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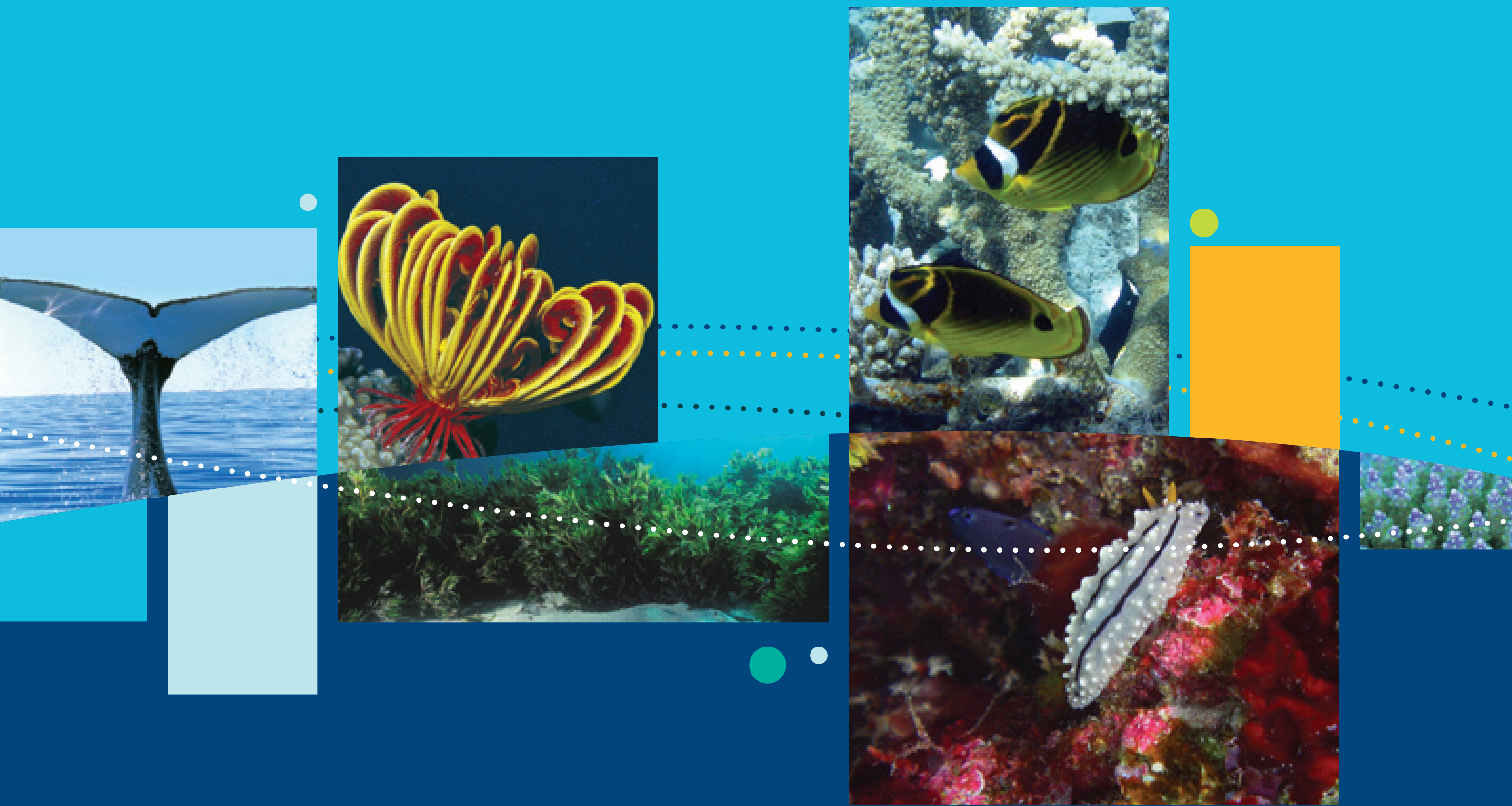

Marine bioregional plan for the North-west Marine Region

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

Images:
Striped Nudibranch – C.Zwick and DSEWPaC, Raccoon butterfly fish – N.Wolfe, Display of colourful coral – Tourism WA, Red and yellow feather star (crinoids) – Tourism WA, Sea Grass Meadow – Lochman Transparencies, Whale tail – Tourism WA, Snorkelling in Ningaloo Marine Park – Tourism WA, Green Turtle – Tourism WA, Black tip reef shark – N.Wolfe, Whale Shark – GBRMPA

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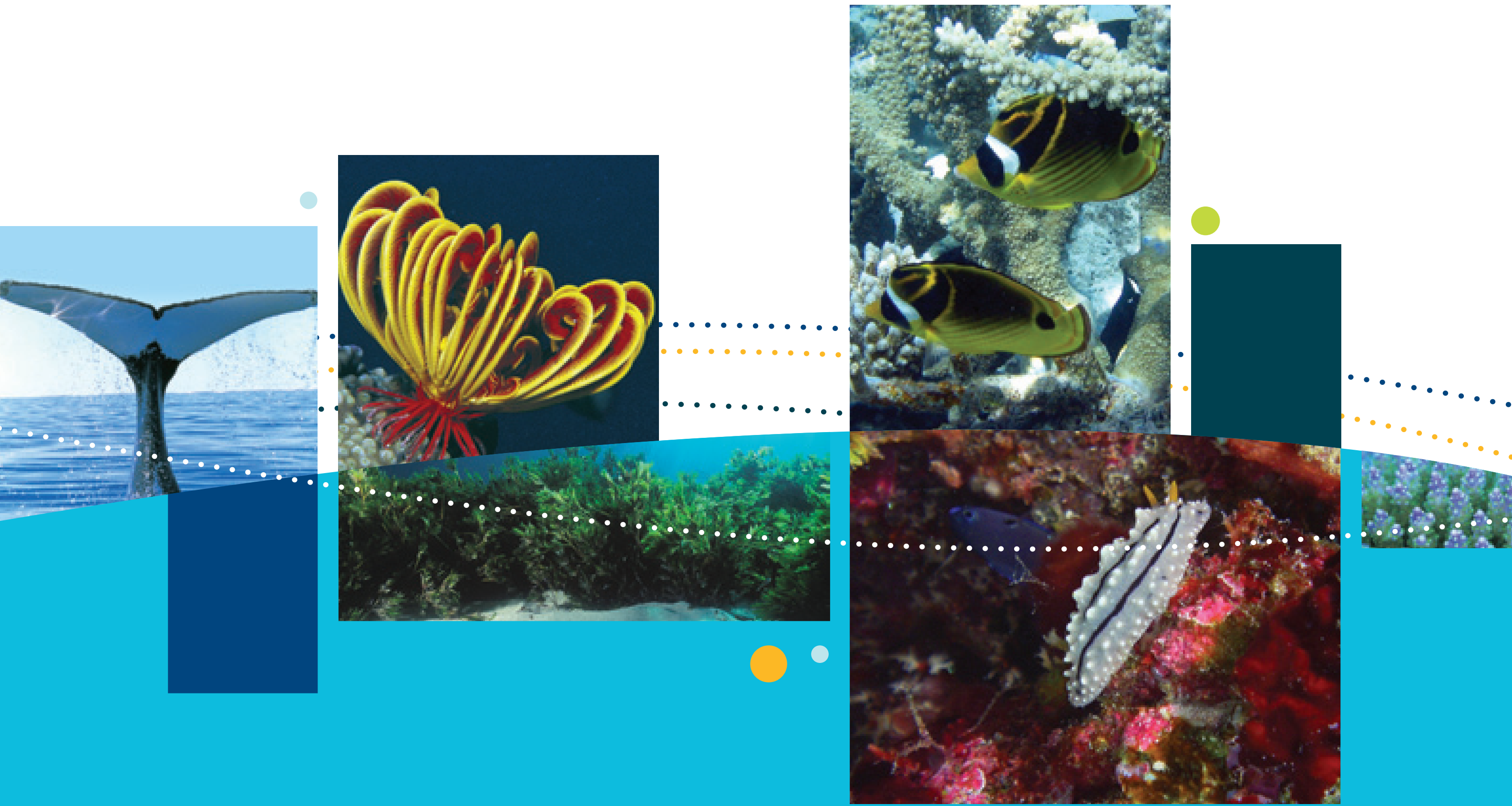

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MINISTERIAL FOREWORD

North-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.

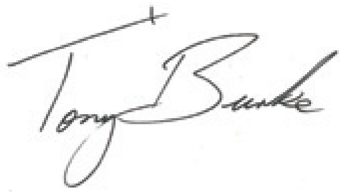
The North-west Marine Region extends from the border between Western Australia and the Northern Territory, to Kalbarri—south of Shark Bay in Western Australia, and includes extensive areas of shallower waters on the continental shelf, as well as deep areas of abyssal plain where water depths are 5000 metres or more.

The North-west Marine Region includes the world famous whale shark aggregations at Ningaloo, and every year, humpback whales migrate through the region to and from their breeding grounds off the Kimberley coast. Six of the seven species of marine turtle in the world are known to live in the region; all have threatened conservation status. Two vulnerable species of sawfish and the Australian snubfin dolphin, which is only present on the Australian continental shelf, are also found in the North-west.

This is a special part of Australia. This region attracts tourists from around the world who come to see the unique environment and numerous coral reef systems, including Ningaloo. The reefs are popular sites for diving and snorkeling, and these areas as well as other habitats are important for recreational fishing, charter fishing and marine mammal watching. Ningaloo Reef was placed on the World Heritage List in 2011, in recognition of its outstanding natural values.

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 North-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 North-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 NORTH-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 and McDonald 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 4000 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 North-west Marine Region in August 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.

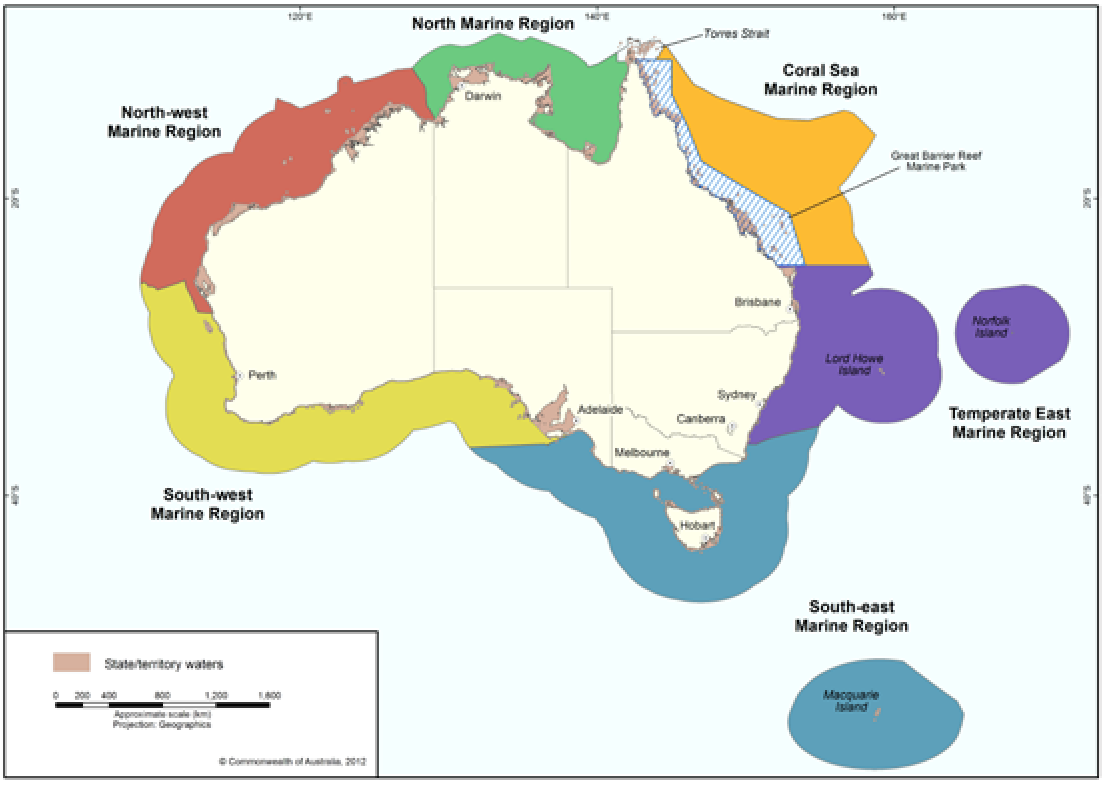


Figure 1.1: Australia's Marine Regions

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 North-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 North-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 North-west Marine Region in relation to some of the region's conservation values.

1.3 Application of the plan

This plan is for the North-west Marine Region, which covers the Commonwealth marine area (Box 1.3) extending from the Western Australian–Northern Territory border to Kalbarri, south of 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.

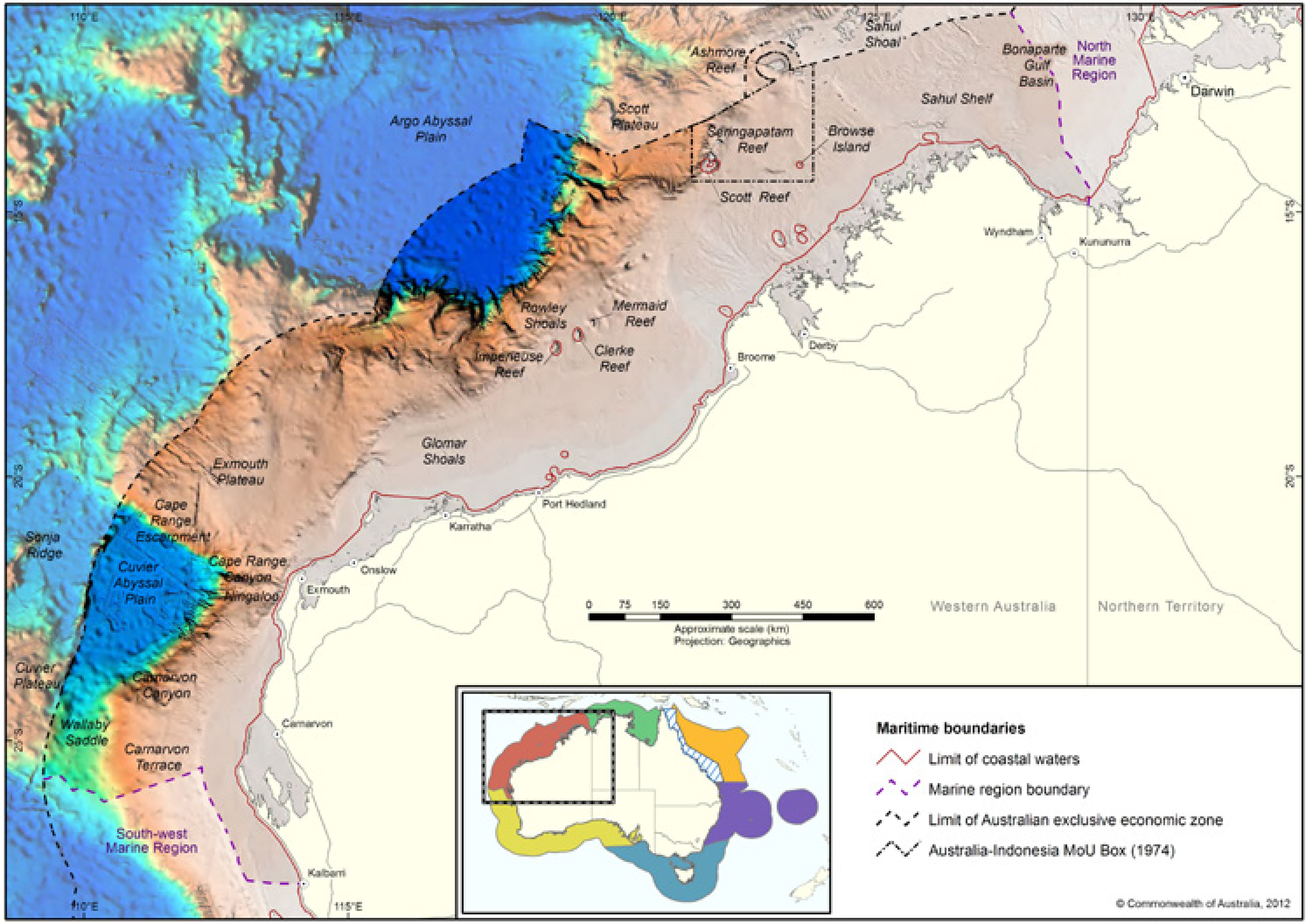


Figure 1.2: North-west Marine Region

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 the 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.

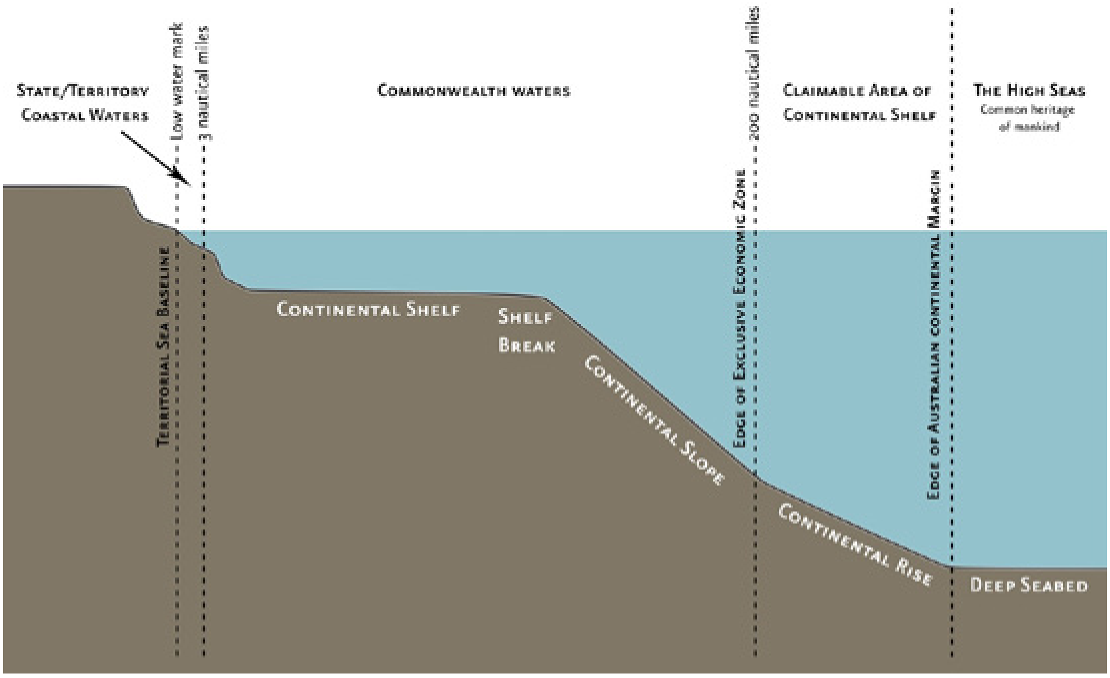


Figure 1.3: Australia's maritime zones

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 North-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 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 North-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 North-west Marine Region. Conservation values include species and places protected under the EPBC Act and key ecological features. There are three types of conservation value 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/north-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 North-west Marine Region are available at **www.environment.gov.au/marineplans/north-west**.

1.5 Who will use the plan?

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

The North-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 North-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 North-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 North-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 NORTH-WEST MARINE REGION AND ITS CONSERVATION VALUES

The North-west Marine Region comprises Commonwealth waters from the Western Australia–Northern Territory border to Kalbarri, south of Shark Bay (Figure 1.2). The region covers approximately 1.07 million square kilometres of tropical and subtropical waters and abuts the coastal waters of Western Australia. The region's north-western boundary is defined in accordance with the Perth Treaty negotiated with the Republic of Indonesia and includes areas over which Australia exercises jurisdiction over both the water column and the seabed and its associated resources. The region extends from shallow waters on the continental shelf at the state waters boundary 3 nautical miles (5.5 kilometres) from shore, to the deep ocean environments at the edge of Australia's exclusive economic zone, 200 nautical miles (370 kilometres) from shore.

The main physical features of the region are:

- extensive areas of continental shelf and slope, plateaux and terraces including the North West and Sahul shelfs, the Exmouth and Scott plateaux, the Wallaby Saddle and the Rowley Terrace
- the narrowest continental shelf on Australia's coastal margin, which occurs near North West Cape where the shelf is just 7 kilometres wide
- coralline algal reefs, and carbonate pinnacles and shoals in the far north of the region
- coral reefs including Ashmore, Hibernia, Scott, Seringapatam, Ningaloo and the Rowley Shoals, all of which have a high diversity of corals and associated fish and other species of both commercial and conservation importance
- the Joseph Bonaparte Gulf, a muddy basin with sparse coverage of sessile filter-feeding organisms and mobile invertebrates
- a number of major canyons on the continental slope that act as conduits for sediment and nutrient transport, including Cape Range, Cloates, Carnarvon and Swan canyons
- two areas of abyssal plain (Cuvier and Argo) with depths in excess of 5000 metres
- the Indonesian Throughflow, a low-salinity water mass that is one of the major elements of the global transfer of heat and water between oceans and which plays a key role in initiating the Leeuwin Current.

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 North-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 their 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

The North-west Marine Region is characterised by shallow-water tropical marine ecosystems with high species richness. Most of the region's species are tropical and are also found in other parts of the Indian and western Pacific oceans. The southern part of the region is a transition zone between tropical and temperate waters and includes the northern extent of the ranges of some temperate species that are more typical of the South-west Marine Region. High diversity is partly driven by the interaction between seafloor features and the currents of the region. The interaction of seafloor features and oceanographic processes also supports unique ecosystems and associated trophic interactions and communities.

The high species richness of the region is also thought to be associated with the diversity of habitats available. Hard habitats such as the limestone pavements of the North West Shelf, coral reefs of the Kimberley, and pinnacles and reefs on the edge of the shelf support a high diversity of benthic filter feeders and producers. Soft-bottom substrates support seagrass along the Pilbara coast, muddy infaunal communities in the Joseph Bonaparte Gulf, and deep sessile communities of filter and deposit feeders in the abyssal plains.

The region has generally low productivity, with boom and bust cycles driven by monsoonal seasonality, but some locations have predictably higher productivity. These are:

- Ningaloo Reef and the associated Cloates and Cape Range canyons
- canyon systems including the Carnarvon Canyon in the south of the region

- coral reefs along the shelf edge including Ashmore, Scott, Seringapatam and the Rowley Shoals
- the carbonate banks and pinnacles of the Sahul Shelf.

Because the region is relatively shallow—less than 200 metres deep for more than 40 per cent of the region—surface currents exert a strong influence. The region is dominated by the Indonesian Throughflow, which is a key link in the global exchange of water and heat between ocean basins and a significant element of the global climate system. It brings warm, low-nutrient (oligotrophic), low-salinity water from the western Pacific Ocean through the Indonesian archipelago to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region.

Another important factor driving the ecological processes in the region is the strong seasonality in wind direction and rainfall. The region experiences monsoonal climate patterns with highly variable tidal regimes and a pronounced cyclone season between December and March. The weakening of the Indonesian Throughflow and Leeuwin Current in the dry season (April to September and particularly during El Niño years), along with the seasonal reversal in wind and cyclones, enhances biological productivity through increased mixing of the deeper, cold, nutrient-rich waters with surface waters.

One of the most unusual and significant oceanographic features of the region, a result of pronounced temperature differences in the water column and the interaction between currents and the sea floor, is the occurrence of internal waves. Internal waves are large in amplitude (up to 75 metres high) and encourage the mixing of surface waters with deeper, more nutrient-rich waters, which is important for biological productivity in the region. Areas such as Exmouth Plateau and the slope adjacent to the North West Shelf are known sites of internal wave activity. Breaking internal waves can increase productivity through enhanced vertical mixing.

The region supports internationally important breeding and feeding grounds for a number of threatened and migratory marine species, including humpback whales, which mate and give birth in the waters off the Kimberley coast. Significant turtle rookeries are found on coastal beaches and offshore islands in and adjacent to the region. Shark Bay is home to one of the largest remaining dugong populations in the world, and the annual aggregation of whale sharks at Ningaloo Reef is the highest known density of whale sharks in the world.

Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment in the North-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
- a 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.

Thirteen key ecological features have been identified in the North-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/north-west**). Understanding of KEFs may evolve as new scientific information emerges.

