of site fidelity that has implications for repeat interactions with site-specific threats (DEWHA 2009).

Additional information on biologically important areas of the white shark can be found in the South-west Conservation Values Atlas.

Nature of the proposed action

Like most sharks, **grey nurse** and **white sharks** have slow development and a low reproductive rate with a long gestation period. Additionally, grey nurse shark displays a rare reproductive strategy called intrauterine cannibalism, whereby embryos feed on other embryos, thus reducing the overall reproductive output. These characteristics contribute to a low reproductive potential, which has implications for the vulnerability of the species to non-natural mortality and the rate at which populations, once depleted, can recover. For example, studies have shown that rebound potential and population recovery times for this species can be of the order of several decades even under full protection conditions, due to its unique reproductive strategy.

Pressures of potential concern for the grey nurse shark include changes in sea temperature and oceanography, ocean acidification, marine debris and bycatch.

Pressures of potential concern for the white shark include changes in sea temperature and oceanography, ocean acidification, marine debris, human presence at sensitive sites and collision and entanglement with infrastructure. In addition, bycatch is of concern.

People planning to undertake actions in biologically important areas for white sharks should carefully consider the potential for their action to have a significant impact on the species. For actions proposed outside a biologically important area for white shark, the risk of significant impact on the species is likely to be lower.

Actions with a **high risk** of significant impact on the white shark include:

- actions which have a real chance or possibility of increasing human disturbance in biologically important areas e.g. tourism activities
- actions which have a real chance or possibility of increasing entanglement in important ('foraging' and 'distribution (high density)') areas. An example is installation of aquaculture cages.

Advice for preparing a referral with respect to impacts on white shark and grey nurse shark in the South-west Marine Region

The 'referral of proposed action' form is available electronically at **www.environment.gov.au/epbc/index.html** and can also be obtained in hard copy by telephoning 1800 803 772. It includes detailed instructions about the type of information that is required in referring a proposed action for consideration.

In addition to the instructions included in the referral of proposed action form, if an action is referred because of the risk that it would result in a significant impact on grey nurse shark and/or white shark, consideration of the following matters is also recommended:

- if the action is proposed within a biologically important area for white shark, information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered
- referrals should include information on how the likelihood of any significant impact on west coast populations of white shark and/or grey nurse shark will be mitigated, based on the advice provided above on likely significant impacts. It is recommended that independent scientific assessments are sought on any intended mitigation measures before submitting a referral and that any such assessment be included in the referral

referrals should be supported by scientifically credible information that places the proposed action in the context of the advice on existing pressures on the west coast population of grey nurse shark and/or white shark and the particular life history characteristics of the two species (e.g. low reproductive rate and longevity). The species group report card—sharks (**www.environment.gov.au/marineplans/south-west**) provides information on current pressures on the species within the South-west Marine Region.

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Table A: Listed marine and cetacean species known to occur in the South-west Marine Region[25]

Species	Conservation status
Bony fishes	
Indonesian pipehorse, Günther's pipehorse *(Solegnathus lettiensis/Solegnathus guentheri)*	Marine
Cetaceans	
Minke whale, dwarf minke whale *(Balaenoptera acutorostrata)*	Cetacean Listed under CITES (Appendix I)
Pygmy sperm whale *(Kogia breviceps)*	Cetacean Listed under CITES (Appendix II)
Dwarf sperm whale *(Kogia simus)*	Cetacean Listed under CITES (Appendix II)
True's beaked whale *(Mesoplodon mirus)*	Cetacean Listed under CITES (Appendix II)
Andrew's beaked whale *(Mesoplodon bowdoini)*	Cetacean Listed under CITES (Appendix II)
Gray's beaked whale, scamperdown whale *(Mesoplodon grayi)*	Cetacean Listed under CITES (Appendix II)
Hector's beaked whale *(Mesoplodon hectori)*	Cetacean Listed under CITES (Appendix II)
Strap-toothed beaked whale, strap-toothed whale, Layard's beaked whale *(Mesoplodon layardii)*	Cetacean Listed under CITES (Appendix II)
Shepherd's beaked whale, Tasman beaked whale *(Tasmacetus shepherdi)*	Cetacean Listed under CITES (Appendix II)

25 Species listed as threatened or migratory under the EPBC Act are not listed here.

Species	Conservation status
Arnoux's beaked whale *(Berardius arnuxii)*	Cetacean Listed under CITES (Appendix I)
Cuvier's beaked whale, goose-beaked whale *(Ziphius cavirostris)*	Cetacean Listed under CITES (Appendix II)
Southern bottlenose whale *(Hyperoodon planifrons)*	Cetacean Listed under CITES (Appendix I)
False killer whale *(Pseudorca crassidens)*	Cetacean Listed under CITES (Appendix II)
Long-finned pilot whale *(Globicephala melas)*	Cetacean Listed under CITES (Appendix II)
Short-finned pilot whale *(Globicephala macrorhynchus)*	Cetacean Listed under CITES (Appendix II)
Common dolphin *(Delphinus delphis)*	Cetacean Listed under CITES (Appendix II)
Risso's dolphin, grampus *(Grampus griseus)*	Cetacean Listed under CITES (Appendix II)
Striped dolphin, euphrosyne dolphin *(Stenella coeruleoalba)*	Cetacean Listed under CITES (Appendix II)
Spotted dolphin, pantropical spotted dolphin *(Stenella attenuate)*	Cetacean Listed under CITES (Appendix II)
Long-snouted spinner dolphin *(Stenella longirostris)*	Cetacean Listed under CITES (Appendix II)
Bottlenose dolphin *(Tursiops truncates)*	Cetacean Listed under CITES (Appendix II)
Spotted bottlenose dolphin, Indo-Pacific bottlenose dolphin *(Tursiops aduncus)*	Cetacean Listed under CITES (Appendix II)
Southern right whale dolphin *(Lissodelphis peronii)*	Cetacean Listed under CITES (Appendix II)