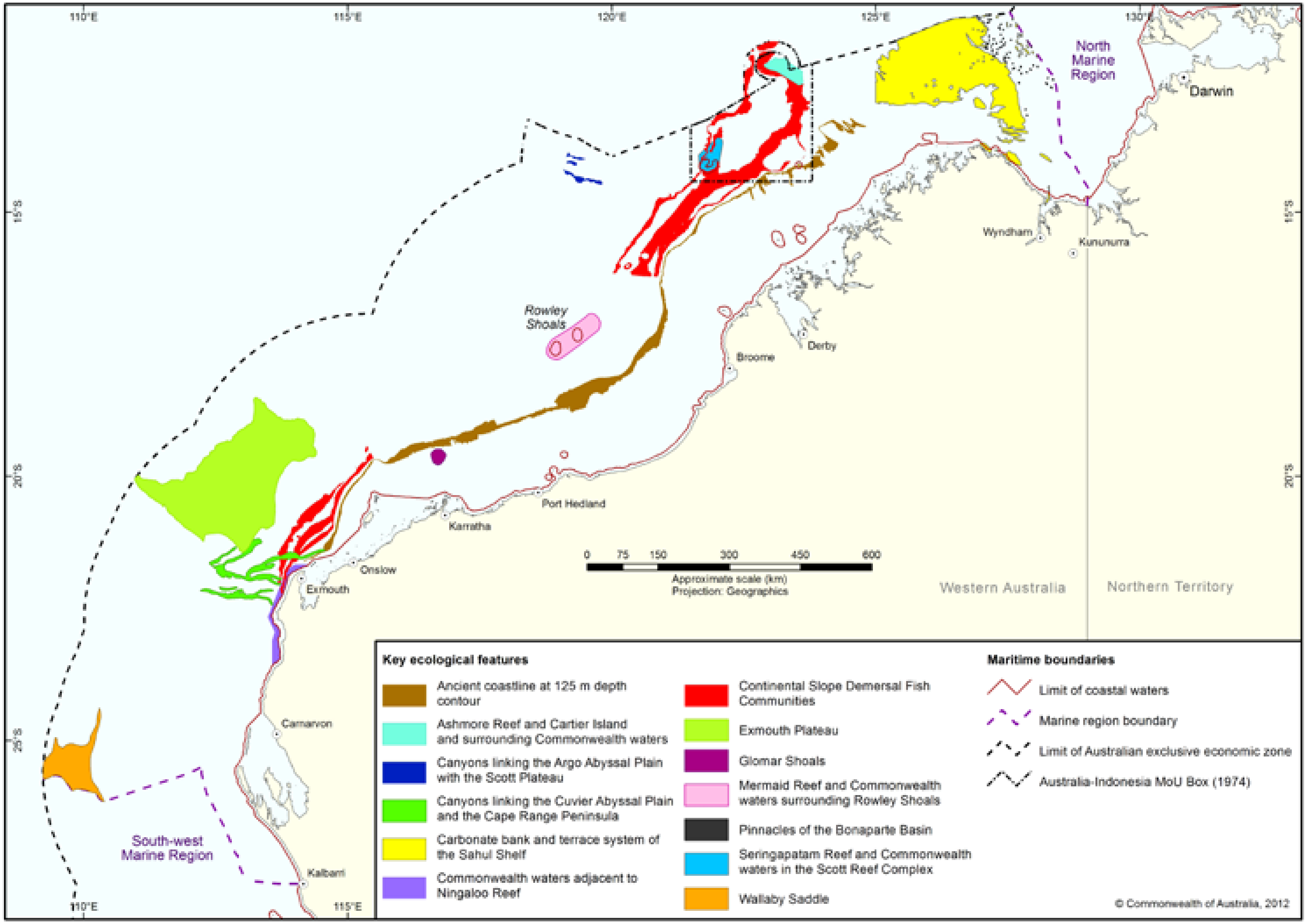


Figure 2.1: Key ecological features of the North-west Marine Region

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

Feature	Values	Description
Carbonate bank and terrace system of the Sahul Shelf	Unique seafloor feature with ecological properties of regional significance	Little is known about the bank and terrace system of the Sahul Shelf but it is regionally important because of its likely ecological role in enhancing biodiversity and local productivity relative to its surrounds. The banks are thought to support a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders. The banks are known to be foraging areas for loggerhead, olive ridley and flatback turtles. Cetaceans and green and freshwater sawfish are likely to occur in the area.
Pinnacles of the Bonaparte Basin	Unique seafloor feature with ecological properties of regional significance	As they provide areas of hard substrate in an otherwise relatively featureless environment, the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	High productivity and aggregations of marine life	Ashmore Reef is the largest of only three emergent oceanic reefs present in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of birds and other marine life; they are areas of enhanced primary productivity in an otherwise low-nutrient environment. Ashmore Reef supports the highest number of coral species of any reef off the west Australian coast.

Feature	Values	Description
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	High productivity and aggregations of marine life	Seringapatam Reef and the Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity and high species richness associated with the reefs themselves. As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.
Continental slope demersal fish communities	High levels of endemism	The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the continental slope.
Canyons linking the Argo Abyssal Plain and Scott Plateau	High productivity and aggregations of marine life	The canyons linking the Argo Abyssal Plain and Scott Plateau are important features likely to be associated with aggregations of marine life.
Ancient coastline at 125 m depth contour	Unique seafloor feature with ecological properties of regional significance	Parts of the ancient coastline, particularly where it exists as a rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column, providing relatively nutrient-rich local environments.
Glomar Shoals	High productivity and aggregations of marine life	The Glomar Shoals are regionally important for their high biological diversity and high localised productivity. Biological data specific to Glomar Shoals is limited; however, the fish of Glomar Shoals are probably a subset of reef-dependent species and anecdotal and fishing industry evidence suggests they are particularly abundant.
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	High productivity and aggregations of marine life	The reefs of the Rowley Shoals (including Mermaid Reef) are areas of enhanced productivity and high species richness. Enhanced productivity that contributes to this species richness is thought to be facilitated by the breaking of internal waves in the waters surrounding the reefs, causing mixing and re-suspension of nutrients from water depths of 500–700 m into the photic zone. The steep changes in slope around the reef also attract a range of migratory pelagic species such as dolphins, tuna, billfish and sharks.

Feature	Values	Description
Exmouth Plateau	Unique seafloor feature with ecological properties of regional significance	The Exmouth Plateau is a regionally and nationally unique deep-sea plateau in tropical waters. The plateau is a very large topographic obstacle that may modify the flow of deep waters, generating internal tides and may contribute to upwelling of deeper water nutrients closer to the surface, thus serving an important ecological role.
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	Unique seafloor features with ecological properties of regional significance	The canyons are associated with upwelling as they channel deep water from the Cuvier Abyssal Plain up onto the slope. This nutrient-rich water interacts with the Leeuwin Current at the canyon heads. Aggregations of whale sharks, manta rays, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area.
Commonwealth waters adjacent to Ningaloo Reef	High productivity and aggregations of marine life	The Leeuwin and Ningaloo currents interact, leading to areas of enhanced productivity in the Commonwealth waters adjacent to Ningaloo Reef. Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area.
Wallaby Saddle	High productivity and aggregations of marine life	The Wallaby Saddle may be an area of enhanced productivity. Historical whaling records provide evidence of sperm whale aggregations in the area of the Wallaby Saddle, possibly due to the enhanced productivity of the area and aggregations of baitfish.

2.3 Conservation values—protected species

The North-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.

Migratory species are those species that are listed under:

- the *Convention on the Conservation of Migratory Species of Wild Animals 1979* (CMS or Bonn Convention)
- the *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment 1974* (JAMBA)
- the *Agreement between the Government of Australia and the 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 lists of protected species established under the EPBC Act are updated periodically. This plan refers to the lists of protected species in the region, current at May 2012. Species or species groups identified as conservation values in the North-west Marine Region are:

- cetaceans
- dugong
- marine reptiles
- seabirds and migratory shorebirds
- seahorses, sea dragons, pipefishes and ghost pipefishes
- sharks and sawfishes.

Report cards describe the protected species (as of May 2012) and include detailed information about species distribution and ecology in the North-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 behaviour is assumed to indicate that the habitat required for the behavior 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 North-west Marine Region Conservation Values Atlas (**www.environment.gov.au/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.

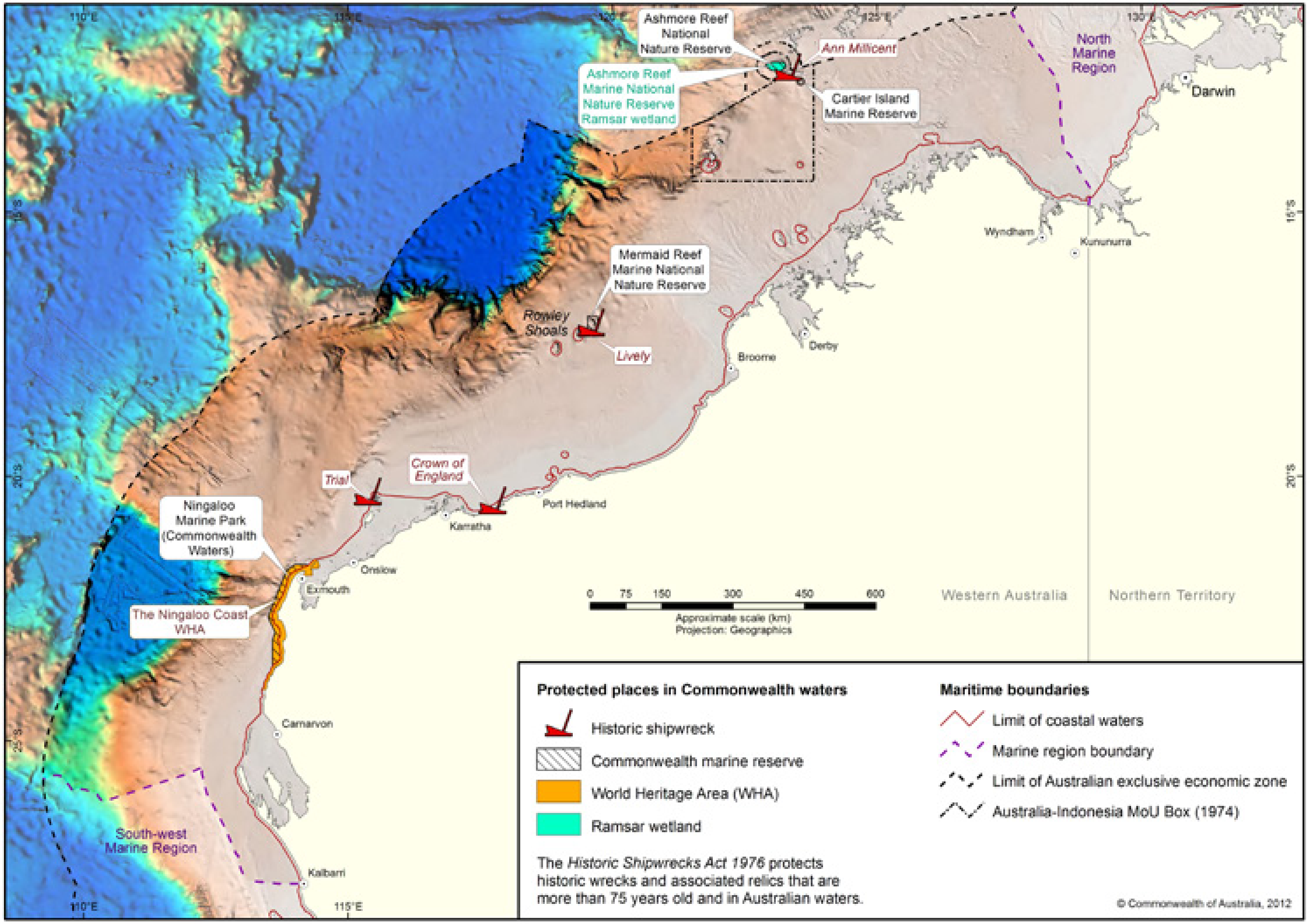


Figure 2.2: Protected places in the North-west Marine Region as of May 2012

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

Protected place	Protection measure	Relevant key ecological feature
Ashmore Reef	Commonwealth marine reserve Commonwealth Heritage List Ramsar site	Ashmore Reef and Cartier Island and surrounding Commonwealth waters
Cartier Island	Commonwealth marine reserve	Ashmore Reef and Cartier Island and surrounding Commonwealth waters
Mermaid Reef	Commonwealth marine reserve Commonwealth Heritage List	Mermaid Reef and the Commonwealth waters surrounding the Rowley Shoals
Ningaloo Reef	World Heritage List National Heritage List Commonwealth marine reserve Commonwealth Heritage List	Commonwealth waters adjacent to Ningaloo Reef
Scott Reef	Commonwealth Heritage List	Seringapatam Reef and Commonwealth waters in the Scott Reef complex
Seringapatam Reef	Commonwealth Heritage List	Seringapatam Reef and Commonwealth waters in the Scott Reef complex
the *Trial*	Historic shipwreck	
the *Lively*	Historic shipwreck	
the *Ann Millicent*	Historic shipwreck	
the *Crown of England*	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 North-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; dugong; marine reptiles; seabirds and shorebirds; bony fishes; and sharks and sawfish. 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 North-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 considerations for selection	Species selected for detailed pressure analysis
Bony fishes—seahorses and pipefishes	Species were selected on the basis of their occurrence in the region, mostly in the shallow waters of Commonwealth marine reserves such as Ashmore and Mermaid, and their listing as marine species under the EPBC Act.	**Montebello seahorse** **Western spiny seahorse (narrow-bellied seahorse)** **Winged seahorse** **Yellow seahorse (spotted seahorse)** **Barbed pipefish (corrugated pipefish)** **Banded pipefish (ringed pipefish)** **Bentstick pipefish** **Bluestripe pipefish (Pacific blue stripe pipefish)** **Brock's pipefish** **Double-ended pipehorse (alligator pipefish)** **Glittering pipefish** **Long-nosed pipefish (straightstick pipefish)** **Messmate pipefish (banded pipefish)** **Mud pipefish (Grey's pipefish)** **Negros pipefish (flagtail pipefish)** **Pacific short-bodied pipefish** **Red-banded pipefish (brown-banded pipefish, Fijian pipefish)** **Reticulate pipefish (yellow banded pipefish)** **Ridge-nose pipefish (red-hair pipefish, Duncker's pipefish)** **Robust ghost pipefish (blue finned ghost pipefish)** **Rough-ridge pipefish (Banner's pipefish)** **Schultz's pipefish (guilded pipefish)** **Western pipehorse**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Cetaceans	The three inshore dolphin species selected, although generally coastal species, also occur in the Commonwealth marine environment of the North-west Marine Region. The Australian snubfin dolphin and Indo-Pacific humpback dolphin occur mostly in shallow waters up to 10 km from the coast and 20 km from the nearest river mouth. The Australian snubfin dolphin has been recorded up to 23 km offshore. Indo-Pacific humpback dolphins are found in open coastal waters around islands and coastal cliffs in association with rock and/or coral reefs, and have been seen 55 km offshore in shallow water. Indo-Pacific bottlenose dolphins tend to occur in deeper, more open coastal waters, primarily in continental shelf waters (<200 m deep), including coastal areas around oceanic islands. Seven species of pelagic dolphin occur in the region, many of which occur in mixed schools or cetacean communities. A combination of large tidal movements and complex sea-floor habitat in the region, off the northern Kimberley, creates a dynamic foraging habitat for cetaceans and very large schools form to take advantage of prey aggregations. Humpback whales migrate through the region each year to breed and calve in the area between Broome and Camden Sound. The west Australian population of humpback whales is genetically distinct from the east Australian population.	**Australian snubfin dolphin** **Indo-Pacific bottlenose dolphin** **Indo-Pacific humpback dolphin** **Bottlenose dolphin** **Fraser's dolphin** **Long-snouted spinner dolphin** **Risso's dolphin** **Rough-toothed dolphin** **Spotted dolphin (pantropical spotted dolphin)** **Striped dolphin** **Humpback whale**
Dugong	The dugong was selected on the basis of its occurrence in the region, the presence of important foraging grounds in and adjacent to the region and its listing as a migratory species under the EPBC Act. A large proportion of the world's dugong population occurs in and adjacent to the region, including a small, genetically distinct population at Ashmore Reef.	**Dugong**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Marine reptiles	Marine turtle species were selected on the basis of their occurrence in the region, their listing as threatened species under the EPBC Act, and the presence of important breeding, nesting and feeding sites for the species in the region. In particular, the region supports globally significant breeding populations of green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and flatback (*Natator depressus*) turtles. Olive ridley turtles (*Lepidochelys olivacea*) are known to feed in the region, but there are only occasional records of the species nesting in the region. Leatherback turtles (*Dermochelys coriacea*) regularly forage over Australian continental shelf waters. Sea snake species were selected on the basis of their occurrence in the region, the importance of the region to their survival and their listing under the EPBC Act as marine or migratory species. Ashmore Reef and Cartier Island in particular have been recognised for their high diversity and density of sea snakes. The region also contains two critically endangered and five endemic species of sea snakes.	**Flatback turtle** **Green turtle** **Hawksbill turtle** **Leatherback turtle** **Loggerhead turtle** **Olive ridley turtle** **Black-ringed seasnake** **Brown-lined seasnake** **Dubois' seasnake** **Dusky seasnake** **Elegant seasnake (bar-bellied sea snake)** **Fine-spined seasnake** **Horned seasnake** **Leaf-scaled seasnake** **Northern mangrove seasnake** **North-western mangrove seasnake** **Olive seasnake** **Olive-headed seasnake** **Ornate seasnake (ornate reef seasnake)** **Shark Bay seasnake** **Short-nosed seasnake** **Slender-necked seasnake** **Small-headed seasnake** **Spectacled seasnake** **Spine-bellied seasnake** **Spine-tailed seasnake** **Stokes' seasnake** **Turtle-headed seasnake** **Yellow-bellied seasnake**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Seabirds and migratory shorebirds	The 23 species selected are considered to be ecologically significant to the North-west Marine Region; that is, they are either endemic to the region, have a high number of interactions with the region (nesting, foraging, roosting or migrating) or have life history characteristics that make them susceptible to population decline. Important areas in the region are also nationally or globally significant for some species. Offshore sites, such as Ashmore Reef, provide important seabird and migratory shorebird habitat.	**White-tailed tropicbird** **Wedge-tailed shearwater** **Greater frigatebird** **Lesser frigatebird** **Brown booby** **Red-footed booby** **Fairy tern** **Lesser crested tern** **Little tern** **Roseate tern** **Greater sand-plover** **Grey plover** **Pacific golden plover** **Bar-tailed godwit** **Common greenshank** **Curlew sandpiper** **Great knot** **Grey-tailed tattler** **Red-necked stint** **Ruddy turnstone** **Sanderling** **Terek sandpiper** **Whimbrel**
Sharks and sawfish	Species were selected on the basis of their occurrence in the region, their listing as migratory or threatened species under the EPBC Act, and the importance of the region to their survival.	**Dwarf sawfish** **Freshwater sawfish** **Green sawfish** **Grey nurse shark** **Whale shark** **White shark**

3.2 Outcome of pressure analysis

Human pressures on marine ecosystems and biodiversity in the North-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 and industrial 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 anthropogenic pressure on conservation values in the 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, storm frequency and intensity)
- domestic and international harvesting of living resources
- increasing petroleum and mineral exploration and development
- rapid industrial development in areas adjacent to the region
- increases in shipping activities and development of port infrastructure.

The findings of the pressure analysis are presented in Schedule 1 of the plan and in the North-west Marine Region conservation value report cards (**www.environment.gov.au/marineplans/north-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 North-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* has 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.

North-west Marine Region priorities

This plan identifies 23 regional priorities for the North-west Marine Region: 12 conservation values and 11 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 North-west Marine Region

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
1	**Marine turtles** *Flatback turtle* *Green turtle* *Hawksbill turtle* (EPBC Act listed as vulnerable, migratory and marine) *Loggerhead turtle* *Olive ridley turtle* *Leatherback turtle* (EPBC Act listed as endangered, migratory and marine)	The North-west Marine Region supports important nesting areas for green, hawksbill, loggerhead and flatback turtles. Olive ridley turtles are known to forage in the northern parts of the region but records indicate that they nest only occasionally in the region. In the North-west Marine Region marine turtles are subject to a number of pressures assessed as *of concern*: invasive species (3 species); dredging (1 species); marine debris (net entanglement and ingestion of debris) (6 species); light pollution from onshore activities (4 species); and human presence at sensitive sites, such as nesting areas (3 species). Marine turtles are also subject to several pressures assessed as *of potential concern*: changes in sea temperatures; changes in sand temperatures (4 species); bycatch in commercial fishing (4 species); noise pollution associated with seismic testing (6 species) and offshore development (4 species); physical habitat modification due to dredging (4 species) and the use of fishing gear (3 species); collision with vessels (3 species); nutrient pollution (1 species); Indigenous harvest (3 species); and changes in turbidity as a result of dredging activities (1 species). The conservation status of marine turtles, the significance of the North-west Marine Region to their recovery and the pressures facing them in the region make the species group a priority for conservation effort.	Strategy A, Actions 2, 3, 6 Strategy B, Action 1 Strategy C, Action 1, 3 Strategy D, Actions 1, 2, 5, 6, 7 Strategy E, Actions 1, 2, 3 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
2	**Inshore dolphins** *Australian snubfin dolphin* *Indo-Pacific bottlenose dolphin (Arafura–Timor sea population)* *Indo-Pacific humpback dolphin* (EPBC Act listed as migratory and cetacean)	Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins rely on the waters in and adjacent to the North-west Marine Region for breeding and foraging. Inshore dolphins are particularly vulnerable to impacts from human activities because their distribution overlaps with areas of intensive human use. Their vulnerability to pressures is intensified due to their small and fragmented populations and their life history characteristics (they are long lived, females take many years to reach sexual maturity and they have a low rate of reproduction). In the North-west Marine Region, Indo-Pacific bottlenose dolphins are subject to one pressure assessed as *of concern*: bycatch in commercial fishing. All three inshore dolphins are subject to several pressures assessed as *of potential concern*: marine debris; physical habitat modification (dredging, onshore and offshore construction); noise pollution; oil pollution; collision with vessels; chemical and nutrient pollution; changes in sea temperatures; ocean acidification; physical habitat modification caused by storm events; human presence at sensitive sites; and changes to hydrological regimes. Sea level rise is also a pressure *of potential concern* for the Australian snubfin dolphin. Inshore dolphins are a regional priority because of the significance of the North-west Marine Region to their survival (especially given their limited and fragmented ranges) and the number of pressures facing them in the region.	Strategy A, Actions 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Actions 1, 5, 7 Strategy E, Actions 2, 3

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
3	**Sawfishes** *Freshwater sawfish* *Green sawfish* (EPBC Act listed as vulnerable)	While relatively little is known about the distribution and abundance of sawfish species in north-western Australia, the North-west Marine Region is considered an important area for the species group because the region and adjacent inshore coastal waters and riverine environments contain nationally and globally significant populations of sawfish species. Due to their slow growth and maturation rates, longevity, low fecundity and low rates of natural mortality, sawfish are particularly vulnerable to human-induced pressures. In the North-west Marine Region, sawfish are subject to several pressures assessed as *of concern*: bycatch (commercial and recreational fishing); and changes in hydrological regimes. Sawfish are also subject to pressures assessed as *of potential concern*: sea level rise; and marine debris. Some research has been undertaken into the distribution, population size, population trends and factors influencing the recovery of species. However, there are significant gaps in knowledge about sawfish species in north-western Australia. These knowledge gaps, along with the conservation status of sawfish, the significance of the North-west Marine Region to them and the pressures facing them in the region make these species a priority for conservation effort.	Strategy A, Actions 2, 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Action 1 Strategy E, Actions 1, 2, 3

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
4	**Sea snakes** (EPBC Act listed as marine)	Twenty-five species of sea snake are known to occur in the North-west Marine Region, two of which (short-nosed seasnake and leaf-scaled seasnake) are listed as critically endangered. Sea snakes are vulnerable to human-induced pressures because of their slow growth rates and low fecundity. Some species also have very specific diets that can make them vulnerable to changes in the food web. Bycatch in commercial fishing is assessed as *of concern* for sea snakes in the North-west Marine Region. Sea snakes are also subject to several pressures assessed as *of potential concern*: physical habitat modification; oil pollution; changes in sea temperature; and ocean acidification. In addition, recent research has revealed a steep decline in sea snake numbers at Ashmore Reef. The reasons for this decline are currently unknown. The conservation status of sea snakes, the significance of the North-west Marine Region to their survival and the pressures facing them in the region make the species group a priority for conservation effort.	Strategy A, Actions 3, 6, 7 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
5	**Humpback whale** (EPBC Act listed as vulnerable, migratory and cetacean)	Humpback whales migrate around June each year from their feeding grounds in Antarctica to the North-west Marine Region where they mate and calve in inshore areas, predominantly between Broome and north Camden Sound. The west Australian population of humpbacks is genetically distinct from the east Australian population and is estimated at around 28 830 individuals. Although the humpback whale population has increased substantially since the cessation of commercial whaling, the species is vulnerable to human-induced pressures because it is long-lived, slow to reach sexual maturity and has a low rate of reproduction. Humpback whales are subject to several pressures assessed as *of potential concern*: noise pollution from seismic surveys, shipping and construction; and collision with vessels. The conservation status of humpback whales, the significance of the North-west Marine Region to the west coast population and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Actions 2, 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Actions 5, 7 Strategy E, Actions 1, 2 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
6	**Seabirds and migratory shorebirds** *Fairy tern* (sub-species *Sternula nereis nereis)* (EPBC Act listed as vulnerable) *White-tailed tropicbird* *Wedge-tailed shearwater* *Greater frigatebird* *Lesser frigatebird* *Brown booby* *Red-footed booby* *Lesser crested tern* *Little tern* *Roseate tern* *Greater sand plover* *Bar-tailed godwit* *Common greenshank* *Curlew sandpiper* *Great knot* *Grey-tailed tattler* *Red-necked stint* *Ruddy turnstone* *Sanderling* *Terek sandpiper* *Whimbrel* (EPBC Act listed as marine and/or migratory)	Seabirds spend most of their lives at sea, ranging over large distances to forage over the open ocean. Many of these species also breed in and adjacent to the North-west Marine Region, including significant populations of terns, shearwaters and boobies. During their migration, shorebirds use a number of staging areas as intermediate feeding sites to rest and restore energy reserves. Within and adjacent to the region, there are a number of sites which are of international or national significance to shorebirds. Seabirds and shorebirds are vulnerable to human-induced pressures due to their low fecundity, site fidelity, longevity and vulnerability to introduced predators. In the North-west Marine Region, seabirds are subject to several pressures assessed as *of potential concern*: invasive species; oil pollution; sea level rise; changes in sea temperatures; ocean acidification; light pollution; and human presence at sensitive sites. Shorebirds are also subject to several pressures assessed as *of potential concern*: sea level rise; changes in sea temperatures; ocean acidification; physical habitat modification and changes in turbidity (climate change); light pollution; human presence at sensitive sites; oil pollution; collision/entanglement with infrastructure; and invasive species. The conservation status of seabirds and shorebirds, the significance of the North-west Marine Region to their survival and the pressures facing them in the region make these species a priority for conservation effort.	Strategy A, Actions 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Action 6 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
7	**Whale shark** (EPBC Act listed as vulnerable)	Whale sharks are migratory, have a widespread global distribution in tropical and warm temperate seas and are widely distributed in Australian waters. Ningaloo Reef is the main known aggregation site for whale sharks in Australian waters and has the greatest known density of whale sharks per square kilometre in the world. The length of gestation, localities of birth and frequency of reproduction are not yet known for the whale shark but, in general, shark life history characteristics (late maturity, slow growth rate, low fecundity, longevity and low rate of natural mortality) result in a limited capacity to withstand human-induced pressures. In the North-west Marine Region, whale sharks are subject to two pressures assessed as *of potential concern*: changes in sea temperature; and extraction of living resources in international waters. The conservation status of whale sharks, the pressures facing them and the limited information about the species make it a priority for conservation effort.	Strategy A, Actions 2, 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Action 2 Strategy E, Action 1 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
8	**Dugong** (EPBC Act listed as migratory and marine)	While most dugongs are found in coastal waters adjacent to the North-west Marine Region, they do migrate through Commonwealth waters and a small, genetically distinct population exists at Ashmore Reef. Some of the coastal waters adjacent to the North-west Marine Region support significant populations of dugong; Shark Bay has an estimated population of approximately 10 000 dugongs. Dugongs are susceptible to human-induced impacts as a result of their biological characteristics, including their longevity (>70 years), long gestation (12–14 months), single offspring, long intervals between births (>2.5 years) and long period before reaching sexual maturity (6–17 years). In the North-west Marine Region, dugongs are subject to several pressures assessed as *of potential concern*: invasive species; vessel collision; oil pollution; physical habitat modification (dredging and coastal development); extraction of living resources (Indigenous harvest); marine debris (net entanglement and ingestion of debris); sea level rise; changes in sea temperature; and physical habitat modification from increased storm events due to climate change. The conservation status of dugongs, the significance of the North-west Marine Region to their survival and the pressures facing them make the species a priority for conservation effort.	Strategy A, Actions 2, 3, 6 Strategy B, Action 1 Strategy C, Actions 1, 3 Strategy D, Action 7 Strategy E, Actions 1, 2, 3,

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
9	**Ashmore Reef and Cartier Island and surrounding Commonwealth waters** (Key ecological feature)	This area constitutes a key ecological feature due to its ecologically important aggregations of marine life. The area supports significant assemblages of many marine plants and animals including invertebrates, fishes, seabirds, shorebirds, sea snakes and dugongs. Ashmore Reef is the largest of only three emergent oceanic reefs in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Emergent reefs are areas of enhanced primary productivity in an otherwise oligotrophic environment. Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are vulnerable to human-induced pressures due to the area's proximity to the edge of the Australian exclusive economic zone. The pressures assessed as *of potential concern* are: invasive species; illegal, unregulated and unreported fishing; oil pollution; marine debris; physical habitat modification due to storm events; sea level rise; changes in sea temperatures; and ocean acidification. Changes in the environment at Ashmore Reef may be responsible for the rapid decline in sea snake diversity and abundance witnessed in recent years. Ashmore Reef and Cartier Island and surrounding Commonwealth waters is a priority for conservation efforts because it is a key ecological feature of the region that is facing several pressures assessed as *of potential concern*.	Strategy A, Actions 3, 4, 7 Strategy B, Actions 1 Strategy C, Actions 1, 3 Strategy D, Action 2 Strategy F, Action 1 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
10	**Seringapatam Reef and Commonwealth waters in the Scott Reef complex** (Key ecological feature)	Seringapatam Reef and Commonwealth waters in the Scott Reef complex constitute a key ecological feature as they support diverse aggregations of marine life, high primary productivity relative to other parts of the region and high species richness. North and South Scott reefs, Seringapatam Reef and the Commonwealth waters surrounding them are vulnerable to human-induced pressures in part due to the area's proximity to the edge of the Australian exclusive economic zone, their presence within the Memorandum of Understanding (MoU) Box, and the high prospectivity for oil and gas exploration. Traditional Indonesian fishing is a pressure *of concern* for Seringapatam Reef and Commonwealth waters in the Scott Reef complex. The pressures assessed as *of potential concern* are: invasive species; physical habitat modification (construction activities, anchorage, Indonesian traditional fishing practices); oil pollution; marine debris; physical habitat modification due to increasing frequency and intensity of storm events; sea level rise; changes in sea temperatures; and ocean acidification. Seringapatam Reef and Commonwealth waters in the Scott Reef complex are a priority for conservation efforts because they are a key ecological feature of the region that is facing several pressures assessed as *of concern* and *of potential concern*.	Strategy A, Actions 3, 4 Strategy B, Actions 1 Strategy C, Actions 1, 3 Strategy D, Action 2 Strategy F, Action 1 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
11	**Mermaid Reef and Commonwealth waters surrounding Rowley Shoals** (Key ecological feature)	Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals are regionally important because they support high species diversity, enhanced productivity and aggregations of marine life. The steep changes in slope around the reef also attract a range of migratory pelagic species including dolphins, tuna, billfish and sharks. Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals are vulnerable to human-induced pressures such as the expansion of the oil and gas industry and the increasing number of vessels using the area. The pressures assessed as *of potential concern* are: invasive species; physical habitat modification from storm events; oil pollution; changes in sea temperatures; sea level rise; and ocean acidification. Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals are a priority for conservation efforts because they are a key ecological feature of the region that is facing several pressures assessed as *of potential concern*.	Strategy A, Actions 3, 4 Strategy B, Actions 1 Strategy C, Actions 1, 3 Strategy E, Action 4 Strategy F, Action 1
12	**Commonwealth waters adjacent to Ningaloo Reef** (Key ecological feature)	Commonwealth waters adjacent to Ningaloo Reef is a key ecological feature of the North-west Marine Region. The reef is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. It is also globally significant as a seasonal aggregation site for whale sharks. The Commonwealth waters adjacent to Ningaloo Reef are potentially vulnerable to human-induced pressures associated with the expansion of the oil and gas industry and the increasing number of vessels using the area. The pressures assessed as *of potential concern* are: invasive species; oil pollution; changes in sea temperatures; and ocean acidification. Commonwealth waters adjacent to Ningaloo Reef is a priority for conservation efforts because it is a key ecological feature of the region facing pressures assessed as *of potential concern*.	Strategy A, Actions 3, 4 Strategy B, Actions 1 Strategy C, Actions 1, 3 Strategy E, Action 4 Strategy F, Action 1

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

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
13	**Climate change**	Climate change-related pressures, including changes in sea temperature, oceanographic processes, ocean acidification, sea level and storm intensity, are predicted to increase in the North-west Marine Region with the potential to impact many conservation values to varying extents. In the North-west Marine Region, pressures related to climate change are assessed as *of potential concern* for all six species of marine turtle known to occur in the region, inshore dolphins, sawfish, sea snakes, whale shark, dugong, all species of seabird and shorebird assessed, the 13 key ecological features of the region and four shipwrecks (Table 3.1). Climate change is a priority for conservation effort in the North-west Marine Region because it is assessed as *of potential concern* for multiple conservation values, pressures associated with it are likely to increase and have unforeseen consequences for the region's natural systems and biodiversity, and because there is a significant gap in knowledge about how the pressures will impact the conservation values of the region.	Strategy A, Action 3 Strategy B, Action 2 Strategy G, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
14	**Marine debris**	Marine debris data for the North-west Marine Region is limited. However, key contributing factors for the introduction and spread of debris in the region are present, including high levels of commercial shipping, increasing use of recreational vessels, major current systems (the Leeuwin Current), active fisheries (IUU, recreational and commercial), and significant coastal urban and industrial development. Vertebrate marine life injury and fatality caused by ingestion of, or entanglement in, harmful marine debris is a listed key threatening process under the EPBC Act. In the North-west Marine Region, interactions with marine debris are *of concern* for marine turtles. Interactions with marine debris are *of potential concern* for inshore dolphins, sawfish, dugong, Ashmore Reef, Cartier Island and surrounding Commonwealth waters, and Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Marine debris is a priority for conservation efforts in the North-west Marine Region because it is *of concern* or *of potential concern* for multiple conservation values in the region, because of the vulnerability of the region to the pressure, and because it is listed under the EPBC Act as a key threatening process.	Strategy A, Action 5 Strategy B, Action 2 Strategy E, Action 3 Strategy G, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
15	**Noise pollution**	Noise pollution from a range of activities, including shipping, seismic surveys, and offshore and onshore construction, is increasing in the North-west Marine Region. There is growing concern that anthropogenic noise poses a significant threat to some species, particularly cetaceans, because it may mask sounds that are vital for their essential activities and behaviours including navigation, identifying the location of prey and predators, attracting mates, and maintaining group cohesion and social interactions. Noise pollution may modify behaviour through attraction and avoidance to sound or cause temporary or permanent physical injury. It is unclear what cumulative impact of increasing noise pollution in the region may have on some species. In the North-west Marine Region, noise pollution is *of potential concern* for humpback whales, inshore dolphins and the six species of marine turtles known to occur in the region. Noise pollution is a priority for conservation effort in the North-west Marine Region because it is *of potential concern* for multiple conservation values and the pressure is increasing in the region.	Strategy A, Action 5 Strategy B, Action 2 Strategy D, Action 5 Strategy E, Action 2 Strategy G, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
16	**Light pollution**	Light pollution is defined as excessive or obtrusive artificial light, which itself is distinct from natural light in five main ways: source, scattering, reflection, directivity and direction. For marine turtle and seabird species, light pollution along, or adjacent to, nesting beaches or rookeries may cause alterations to critical behaviours, such as foraging at sea, the selection of nesting sites and the passage of emerging turtle hatchlings from the beach to the sea. The attraction some species have for artificial light sources can also significantly increase their vulnerability to predation. Sources of light pollution include coastal development, shipping and offshore sites, such as oil rigs. In the North-west Marine Region, light pollution is *of concern* for flatback, green, hawksbill and loggerhead turtles and is *of potential concern* for all species of seabird and shorebird assessed (Table 3.1). Light pollution is a priority for conservation effort in the North-west Marine Region because it is *of concern* or *of potential concern* for multiple conservation values and the pressure is likely to increase in the region.	Strategy A, Action 5 Strategy B, Action 2 Strategy D, Action 6 Strategy E, Action 2

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
17	**Extraction of living resources**	Some conservation values in the North-west Marine Region are vulnerable to extraction of living resources from a number of sources including traditional Indonesian fishing; commercial and recreational fishing; illegal, unregulated and unreported fishing; and Indigenous harvest. Commercial fishing effort overlaps with the Glomar Shoals and it is unclear whether the removal of non-target species is impacting on its values. Traditional Indonesian fishing effort is intense at Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Depending on the intensity of effort and composition of catch, the extraction of living resources from these key ecological features may affect trophic structures and ecological functioning. The extraction of living resources via illegal, unregulated and unreported fishing along the northern edges of the region is a pressure *of potential concern* for the carbonate bank and terrace system of the Sahul Shelf, the pinnacles of the Bonaparte Basin, and the Commonwealth waters surrounding Ashmore Reef and Cartier Island. Indigenous harvest of traditional marine resources (e.g. turtles and dugong) adjacent to the region is a pressure *of potential concern*. Extraction of living resources in international waters is also *of potential concern* to whale sharks. Extraction of living resources has been identified as a priority because it interacts with multiple conservation values and because there is a limited understanding of its impact on ecosystem functioning.	Strategy A, Actions 5 Strategy B, Action 2 Strategy D, Action 2 Strategy G, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
18	**Bycatch**	Some conservation values in the North-west Marine Region are vulnerable to bycatch from commercial fishing operations in the region, increasing levels of recreational fishing in and adjacent to the region, and the region's proximity to the illegal, unreported and unregulated fishing operations that take place at the edges of the Australian exclusive economic zone. In the North-west Marine Region, bycatch is *of concern* for sawfish, sea snakes, Indo-Pacific bottlenose dolphin, bottlenose dolphin and Fraser's dolphin. Bycatch is *of potential concern* for the snubfin dolphin, Indo-Pacific humpback dolphin, flatback turtle, green turtle, hawksbill turtle, loggerhead turtle and seahorses and pipefishes. It is also *of potential concern* for continental slope demersal fish communities. Bycatch has been identified as a priority because of its interaction with a range of conservation values across the region.	Strategy A, Action 5 Strategy B, Action 2 Strategy D, Action 1 Strategy G, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
19	**Invasive species**	Some conservation values in the North-west Marine Region are vulnerable to invasive species including pest species introduced into the marine environment by vessel traffic, and introduced species such as feral pigs, rodents, cats and dogs that prey on native species and their eggs (feral pigs, dogs and foxes prey on turtle eggs in coastal areas adjacent to the northern part of the region). In the North-west Marine Region, interactions with invasive species are *of concern* for green, flatback and loggerhead turtles. Interactions with invasive species are *of potential concern* for dugong and all species of seabird and shorebird assessed (Table 3.1). The North-west Marine Region has high levels of international shipping traffic; traditional Indonesian fishing; and illegal, unreported and unregulated fishing activity. These activities are potential vectors of invasive species via hull fouling and ballast water. Invasive species have been assessed as *of potential concern* for the following key ecological features: Ashmore Reef and Cartier Island and surrounding Commonwealth waters; Seringapatam Reef and Commonwealth waters in the Scott Reef complex; Glomar Shoals; Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals; and the Commonwealth waters adjacent to Ningaloo Reef. Invasive species are a focus for conservation effort in the North-west Marine Region because they are *of concern* or *of potential concern* for multiple conservation values and because the region is vulnerable to the pressure.	Strategy A, Action 5 Strategy B, Action 2 Strategy E, Action 2

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
20	**Physical habitat modification**	The North-west Marine Region is vulnerable to physical habitat modification from dredging operations (and associated changes in turbidity); anchoring; onshore and offshore construction associated with mining and oil and gas infrastructure; and coastal development. This pressure is increasing in and adjacent to the region with growth in the number of large-scale projects associated with the resources sector. In the North-west Marine Region, physical habitat modification is *of concern* for flatback turtles and *of potential concern* for sea snakes; olive ridley, green, loggerhead and hawksbill turtles; dugong; inshore dolphins; seahorses and pipefish; *Crown of England* shipwreck; continental slope demersal fish communities; and Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Physical habitat modification is a priority for conservation effort in the North-west Marine Region because it is *of concern* or *of potential concern* for multiple conservation values, it is likely to increase in the region and it is likely to have cumulative impacts on a range of conservation values.	Strategy A, Action 5 Strategy B, Action 2 Strategy C, Action 2 Strategy E, Action 2

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
21	**Collision with vessels**	There is significant vessel traffic in the North-west Marine Region associated with commercial and recreational fishing, tourism, international shipping, and oil and gas operations. There are several major harbours adjacent to the region including the ports of Broome, Port Hedland and Dampier, and new ports are under development. Vessel traffic is likely to increase markedly in the region with the continued expansion of the resources sector, a rise in tourism and population growth in north-western communities. Collision with vessels is *of potential concern* for inshore dolphins; humpback whale; dugong; and green, hawksbill and loggerhead turtles. This pressure is a priority for conservation effort in the North-west Marine Region because of its interaction with multiple conservation values and because the pressure is likely to increase in the region.	Strategy A, Action 5 Strategy B, Action 2 Strategy C, Action 2 Strategy D, Action 7 Strategy E, Action 2

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
22	**Changes in hydrological regimes**	The North-west Marine Region is vulnerable to changes in hydrological regimes due to expanding coastal development and irrigation scheme proposals adjacent to the region. Australian tropical rivers have highly energetic, episodic flows related to the monsoonal wet season that transport sediments downstream with little trapping of materials in waterways. Changes in hydrological regimes can cause siltation, changes to saltwater intrusion, and a reduction in connectivity and environmental or lifecycle cues between estuary and offshore waters. Changes in hydrological regimes adjacent to the North-west Marine Region are assessed as *of concern* for sawfish and *of potential concern* for inshore dolphins. This pressure is a priority for conservation effort in the North-west Marine Region because it is *of concern* or *of potential concern* for multiple conservation values and is likely to increase in areas adjacent to the region.	Strategy A, Action 5 Strategy C, Action 2 Strategy E, Action 2
23	**Human presence at sensitive sites**	Some conservation values in the North-west Marine Region are vulnerable to human presence as a result of tourism and recreational and charter fishing. Tourism and coastal development are expanding in and adjacent to the region. Important behaviours including nesting, breeding, feeding or resting can be disturbed by vessels, vehicles, camp fires, animals (e.g. dogs) and human beings. In the North-west Marine Region, human presence at sensitive sites is assessed as *of concern* for flatback, green and loggerhead turtles and *of potential concern* for inshore dolphins and all species of seabirds and shorebirds assessed (Table 3.1). Human presence at sensitive sites is a priority for conservation effort in the North-west Marine Region because it is assessed as *of concern* or *of potential concern* for multiple conservation values and is likely to increase in and adjacent to the region.	Strategy A, Action 5 Strategy B, Action 2 Strategy E, Action 2

EPBC Act = *Environment Protection and Biodiversity Act 1999*

4.2 Strategies and actions

The North-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 North-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 North-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 marine turtles, whale shark, sawfish, humpback whale and dugong (regional priorities 1, 5, 7, 8—short term; regional priority 3—medium 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 1–13—medium to long term).

4. Improve knowledge of the processes driving biodiversity and ecosystem functioning of priority key ecological features of the North-west Marine Region (regional priority 9–12 —medium to long term).

5. Improve knowledge on the pressures of marine debris, noise pollution, light pollution, extraction of living resources, bycatch, invasive species, physical habitat modification, collision with vessels, changes in hydrological regimes and human presence at sensitive sites in the North-west Marine Region (regional priorities 14–23—short to medium term).

6. Improve information on biologically important areas for protected species and species considered under pressure within the North-west Marine Region, with priority given to:
   – marine turtles (regional priority 1—short to medium term)
   – inshore dolphins (regional priority 2—short to medium term)
   – sawfishes (regional priority 3—short to medium term)
   – sea snakes (regional priority 4—short to medium term)
   – humpback whale (regional priority 5—short to medium term)
   – seabirds and migratory shorebirds (regional priority 6—short to medium term)
   – whale shark (regional priority 7—short to medium term)
   – dugong (regional priority 8—short to medium term).
7. Support research to understand the decline in sea snakes at Ashmore Reef (regional priorities 4, 9—short to long term).

Strategy B: Establish and manage a Commonwealth marine reserve network in the North-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 1–12—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 North-west Marine Region (regional priorities 9–23—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 (regional priorities 1–12—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 20–22—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) (regional priorities 1–12—immediate).

4. Evaluate the role of the plan and its supporting information resources in streamlining the 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 North-west Marine Region) (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 sawfishes, sea snakes, marine turtles, inshore dolphins, bottlenose and Fraser's dolphins, and seahorses and pipefishes—focusing on improving information on the cumulative effects of bycatch across multiple fisheries and the establishment of ongoing monitoring indicators (regional priorities 1–4, 18—short to medium term).

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 1, 7, 9, 10, 17—short to medium term).

3. 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).

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

5. Collaborate with industry to improve understanding of the effects of increased noise on marine turtles, inshore dolphins and humpback whales (regional priorities 1, 2, 5, 15—short to medium term).

6. Collaborate with industry to improve understanding of the effects of increased light on flatback turtles, green turtles, hawksbill turtles, loggerhead turtles, seabirds and migratory shorebirds (regional priorities 1, 6, 16—short to medium term).

7. Collaborate with relevant agencies to improve compliance in the reporting of vessel collisions with inshore dolphin species; green, hawksbill and loggerhead turtle species; humpback whales and dugongs (regional priorities 1, 2, 5, 8, 21—short to medium 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 sawfishes, whale sharks, marine turtles, humpback whales and dugongs and assess their effectiveness in reducing the risk to the species' recovery (regional priorities 1, 5, 7, 8—immediate; regional priority 3—short term).
2. Collaborate with the Western Australian Government and coastal communities to develop protection measures to limit disturbances during the nesting season for marine turtles, the breeding season for inshore dolphins and humpback whales, foraging areas for the dugong, and the pupping season for sawfishes, focusing on areas in proximity to inhabited areas or areas where sources of disturbance exist or are emerging (regional priorities 1–3, 5, 8, 15, 16, 19-23—short to medium term).
3. Increase information on the sources and impacts of marine debris on the region's marine life and ecosystems, including supporting monitoring of marine debris at selected locations in and adjacent to the North-west Marine Region (regional priorities 1, 2, 3, 8 14—short to medium term).
4. Continue to collaborate with the Western Australian Government to manage adjoining Commonwealth and state marine reserves in a cooperative manner (regional priorities 11, 12—ongoing).

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 (regional priorities 9-12—medium to long term).

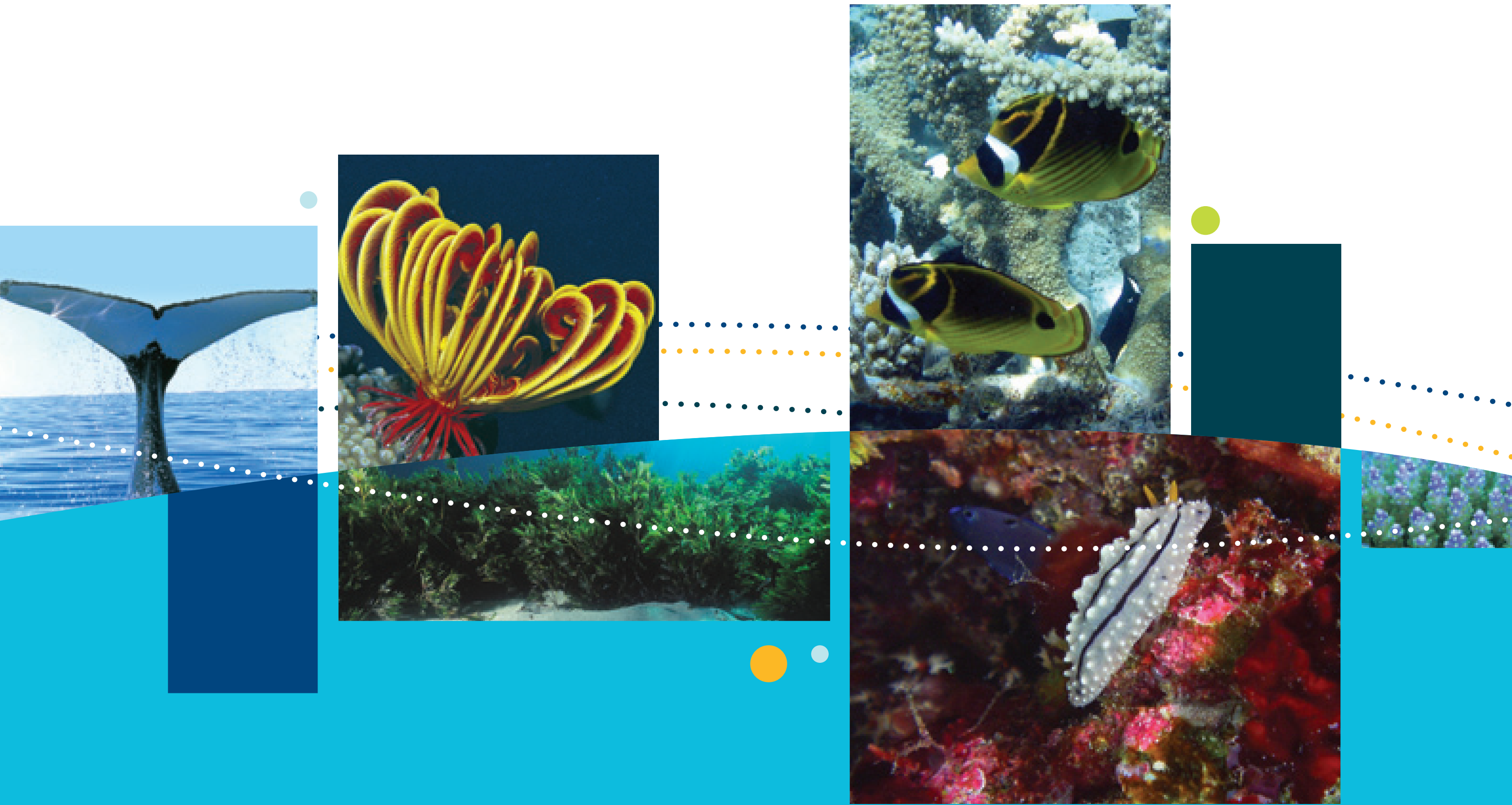
   Key ecological features to be investigated are:

   - Ashmore Reef and Cartier Island and surrounding Commonwealth waters
   - Seringapatam Reef and Commonwealth waters in the Scott Reef complex
   - Mermaid Reef and Commonwealth waters surrounding Rowley Shoals
   - Commonwealth waters adjacent to Ningaloo Reef.

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 priorities 1, 5, 6, 7, 9, 10, 13, 14, 15, 17, 18—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 North-west Marine Region.



SCHEDULE 1

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

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

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

S1.1 How were 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 North-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 North-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	Shipping Vessels (other) Aquaculture operations Renewable energy operations Urban development (urban and/or industrial infrastructure) Agricultural activities Onshore and offshore mining operations
Nutrient pollution	Aquaculture operations Agricultural activities Urban development
Changes in turbidity	Dredging (spoil dumping) Land-based activities Onshore and offshore mining operations Climate change (changes in rainfall, storm frequency)
Marine debris[1]	Land-based activities Fishing boats Shipping Vessels (other) Oil rigs Aquaculture infrastructure Renewable energy infrastructure Urban development

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

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

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

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** (see Box S1.1), 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 impact** 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 presssure 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/north-west**).

Box S1.1: 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 North-west Marine Region is presented in Table S1.2. A summary of the pressure analysis findings on selected protected species in the North-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 North-west Marine Region
  - Pressures *of concern*—Table S1.4
  - Pressures *of potential concern*—Table S1.5
- Selected bony fish species
  - Pressures *of potential concern*—Table S1.6
- Selected cetacean species
  - Pressures *of concern*—Table S1.7
  - Pressures *of potential concern*—Table S1.8
- Dugongs
  - Pressures *of potential concern*—Table S1.9
- Selected marine reptile species
  - Pressures *of concern*—Table S1.10
  - Pressures *of potential concern*—Table S1.11
- Selected seabird and shorebird species
  - Pressures *of potential concern*—Table S1.12
- Selected shark and sawfish species
  - Pressures *of concern*—Table S1.13
  - Pressures *of potential concern*—Table S1.14
- Historic shipwrecks of the North-west Marine Region
  - Pressures *of potential concern*—Table S1.15

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

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

Key ecological feature	Pressure[5]							
	Sea level rise	Changes in sea temperature	Ocean acidification	Changes in oceanography	Chemical pollution/ contaminants	Nutrient pollution	Marine debris	Noise pollution
1. Carbonate bank and terrace system of the Sahul Shelf	not of concern	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	of less concern	not of concern
2. Pinnacles of the Bonaparte Basin	of less concern	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	of less concern	not of concern
3. Ashmore Reef and Cartier Island and surrounding Commonwealth waters	of potential concern	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	of potential concern	not of concern
4. Seringapatam Reef and Commonwealth waters in the Scott Reef coplex	of potential concern	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	of potential concern	of less concern
5. Continental slope demersal fish communities	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
6. Canyons linking the Argo Abyssal Plain with the Scott Plateau	not of concern	not of concern	of potential concern	data deficient or not assessed	not of concern	not of concern	not of concern	of less concern
7. Ancient coastlines at 125m depth contour	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	of less concern
8. Glomar Shoals	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
9. Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	of potential concern	of potential concern	of potential concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	not of concern

Legend of concern; of potential concern; of less concern; not of concern; data deficient or not assessed

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 historic shipwrecks can be found in the conservation value report cards.