Species	Conservation status
Marine reptiles	
Yellow-bellied sea-snake *(Pelamis platurus)*	Marine
Pinnipeds	
New Zealand fur seal *(Arctocephalus forsteri)*	Marine Listed under CITES (Appendix II)
Australian fur seal *(Arctocephalus pusillus)*	Marine Listed under CITES (Appendix II)
Seabirds	
Cape petrel *(Daption capense)*	Marine
Great-winged petrel *(Pterodroma macroptera)*	Marine
White-faced storm-petrel *(Pelagodroma marina)*	Marine
Fluttering shearwater *(Puffinus gavia)*	Marine
Little shearwater *(Puffinus assimilis)*	Marine
Hutton's shearwater *(Puffinus huttoni)*	Marine
Antarctic prion *(Pachyptila desolata)*	Marine
Salvin's prion *(Pachyptila salvini)*	Marine
Fairy prion *(Pachyptila turtur)*	Marine
Fairy tern *(Sternula nereis)*	Marine

Species	Conservation status
Sooty tern *(Onychoprion fuscata)*	Marine
Gull-billed tern *(Gelochelidon nilotica)*	Marine
Arctic tern *(Sterna paradisaea)*	Marine
Crested tern *(Thalasseus bergii)*	Marine
Roseate tern *(Sterna dougallii)*	Marine
Kelp gull *(Larus dominicanus)*	Marine
Silver gull *(Chroicocephalus novaehollandiae)*	Marine
Pacific gull *(Larus pacificus)*	Marine
Little penguin *(Eudyptula minor)*	Marine
Red-tailed tropicbird *(Phaethon rubricauda)*	Marine
Pelican, Australian pelican *(Pelecanus conspicillatus)*	Marine
Australasian gannet *(Morus serrator)*	Marine
Black-faced cormorant *(Phalacrocorax fuscescens)*	Marine

MAP DATA SOURCES

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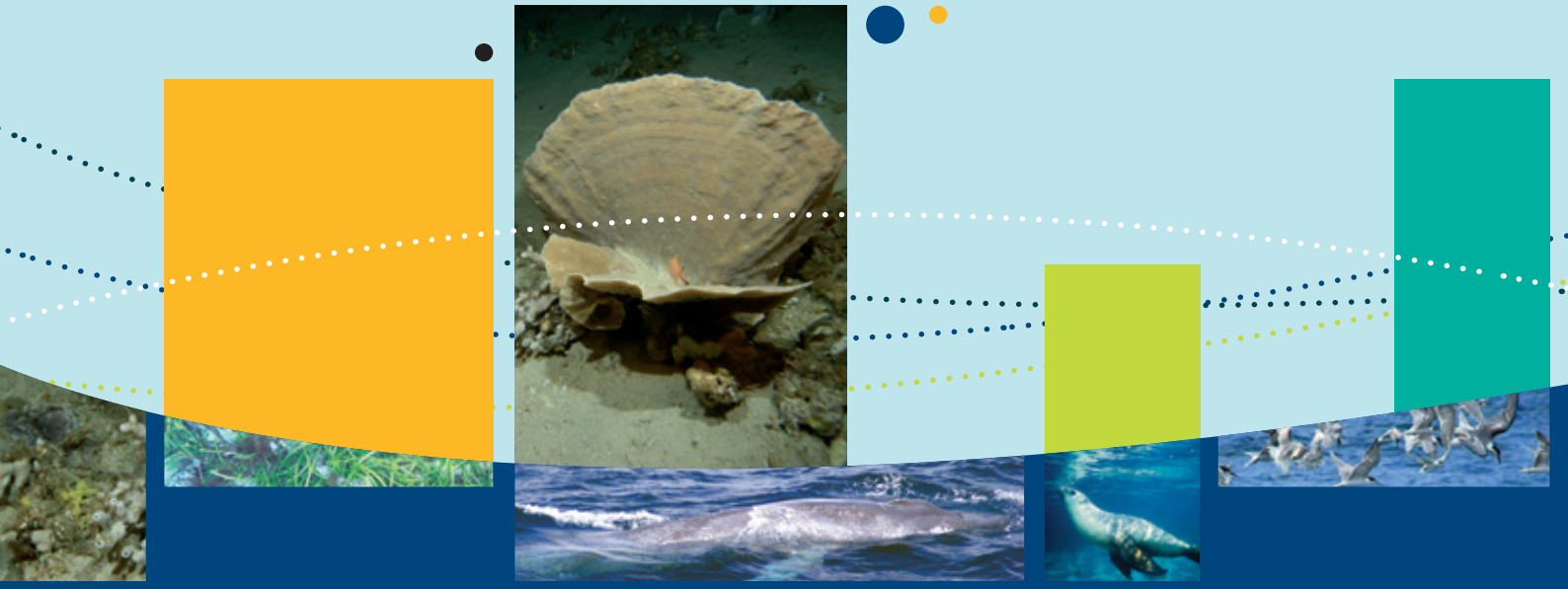

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