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

Key ecological feature	Pressure[5]							
	Light pollution	Physical habitat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Invasive species
1. Carbonate bank and terrace system of the Sahul Shelf	not of concern	of less concern	not of concern	of potential concern	of less concern	not of concern	not of concern	not of concern
2. Pinnacles of the Bonaparte Basin	not of concern	of less concern	not of concern	of potential concern	not of concern	not of concern	not of concern	not of concern
3. Ashmore Reef and Cartier Island and surrounding Commonwealth waters	not of concern	of potential concern	data deficient or not assessed	of potential concern	data deficient or not assessed	of potential concern	not of concern	of potential concern
4. Seringapatam Reef and Commonwealth waters in the Scott Reef coplex	not of concern	of potential concern	of less concern	of concern	data deficient or not assessed	of potential concern	not of concern	of potential concern
5. Continental slope demersal fish communities	not of concern	of potential concern	data deficient or not assessed	not of concern	of potential concern	not of concern	not of concern	of less concern
6. Canyons linking the Argo Abyssal Plain with the Scott Plateau	not of concern	not of concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern	not of concern
7. Ancient coastlines at 125m depth contour	not of concern	not of concern	data deficient or not assessed	of less concern	data deficient or not assessed	of less concern	of less concern	not of concern
8. Glomar Shoals	not of concern	of less concern	data deficient or not assessed	of potential concern	data deficient or not assessed	of less concern	not of concern	of potential concern
9. Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	data deficient or not assessed	of potential concern	data deficient or not assessed	of less concern	data deficient or not assessed	of potential concern	not of concern	of potential concern

Legend of concern; of potential concern; of less concern; not of concern; data deficient or not assessed

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 historic shipwrecks can be found in the conservation value report cards.

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

Key ecological feature	Pressure[5]							
	Sea level rise	Changes in sea temperature	Ocean acidification	Changes in oceanography	Chemical pollution/ contaminants	Nutrient pollution	Marine debris	Noise pollution
10. Exmouth Plateau	not of concern	not of concern	of potential concern	data deficient or not assessed	not of concern	not of concern	not of concern	not of concern
11. Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
12. Commonwealth waters adjacent to Ningaloo Reef	of less concern	of potential concern	of potential concern	data deficient or not assessed	not of concern	not of concern	of less concern	not of concern
13. Wallaby Saddle	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
Historic shipwrecks								
Trial shipwreck	data deficient or not assessed	of potential concern	data deficient or not assessed	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
Lively shipwreck	data deficient or not assessed	of potential concern	data deficient or not assessed	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
Ann Millicent shipwreck	data deficient or not assessed	of potential concern	data deficient or not assessed	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern
Crown of England shipwreck	data deficient or not assessed	of potential concern	data deficient or not assessed	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	not of concern

Legend of concern; of potential concern; of less concern; not of concern; data deficient or not assessed

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 historic shipwrecks can be found in the conservation value report cards.

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

Key ecological feature	Pressure[5]							
	Light pollution	Physical habitat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Invasive species
10. Exmouth Plateau	not of concern	of less concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern	not of concern
11. Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula	not of concern	not of concern	data deficient or not assessed	of less concern	data deficient or not assessed	of less concern	not of concern	not of concern
12. Commonwealth waters adjacent to Ningaloo Reef	not of concern	of less concern	not of concern	of less concern	data deficient or not assessed	of potential concern	not of concern	of potential concern
13. Wallaby Saddle	not of concern	not of concern	data deficient or not assessed	of less concern	data deficient or not assessed	not of concern	not of concern	not of concern
Historic shipwrecks								
Trial shipwreck	not of concern	of less concern	not of concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern
Lively shipwreck	not of concern	not of concern	not of concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern
Ann Millicent shipwreck	not of concern	not of concern	not of concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern
Crown of England shipwreck	not of concern	of potential concern	not of concern	not of concern	not of concern	data deficient or not assessed	not of concern	not of concern

Legend of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

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 historic shipwrecks can be found in the conservation value report cards.

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

Species group	Protected species	Pressure[6]									
		Sea level rise	Changes in sea temperature	Ocean acidification	Changes to terrestrial sand temperatures	Chemical pollution/ contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Bony fishes *Seahorses and pipefishes*	Seahorses and pipefishes[7]	of less concern	of less concern	of less concern	not of concern	of potential concern	data deficient or not assessed	data deficient or not assessed	of less concern	data deficient or not assessed	data deficient or not assessed
Cetaceans	Australian snubfin dolphin	of potential concern	of potential concern	of potential concern	not of concern	of potential concern	of potential concern	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed
	Indo-Pacific bottlenose dolphin	of less concern	of potential concern	of potential concern	not of concern	of potential concern	of potential concern	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed
	Indo-Pacific humpback dolphin	of less concern	of potential concern	of potential concern	not of concern	of potential concern	of potential concern	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed
	Bottlenose dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Fraser's dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Long-snouted spinner dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Risso's dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Rough-toothed dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Spotted dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Striped dolphin	of less concern	of less concern	data deficient or not assessed	not of concern	of less concern	of less concern	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed
	Humpback whale	data deficient or not assessed	data deficient or not assessed	of less concern	not of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed
Dugongs	Dugong	of potential concern	of potential concern	not of concern	not of concern	of less concern	not of concern	data deficient or not assessed	of potential concern	of less concern	data deficient or not assessed

Legend of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 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 individual species can be found in the species group report cards.

7 Twenty-three species of seahorse and pipefish were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the seahorse and pipefish pressure analysis can be found in the bony fishes species group report card.

8 Twenty-five species of sea snake were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the sea snake pressure analysis can be found in the marine reptiles species group report card.

9 Ten species of seabird were selected for analysis. Nine of these species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

10 Thirteen species of shorebird were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

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

Species group	Protected species	Pressure[6]: Physical habitat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Collision/ entanglement with infrastructure	Invasive species	Changes in hydrological regimes
Bony fishes *Seahorses and pipefishes*	Seahorses and pipefishes[7]	of potential concern	data deficient or not assessed	of less concern	of potential concern	of less concern	not of concern	not of concern	of less concern	data deficient or not assessed
Cetaceans	Australian snubfin dolphin	of potential concern	of potential concern	of less concern	of potential concern	of potential concern	of potential concern	not of concern	data deficient or not assessed	of potential concern
	Indo-Pacific bottlenose dolphin	of potential concern	of potential concern	of less concern	of concern	of potential concern	of potential concern	not of concern	data deficient or not assessed	of potential concern
	Indo-Pacific humpback dolphin	of potential concern	of potential concern	of less concern	of potential concern	of potential concern	of potential concern	not of concern	data deficient or not assessed	of potential concern
	Bottlenose dolphin	of less concern	of less concern	of less concern	of concern	of less concern	of less concern	not of concern	data deficient or not assessed	data deficient or not assessed
	Fraser's dolphin	of less concern	of less concern	of less concern	of concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Long-snouted spinner dolphin	of less concern	of less concern	of less concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Risso's dolphin	of less concern	of less concern	of less concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Rough-toothed dolphin	of less concern	of less concern	of less concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Spotted dolphin	of less concern	of less concern	of less concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Striped dolphin	of less concern	of less concern	of less concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern
	Humpback whale	data deficient or not assessed	data deficient or not assessed	not of concern	data deficient or not assessed	of less concern	of potential concern	data deficient or not assessed	data deficient or not assessed	not of concern
Dugongs	Dugong	of potential concern	of less concern	of potential concern	of less concern	of potential concern	of potential concern	data deficient or not assessed	of potential concern	data deficient or not assessed

Legend of concern · of potential concern · of less concern · not of concern · data deficient or not assessed

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9 Ten species of seabird were selected for analysis. Nine of these species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

10 Thirteen species of shorebird were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

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

Species group	Protected species	Pressure[6]: Sea level rise	Changes in sea temperature	Ocean acidification	Changes to terrestrial sand temperatures	Chemical pollution/ contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Marine reptiles *Marine turtles*	Flatback turtle	of less concern	of potential concern	of less concern	of potential concern	of less concern	of less concern	of less concern	of concern	of potential concern	of concern
	Green turtle	of less concern	of potential concern	of less concern	of potential concern	of less concern	of potential concern	of potential concern	of concern	of potential concern	of concern
	Hawksbill turtle	of less concern	of potential concern	of less concern	of potential concern	of less concern	of less concern	of less concern	of concern	of potential concern	of concern
	Leatherback turtle	of less concern	of potential concern	of less concern	not of concern	not of concern	not of concern	not of concern	of concern	of potential concern	of less concern
	Loggerhead turtle	of less concern	of potential concern	of less concern	of potential concern	of less concern	of less concern	of less concern	of concern	of potential concern	of concern
	Olive ridley turtle	of less concern	of potential concern	of less concern	not of concern	not of concern	not of concern	of less concern	of concern	of potential concern	of less concern
Sea snakes	Sea snakes[8]	data deficient or not assessed	of potential concern	of potential concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed
Seabirds and shorebirds	Wedge-tailed shearwater	of potential concern	of potential concern	of potential concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of potential concern
	All other seabird species[9]	of potential concern	of potential concern	of potential concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of potential concern
	Shorebirds[10]	of potential concern	of potential concern	of potential concern	of less concern	of less concern	data deficient or not assessed	of potential concern	of less concern	of less concern	of potential concern
Sharks and sawfish	Sawfishes (freshwater, green and dwarf sawfish)	of potential concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of less concern	of less concern	data deficient or not assessed	of potential concern	data deficient or not assessed	data deficient or not assessed
	Grey nurse shark	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	not of concern	data deficient or not assessed	not of concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed
	Whale shark	data deficient or not assessed	of potential concern	data deficient or not assessed	not of concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed
	White shark	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	not of concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed

Legend of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

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8 Twenty-five species of sea snake were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the sea snake pressure analysis can be found in the marine reptiles species group report card.

9 Ten species of seabird were selected for analysis. Nine of these species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

10 Thirteen species of shorebird were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

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

Species group	Protected species	Pressure[6]								
		Physical habitat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Collision/ entanglement with infrastructure	Invasive species	Changes in hydrological regimes
Marine reptiles *Marine turtles*	Flatback turtle	of concern	of concern	of potential concern	of potential concern	of less concern	not of concern	data deficient or not assessed	of concern	data deficient or not assessed
	Green turtle	of potential concern	of concern	of potential concern	of potential concern	of less concern	of potential concern	data deficient or not assessed	of concern	data deficient or not assessed
	Hawksbill turtle	of potential concern	of less concern	of potential concern	of potential concern	of less concern	of potential concern	data deficient or not assessed	not of concern	data deficient or not assessed
	Leatherback turtle	not of concern	not of concern	not of concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern	data deficient or not assessed
	Loggerhead turtle	of potential concern	of concern	of less concern	of potential concern	of less concern	of potential concern	data deficient or not assessed	of concern	data deficient or not assessed
	Olive ridley turtle	of potential concern	not of concern	not of concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern	data deficient or not assessed
Sea snakes	Sea snakes[8]	of potential concern	not of concern	data deficient or not assessed	of concern	of potential concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed
Seabirds and shorebirds	Wedge-tailed shearwater	of potential concern	of potential concern	of less concern	of less concern	of potential concern	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed
	All other seabird species[9]	of potential concern	of potential concern	of less concern	not of concern	of potential concern	data deficient or not assessed	data deficient or not assessed	of potential concern	data deficient or not assessed
	Shorebirds[10]	of potential concern	of potential concern	of less concern	of less concern	of potential concern	not of concern	data deficient or not assessed	of potential concern	data deficient or not assessed
Sharks and sawfish	Sawfishes (freshwater, green and dwarf sawfish)	of less concern	data deficient or not assessed	of less concern	of concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern
	Grey nurse shark	not of concern	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed
	Whale shark	data deficient or not assessed	not of concern	of potential concern	data deficient or not assessed	data deficient or not assessed	of less concern	data deficient or not assessed	not of concern	data deficient or not assessed
	White shark	data deficient or not assessed	not of concern	not of concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed

Legend of concern | of potential concern | of less concern | not of concern | data deficient or not assessed

6 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 individual species can be found in the species group report cards.

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8 Twenty-five species of sea snake were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the sea snake pressure analysis can be found in the marine reptiles species group report card.

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10 Thirteen species of shorebird were selected for analysis. These species were assessed as having the same ratings for all pressures considered. More information on the seabird pressure analysis can be found in the seabirds and shorebirds species group report card.

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

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Extraction of living resources (non-domestic commercial fishing)	Seringapatam Reef and Commonwealth waters in the Scott Reef complex	In 1974, a memorandum of understanding (MoU) was signed between the Australian and Indonesian governments that recognised traditional fishing in the area, and permits traditional Indonesian fishers to fish in the MoU box, including on and around Scott and Seringapatam reefs. The MoU requires Indonesian fishers to use traditional sail-powered fishing vessels and nonmotorised equipment, and prohibits them from taking protected species such as turtles, dugongs and clams. Fishers target a range of animals, including sea cucumbers (bêche-de-mer), trochus (topshell), reef fish and sharks. Indonesian fishing effort is high at Scott Reef. In 2008, approximately 80 Indonesian fishing vessels were observed at Scott Reef (Woodside 2009). Given the level of fishing pressure, it is predicted that many target species are overexploited (Meekan et al. 2006b; Skewes et al. 1999). Studies show that shark populations were severely depleted at Scott Reef compared to the Rowley Shoals, and that the most plausible reason was overfishing (Meekan et al. 2006b). Fishers are increasingly harvesting large reef fish species, such as the bumphead parrotfish and humphead wrasse. The bumphead parrotfish is a large, herbivorous species that is thought to be important in regulating the growth of coral and algae in reef communities, hence its removal could have implications for system functioning and reef resilience to other pressures (Bellwood et al. 2003).

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

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Sea level rise (Climate change)	Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	Sea level has been rising at approximately 7.1 mm per year in the North-west Marine Region since the 1990s, the largest increase in Australia (NTC 2010). 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 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). Sea level rise is of *potential concern* for key ecological features with shallow reefs. Under pre-climate change conditions, reefs could be expected to grow upward to match sea level rise. However, the cumulative effects of coral bleaching (sea temperature) and decline in calcification in corals (ocean acidification) may render corals incapable of recovery to match sea level rise (Hoegh-Guldberg 2011). Sediment production, erosion and sediment transport will depend on water depth and wave-generated forces, and the microtopography of reef crests will change and effect the habitat of biota (Sheppard et al. 2002). Critically, the growth of reefs more than 30–40 m deep will most likely not match sea level rise regardless of calcification rates. During the Holocene transgression, sea levels rose at 10–20 mm per year and corals reef growing at depths below the critical 30–40 m failed to flourish (Grigg & Epp 1989).

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Changes in sea temperature (Climate change)	Carbonate bank and terrace system of the Sahul Shelf Pinnacles of the Bonaparte Basin Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Continental slope dermersal fish communities Glomar Shoals Mermaid Reef and Commonwealth waters surrounding Rowley Shoals Commonwealth waters adjacent to Ningaloo Reef	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). Key ecological features supporting coral reef communities are vulnerable to bleaching and mortality from elevated sea temperatures. Projected temperature changes in Australian seas exceed the threshold for inducing bleaching events on an annual basis (Hobday et al. 2006). A decrease in coral abundance would lead to changes in ecosystem structure, processes, and connectivity between reefs and adjacent waters. Nutrients and organic matter sourced from dynamic reef complexes may be disrupted. In 1998, high sea temperature led to widespread bleaching of corals at Ashmore and Cartier reefs, the Rowley Shoals, and Scott and Seringapatam reefs (Gilmour et al. 2007; Pittock 2003). At Scott and Seringapatam reefs, corals bleached at depths up to 30 m and hard coral cover decreased from 41% before the event to 15% (Pittock 2003). Ningaloo Reef bleached for the first time in February 2011 (Ridgeway 2011) due to prolonged high sea surface temperatures. In 2005, elevated sea surface temperatures resulted in a minor bleaching event at the Rowley Shoals, which impacted a large proportion of benthic organisms, including corals, clams and anemones (Gilmour et al. 2007). While the effects of increased sea temperatures are likely to vary greatly across communities and ecosystems, there is a high level of agreement from different data sets that warming is affecting distributional ranges and larval phase of tropical marine fishes (Munday et al. 2009). Changes in sea temperature may also result in changes to phytoplankton and zooplankton communities, with implications for trophic dynamics (Richardson et al. 2009) and fish larval supply and survival (Lo-Yat et al. 2011). Increases in ocean water temperature may also affect deeper water fish species, such as those within the demersal slope fish key ecological feature. Climate change modelling predicts that by 2070 ocean water temperatures at a depth of 500 m will warm by 0.5–1 °C, which could adversely impact larval fish development and survival (Hobday et al. 2006). Benthic and demersal fish species may shift south and some populations may decline where ranges are bounded to the south (Hobday et al. 2006). Structurally complex epifauna (i.e. sponges, algae and coralline algae) may also suffer mortality from elevated water temperatures (Lawrence et al. 2007).

Key ecological features assessed = 13

Pressure	KEF	Rationale
Ocean acidification (Climate change)	Carbonate bank and terrace system of the Sahul Shelf Pinnacles of the Bonaparte Basin Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Continental slope demersal fish communities Canyons linking the Argo Abyssal Plain with the Scott Plateau Ancient coastline at 125m depth contour Glomar Shoals Mermaid Reef and Commonwealth waters surrounding Rowley Shoals Exmouth Plateau Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula Commonwealth waters adjacent to Ningaloo Reef Wallaby Saddle	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). Ocean acidification will compromise carbon accretion and, together with increasing ocean temperatures, may result in loss of ecosystems based on geologic features formed from coral or coralline algae (Hoegh-Guldberg 2011; Hoegh-Guldberg et al. 2007; Kleypas & Yates 2009; Kuffner et al. 2008). Increasing acidity impairs the ability of species with calcareous shells, such as echinoderms, crustaceans and molluscs, to maintain shell integrity resulting in reductions of the overall abundance and biodiversity of these species (see review by Kleypas & Yates 2009). A decrease in the abundance of fauna with carbonate-based skeletons and coral and coralline algal abundance, and the complex structural habitats they create, could lead to changes in ecosystem structures, processes, and connectivity between the reef complex and the adjacent deeper waters.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Marine debris (land-based activities, shipping, vessels)	Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex	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 2009). Debris harmful to marine wildlife includes plastics washed or blown from land into the sea, recreational and commercial fishing gear (known as ghost nets), and solid floating materials (such as plastics) from ships at sea. Large amounts of fishing net are discarded or lost from the fisheries of the Arafura Sea (Limpus 2009). However, the characteristics and impacts of debris disposed of or lost overboard in the Arafura Sea are largely unknown (Kiessling 2003) and it is not known what proportion of such debris enters the North-west Marine Region.
Physical habitat modification (shipping anchorage)	Seringapatam Reef and Commonwealth waters in the Scott Reef complex	Vessel anchorage may modify or damage benthic communities of Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Each year, approximately 80 traditional Indonesian fishing vessels anchor in the waters of this key ecological feature, but there are currently no restrictions on where or how they can anchor. Petroleum industry and Australian surveillance vessels also use the area and, due to their size, must have appropriate anchoring systems in place and follow anchorage procedures to ensure the safety of crew and the surrounding environment (Australian Transport Commission 2010). The North West Slope Trawl Fishery operates in the area and targets deepwater species on muddy benthos. It is not known what impact the anchoring of these vessels is having on the values of this key ecological feature.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Physical habitat modification (fishing gear)	Continental slope demersal fish communities	Trawling is potentially damaging to benthic habitats which can adversely affect demersal fish and other fauna dependent on these habitats. The continental slope provides a habitat for a rich and diverse range of demersal fish species, many of which are endemic to the North-west Marine Region (Last et al. 2005). Loss of benthic habitat along the continental slope at depth ranges known to support demersal fish communities (225–500 m and 750–1000 m) could lead to a decline in species richness and diversity associated with this feature. Evidence exists for physical habitat modification as a result of North-west Slope Trawl fishing on demersal slope fish communities. According to logbook data for 2001–04, between a third and a half of the total catch was discarded (Wayte et al. 2007). The full composition of bycatch was unknown. However, in 1998–2000, benthic taxa were the dominant (23.1%) bycatch category by weight of exploratory trawls in the North-west Slope Trawl Fishery (Wayte et al. 2007). Fewer hexactinellid sponges have been recorded from heavily trawled areas in the North-west Slope Trawl Fishery. Concern has also been raised about the impacts of trawling on bryozoan-rich substrates that appear from a depth of 120 m and progressively dissipate until a depth of 300 m. In addition, distribution patterns of female giant crabs (*Pseudocarcinus gigas*) may be correlated with bryozoan-rich substrates and giant crabs form a major part of catches taken in the West Coast Deep-Sea Crab Fishery (Wayte et al. 2007).

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Physical habitat modification (offshore construction)	Seringapatam Reef and Commonwealth waters in the Scott Reef complex	The installation of infrastructure may directly impact the benthic communities associated with Seringapatam Reef and Commonwealth waters in the Scott Reef complex. Construction, commissioning and operation of offshore gas facilities may also result in the release of marine discharges and effluents that could locally affect the quality of the receiving marine waters. Suspended solids generated from the disturbance to the seabed from the installation of infrastructure and from the discharge of drilling cuttings and muds may directly impact the physical and chemical properties of the receiving waters. In turn, this may indirectly affect flora and fauna in the area via physiological or toxicological impacts, and may also result in localised smothering of benthic communities and reduction in light availability (Woodside 2008). It is unclear what effect, if any, the modification of benthic habitats could have on the broader functioning and integrity of this key ecological feature. However, the effects of construction and installation activities may have both direct and indirect impacts on the listed threatened species of marine mammals, turtles, birds and whale sharks that may occur in this area. These impacts may include avoidance behaviour, potential physiological effects and direct impact on foraging areas (Woodside 2008).
Physical habitat modification (fishing practices)	Seringapatam Reef and Commonwealth waters in the Scott Reef complex	Habitat modification through physical damage can result from traditional Indonesian fishing practices. Traditional Indonesian fishers access Scott and Seringapatam reefs to fish for holothurians, trochus, molluscs and finfish, including shark. Some fishing involves walking the reef at low tide to hand collect species, such as holothurians, and involves turning over coral boulders. Corals are left upturned as ‘markers’ to indicate that the area has been searched. This practice may result in the death of other organisms left exposed, and may degrade and/or reduce habitat for other marine organisms. It is not known what effect this has on the coral ecosystem. However, since hundreds of traditional fishers walk the same reefs for extended periods, it is possible this fishing practice is placing pressure on the reef environment.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Physical habitat modification (storm events)	Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	The intensity of storms is predicted to increase (Hyder Consulting 2008). Present indications are that modest to moderate (0–20 per cent) increases in average and maximum cyclone intensities are expected by the end of the century in some regions (Walsh & Ryan 2000). In conjunction with a more fragile coral matrix structure and a slower growth (recovery) rate due to ocean acidification, reefs may become extremely vulnerable to severe storm events, leading to severe flow-on effects for communities dependent on coral reef habitats.
Extraction of living resources (commercial fishing)	Glomar Shoals	The main trawl fishery operating over the Glomar Shoals is the Pilbara Demersal Finfish Fishery, which operates in water depths of 50–200 m (Fletcher & Santoro 2009). Data from this fishery indicates that catch is greatest in the area that includes the Glomar Shoals. The fishery as a whole retained 1044 tonnes of demersal finfish species in 2009 and this level of catch is considered sustainable (Fletcher & Santoro 2010). However, it is not known if the catch of nonretained species is sustainable or what the impact of removing target and nontarget species is on the Glomar Shoals. A study by Moran and Stephenson (2000) found that the gear used in the fishery removed large epibenthos (organisms greater than 20 cm) density by 15.5 per cent per trawl pass. The removal of biomass and disturbance to benthic communities has the potential to adversely affect the values of the Glomar Shoals.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Extraction of living resources (IUU fishing)	Carbonate bank and terrace system of the Sahul Shelf Pinnacles of the Bonaparte Basin Ashmore Reef and Cartier Island and surrounding Commonwealth waters	Illegal, unreported and unregulated (IUU) fishing has in the past been a significant issue in the North-west Marine Region and posed a major threat to target species and the conservation of the broader marine environment. In 2005, 13 018 illegal fishing vessels were sighted in Australian waters and of those, 600 were apprehended by Australian officials (Vince 2007). While the number of illegal vessels sighted per day has declined since 2005, there is concern that more powerful vessels with more sophisticated equipment may now be being used (Lack & Sant 2008). The Australian Government is also concerned with the issues of border security and quarantine that coincide with IUU fishing activities (Vince 2007). IUU fishers predominantly target shark species for the valuable fin market. IUU catch of sharks is estimated to be twice that of reported legal catch (Heupel & McAuley 2007). The full extent of IUU shark fishing in northern Australia is largely unquantified; however, shark stocks targeted by IUU fishers have declined or are overfished (Heupel & McAuley 2007). The effect on the marine environment of these key ecological features following the removal of sharks is unknown. However, it is hypothesised that an increase in large reef fish species at Scott Reef is a result of the decline in abundance of shark species (Gilmour et al. 2009, cited in Woodside 2009). Due to the life history characteristics of sharks (long life, slow to mature and small numbers of offspring) it may take some time before the effects of overfishing of sharks in the region is reversed, despite drops in the level of IUU activity in the region.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Bycatch (commercial fishing)	Continental slope demersal fish communities	The North West Slope Trawl Fishery operates in waters 250–800 m deep on muddy substrates. Target species include scampi and deepwater prawns (Wilson et al. 2010). There are currently seven permits to fish and the fishery operates over the entire continental slope of the region. The fishery is considered to be sustainable as far as the harvest of target species (Wilson et al. 2010). However, there is little information available on the composition and volume of the rest of the biomass removed by the North West Slope Trawl Fishery. Bycatch diversity is reputedly high and, according to logbook data for 2001–04, between a third and a half of the total catch is discarded (Wayte et al. 2007). It is not known what impact trawling has on the demersal slope communities and whether it has the potential to diminish the species richness and diversity of these communities.

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Oil pollution (oil rigs)	Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Mermaid Reef and Commonwealth waters surrounding Rowley Shoals Commonwealth waters adjacent to Ningaloo Reef	Oil pollution is of *potential concern* for key ecological features with values vulnerable to the impacts of an oil spill, such as highly diverse coral communities that support an abundant array of marine species. The North-west Marine region is an area subject to significant petroleum exploration, development and production and this is likely to increase in the future (DEWHA 2008c). Shipping is likely to continue to expand in the region as a result of the growth of the resources sector. 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 level of impact that actually occurs depends on a number of factors including concentration of oil; chemical and physical properties of the oil (or oil and dispersant mixture); the timing of breeding cycles and seasonal migrations of species; the time of contact; susceptibility of particular species; and the health, age and reproductive status of the individuals (AMSA 2011a). Coral reef communities are highly sensitive to both oil and oil/dispersant mixtures (Shafir et al. 2007). Oil spills are particularly significant for corals when spawning because broadcast coral gametes collect at the surface and may be exposed to petroleum products. Coral eggs and larvae are buoyant for the first few days after spawning and may suffer significant mortality if any oil or oil/dispersant mixture is encountered in significant concentrations. There is also evidence that metamorphosis (around 1–3 weeks following spawning) is particularly susceptible to oil (Negri & Heyward 2000). Scott and Seringapatam reefs and the Rowley Shoals are likely to be self-seeding over ecological timescales (Underwood 2009; Underwood et al. 2007, 2009). Therefore, recovery from damage by oil is likely to be far slower in such isolated reefs than in coastal settings and interconnected groups of reefs. To manage oil spills, chemical dispersants (powerful detergents) may be applied to oil slicks on the surface to accelerate weathering processes and to disperse the oil into the water column to minimise the surface transport of oil to sensitive habitats, such as foreshores. These dispersants contain toxic elements that can be harmful to coral (Shafir et al. 2007). Certain dispersants combined with crude oil increase the toxicity of oil to some fish and invertebrates (Gulec & Holdway 2000, in Fandry et al. 2006). However, dispersants are only used when all environmental effects have been considered and are generally not used in close proximity to coral reefs (AMSA 2011b).

Key ecological features assessed = 13		
Pressure	**KEF**	**Rationale**
Invasive species (shipping, fishing vessels, vessels, land-based activities)	Ashmore Reef and Cartier Island and surrounding Commonwealth waters Seringapatam Reef and Commonwealth waters in the Scott Reef complex Glomar Shoals Mermaid Reef and Commonwealth waters surrounding Rowley Shoals Commonwealth waters adjacent to Ningaloo Reef	Invasive species have the potential to impact directly on benthic communities, coral and fish via competition for habitat and food resources. The two primary mechanisms for the inadvertent introduction and spread of invasive marine species are ballast water discharge and vessel biofouling. Key ecological features in areas of high international and domestic shipping traffic are at greater risk of an invasive species incursion. Offshore petroleum development also has the potential to introduce invasive species through the installation of rigs and subsea infrastructure. Seringapatam Reef, Commonwealth waters in the Scott Reef complex, Ashmore Reef and Cartier Island are also visited by traditional Indonesian fishing vessels and illegal vessels. These foreign vessels have the potential to carry invasive species on their hulls, which could endanger the relatively pristine marine environments of these two offshore reef systems.

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

Species assessed = 23		
Pressure	**Species**	**Rationale**
Chemical pollution/ contaminants (shipping, vessels, urban development and onshore and offshore mining operations)	Western spiny seahorse Winged seahorse Yellow seahorse Montebello seahorse Barbed pipefish Banded pipefish Bent stick pipefish Blue-stripe pipefish Brock's pipefish Double-ended pipehorse	The North-west Marine Region and adjacent coastal areas support a number of industries including petroleum exploration and production, minerals extraction, ports, shipping, commercial and recreational fishing, pearling and aquaculture, marine tourism, salt production, agriculture and defence-related activities (Clifton et al. 2007; Jonasson 2008). These industries are all potential sources of chemical pollution and contamination. Some of the industries, particularly mining and petroleum exploration and development, have grown rapidly over the past few decades, as has the infrastructure necessary to support them (Jonasson 2008). Chemical pollution has the potential to adversely impact syngnathids primarily through habitat loss or damage. The highly specialised characteristics of syngnathid biology, including a restricted diet, specific habitat requirements, low mobility and low reproductive output with obligate male brooding, render syngnathid species particularly susceptible to threats that involve loss or degradation of habitat (Kuiter 2001; Martin-Smith & Vincent 2006; Pogonoski et al. 2002). In addition, the species' tendency to have specific habitat preferences within small home range sizes reduces their ability to find and adapt to new habitats, thereby making them vulnerable to habitat loss or damage (McClatchie et al. 2006).

Species assessed = 23		
Pressure	**Species**	**Rationale**
Physical habitat modification (dredging and/or dredge spoil, fishing gear, offshore mining operations and offshore construction and installation of infrastructure)	Glittering pipefish Long-nosed pipefish Messmate pipefish Mud pipefish Negros pipefish Pacific short-bodied pipefish Red-banded pipefish Reticulate pipefish Ridge-nose pipefish Robust ghost pipefish Rough-ridge pipefish Schultz's pipefish Western pipehorse	Seahorses (*Hippocampus spp.*) and pipefish (*Solegnathus spp.*) are among the site-associated fish genera that have life histories that render them vulnerable to habitat damage. Species associated with soft bottom substrates are particularly vulnerable to habitat loss and degradation (Martin-Smith & Vincent 2006; Pogonoski et al. 2002; Vincent et al. 2005). Expanding offshore oil and gas exploration and production, and associated increases in shipping and port development have the potential to cause habitat modification through activities such as dredging, installation of infrastructure and sea dumping. The use of some fishing gear types is a source of habitat degradation. There are five commercial fisheries in the region that use trawling methods that can physically impact on benthic communities (Fletcher & Santoro 2007; Heupel & McAuley 2007; Larcombe & McLoughlin 2007; Newton et al. 2007).
Bycatch (commercial fishing)		Syngnathid species caught as bycatch in deepwater trawling operations (e.g. Solegnathus species) are unlikely to survive if returned to the water (Connolly et al. 2001; Dodt 2005, 2006). However, syngnathids taken from shallow-water trawl or dredging activities may survive if returned to the water, especially if the trawl duration is relatively short (A Mednis, pers. comm., in Pogonoski et al. 2002). Syngnathid species have been recorded as bycatch in the North-west Marine Region through the trawl operations of the North West Slope Trawl Fishery, Northern Prawn Fishery and Pilbara Trawl Fishery (Stobutzki et al. 2000, Fletcher and Santoro eds 2009). Syngnathid species caught as bycatch in trawl fisheries operating in the region include ribboned sea dragon, pallid pipefish, alligator pipefish and long-nosed pipefish (Griffiths et al. 2004).

Table S1.7: Pressures *of concern* to selected cetaceans in the North-west Marine Region

Species assessed = 11		
Pressure	**Species**	**Rationale**
Bycatch (commercial fishing)	Indo-Pacific bottlenose dolphin Bottlenose dolphin Fraser's dolphin	Bycatch interactions with dolphins have been reported in the Pilbara Trawl Fishery. Allen and Loneragan (2010) reported that the species interacting most with the fishery were bottlenose dolphins. However, they also reported bycatch of Indo-Pacific bottlenose and Fraser's dolphins. Current bycatch exclusion devices may lead to under-reporting of injury and mortality as some animals fall to the sea floor unobserved (Allen & Loneragan 2010). It is unclear what level of impact bycatch has on the populations of the species affected in the North-west Marine Region. However, the impact of bycatch can be particularly problematic for marine mammals because they are long-lived, and have slow growth rates and low fecundity (Cox et al. 2003).

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

Species assessed = 11		
Pressure	**Species**	**Rationale**
Sea level rise (Climate change)	Australian snubfin dolphin	Sea level has been rising at approximately 7.1 mm per year in the North-west Marine Region since the 1990s, the largest increase in Australia (NTC 2010). Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). Sea level rise is expected to have long term impacts in areas adjacent ot the North-west Marine region including mangrove habitats and seagrass beds which are important habitats for Australian snubfin dolphins and their prey (Parra & Corkeron 2001; Parra et al. 2002; Robertson & Arnold 2009). There is uncertainty about how seagrasses and mangroves might adapt to sea level rise, including their capacity to colonise new areas. While the impacts of sea level rise on this species are likely to be mainly in coastal waters, any consequent changes in the species' prey or habitat availability may affect the species across its range.
Changes in sea temperature (Climate change)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	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 can have trophic-level effects on prey species (Hobday et al. 2006; Lough 2009; McLeod 2009) with subsequent negative effects on higher trophic-level species, such as dolphins. For example, changes in sea temperature are predicted to have a significant impact on the distribution and abundance of benthic fishes, demersal fishes and zooplankton, and on the biological communities associated with these groups (Hobday et al. 2006). Some of these are primary prey species for inshore dolphins.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Ocean acidification (Climate change)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	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). Increases in ocean acidification may alter prey availability and have a physiological effect on many species, although an accurate calculation of impacts is not possible at present (Howard et al. 2009; Raven et al. 2005). Prey availability is likely to be reduced for top predators that rely on reef species (Hobday et al. 2006) and decreases in the abundance of many species of zooplankton could have profound ecological consequences. Indo-Pacific humpback and Indo-Pacific bottlenose dolphins consume reef species where their habitat includes islands and reefs. Australian snubfin dolphins are also found in habitat complexes that include reefs.
Chemical pollution/ contaminants **Nutrient pollution (agricultural activities, urban development)**	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Inshore dolphins have been recorded in the nearshore waters of the region, adjacent to coastal communities including Exmouth, Onslow, Dampier Archipelago, Port Hedland and Broome (Allen et al. in press 2012). Cetaceans that predominantly use coastal waters are more susceptible to high levels of chemical pollutants than wholly offshore species (Jacob 2009). Various pollutants, such as heavy metals, pesticides, herbicides, nutrients and sediments, enter Australian waters from many different sources, including industrial and sewage discharges, catchment run-off and groundwater infiltration (Cosser 1997; Hale 1997; Haynes & Johnson 2000; Kemper et al. 1994). Many of these compounds have been shown to have adverse physiological effects on a variety of vertebrates. These effects,which include immuno-suppression, hepatoxicity, carcinogenesis, reproductive and developmental toxicity, dermal toxicity and neurotoxicity, can lead to impaired fertility, reduced fecundity and increased mortality.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Marine debris (land-based activities, fishing boats, shipping, vessels)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	The injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris is listed as a key threatening process under the EPBC Act. All dolphin species are at risk of entanglement or capture in nets, ingestion of plastic and displacement from habitat (Bannister et al. 1996). Whales and dolphins have been recorded entangled in derelict fishing gear around Australia's coasts (Chatto & Warneke 2000). Polyfilament and monofilament scarring and other net injuries on individual cetaceans have been recorded in Western Australia and other regions (WWF 2010). Between 1990 and 2008, the death or injury of cetaceans from 14 species was directly attributed to interactions with plastic debris (Ceccarelli 2009). Species affected include the Indo-Pacific humpback dolphin and Indo-Pacific bottlenose dolphin (Ceccarelli 2009). However, the degree of impact on cetaceans is largely unknown.
Noise pollution (seismic exploration)	Humpback whale	Oil and gas exploration and other geophysical surveys involve the use of seismic 'air guns', which generate a rapid release of air under high pressure to obtain a geologic profile of the sea floor and substrate. This activity creates a noise signal with peak frequencies that overlap the acoustic range used by baleen whales. This activity has been found to alter the vocal behaviour of blue whales and may similarly affect other baleen whales (Di Iorio & Clark 2010). It is unknown whether there may also be physical effects on some species of cetaceans (DEWHA 2008a). High levels of seismic activity may result in baleen whales (e.g. humpback whales) detouring from migration routes, or cause their displacement from important breeding and calving areas. Extremely close encounters may damage their ears. The *EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales* provides guidance on measures to minimise potential impacts of seismic surveys on cetaceans (DEWHA 2008b). Seismic surveying in the North-west Marine Region is increasing due to the expansion of the resource sector.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Noise pollution (shipping)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin Humpback whale	A range of vessels, including shipping, commercial fishing vessels, recreational and charter fishing vessels, cruise ships and tour boats traverse the North-west Marine Region and adjacent areas. Shipping is a major activity in the region, transporting goods between Australian and international ports, and is expected to increase (Clifton et al. 2007), mainly due to increasing oil and gas exploration and development and new port developments associated with expansion of the resource sector. Increased vessel traffic will increase the levels of noise in the marine environment. Shipping noise directly overlaps with the frequency range of baleen whales. A recent study in the United States found evidence of increased stress levels in right whales due to noise from shipping traffic (Rolland et al. 2012). Although there is a lack of specific data on the effects of shipping noise pollution on cetaceans in the North-west Marine Region, noise pollution from anthropogenic sources has the potential to adversely impact small cetaceans (Nowacek et al. 2007). The potential impacts of elevated noise levels on humpback whales and inshore dolphins include limiting the detection of natural sounds and disturbing normal behaviour, which may displace them (Di Iorio & Clark 2010; Nowacek et al. 2007; NRC 2005; Richardson et al. 1995). In addition, cetaceans rely on acoustic signals to maintain contact with associates and vessel noise can mask communication (Van Parijs & Corkeron 2001). In particular, the Australian snubfin dolphin and the Indo-Pacific humpback dolphin may exhibit vessel avoidance behaviour in response to vessel traffic noise (DEWHA 2011a, 2011b) because they produce whistles at a frequency that overlaps with the frequencies emanating from vessel traffic.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Noise pollution (onshore and offshore construction)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin Humpback whale	Onshore and offshore construction can generate significant levels of noise from activities such as pile-driving and the use of explosives. At close range, loud noises, such as those generated by pile–driving, can physically injure animals or cause temporary or permanent damage to hearing thresholds (David 2006; Nowacek et al. 2007; Richardson et al. 1995). Salgado Kent and colleagues (2009) suggest that the frequencies of high sensitivity to marine mammals overlap with the higher frequencies of pile-driving noise levels (5–10 kHz). In Western Australia, there are a number of projects under development that will introduce noise from blasting and other construction and maintenance activities into the marine environment for extensive periods (Salgado Kent et al. 2009; WADSD 2010). The cumulative impact of these activities along the north-west coast may negatively impact on the behaviour, extent of occurrence or area of occupancy of inshore dolphins and humpback whales.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Physical habitat modification (dredging and/or dredge spoil)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Inshore dolphins are known to utilise the nearshore waters of the region where dredging has and will occur such as the Dampier Archipelago, Port Hedland and Onslow (Allen et al. in press 2012). Dredging has the potential to substantially impact on Australian snubfin dolphins due to their preference for localised, shallow-water habitat and residency. Dredging for major developments, particularly port developments, can occur on a large scale and over a number of years. These activities are likely to result in local-scale change in the composition, structure and function of the coastal estuarine habitat, and increase the potential for a wide range of pressures, including direct removal of key inshore dolphin habitat (e.g. seagrass and mangroves), physical disturbance and sedimentation. Depending on area and extent, the removal of bottom materials can reduce or eliminate elements of benthic communities important to local cetacean populations (Bannister et al. 1996). The coastline of the North-west Marine Region is under pressure from an expanding resources sector and associated port facilities. There are 12 ports adjacent to the North-west Marine Region, and a number of new ports (including James Price Point, Port Hedland expansion, Dixon Island, Cape Lambert and Cape Preston) are being considered (DEWHA 2008c; DPI 2007; IRC 2007). These developments require dredging, pile-driving and shoreline modification that have the potential to negatively affect inshore dolphins. Dredging of the sea floor is required both during the construction of ports and during the subsequent maintenance of shipping channels.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Physical habitat modification (onshore and offshore construction)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Construction activities that physically modify the marine environment have the potential to displace populations of dolphins, such as inshore dolphins, that rely on specific characteristics of an area. As populations of inshore dolphins are small and localised, they are particularly susceptible to habitat degradation and displacement from coastal construction activities (Corkeron et al. 1997, Parra et al. 2006; Ross 2006). Inshore dolphins are known to utilise the nearshore waters of the region where construction is occurring or is planned for the future such as the Dampier Archipelago, Port Hedland and Onslow (Allen et al. in press 2012). Although the long-term impacts of habitat loss and degradation on coastal cetaceans in Australia are largely unknown, globally, habitat loss and degradation due to coastal development have significantly affected many riverine and coastal cetacean populations (CMS 2011; Elliot et al. 2009; IUCN 2010; Jefferson et al. 2009). Habitat modification due to coastal development is considered one of the greatest threats to inshore dolphins (Corkeron et al. 1997; Parra et al. 2006; Ross 2006). Increased physical habitat modification associated with onshore and offshore construction is expected in and adjacent to the North-west Marine Region, given the growth of the resources sector in the area.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites (tourism, recreational and charter fishing, research)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	The expedition and cruising industry in the Kimberley region is growing in both the size and number of vessels, offering adventure and luxury cruises along the coast between Broome and Wyndham, including interactions with wildlife (Scherrer et al. 2008). Small, isolated, coastal cetacean populations, with little or no emigration or immigration, are more vulnerable to biological impacts from vessel disturbance and tourism, even with low levels of exposure (Bejder et al. 2006; Lusseau et al. 2006). There is substantial evidence that vessel disturbance can cause repeated disruption to cetacean feeding, breeding, social or resting behaviour, and can ultimately have adverse impacts on reproductive success, distribution and ranging patterns, access to preferred habitat, and individual health and fitness (Barr & Slooten 1999; Bejder & Samuels 2003; Bejder et al. 2006, Lusseau 2004, Ng & Leung 2003). Interactions with wildlife are difficult to manage in remote locations but the *Australian national guidelines for whale and dolphin watching 2005* outline the standards that allow people to observe and interact with whales and dolphins in a way that ensures animals are not harmed (DEH 2006). Tourism operations differ considerably in their approach to environmental management (Scherrer et al. 2008). Tourism in the Kimberley is partly regulated through charter fishing licenses and permit requirements for state national parks, but interactions with wildlife are difficult to monitor in remote locations and the fast growing industry will require more coordinated management in the future (Scherrer et al. 2008).
Bycatch (commercial fishing—domestic)	Australian snubfin dolphin Indo-Pacific humpback dolphin	Cetaceans may be caught as bycatch in different types of fishing gear. Gillnets in particular have the potential to impact on the Australian snubfin and Indo-Pacific humpback dolphins, particularly when nets are set across creeks, rivers and shallow estuaries as these are important habitats for these species (Reeves et al. 2003; Read et al. 2006; Reeves & Brownell 2009; Slooten 2007).

Species assessed = 11		
Pressure	**Species**	**Rationale**
Oil pollution (shipping, oil rigs)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	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 growth of the resources sector in the North-west Marine Region has caused an increase in port facilities and shipping, petroleum exploration and development. As technology advances, petroleum operations are expanding into deeper waters. The isolated distribution of inshore dolphin populations and low numbers of animals at many sites means that a spill that affects a biologically important area for any of these species could have population-level impacts due to displacement, loss of habitat, loss of access to prey and/or death of individual dolphins.
Collision with vessels	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin Humpback whale	Vessel traffic in the North-west Marine Region is increasing. The expansion of northern Western Australia's economy is reflected in the increasing number of vessel visits to the Region's ports and intensification of shipping activity (IRC 2007). Population growth in the region is also likely to lead to an increase in the use of recreational vessels for fishing and tourism. Important habitat for the Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphin species overlap with gillnet recreational fishing and boating areas, which increases the probability for recreational vessel-strike (WWF 2010). In addition, the expedition and cruising industry in the Kimberley region is growing in both the size and number of vessels, offering adventure and luxury cruises along the coast between Broome and Wyndham, including wildlife interactions (Scherrer et al. 2008). Currently there is little information about vessel strike in the region although there are records of injuries to inshore dolphin species from vessel strike in State waters, including Roebuck Bay ,Yampi Sound and Cone Bay (WWF 2010, Thiele 2010). Increasing shipping activity and the large and growing number of humpback whales undertaking annual migration along the Western Australian coastline, means that the likelihood of vessel strikes on humpbacks is also increasing.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Changes in hydrological regimes	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Proposals have been made to divert 'excess' water from the Kimberley wet season flows to Perth and other areas in southern Western Australia. Australian tropical rivers have highly energetic, episodic flows related to the monsoonal wet season that transport sediments downstream with little trapping of materials in waterways (Brodie & Mitchell 2005). The wet season freshwater input into the nearshore marine environments of the Kimberley coast is a significant driver for critical ecological processes for many marine species. Changes in hydrological regimes could lead to adverse changes in these ecological processes with adverse consequences for marine species. As populations of the Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins are thought to be generally small and localised, they are particularly susceptible to changes in their habitats. Although the specific impact of changes in hydrological regimes on inshore dolphins is currently unknown, it is likely that these species could be negatively affected by the reduction in the productivity of near-shore marine environments that changes in hydrological regimes could cause.

Table S1.9: Pressures *of potential concern* to dugongs in the North-west Marine Region

Species assessed = 1		
Pressure	**Species**	**Rationale**
Sea level rise (Climate change)	Dugong	Sea level has been rising at approximately 7.1 mm per year in the North-west Marine Region since the 1990s, the largest increase in Australia (NTC 2010). 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 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). The resultant decrease in available light for seagrass meadows may lead to a reduction in growth and productivity of seagrass, and the loss of seagrass in deeper waters as water depth increases. Sea level rise is also likely to lead to erosion of coastlines, which will increase turbidity of coastal waters and impact on survival of seagrasses. The effect of seagrass loss or dieback on dugongs is twofold. Some dugongs may remain in the affected areas but lose body condition, reduce breeding and suffer increased mortality, while others may move hundreds of kilometres with uncertain consequences (Marsh & Kwan 2008; Preen & Marsh 1995). Although it is possible that new seagrass habitats will develop as low-lying coastal areas become intertidal, the overall effect of sea level rise on dugong habitats in the North-west Marine Region is uncertain and thus of *potential concern*.
Changes in sea temperature (Climate change)	Dugong	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). Increased sea temperature as a result of climate change is expected to affect all Australian seagrass habitats through impacts on their growth, distribution, abundance and survival (Campbell et al. 2006; Connolly 2009). Seagrass loss or dieback as a result of increasing sea temperatures has the potential to affect dugongs through loss of suitable feeding habitat. Consequently, in areas where seagrass availability is decreasing, dugongs may either remain in the area but lose body condition, delay breeding and suffer increased mortality; or move hundreds of kilometres with unknown consequences (Marsh & Kwan 2008; Preen & Marsh 1995).

Species assessed = 1		
Pressure	**Species**	**Rationale**
Marine debris (land-based activities, fishing boats, shipping, vessels)	Dugong	*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. Debris harmful to marine wildlife includes plastics washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers (known as ghost nets), and solid floating materials (such as plastics) disposed of by ships at sea. Large amounts of fishing net are discarded or lost from the fisheries in the Arafura Sea (Limpus 2009). However, the characteristics and impacts of debris disposed of or lost overboard in the Arafura Sea are largely unknown (Kiessling 2003) and it is not known what proportion of such debris enters the North-west Marine Region. This pressure is of *potential concern* because it is likely to cause injury or death to individual dugongs and there is inconclusive evidence of the adequacy of management measures to minimise these impacts on dugongs.
Physical habitat modification (dredging and/or dredge spoil)	Dugong	The rapid expansion of industries (offshore oil and gas and land-based mining) and associated port and coastal development in and adjacent to the North-west Marine Region has the potential to adversely affect dugong habitats because dredging and related activities (including spoil dumping) may reduce light penetration to the seagrass beds and smother them, thereby degrading them. Currently, there is little evidence of substantial impact in the region but there is an established link between smothering, absence of light and seagrass decline (Cabaco et al. 2008). The distribution of the dugong is typically fragmented. There is also evidence that dugongs are faithful to specific areas learned from their mothers and are slow to recolonise other areas (Marsh et al. 2011). Therefore, local loss of seagrass habitat may lead to population declines.

Species assessed = 1		
Pressure	**Species**	**Rationale**
Physical habitat modification (storm events)	Dugong	Modelling predicts that climate change will result in increased intensity of storms and storm surges (Connolly 2009; Hyder Consulting 2008). Present indications are that modest to moderate (up to 20%) increases in average and maximum cyclone intensities are expected in some regions by the end of the century (Walsh & Ryan 2000). Increased storm intensity is a primary way in which dugong populations might be severely affected by climate change, due to its impact on seagrass resources at the local scale (Lawler et al. 2007). Evidence from various parts of northern Australia outside the North-west Marine Region points to episodic losses of hundreds of square kilometres of seagrass associated with extreme weather events, such as cyclones and floods (Preen & Marsh 1995; Preen et al. 1995; Poiner & Peterkin 1996). Light availability for seagrass is typically significantly reduced after extreme weather events and deposited sediments can physically smother seagrass surfaces (Cabaco et al. 2008). In addition, dugongs could be adversely affected by increased storm frequency and intensity through direct injury or mortality as storm surges can lead to dugongs being stranded above the high-tide level (Marsh 1989).
Extraction of living resources (Indigenous harvest)	Dugong	Indigenous harvest of dugongs occurs in communities adjacent to the North-west Marine Region under the provisions of section 211 of the *Native Title Act 1993*. The level of harvest, and thus the sustainability of this harvest, is unknown. However, the low reproductive rate, long generation and large investment in offspring make dugongs vulnerable to over-exploitation. Marsh et al. (2002) note that the maximum rate of dugong population increase under optimum conditions when natural mortality is low would be around 5% per year, and conclude that a reduction in adult survivorship as a result of all sources of mortality (including habitat loss, disease, hunting or incidental drowning in nets) can cause a decline in a population.

Species assessed = 1		
Pressure	**Species**	**Rationale**
Oil pollution (oil rigs)	Dugong	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 coincidence of large dugong populations and their habitats, and extensive oil and gas exploration and production in the North-west Marine Region is of potential concern for dugongs. While there is little evidence of a substantial impact on dugongs within the region at present and the effects of oil spills on seagrasses may not persist for long periods (e.g. Kenworthy et al. 1993), oil pollution may result in dugong mortality and/or loss of seagrass habitat.
Collision with vessels	Dugong	The North-west Marine Region is experiencing a significant growth in vessel movements associated with increases in industrial development due to the resources boom and consequent increases in the human population. This population has one of the highest levels of boat ownership per capita in Australia, and there is a high level of shore-based tourist boat activity in and adjacent to the North-west Marine Region, including in the vicinity of seagrass beds in Ningaloo Marine Park, Shark Bay and Exmouth Gulf. The risk of vessel strike on dugongs is increasing. Dugongs are killed accidentally when struck by boats and propellers while feeding in shallow inshore waters, particularly in areas where fast boats are used (Marsh et al. 2002). The relative contribution of vessels of different types to dugong mortality is not known and is likely to be area specific. The greatest danger of a collision appears to be in narrow channels used by boats and dugongs at low tide (Groom et al. 2004). Dugongs can become habituated to boat traffic, especially traffic concentrated around large seagrass meadows on which they feed. There are anecdotal reports of dugongs being killed by vessel strike in and adjacent to the North-west Marine Region, even though there is little evidence of a substantial impact within the region to date.

Species assessed = 1		
Pressure	**Species**	**Rationale**
Invasive species (shipping, fishing vessels, vessels	Dugong	Asian bag or date mussel (*Musculista senhousia*) is a medium-priority marine pest (i.e. it has a reasonably high impact and/or invasion potential) (Hayes et al. 2005). A review by Aquenal (2008) suggests that this species has a high potential to become established in the North-west Marine Region. *Musculista* is transported in ballast water and as biofoul on vessel hulls. Shipping between the ports of Freemantle, north-western Australia and Asia is likely to increase in the future, thus increasing the potential for the mussel to be introduced into the North-west Marine Region (DEWHA 2008c). As *Musculista* invasion in the northern hemisphere has been linked with fragmentation of eelgrass beds (similar to seagrass), there are reasonable grounds to predict that, were the pest to be introduced, it has the potential to impact on seagrass habitats on which dugongs depend (Aquenal 2008).

Table S1.10: Pressures *of concern* to selected marine reptiles in the North-west Marine Region

Species assessed = 29		
Pressure	**Species**	**Rationale**
Marine debris (shipping, vessels, fishing boats, land-based activities)	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Olive ridley 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. Debris harmful to marine wildlife includes plastics washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers (known as ghost nets) and solid, floating materials (such as plastics) disposed of by ships at sea. Marine turtles are vulnerable to marine debris through entanglement and ingestion. Young turtles are especially vulnerable to ingestion of, or entanglement in, marine debris, possibly because they drift within convergence zones (e.g. rips, fronts and drift lines formed by ocean currents) where high densities of marine debris also accumulate. However, it is unknown how much marine debris enters the North-west Marine Region. The throat structure of marine turtles prevents the turtles regurgitating swallowed items. Swallowed items are trapped in the gut where they decompose and leak gases into the body cavity, causing the animals to float and ultimately die. White plastic debris (e.g. plastic bags) is of most concern to turtles, as it is often mistaken for jellyfish, which are a key prey for some species (Derraik 2002). In a recent study by Boyle and Limpus (2008), 46 per cent of the stomach content in green turtle post-hatchlings was ingested synthetic materials. In addition to the direct impacts of plastic ingestion, research also indicates that toxins within the materials are being absorbed by the animals, with unknown but potentially great negative effect on their demography (Bjorndal et al. 1994). Turtles may also be injured or killed if they become entangled in debris (DSEWPaC 2011).

Species assessed = 29		
Pressure	**Species**	**Rationale**
Light pollution (onshore activities)	Flatback turtle Green turtle Hawksbill turtle Loggerhead turtle	Light pollution along, or adjacent to, nesting beaches poses a particular issue for turtles because it alters critical nocturnal behaviours, particularly the selection of nesting sites and the passage of adult females and emerging hatchlings from the beach to the sea (Limpus 2009). The impacts of these changes include a decrease in nesting success, beach avoidance by nesting females and disorientation, leading to increased mortality through predation, road kill or dehydration (Limpus 2009; Lorne & Salmon 2007; Witherington & Martin 2000). Given the particular sensitivity of turtles during nesting, light pollution from coastal and industrial development poses the most serious threat to turtle populations. Industrial development along the coastal fringe and some adjacent islands of the North-west Marine Region is extensive and likely to increase.
Physical habitat modification (dredging and/or dredge spoil)	Flatback turtle	Dredging occurs extensively along the North West Shelf and is projected to become more frequent as industrial activities increase the demand for new and improved harbour access. The impacts of dredging on marine turtles are twofold: direct mortality of individuals and indirect mortality arising from habitat modification. Direct mortality is well established in stranding records, with turtles killed in this manner having extensive and characteristic injuries (Greenland et al. 2004; Haines & Limpus 2001). Dredging may increase sedimentation, decrease water quality and lead to the smothering of important turtle habitat. Dredging removes existing bottom sediments, leaving smooth channels, which anecdotal reports suggest are used by resting turtles. This puts the animals directly in the path of high vessel traffic, thus increasing their exposure to vessel strike injuries and the associated negative impact on populations.

Species assessed = 29		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites (tourism, recreational and charter fishing, research)	Flatback turtle Green turtle Loggerhead turtle	Marine turtles reside along the region's coastal zone and breed on numerous sandy beaches adjacent to the region. Marine turtles are particularly sensitive while on shore for nesting and can be easily disturbed by movement (e.g. people walking) and light (e.g. people driving along beaches). Clutches of eggs are buried about 50 centimetres deep, and incubating nests and emerging hatchlings can be disturbed by vehicles, camp fires, pets (e.g. dogs), vehicles and human tracks. The potential impacts of human presence on marine turtles vary according to species and location. The potential impact varies among the species and differs among sites; however, its management warrants precaution.
Bycatch (commercial fishing)	Sea snakes	Sea snake bycatch has been recorded in the Northern Prawn (although only a small component of the fishery operates in the North-west Marine Region), Pilbara Trawl, Pilbara Trap and Northern Demersal Scalefish fisheries. Sea snakes are particularly vulnerable to trawling because the mesh size of nets is likely to capture the larger, more fecund, females (Fry et al. 2001), with the potential to negatively impact breeding capacity. Being air breathers, sea snakes need to surface approximately every 20 minutes when actively foraging (Heatwole 1999). As a consequence, many more survive being captured in trawl nets when the tow time is short, such as in the banana prawn fishery. Longer tows, such as three hours in the tiger prawn fishery, make it more difficult for sea snakes to survive, unless bycatch reduction devices are installed in the nets (Heales et al. 2008). The Pilbara Trawl Fishery uses bycatch reduction devices with exclusion grids to reduce the capture of non target species such as sea snakes. The bycatch of sea snakes recorded in logbooks in 2008 was 110 individuals and the most common species captured was the bar bellied seasnake (*Hydrophis elegans*) (Fletcher & Santoro eds 2009). Low levels of sea snake bycatch has been reported in the Pilbara Trap and Northern Demersal Scalefish fisheries although logbook data is not available.

Species assessed = 29		
Pressure	**Species**	**Rationale**
Invasive species (shipping, fishing vessels, land-based activities)	Flatback turtle Green turtle Loggerhead turtle	Egg predation by invasive species is a significant issue for marine turtle populations. Once nests have been disturbed, remaining eggs or hatchlings are likely to be consumed by other predators or to die from exposure. Of particular concern to marine turtle populations within the region is predation by the European red fox and feral pig, both of which have had catastrophic impacts on stocks, particularly of the loggerhead turtle and mainland nesting populations of green turtles (Limpus & Limpus 2003; Limpus & Parmeter 1985). A fox eradication program by the Western Australian Government and private land holders has been successful in reducing the effect of foxes to low levels in some sites (e.g. Ningaloo and Gnaraloo), but uncontrolled egg predation remains an issue, particularly by feral pigs along the coast adjacent to the northern part of the region.

Table S1.11: Pressures *of potential concern* to selected marine reptiles in the North-west Marine Region

Species assessed = 29		
Pressure	**Species**	**Rationale**
Changes in sea temperature (Climate change)	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Olive ridley turtle Sea snakes	Sea temperatures have warmed by 0.7 ºC between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 ºC warmer by 2030 (Lough 2009). Increasing sea temperatures have the potential to effect marine turtles in a number of significant ways, including by causing a shift in distribution that may either increase or decrease species range (Davenport 1997; Hawkes et al. 2009; Milton & Lutz 2003); alterations to life history characteristics, such as growth rates, age at maturity and reproductive periodicity (Balazs & Chaloupka 2004; Chaloupka & Limpus 2001; Hamann et al. 2007 in Fuentes et al. 2009); and reduced prey availability (Chaloupka et al. 2008 in Fuentes et al. 2009). Little is known of the thermal requirements and tolerances of sea snakes and how increased temperatures will affect their behaviour and ecology (Hamann et al. 2007). However, predicted changes in sea temperatures are thought likely to affect the availability of sea snake prey species and alter their seasonal movements for either breeding or feeding (Fuentes et al. 2009; Hamann et al. 2007).
Ocean acidification (Climate change)	Sea snakes	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). Ocean acidification may lead to metabolic changes in young and adult sea snakes and changes in the availability of sea snake prey. As some sea snake species, including two critically endangered species, use coral habitats, a decline in coral communities as a result of ocean acidification may adversely affect some sea snake species. However, without further focused research, any predicted ocean acidification impacts on sea snakes remain speculative (Hamann et al. 2007).

Species assessed = 29		
Pressure	**Species**	**Rationale**
Changes in terrestrial sand temperature (Climate change)	Flatback turtle Green turtle Hawksbill turtle Loggerhead turtle	Another effect of rising global temperatures is the trend towards an increasing female bias in the sex ratio of turtle hatchlings due to increasing sand temperatures (Fuentes et al. 2009). This impact may result in the feminising of populations (Fuentes et al. 2009). A rise in sand temperatures may also compromise egg incubation, leading to lower hatchling success and impacted survival of hatchlings (Fuentes et al. 2009). However, recent literature suggests that turtles are responding to these pressures in a highly adaptive manner; for example, shifting nesting periods to correspond to lower temperatures (Poloczanska et al. 2010). This pressure has the potential to affect turtle populations that nest in the region on Ashmore Island or Cartier Island.
Nutrient pollution (urban development, agriculture)	Green turtle	Nutrient pollution comes from a number of sources, including industrial outfalls, effluent from vessels and agricultural run-off. Nutrient pollution has the potential to effect marine turtles in a number of ways. For example, substandard diets in turtles have been associated with algal blooms. Such diets may hamper growth and development, and lead to reduced reproduction (Arthur et al. 2006). Nutrient pollution may also be associated with tumour-promoting toxins that have been implicated in the occurrence of fibropapilloma (Greenblatt et al. 2005). Given the anticipated increase in nutrient pollution associated with the expected growth in industrial and coastal development in north-western Australia, experts consider this pressure to be of increasing concern to turtle populations.

Species assessed = 29		
Pressure	**Species**	**Rationale**
Changes in turbidity (dredging)	Green turtle	Green turtles forage for seagrass and algae within estuarine, rocky, coral reef and seagrass habitats (Limpus 2004; Limpus & Chatto 2004). Green turtle feeding areas in the region include Montgomery Reef (Prince 1993), Shark Bay (EA 2003), and the waters surrounding Thevenard and Barrow islands (Donovan et al. 2008; DEWHA 2008c). It is likely that green turtles would forage in any seagrass habitat and much of the coral reef habitat that occurs along the Western Australian coast, from at least Shark Bay to the northern extent of the North-west Marine Region. Dredging occurs extensively along the North West Shelf and is projected to become more frequent as recreational boating and industrial activities increase demand for new and improved harbour access in the area. Dredging can lead to changes in turbidity, which can impact seagrass meadows. There is little evidence of current substantial impact in the region but there is an established link between smothering, absence of light and seagrass decline (Cabaco et al. 2008). Modification of seagrass meadows in the North-west Marine Region could impact the foraging areas of green turtles and therefore affect their population levels.
Noise pollution (seismic exploration)	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Olive ridley turtle	Oil and gas exploration and other geophysical surveys involve the use of seismic ‘air guns’, which generate a rapid release of air under high pressure to obtain a geologic profile of the sea floor and substrate. There is limited data on the impacts of noise pollution on marine turtles although one study indicated turtles exhibit avoidance behaviour when proximate to noise emitted during seismic surveys (McCauley et al. 2000). However, dependent on the location of the activity and time of year, seismic surveys may cause changes in their foraging, internesting, courting or mating behaviour. As this pressure is increasing in the region, understanding the influence of noise pollution on marine turtles warrants further investigation.

Species assessed = 29		
Pressure	**Species**	**Rationale**
Noise pollution (onshore and offshore construction)	Flatback turtle Green turtle Hawksbill turtle Loggerhead turtle	There is limited data on the impacts of noise pollution on marine turtles. However, there is widespread industrial development within the region and noise generated through construction operations, such as pile-driving and blasting, may adversely affect marine turtles, particularly if these activities occur within areas known to be important for the species and/or during critical lifecycle stages (e.g. nesting). For example, noise pollution may induce startle responses and disturb foraging activities, breeding activities and migration pathways. There is overlap between marine turtle hearing frequencies and the noises generated by pile–driving: the estimated hearing sensitivities are between 250 Hz and 700 Hz (Weir 2007). Pile-driving noises generally fall in the low frequency bandwidth, which is approximately <1000 Hz, depending on pile material, diameter and other properties (Kent et al. 2009).
Physical habitat modification (dredging and/or dredge spoil)	Green turtle Hawksbill turtle Loggerhead turtle Olive ridley turtle	Dredging occurs extensively along the North West Shelf and is projected to become more frequent as recreational boating and industrial activities increase demand for new and improved harbour access in the area. The impacts of dredging on marine turtles are twofold: direct mortality of individuals and indirect mortality arising from habitat modification. Direct mortality is well established in stranding records, with turtles killed in this manner having extensive and characteristic injuries (Greenland et al. 2004; Haines & Limpus 2001). The direct impact of localised habitat modification may be insignificant given the relative size of the area affected. However, there is an indirect effect from habitat modification that is unexpected and of increasing concern. Dredging removes existing bottom sediments, leaving smooth channels, which anecdotal reports suggest are extremely attractive for turtles that come to sleep at their edges. This puts the animals directly in the path of high shipping traffic, thus increasing their exposure to ship strike injuries and the associated negative impact on populations.

Species assessed = 29		
Pressure	**Species**	**Rationale**
Physical habitat modification (fishing gear)	Flatback turtle Loggerhead turtle Olive ridley turtle	Data indicate that trawling activities can change the diversity and abundance of benthic fauna as well as potentially change ecosystem structure and function (Pitcher et al. 2009; Sainsbury et al. 1992). Empirical links between changed benthic habitats and marine turtle dietary ecology have not yet been made but are possible. For example, it is possible that coastal fisheries, such as the Pilbara Fish Trawl Fishery, have influenced benthic communities that correspond with important foraging areas for benthic foraging species such as flatback and loggerhead turtles.
Physical habitat modification (onshore and offshore construction)	Sea snakes	The coastline adjacent to the North-west Marine Region is under pressure from an expanding resources sector and associated development of port facilities, especially for transporting iron ore from the Pilbara. These developments require dredging, pile-driving and shoreline modification that have the potential to negatively affect sea snakes. No data are available on the impact of these activities on sea snakes. However, potential impacts include physical entrainment in equipment; removal from the area by excessive shock waves from explosions, pile-driving and seismic surveys; removal of habitat of prey species; increased turbidity affecting species that rely on vision for feeding; and the covering of foraging habitat with dredge spoil. Data on sea snakes from elsewhere indicate that once removed from an area, sea snakes are slow to re-colonise and may not do so at all (Burns & Heatwole 1998; Lukoschek et al. 2007).

Species assessed = 29		
Pressure	**Species**	**Rationale**
Extraction of living resources (Indigenous harvest)	Flatback turtle Green turtle Hawksbill turtle	The Indigenous harvest of marine turtles has occurred for millennia, with turtles taken for their meat and to make a range of products, including leather, cosmetics, jewellery and other ornaments (Limpus 2009). Indigenous harvest continues in communities adjacent to the North-west Marine Region under the provisions outlined in section 211 of the *Native Title Act 1993*. Green turtles are preferentially taken, with smaller, yet consistent numbers of hawksbill, flatback and loggerhead turtles also harvested. The pressure to loggerhead turtles associated with Indigenous harvest in the North-west Marine Region is of less concern. In addition, the harvest of eggs is also widespread, with anecdotal reports suggesting up to 70% of eggs are removed from some beaches, such as those close to communities. However, the level of marine turtle harvest in the North-west Marine Region, and thus its sustainability, is unknown.
Bycatch (commercial fishing)	Flatback turtle Green turtle Hawksbill turtle Loggerhead turtle	Globally, bycatch is considered to be one of the most significant threats to the ongoing survival of marine turtles (Lewison et al. 2004). Typically, bycatch interactions result in the death of individual turtles by drowning. Turtles are particularly vulnerable to trawl, gillnet and longline fishing gear, all of which are used in the North-west Marine Region. Although bycatch records for the region are limited, turtle bycatch has been recorded in the Pilbara Trawl Fishery, Northern Prawn Fishery and in the adjacent Exmouth Gulf Prawn and Shark Bay Prawn fisheries. The introduction of bycatch reduction devices (with excluder grids) and turtle excluder devices in these fisheries has resulted in a significant reduction in the number of turtles caught as bycatch (Chaloupka & Limpus 2001; Fletcher & Santoro 2009; Limpus 2009).

Species assessed = 29		
Pressure	**Species**	**Rationale**
Oil pollution (oil rigs)	Sea snakes	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. Being air breathers, sea snakes are vulnerable to injury or mortality from oil on the sea surface (AMSA 2010a; Watson et al. 2009). Oil, its residue and chemicals used to disperse it can be either inhaled or ingested (Gagnon 2009). At least two sea snakes were killed in the Montara incident in August–October 2009 (Gagnon 2009; Watson et al. 2009). The expansion of oil and gas exploration and extraction in the North-west Marine Region could increase the likelihood of sea snakes being impacted by oil pollution.
Collision with vessels (tourism, fishing)	Green turtle Hawksbill turtle Loggerhead turtle	Boat strikes are a common cause of death and injury in marine turtles, with the species' poor hearing and vision hampering their ability to avoid boats. Turtles are most vulnerable to boat strike when they are in shallow waters, or at the sea surface to bask in the sun or breathe. In the region there are few quantifiable data; however, in eastern Australia, boat strikes cause a significant number of turtle deaths (Limpus 2009). The expedition and cruising industry in the Kimberley region is growing in both the size and number of vessels, offering adventure and luxury cruises along the coast between Broome and Wyndham, including wildlife interactions (Scherrer et al. 2008). With increasing coastal development in the North-west Marine Region and the associated rise in shipping and boating activity, marine turtle mortality rates due to boat strike are expected to increase.

Table S1.12: Pressures *of potential concern* to selected seabirds and shorebirds in the North-west Marine Region

Species assessed = 10		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	White-tailed tropicbird Wedge-tailed shearwater Great frigatebird Lesser frigatebird Brown booby Red-footed booby Fairy tern Lesser crested tern Little tern Roseate tern Greater Sand Plover	Sea level has been rising at approximately 7.1 millimetres per year in the North-west Marine Region since the 1990s, the largest increase in Australia (NTC 2010). 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 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). Some seabird and shorebird foraging areas and low-lying nesting habitats may be altered or lost with sea level rise (Hobday et al. 2006). Even a relatively small sea level rise could have major impacts on breeding activity at Ashmore Reef and Bedwell Island in the Rowley Shoals, as most of these islands are very low-lying. Birds that prefer to nest on offshore islands are particularly vulnerable to this pressure. The low profiles of Ashmore Island and Cartier Reef (Clarke 2010; Maughan et al. 2009), and Browse Island and Scott Reef (Clarke 2010) predispose them to high vulnerability to rises in sea level, storm surges and extreme events. These are important feeding and roosting sites for migratory shorebirds and are used primarily during the months of September to March. Loss of these feeding and roosting sites would result in the shorebirds being displaced, likely to adjacent feeding and roosting sites on the Australian mainland, such as Roebuck Bay and Eighty-mile Beach. This displacement could result in increased competition for prey resources and for roosting habitat at the adjacent sites.

Species assessed = 10		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Grey plover Pacific golden plover Bar-tailed godwit Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint	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). Increasing sea temperatures are expected to expand or shift seabird, shorebird and prey distribution southwards, and to alter reproductive timing, chick growth rates, breeding success, foraging areas and possibly prey species (Chambers et al. 2005; Cullen et al. 2009; Poloczanska et al. 2007). Southward expansion in the range of some seabird species over the past 50 years has been reported, including for the roseate tern and wedge-tailed shearwater. There is also recent evidence that sea temperature variation at smaller within-season and day-to-day timescales significantly affect seabird foraging success, growth patterns and reproductive output (Johnson & Marshall 2007). There is insufficient nesting habitat to accommodate a large increase in displacement of seabirds and shorebirds from the North-west Marine Region to the South-west Marine Region as a result of shifts in climate change. In addition, there may be loss of suitable island habitats in the South-west Marine Region as a result of sea level rise.

Species assessed = 10		
Pressure	**Species**	**Rationale**
Ocean acidification (climate change)	Ruddy turnstone Sanderling Terek sandpiper Whimbrel	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). Seabirds and shorebirds might be affected by large-scale changes in the food chain. As efficient indicators of ecosystem health due to their sensitivities to changes at lower trophic levels, seabirds may be one of the first species groups to register the changes wrought by ocean acidification (Hobday et al. 2006). It has been suggested that squid (prey species for white-tailed tropicbird, wedge-tailed shearwater, brown booby and lesser frigatebird) may be especially vulnerable to ocean acidification. Squid have a high metabolism and their swimming method requires a good supply of oxygen. An increase in carbon dioxide concentration reduces alkalinity and may reduce the squid's capacity to carry oxygen (TRS 2005 in Frisch 2006). Ocean acidification has been shown to impair the early development and physiology of marine invertebrates. Ocean acidification is predicted to adversely affect the populations of many invertebrates, including those that are prey for shorebirds such as bivalves like mussels (Kurihara et al. 2008). The adverse effects of ocean acidification on seabirds and shorebirds is presently unknown but can be expected to be significant from the altered ecological conditions predicted (Grémillet & Boulinier 2009).

Species assessed = 10		
Pressure	**Species**	**Rationale**
Changes in turbidity (climate change)	Greater sand-plover Grey plover Pacific golden plover Bar-tailed godwit Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint Ruddy turnstone Sanderling Terek sandpiper Whimbrel	Changes in rainfall patterns, hydrological regimes or in oceanographic conditions (Hobday et al. 2006) may lead to changes in turbidity, which could adversely affect shorebird foraging behaviour. An increase in turbidity is likely to reduce the opportunities for resident and migratory shorebirds to feed. A reduction in the capacity of migratory shorebirds to feed would potentially affect their ability to replace used energy reserves (body fat) or to prepare for breeding or migration.

Species assessed = 10

Pressure	Species	Rationale
Light pollution (oil and gas infrastructure, shipping, vessels, onshore and offshore activities, onshore and offshore mining operations)	White-tailed tropicbird Wedge-tailed shearwater Great frigatebird Lesser frigatebird Brown booby Red-footed booby Fairy tern Lesser crested tern Little tern	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). Light pollution is a particular issue for wedge-tailed shearwaters due to their nocturnal habits and migratory shorebirds as they undertake their migratory flights at night (Geering et al. 2007). For operational safety reasons, offshore oil and gas facilities are well lit (EPA 2001), as are vessels at sea. Gas flares and facility lights on petroleum production and processing plants are a significant source of artificial lighting that attract seabirds (Wiese et al. 2001) and could potentially attract migrating shorebirds. Nesting birds may be disoriented where lighting is situated adjacent to rookeries. This is evident for young fledglings, in particular wedge-tailed shearwaters, leaving breeding colonies for the first time. Bright lights can also impact on migrating birds. Illumination at night from artificial lights can reduce the extent of foraging behaviour in shorebirds (Thomas et al. 2004), potentially reducing their abilities to replace used energy reserves (body fat) or to prepare for breeding or migration. It is planned to introduce measures to reduce or limit exposure to light pollution, in line with measures to reduce light pollution for sea turtles.
Physical habitat modification (climate change)	Roseate tern Greater sand-plover Grey plover Pacific golden plover Bar-tailed godwit	Increased frequencies of extreme storm events are predicted to significantly alter coastal landscapes, particularly sandy beaches and low-lying islands, resulting in changes to the structure, function and capacity of coastal ecosystems to deliver ecosystem function (Fitzgerald et al. 2008; Hopkinson et al. 2008; Schlacher et al. 2008; Mcleod et al. 2010; Erwin et al. 2011). Any trend towards an increase in severe storm events is likely to reduce the capacity for all shorebirds to feed, potentially affecting their abilities to replace used energy reserves (body fat) or to prepare for breeding or migration. The loss or reduction in the capacity of coastal islands to support shorebirds would impact on their populations in the North-west Marine Region.

Species assessed = 10		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites (tourism, recreational and charter fishing, research)	Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint Ruddy turnstone Sanderling Terek sandpiper Whimbrel	Human disturbance of seabird breeding sites can cause breeding failure through modification or destruction of breeding habitat, displacement of breeders, nest desertion by all or part of a breeding population, destruction or predation of eggs, and exposure or crushing of young chicks, particularly in ground-nesting species (National Oceans Office 2004; WBM Oceanics & Claridge 1997). For example, the crested tern is susceptible to human disturbance of breeding colonies with birds taking flight when people approach within 20 m, exposing eggs and chicks to predation by gulls (Langham & Hulsman 1986). People walking through wedge-tailed shearwater colonies can easily collapse breeding burrows, which may cause the destruction of the egg or chick and/or the death of the adult. Human disturbance at shorebird feeding and roosting sites can impact on birds' feeding activities or cause disturbance to roosting birds, and deplete energy reserves otherwise to be used for migration. Shorebirds can only feed on falling, low and on rising tides. During high tide periods, birds rest and minimise their energy use. Energy reserves used or depleted because of disturbance must be replaced before the birds migrate, potentially decreasing the time available for breeding (Geering et al. 2007).

Species assessed = 10		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites (defence/ surveillance activities, aircraft)	Greater sand-plover Grey plover Pacific golden plover Bar-tailed godwit Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint Ruddy turnstone Sanderling Terek sandpiper Whimbrel	Human disturbance at shorebird feeding and roosting sites can impact on birds' feeding activities or cause disturbance to roosting birds, and deplete energy reserves otherwise to be used for migration. Shorebirds can only feed on falling, low and on rising tides. During high tide periods, birds rest and minimise their energy use. Energy reserves used or depleted because of disturbance must be replaced before the birds migrate, potentially decreasing the time available for breeding (Geering et al. 2007).

Species assessed = 10		
Pressure	**Species**	**Rationale**
Oil pollution (oil rigs)	White-tailed tropicbird Wedge-tailed shearwater Great frigatebird Lesser frigatebird Brown booby Red-footed booby Fairy tern Lesser crested tern Little tern Roseate tern	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. Seabirds are vulnerable to oil spills due to the amount of time they spend on or near the surface of the sea and on foreshores. Shorebirds are most likely to encounter oil within the inter-tidal zone and onshore due to their feeding habits. Seabirds may also come in contact with oil spills while searching for food, since several species of fish are able to survive beneath floating oil (AMSA 2010c). Seabirds are considered to be significantly affected by oil spills from the direct toxicity of oil; direct oiling of foraging seabirds resulting in fatalities; a reduction in the availability of prey due to exposure of fish eggs and larvae to oil slicks and sheens; degradation of breeding habitat for ground-nesting seabirds; hypothermia; dehydration; and an increased risk of predation (AMSA 2010c). Chemicals used to disperse oil pollution can themselves be toxic to marine life (AMSA 2011b). In addition, even at very low levels, petroleum-based products have been shown to kill seabirds in the embryonic phase (AMSA 2010b).

Species assessed = 10		
Pressure	**Species**	**Rationale**
Invasive species (shipping, fishing vessels, vessels, land based activities)	Greater sand-plover Grey plover Pacific golden plover Bar-tailed godwit Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint Ruddy turnstone Sanderling Terek sandpiper Whimbrel	The adults, young and eggs of all species are at risk of predation from introduced mammalian predators (e.g. cats, rats, foxes). Rats are significant predators of seabirds, and the impacts are reviewed by Jones et al. (2008). The threats posed by rats to seabirds (eg predation) would also be applicable to migratory and resident shorebirds. Fishing vessels (legal and illegal) may have rats (*Rattus* spp.) on board. Rats potentially may be introduced to remote islands such as Ashmore Reef by swimming from anchored vessels or vessels that run aground although there have been no reports of rats on Ashmore Reef to date. Seabird breeding colonies and shorebird roosting communities can be threatened by the introduction of invasive ant species like the yellow crazy ant (*Anoplolepis gracilipes*). Exotic plant species can also affect seabird breeding and shorebird roosting sites by reducing nesting and roosting habitat, eroding burrowing substrate, giving cover to predators and reducing cover and shade for chicks (WBM Oceanics & Claridge 1997), or altering beach topography (Heyligers 1985). For example, threats to fairy terns include predation by dogs, black rats (*Rattus rattus*), silver gulls (*Larus novaehollandiae*) and ravens (*Corvus spp*.). In addition, on the mainland, foxes may be a significant predator (Garnett & Crowley 2000). Fairy terns are also susceptible to decreased breeding success due to breeding sites becoming overgrown by invasive vegetation (Garnett et al. 2011). The wedge-tailed shearwater is vulnerable at its breeding sites to introduced rodents, pigs and cats (Taylor 2000). Crested terns are often attacked or killed by cats and dogs (Higgins & Davies 1996). Threat abatement plans have been prepared under the EPBC Act for exotic rodents on small islands, pigs and cats (DEWHA 2009a, 2008d; DEH 2005c).

Species assessed = 10		
Pressure	**Species**	**Rationale**
Invasive species (IUU fishing and illegal immigration vessels, tourism)	Greater sand-plover Grey plover Pacific golden plover Bar-tailed godwit Common greenshank Curlew sandpiper Great knot Grey-tailed tattler Red-necked stint Ruddy turnstone Sanderling Terek sandpiper Whimbrel	The adults, young and eggs of all species are at risk of predation from introduced mammalian predators (e.g. cats, rats, foxes). Rats are significant predators of seabirds, and the impacts are reviewed by Jones et al (2008). The threats posed by rats to seabirds (eg predation) would also be applicable to migratory and resident shorebirds. Fishing vessels (legal and illegal) may have rats (*Rattus* spp.) on board. Rats potentially may be introduced to remote islands such as Ashmore Reef by swimming from anchored vessels or vessels that run aground although there have been no reports of rats on Ashmore Reef to date. Shorebird roosting communities can be threatened by the introduction of invasive ant species like the yellow crazy ant (*Anoplolepis gracilipes*). Exotic plant species can also affect shorebird roosting sites by reducing nesting and roosting habitat, eroding burrowing substrate, giving cover to predators and reducing cover and shade for chicks (WBM Oceanics & Claridge 1997), or altering beach topography (Heyligers 1985). .

Table S1.13: Pressures *of concern* to selected shark and sawfish species in the North-west Marine Region

Species assessed = 5		
Pressure	**Species**	**Rationale**
Bycatch (commercial fishing)	Freshwater sawfish Green sawfish	Entanglement in commercial fishing nets is considered the main threat to sawfish populations in northern Australia (Stevens et al. 2008). The rostra of sawfish make them particularly susceptible to capture in all forms of net fishing gear (Stevens et al. 2008). In particular, green sawfish have limited, tidally influenced movements and are vulnerable to net fishing operations when they are actively feeding on mud and sand flats (Stevens et al. 2008). While bycatch rates in commercial fisheries are reportedly low, sawfish mortality from bycatch in gillnets has been shown to be about 50% of captured individuals (Field et al. 2008). Post-release mortality can also occur as a result of capture and handling. Although post-release survival rates will be higher for larger, safely released sawfish (FSERC 2009; Salini 2007), it is difficult to release large sawfish safely.
Bycatch (recreational fishing)	Freshwater sawfish Green sawfish	Recreational fishing is a popular activity in the North-west Marine Region. Most effort tends to be concentrated in waters adjacent to population centres. Recreational fishing continues to grow in popularity and, with a growing population (due to expansion of the resource sector) and improvements in technology, larger recreational boats are giving greater access to the coast and offshore marine areas so that more remote areas are becoming accessible to recreational fishers. This will result in increased overlap between recreational fishing activities and sawfish habitat which will increase the potential for mortality as a result of bycatch. Observations of dead, discarded sawfish from recreational fishing highlights that mortality occurs as a direct result of capture and discarding (Stevens et al. 2005; Thorburn et al. 2003). Given the suspected small population sizes and restricted habitats of sawfish (e.g. green sawfish repeatedly use restricted areas of habitat [Stevens et al. 2008]), these species are vulnerable to localised depletion from incidental mortality.

Species assessed = 5		
Pressure	**Species**	**Rationale**
Changes in hydrological regimes (land-based activities)	Freshwater sawfish Green sawfish	Neonate and juvenile sawfish use estuarine and/or freshwater environments (Pillans et al. 2010; Stevens et al. 2005), as well as offshore environments, and freshwater environments are also an important nursery area for freshwater sawfish. Wet season freshwater flows may be the cue for triggering sawfish pupping (Peverell 2005). Whitty et al. (2008) demonstrated that the number of new recruits of freshwater sawfish captured in the dry season of each year is significantly correlated to higher water levels during the late wet season. Australian tropical rivers have highly energetic, episodic flows related to the monsoonal wet season that transport sediments downstream with little trapping of materials in waterways (Brodie & Mitchell 2005). The alteration of flow could change the timing of sawfish reproduction and levels of recruitment. Barriers and impoundments can cause siltation and a reduction in saltwater intrusion, and restrict movements of sawfish species. Dredge and fill activities can cause reduced light penetration by increased turbidity; altered tidal exchange, mixing and circulation; reduced nutrient outflow from marshes and swamps; increased saltwater intrusion; and creation of an environment highly susceptible to recurrent, low-dissolved oxygen levels (Johnston 2004). The riverine habitat of freshwater sawfish is often restricted to isolated pools during the dry season, reducing available habitat. Any further reduction of dry season flows would further restrict habitat availability.

Table S1.14: Pressures *of potential concern* to selected shark and sawfish species in the North-west Marine Region

Species assessed = 5		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Freshwater sawfish Green sawfish	Sea level has been rising at approximately 7.1 mm per year in the North-west Marine Region since the 1990s, the largest increase in Australia (NTC 2010). 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 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). Sea level rise will have significant effects on coastal habitats, including increasing salinity in estuaries and the lower reaches of creeks and rivers. Mangroves may decline in some areas (Chin & Kyne 2007). Sawfish species use estuarine and freshwater habitats for key life stages (Pillans et al. 2010; Stevens et al. 2008), and some sawfish are known to use mangrove habitat (Stevens et al. 2008). There is evidence that salinity levels influence species distributions of northern Australian elasmobranchs able to tolerate a wide range of salt levels (Thorburn et al. 2003). Given the fairly restrictive habitat ranges of sawfish, it is likely that changes in key habitats will have adverse impacts on these species. In an analysis of the Great Barrier Reef region, sawfish have been ranked as moderately vulnerable overall to climate change, with high exposure to the effects of rising sea levels (Chin et al. 2010).

Species assessed = 5		
Pressure	**Species**	**Rationale**
Changes in sea temperature (climate change)	Whale shark	Sea temperatures have warmed by 0.7 ºC between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 ºC warmer by 2030 (Lough 2009). Changes in sea temperature have the potential to significantly affect the availability of whale shark prey. Although there is little empirical data on the effects of climate change on whale sharks, there is some evidence to suggest that the abundance of whale sharks at Ningaloo is correlated to various climatic conditions; therefore, changes in climate could potentially alter this relationship. Wilson et al. (2001) suggest that there is a positive, but complex, correlation between the Southern Oscillation Index, strength of the Leeuwin Current, coastal water temperatures and abundance of whale sharks off Ningaloo Reef. Larger numbers of whale sharks are present during La Niña years than El Niño years. It is possible that changes in temperatures as a result of climate change could magnify the climate-related seasonal abundance of these species at Ningaloo Reef. Whale sharks usually occur in waters where the surface temperature is between 21° C and 25 °C, and there are upwellings of colder water and a salinity range of 34–34.5 parts per thousand (Colman 1997). These conditions may produce localised concentrations of the planktonic and nektonic prey on which whale sharks feed (Colman 1997). Climate change modelling predicts that ocean warming will cause large southward shifts in the distribution of many tropical and subtropical zooplankton, displacing many local species, and the earlier annual appearance of many groups (Hobday et al. 2006). As zooplankton is such a critical food source for higher trophic-level species, both of these impacts will alter trophic and competitive relationships among species and disrupt food webs (Hobday et al. 2006). Alterations in the seasonal abundance and distribution of plankton at Ningaloo Reef could influence the abundance of whale sharks and the timing of their annual migration.

Species assessed = 5		
Pressure	**Species**	**Rationale**
Marine debris (land-based activities, fishing boats, shipping)	Freshwater sawfish Green sawfish	*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. Debris harmful to marine wildlife includes plastics washed or blown from land into the sea, recreational and commercial fishing gear (known as ghost nets), and solid floating materials (such as plastics) from ships at sea. Large amounts of fishing net are discarded or lost from the fisheries of the Arafura Sea (Limpus 2009). However, the characteristics and impacts of debris disposed of or lost overboard in the Arafura Sea are largely unknown (Kiessling 2003) and it is not known what proportion of such debris enters the North-west Marine Region. Because of their saw-like rostrum, sawfish may be especially susceptible to entanglement in marine debris. Sawfish entanglement has been reported in a number of types of marine debris, including PVC piping, elastic bands, and various types of fishing line and bait nets (Chatto pers. comm. 2003 in Kiessling 2003; Seitz & Poulakis 2006). Such entanglement can cause serious or fatal injury (Thorburn et al. 2004). The occurrence of sawfish in popular recreational fishing locations may expose them to discarded fishing line and other debris. Offshore, they may interact with larger marine debris.

Species assessed = 5		
Pressure	**Species**	**Rationale**
Extraction of living resources (commercial fishing—non-domestic)	Whale shark	Whale sharks are fully protected in Australian waters, but because whale sharks roam internationally, apparent declines in seasonal sightings may be due to unsustainable fishing in other parts of the species' range. Recent evidence indicates that overseas fishing may be the primary cause of perceived recent declines in whale shark numbers (Bradshaw et al. 2007, 2008). Fishery data for whale shark, though scarce, points to a decline in seasonal catches, with the declines occurring in the period since directed commercial fisheries were established, for example in the Philippines (DEH 2005b). The rapid change in population composition over a decade (<1 whale shark generation) supports the hypothesis of unsustainable mortality in other parts of their range (e.g. through overfishing), rather than the alternative of long-term abiotic or biotic shifts in the Australian marine environment (Bradshaw et al. 2008). The continued direct and illegal or unreported take of whale sharks in other regions is likely to impact negatively on the Australian population. Whale sharks are easy to capture and have a widespread distribution in small, highly mobile populations, which increases their susceptibility to over-exploitation. Slow growth rates, late maturity and infrequent reproduction means that population reduction due to overfishing is likely, and that recovery will be slow (Meekan et al. 2006a; Stewart & Wilson 2005). Trade in whale shark products is largely driven by demand in Asia for meat and fins.

Table S1.15: Pressures *of potential concern* to historic shipwrecks of the North-west Marine Region

Heritage places assessed = 4		
Pressure	**Species**	**Rationale**
Changes in sea temperature (Climate change)	*Trial* shipwreck *Lively* shipwreck *Ann Milicent* shipwreck *Crown of England* shipwreck	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). Shifts in temperature can affect the long-term preservation of shipwrecks, especially those such as the *Lively*, which is located in shallow waters. Research has identified that increases in sea temperature may hasten the decay of wrecks, with the rate of deterioration dependent on vessel composition.
Physical habitat modification (dredging and offshore construction)	*Crown of England* shipwreck	Physical disturbance or smothering (from sediment dispersal) may progressively deteriorate a shipwreck. The *Crown of England* is located at Depuch Island, approximately 100 km east of Dampier. Depuch Island lies 55 km to the east of major oil and gas operations and fields. The coastline of the North-west Marine Region is under pressure from an expanding and developing oil and gas industry and the establishment of port facilities for the export of minerals, especially iron ore from the Pilbara. Industrial growth and shipping activity is projected to expand. New port sites have been proposed for the area, including some that are close to Depuch Island (DEWHA 2008c).

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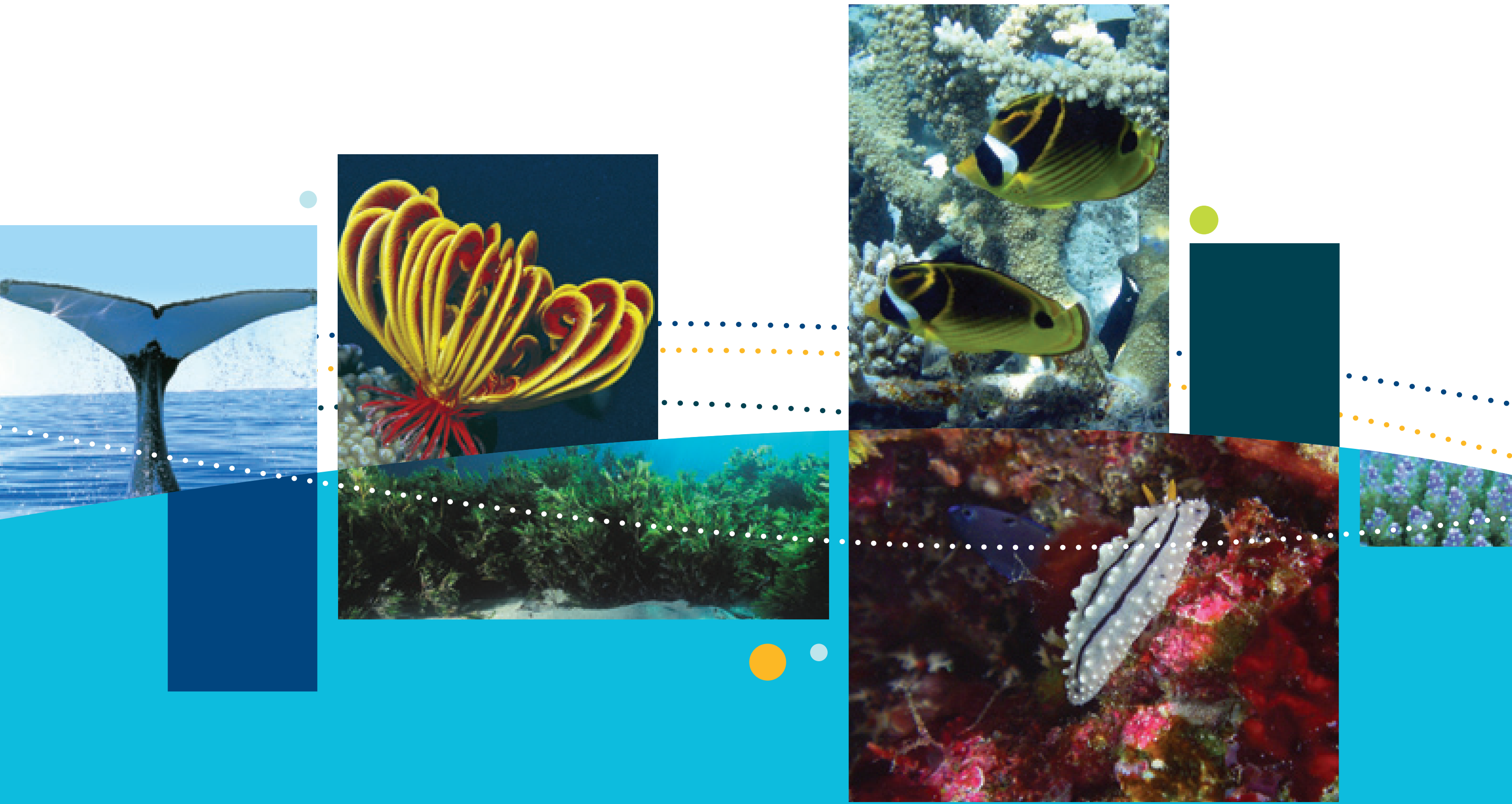

SCHEDULE 2

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 North-west Marine Bioregional Plan has been prepared under the EPBC Act. It contains information about matters of national environmental significance within the North-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 North-west Marine Region) and should not be regarded as definitive in relation to those matters for which advice is provided.

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 value report cards, which are available on the website of the Department of Sustainability, Environment, Water, Population and Communities: **www.environment.gov.au/marineplans/north-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: **www.environment.gov.au/cva**)
- trends in pressures.

Commonwealth marine environment: Section 24 of the EPBC Act defines a Commonwealth marine area (see glossary for further details insert web link). 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 (370 kilometres) from shore. 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 North-west Marine Region and protected places
- protected species that occur in the North-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 either for 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*. 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 EPBC Act *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 North-west Marine Region

The Commonwealth marine environment, including the North-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 (refer to glossary), 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.[11]

The North-west Marine Region covers the Commonwealth waters from the Western Australia–Northern Territory border to Kalbarri, south of Shark Bay, 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: Significant impact guidelines—matters of national environmental significance* 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 Commonwealth marine environment 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

11 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 an 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 North-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

One marine pest[12] species has been recorded in the Commonwealth waters of the North-west Marine Region. A further eight marine pest species are known to occur in waters adjacent to the region where they are currently limited to port and inshore environments (Table S2.1). Other species currently not recorded in the region but that have the potential to cause serious damage if introduced include the Asian green mussel, *Perna viridis*. It can grow rapidly and out compete other species, altering the ecological balance on coastlines. The species can foul industrial structures, jetties, the hulls of ships and their internal pipes (Wells et al. 2009). 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.[13]

12 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.

13 **www.marinepests.gov.au**

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

Pest name	Location	Impact	Habitat
Hydroid (*Gymanqium gracilicaule*)	Port Hedland	Fouler in hulls.	Occurs primarily in shallow water on coral rock and rubble but has been recorded in depths of up to 100m.
Bryozoan (*Amathia distans*)	Port Hedland	Fouling organism. No known predators of this species.	Grows in waters up to 20 m in depth on a wide variety of surfaces, including other bryozoans, algae, seagrasses, oyster valves, sandstone boulders, docks, pilings, breakwaters and man-made debris.
Bryozoan (*Bugula neritina*)	Port Hedland	An abundant fouling organism.	The species colonises heavily on any freely available substratum, including many artificial underwater structures, vessel hulls, ship intake pipes and condenser chambers. In Australia, it occurs primarily in sheltered waters of up to 30 m in depth on artificial substrata, such as jetty pylons.
Bryozoan (*Schizoporella errata*)	Shark Bay	Fouling organism, known to inhibit the growth of adjacent species.	Found in shallow water in ports and harbours on hard substrates (pilings, hulls, coral rubble, etc.) and reefs. Forms encrustations on ships, piers, buoys and other man-made structures.
Bryozoan (*Watersipora subtorquata*)	Shark Bay	Is tolerant to certain antifouling coatings and hence is an abundant fouler of ships hulls. It also facilitates the fouling and spread of other marine invasive species.	Most common in lower intertidal and shallow subtidal areas and grows on docks, vessel hulls, pilings, debris and rocks. Found in depths of up to 10 m and temperatures of 12–28 °C.
Bryozoan (*Zoobotryon verticillatum*)	Shark Bay and Port Hedland	Common fouling species that can have ecological and economic impacts due to its capacity to expand in an aggressive way. Few known predators.	Is common in ports and harbours in warmer waters with optimal temperatures above 22 °C. Can grow on virtually any hard subtidal surface.

Pest name	Location	Impact	Habitat
Acorn barnacle (*Megabalanus rosa*)	Ranges from Cockburn Sound in the south to Cockatoo Island in the Kimberley	A fouling species that readily colonises ship hulls. No recorded predators.	This species is often found on wharf pylons, vessel hulls and other artificial structures. It is recorded to a depth of 300 m, in waters ranging in temperature from 15 °C to 28 °C.
Colonial ascidian (*Botrylloides leachi*)	Dampier Archipelago and offshore at the Rowley Shoals	Dominant competitor, overgrowing and excluding many other suspension-feeding species. Fouling on aquaculture structures can decrease water flow as well as compete for food with suspension-feeding aquaculture species. May also encrust coral reefs.	Grows on both natural and artificial substrata in the lower intertidal and shallow subtidal zones. It is often seen on seagrasses and may occur on reefs.
Solitary ascidian (*Styela plicata*)	Montebello Islands	A fouler of ships, boats, docks and aquaculture facilities, attaching to hard substrates. It competes with other organisms, excluding them from the space it occupies. Its larvae are capable of invading occupied space and growing to a large size in a relatively short period of time, attached to other organisms. *S plicata* then sloughs off because of its large size, often taking other marine organisms with it. This sloughing may destabilise the marine community.	Occurs from low intertidal to 30 m depths, where it is found on hard substrata in protected embayments and harbours. Its range extends throughout tropical to warm temperate seas and it can tolerate great fluctuations in salinity.

Source: Wells et al. (2009)

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 space where marine species can settle, come in close contact with the sea bottom or remain in a single area for extended periods. These characteristics increase the likelihood that a species can establish on a vessel, from where it can be 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.

Shallow and 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 or expand into deeper waters, including in the offshore Commonwealth marine environment.

The introduction of marine pests is a particularly important issue for the North-west Marine Region given the high levels of sea transport to and through the region, the presence of drilling rigs, supply vessels, traditional Indonesian fishing vessels and illegal fishing vessels.

The following types of actions have a real chance or possibility of resulting 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*[14] and the *National biofouling management guidelines for recreational vessels*[15] 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**.

14 www.marinepests.gov.au/_data/assets/pdf_file/0011/1109594/Biofouling_guidelines_commercial_vessels.pdf
15 www.marinepests.gov.au/_data/assets/pdf_file/0009/1109592/biofouling_guidelines_rec.pdf

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

The North-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 North-west Marine Region by virtue of their regional importance for biodiversity and/or ecosystem functioning and integrity. The North-west Commonwealth marine environment 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 North-west Marine Bioregional Plan recognises 12 areas and/or types of habitats and one species group that are key ecological features in the region (Figure S2.1). Further information on these key ecological features is provided in the North-west Commonwealth marine environment report card (**www.environment.gov.au/marineplans/north-west**).

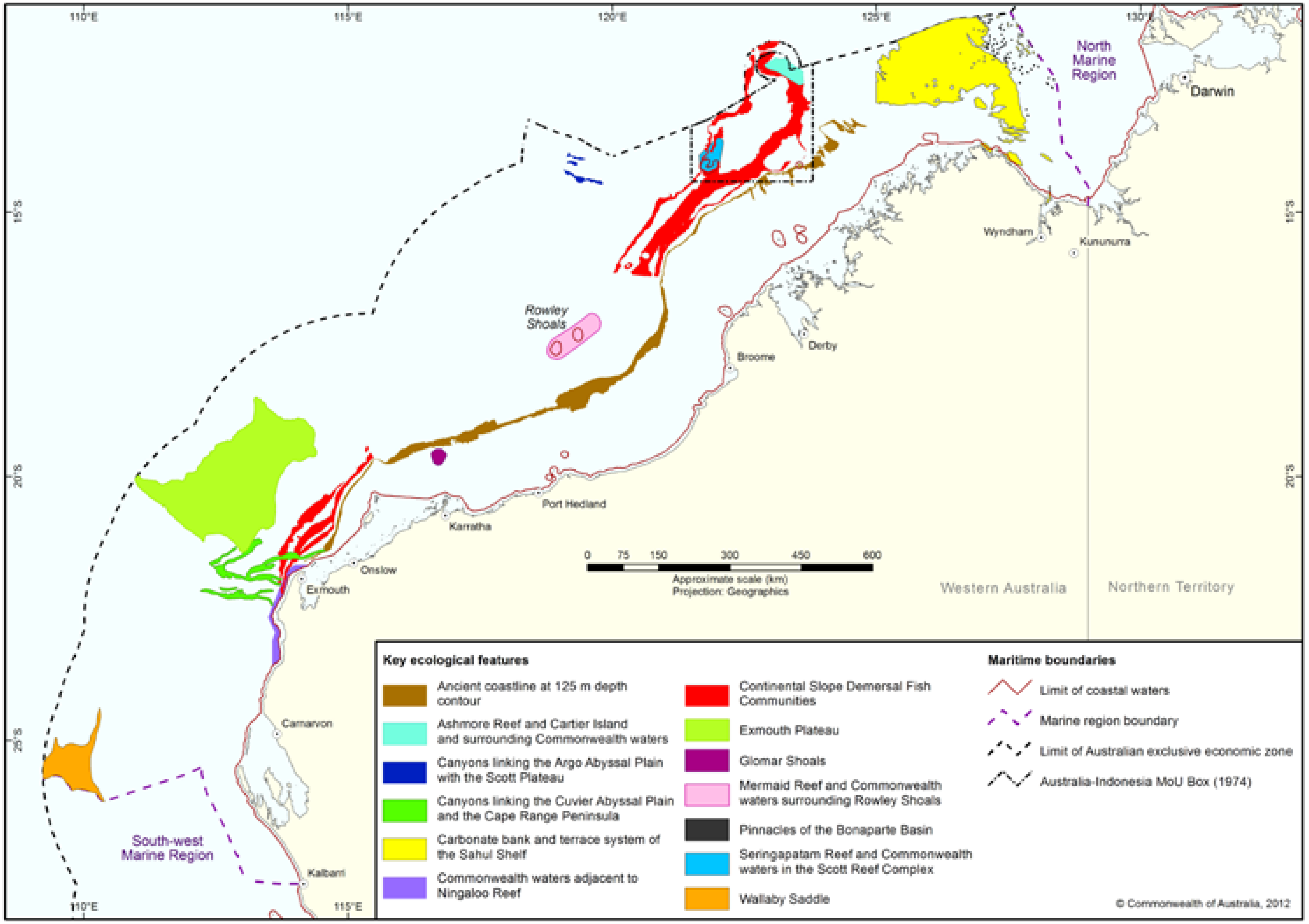

Figure S2.1: Key ecological features in the North-west Marine Region

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.

Carbonate bank and terrace system of the Sahul Shelf: This key ecological feature is recognised for its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats of this feature. The carbonate bank and terrace system of the Sahul Shelf is located in the western Joseph Bonaparte Gulf in the far north of the North-west Marine Region. The carbonate banks and terraces are part of a larger complex of banks and terraces that occurs on the Van Diemen Rise in the adjacent North Marine Region. The banks consist of a hard substrate and have flat tops. Each bank occupies an area generally less than 10 square kilometres and is separated from the next bank by narrow sinuous channels up to 150 metres deep. More than 90 per cent of carbonate banks in the North-west Marine Region are in the Northwest Shelf Transition Bioregion and the North-west Marine Region contains up to 60 per cent of banks and shoals in the entire Australian exclusive economic zone. Although little is known about the bank and terrace system of the Sahul Shelf, it is considered to be regionally important due to its continuous and large expanse and the ecological role it is likely to play in the biodiversity and productivity of the Sahul Shelf.

The banks support a high diversity of organisms including reef fish, sponges, soft and hard corals, gorgonians, bryozoans, ascidians and other sessile filter feeders (Brewer et al. 2007). The banks are foraging areas for loggerhead, olive ridley and flatback turtles. Humpback whales and green and freshwater sawfish are also likely to occur in the area (Donovan et al. 2008).

Pressures *of potential concern* on the biodiversity values of this key ecological feature are:

- illegal, unregulated and unreported fishing, which may lead to overexploitation of marine species and the presence of marine debris
- changes to sea temperature and ocean acidification as a result of climate change.

Generally, most actions in or adjacent to the North-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the carbonate bank and terrace system of the Sahul Shelf.

Pinnacles of the Bonaparte Basin: This key ecological feature is recognised for its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats of this feature.

The limestone pinnacles are located in the western Joseph Bonaparte Gulf. They represent 61 per cent of the limestone pinnacles in the North-west Marine Region and 8 per cent of limestone pinnacles in the Australian exclusive economic zone (Baker et al. 2008). As they provide areas of hard substrate in an otherwise relatively featureless environment they are presumed to support a high number of species. Associated communities are thought to include sessile benthic invertebrates including hard and soft corals and sponges, and aggregations of demersal fish species such as snapper, emperor and grouper (Brewer et al. 2007). The pinnacles are thought to be a feeding area for flatback, loggerhead and olive ridley turtles, while green turtles may traverse the area. Freshwater and green sawfish as well as humpback whales may also occur in the area (Donovan et al. 2008).

Pressures *of potential concern* on the biodiversity values of this key ecological feature are:

- illegal, unregulated and unreported fishing, which may lead to overexploitation of marine species and the presence of marine debris
- changes to sea temperature and ocean acidification as a result of climate change.

> Generally, most actions in or adjacent to the North-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the pinnacles of the Bonaparte Basin.

Ashmore Reef and Cartier Island and surrounding Commonwealth waters: This key ecological feature is recognised for its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values, which apply to both the benthic and pelagic habitats within the feature.

Ashmore Reef is the largest of only three emergent oceanic reefs in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. The waters surrounding Ashmore Reef and Cartier Island are important because they are areas of enhanced productivity in relatively unproductive waters. Localised upwelling and turbulent mixing in the Commonwealth waters around the reef systems provide nutrients to the system and therefore support the reef structure and ecology (DEWHA 2008).

Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regarded as biodiversity hotspots as they support a diverse array of pelagic and benthic marine species. The reefs are rich in coral species and provide varied habitat that attracts a diverse range of primary and secondary consumers, including a particularly diverse fish fauna. Toothed whales, dolphins and whale sharks are found in the Commonwealth waters around these reefs, as is a genetically distinct dugong population at Ashmore Reef (Whiting 1999). Both Ashmore and Cartier reefs support an unusually high diversity of sea snakes, for which these reefs are internationally significant. The sea snake population at Ashmore Reef has suffered significant decline in recent years for reasons that are yet to be understood. Ashmore Reef and Cartier Island also support a genetically distinct breeding population of green turtles and provide foraging grounds for this species as well as for loggerhead and hawksbill turtles (Limpus 2008). The reef system is an important staging post for seabirds and migratory shorebirds and the area is home to some of the most important seabird colonies in the North-west Marine Region (Milton 2005). The importance of Ashmore Reef for seabirds and shorebirds is reflected in its listing as a Ramsar Wetland of International Importance in 2003.

Pressures *of potential concern* on the ecological values of this key ecological feature are:

- oil pollution—coral ecosystems are vulnerable to oil and a number of species aggregate at Ashmore Reef and Cartier Island and the Commonwealth waters surrounding them
- invasive species
- marine debris
- extraction of living resources as a result of illegal, unregulated and unreported fishing
- changes in sea temperature, sea level rise, ocean acidification and storm intensity as a result of climate change.

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) at Ashmore Reef and Cartier Island and surrounding Commonwealth waters have a **risk** of a significant impact on the Commonwealth marine environment of the North-west Marine Region.

Actions that have a real chance or possibility of introducing marine debris to Ashmore Reef and Cartier Island and surrounding Commonwealth waters have a **risk** of significant impact.

Seringapatam Reef and Commonwealth waters in the Scott Reef complex: This key ecological feature is recognised for its ecological functioning and integrity (high productivity) and biodiversity (aggregations of marine life) values, which apply to both the benthic and pelagic habitats within the feature.

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 metre contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). They provide an important biophysical environment in the region as one of few offshore reefs in the north-west. Scott Reef consists of two separate reef formations, North Reef and South Reef. The key ecological feature encompasses the waters beyond the 3-nautical-mile limit at South Scott Reef and the reefs and surrounding waters at North Scott and Seringapatam reefs. The total area of the key ecological feature is approximately 2418 square kilometres.

The coral communities at Scott and Seringapatam reefs play a key role in maintaining the species richness and subsequent aggregations of marine life identified as conservation values for this key ecological feature. Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Woodside 2009).

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales and other cetacean species, whale sharks and sea snakes (Donovan et al. 2008; Jenner et al. 2008; Woodside 2009). Two species of marine turtle, the green and hawksbill, nest during the summer months on Sandy Islet, located on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). This key ecological feature also provides foraging areas for seabird species such as the lesser frigatebird, wedge-tailed shearwater, brown booby and roseate tern (Donovan et al. 2008).

A pressure of concern on the ecological values of this key ecological feature is extraction of living resources by traditional Indonesian fishers.

Pressures *of potential concern* on the ecological values of this key ecological feature include:

- offshore construction and the installation of infrastructure associated with oil and gas—these actions could potentially affect pelagic and benthic species and communities and water quality
- oil pollution from petroleum infrastructure that could have adverse consequences on ecosystem functioning and biodiversity as coral ecosystems are vulnerable to oil and a number of species aggregate at Seringapatam Reef and the Commonwealth waters in the Scott Reef complex
- invasive species
- physical habitat modification as a result of vessel anchorage and fishing practices by traditional Indonesian fishers
- marine debris
- changes in sea temperature, ocean acidification, sea level rise and increases in storm intensity as a result of climate change.

Actions that, irrespective of where they occur, have a real chance or possibility of modifiying, destroying, fragmenting, isolating or disturbing an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or biodiversity of Seringapatam Reef and Commonwealth waters in the Scott Reef complex results have a **high risk** of significant impact on the Commonwealth marine environment.

Actions that, irrespective of where they occur, have a real chance or possibility of substantially changing water quality (including temperature) such that there is an adverse impact on the biodiversity, ecosystem functioning or integrity of Seringapatam Reef and Commonwealth waters in the Scott Reef complex have a **high risk** of a significant impact on the Commonwealth marine environment. Such actions may include release of cooling water and produced formation water or production of drill cuttings which persistently affect light penetration across a substantial area and/or smother ecologically important habitats and/or change the characteristics of the receiving 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) at Seringapatam Reef and Commonwealth waters in the Scott Reef complex have a **risk** of a significant impact on the Commonwealth marine environment of the North-west Marine Region.

Actions that have a real chance or possibility of introducing marine debris to Seringapatam Reef and Commonwealth waters in the Scott Reef complex have a **risk** of significant impact.

Canyons linking the Argo Abyssal Plain with the Scott Plateau: This key ecological feature is recognised because of its biodiversity (aggregations of marine life) and ecological functioning and integrity (high productivity) values, which apply to both the benthic and pelagic habitats within the feature.

The Bowers and Oats canyons are major canyons on the slope between the Argo Abyssal Plain and Scott Plateau. The canyons cut deeply into the south-west margin of the Scott Plateau at a depth of approximately 2000–3000 metres, and act as conduits for transport of sediments to depths of more than 5500 metres on the Argo Abyssal Plain (Stagg 1978, cited in Falkner et al. 2009). Benthic communities at these depths are likely to be dependent on particulate matter falling from the pelagic zone to the sea floor. The ocean above the canyons may be an area of moderately enhanced productivity, attracting aggregations of fish and higher-order consumers such as large predatory fish, sharks, toothed whales and dolphins. Whaling records from the 19th century suggest that sperm whales aggregated over Scott Plateau for reasons that remain unclear.

Pressures *of potential concern* on the ecological values of this key ecological feature include:

- ocean acidification as a result of climate change.

> Generally, most actions in or adjacent to the North-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the canyons linking the Argo Abyssal Plain with the Scott Plateau.

Ancient coastline at 125 m depth contour: This key ecological feature is recognised for its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats within the feature.

The shelf of the North-west Marine Region contains several terraces and steps that reflect increases in sea level across the shelf that occurred during the Holocene. The most prominent of these occurs episodically as an escarpment through the Northwest Shelf Province and the Northwest Shelf Transition, at a depth of approximately 125 metres.

The ancient submerged coastline provides areas of hard substrate and therefore may provide sites for higher diversity and enhanced species richness relative to surrounding areas of predominantly soft sediment. Little is known about fauna associated with the hard substrate of the escarpment but it is likely to include sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the North West Shelf bioregion.

The escarpment may facilitate increased availability of nutrients in particular locations off the Pilbara coast by disrupting internal waves thereby facilitating enhanced vertical mixing of water layers. Enhanced productivity may attract opportunistic feeding by larger marine life including humpback whales, whale sharks and large pelagic fish.

Pressures *of potential concern* on the biodiversity values of this key ecological feature include:

- ocean acidification as a result of climate change.

> Generally, most actions occurring along the ancient coastline at the 125 metre depth contour are unlikely to impact adversely on the ecosystem functioning and integrity of this key ecological feature.

Glomar Shoals: This key ecological feature is recognised because of its ecological functioning and integrity values (high productivity) and biodiversity values (aggregations of marine life), which apply to both its benthic and pelagic habitats.

The Glomar Shoals are a submerged littoral feature located approximately 150 kilometres north of Dampier on the Rowley shelf at depths of 33–77 metres (Falkner et al. 2009). The shoals consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (McLoughlin & Young 1985). The area's higher concentrations of coarse material in comparison to surrounding areas are indicative of a high-energy environment subject to strong sea-floor currents (Falkner et al. 2009). Cyclones are also frequent in this area of the north-west and stimulate periodic bursts of productivity as a result of increased vertical mixing. While much of the biodiversity associated with the Glomar Shoals has not been studied, it is known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown-striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Fletcher & Santoro 2010). These species have recorded high catch rates associated with the Glomar Shoals, indicating that the shoals are likely to be an area of high productivity.

Pressures *of potential concern* on the integrity of habitats and biodiversity values of this key ecological feature are:

- extraction of living resources by commercial fishing
- marine pest incursions
- ocean acidification and changes in sea temperature as a result of climate change.

Generally, most actions in or adjacent to the Glomar Shoals are unlikely to impact adversely on the ecosystem functioning and integrity of this key ecological feature.

Mermaid Reef and Commonwealth waters surrounding the Rowley Shoals: This key ecological feature is recognised because of its biodiversity (aggregations of marine life) and ecological functioning and integrity (high productivity) values, which apply to both the benthic and pelagic habitats within the feature.

The Rowley Shoals are a collection of three atoll reefs, Clerke, Imperieuse and Mermaid, which are located about 300 kilometres north-west of Broome. The key ecological feature encompasses Mermaid Reef Marine National Nature Reserve as well as waters from 3 nautical miles out to 6 nautical miles surrounding Clerke and Imperieuse reefs. Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs themselves (Done et al. 1994). The shoals contain 214 coral species and around 530 species of fish (Done et al. 1994; Gilmour et al. 2007). The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the north-west. They have steep and distinct reef slopes and associated fish communities. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

Pressures *of potential concern* on the biodiversity and integrity of habitat values of this key ecological feature include:

- marine pest incursions
- oil pollution from offshore petroleum development, which have the potential to impact on water quality
- climate change–related pressures, particularly sea level rise, changes in sea temperature and ocean acidification.

Actions that, irrespective of where they occur, have a real chance or possibility of substantially changing water quality (including temperature) such that there is an adverse impact on the biodiversity, ecosystem functioning or integrity of Mermaid Reef and Commonwealth waters surrounding the Rowley Shoals have a **high risk** of a significant impact on the Commonwealth marine environment. Such actions may include release of cooling water and produced formation water or production of drill cuttings which persistently affect light penetration across a substantial area and/or smother ecologically important habitats and/or change the characteristics of the receiving 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) in Mermaid Reef and the Commonwealth waters surrounding the Rowley Shoals have a **risk** of a significant impact on the Commonwealth marine environment of the North-west Marine Region.

Exmouth Plateau: This key ecological feature is recognised for its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats within the feature.

The Exmouth Plateau is located in the Northwest Province and covers an area of 49 310 square kilometres in water depths of 800–4000 metres (Exon & Willcox 1980, cited in Falkner et al. 2009; Heap & Harris 2008). Although the seascapes of this plateau are not unique (Falkner et al. 2009), it is believed that the large size of Exmouth Plateau and its expansive surface may modify deepwater flow and be associated with the generation of internal tides. Both may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer et al. 2007). The topography of the plateau (with valleys and channels), in addition to potentially constituting a range of benthic environments, may provide conduits for the movement of sediment and other material from the plateau surface through the deeper slope to the abyss.

The Exmouth Plateau is generally an area of low habitat heterogeneity; however, it is likely to be an important area of biodiversity as it provides an extended area offshore for communities adapted to depths of around 1000 metres. Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer et al. 2007).

Pressures *of potential concern* on the biodiversity values of this key ecological feature include:

- ocean acidification as a result of climate change.

> Generally, most actions in or adjacent to the North-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Exmouth Plateau.

Canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula: This key ecological feature is recognised for its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats within the feature.

The canyons on the slope of the Cuvier Abyssal Plain and Cape Range Peninsula are connected to the Commonwealth waters adjacent to Ningaloo Reef, and may also have connections to Exmouth Plateau. The canyons are thought to interact with the Leeuwin Current to produce eddies inside the heads of the canyons, resulting in waters from the Antarctic intermediate water mass being drawn into shallower depths and onto the shelf (Brewer et al. 2007). These waters are cooler and richer in nutrients and strong internal tides may also aid upwelling at the canyon heads (Brewer et al. 2007). The narrow shelf width (about 10 kilometres) near the canyons facilitates nutrient upwelling. Thus the canyons probably play a part in the enhanced productivity of the Ningaloo Reef system.

The canyons are also repositories for organic and inorganic particulate matter from the shelf and serve as conduits for its transfer from the surface and shelf to greater depths. The hard substrates of canyons provide habitat for deepwater snapper and other species (Brewer et al. 2007). Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area and are a reflection of the area's enhanced productivity (Sleeman et al. 2007).

Pressures *of potential concern* on the biodiversity values of this key ecological feature include:

- ocean acidification as a result of climate change.

> Generally, most actions occurring in the canyons linking the Cuvier Abyssal Plain with the Cape Range Peninsula are unlikely to impact adversely on the ecosystem functioning and integrity of this key ecological feature.

Commonwealth waters adjacent to Ningaloo Reef: This key ecological feature is recognised for its biodiversity (aggregations of marine life) values, which apply to both the benthic and pelagic habitats within the feature.

The Commonwealth waters adjacent to Ningaloo reef include Ningaloo Marine Park (Commonwealth waters) and encompass an area of 2435 square kilometres. This feature lies adjacent to the Ningaloo Reef state water margin at the 3 nautical mile limit. Ningaloo Reef is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Upwellings associated with canyons on the adjacent slope and interactions between the Ningaloo and Leeuwin currents are thought to support the rich aggregations of large marine species present at Ningaloo Reef. Shelf waters and nutrient-rich upwellings on the seaward side support aggregations and migration pathways of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds (Donovan et al. 2008; Gunn et al. 1999; Waples & Hollander 2008). Detrital input from phytoplankton production in surface waters and from higher-trophic consumers cycles back to the deeper waters of the shelf and slope (Brewer et al. 2007). Deepwater biodiversity includes fish, molluscs, sponges, soft corals and gorgonians. Some of these sponge and filter-feeding communities appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters of Ningaloo Marine Park have some particular areas of potentially high and unique sponge biodiversity (Rees et al. 2004).

Pressures *of potential concern* on the biodiversity values of this key ecological feature are:

- the introduction of invasive species, which may adversely impact on the biological diversity and ecological integrity values of this feature
- oil pollution from petroleum infrastructure that could have adverse consequences on ecosystem functioning and biodiversity as coral ecosystems are vulnerable to oil and a number of species aggregate in Commonwealth waters adjacent to Ningaloo
- changes to sea temperature and ocean acidification as a result of climate change. These climate change–related pressures may impact coral reef and sponge ecosystems and alter localised productivity and/or community structures and species distribution.

Actions that, irrespective of where they occur, have a real chance or possibility of substantially changing water quality (including temperature) such that there is an adverse impact on the biodiversity, ecosystem functioning or integrity of the Commonwealth waters adjacent to Ningaloo Reef have a **high risk** of a significant impact on the Commonwealth marine environment. Such actions may include release of cooling water and produced formation water or production of drill cuttings which persistently affect light penetration across a substantial area and/or smother ecologically important habitats and/or change the characteristics of the receiving 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) in Commonwealth waters adjacent to Ningaloo Reef have a **risk** of a significant impact on the Commonwealth marine environment of the North-west Marine Region.

Wallaby Saddle: This key ecological feature is recognised for its biodiversity (aggregations of marine life) and ecological functioning and integrity (high productivity) values, which apply to both the benthic and pelagic habitats within the feature.

The Wallaby Saddle is regionally important in that it represents almost the entire area of this type of geomorphic feature in the North-west Marine Region. It is a unique habitat that neither occurs anywhere else nearby (within hundreds of kilometres) nor with as large an area (Falkner et al. 2009). The Wallaby Saddle covers 7880 square kilometres of sea floor (Heap & Harris 2008) in water depths of 4000–4700 metres (Falkner et al. 2009) and is located within the Indian Ocean water mass. It is thus differentiated from the subregions to the north that are dominated by transitional fronts or the Indonesian Throughflow. The area may be one of relatively enhanced productivity and low habitat diversity and little is known about it or the natural systems associated with it (Brewer et al. 2007, cited in Falkner et al. 2009).

Pressures *of potential concern* on the biodiversity and ecological integrity values of this key ecological feature include:

- ocean acidification as a result of climate change.

Generally, most actions in or adjacent to the North-west Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Wallaby Saddle.

S2.1.3: Adverse impacts on populations of a marine species or cetacean (excluding those listed as threatened or migratory)[16]

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 North-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 North-west Marine Region's ecosystem structure and functioning and/or to have 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.

16 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 2.6 (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)

Sixty-nine species protected under Part 13 of the EPBC Act (but not listed as threatened or migratory) are currently known to occur in the North-west Marine Region (see Table A appended to this Schedule). The information currently available on many of these species is insufficient to provide separate regional advice. Further information on marine species in the North-west Marine Region is contained in the conservation values report cards (**www.environment.gov.au/marineplans/north-west**).

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 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 North-west Marine Bioregional Plan recognises one species assemblage as a key ecological feature, because it is thought to play an important role in the region's ecological process and/or to have particular relevance for its biodiversity. As more data become available, our understanding of the role of communities will become clearer.

Continental Slope Demersal Fish Communities: This species assemblage is recognised as a key ecological feature because of its biodiversity values, including high levels of endemism.

The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the Australian continental slope. The continental slope between North West Cape and the Montebello Trough has more than 500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia (Last et al. 2005). The demersal fish species occupy two distinct demersal community types associated with the upper slope (water depth of 225–500 metres) and the mid slope (750–1000 metres).

Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system. Loss of benthic habitat along the continental slope at depths known to support demersal fish communities may lead to a decline in species richness, diversity and endemism associated with this feature.

Pressures *of potential concern* on the biodiversity values of this key ecological feature are:

- physical habitat modification as a result of fishing gear (active and derelict)
- bycatch from commercial fishing
- ocean acidification and changes in sea temperatures as a result of climate change.

Generally, most actions occurring within the Continental Slope Demersal Fish Communities are unlikely to impact adversely on the biodiversity values of this key ecological feature.

S2.1.4: Adverse impacts on heritage values

Historic shipwrecks

Four historic shipwrecks are located in the North-west Marine Region (Figure S2.2). The conservation value report card on protected places provides further information: **www.environment.gov.au/marineplans/north-west**. 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.

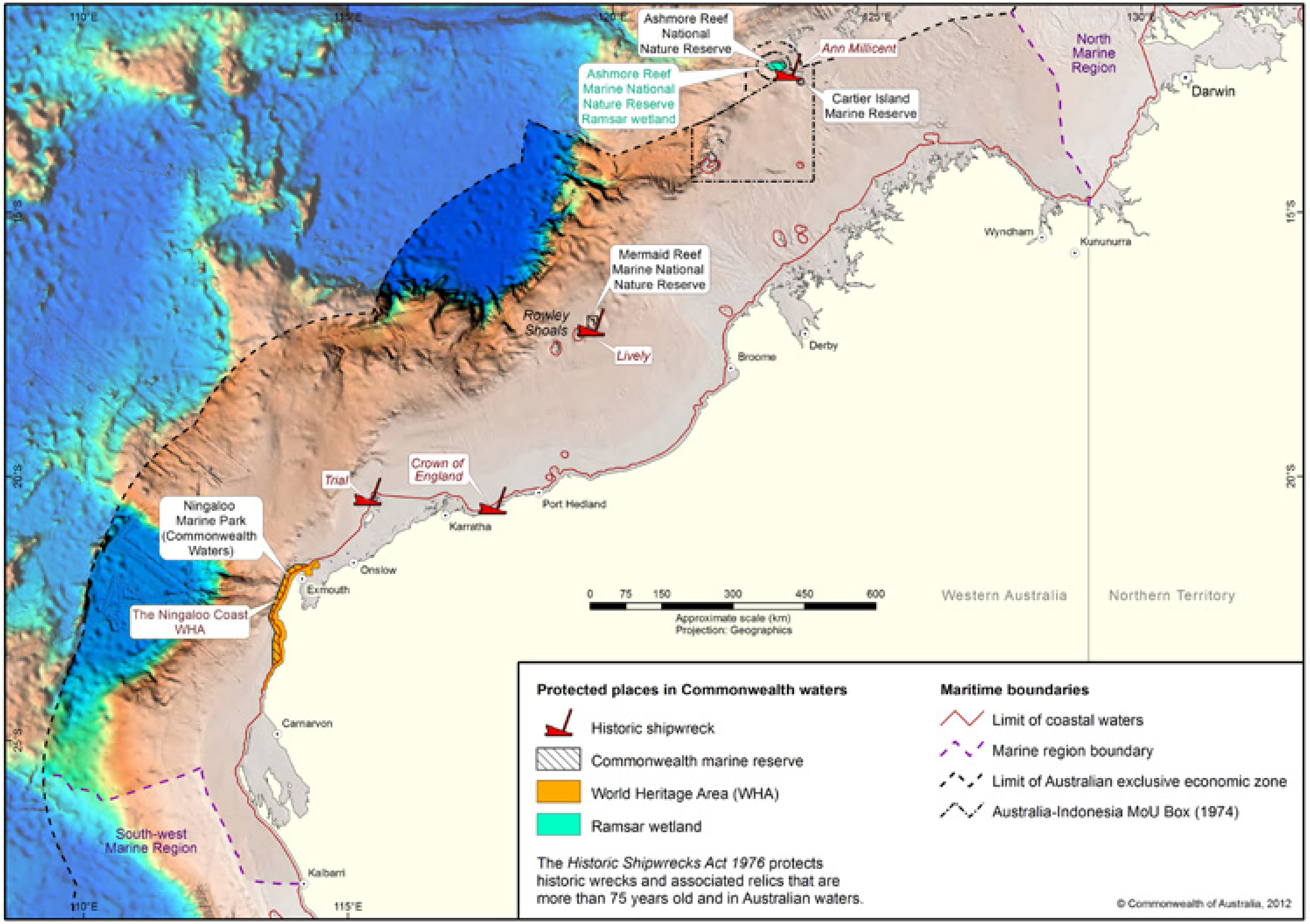

Figure S2.2: Heritage places in the North-west Marine Region as of May 2012

Other heritage places

A number of sites in the North-west Marine Region are listed as different types of heritage places under the EPBC Act (Figure S2.2). A list of each heritage place, the categories it has been listed under and the key ecological feature it is situated in can be found in Table S2.2.

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

Heritage place	Commonwealth marine reserve	World Heritage List	Commonwealth Heritage List	National Heritage List	Ramsar site	Relevant key ecological feature
Ningaloo Reef	✓	✓	✓	✓	✗	Commonwealth waters adjacent to Ningaloo Reef
Ashmore Reef	✓	✗	✓	✗	✓	Ashmore Reef and Cartier Island and surrounding Commonwealth waters
Cartier Island	✓	✗	✗	✗	✗	
Mermaid Reef	✓	✗	✓	✗	✗	Mermaid Reef and the Commonwealth waters surrounding the Rowley Shoals
Scott Reef	✗	✗	✓	✗	✗	Seringapatam Reef and Commonwealth waters in the Scott Reef complex
Seringapatam Reef	✗	✗	✓	✗	✗	

Ningaloo Marine Park (Commonwealth waters) is listed on Australia's Commonwealth Heritage List and also forms part of the Ningaloo Coast World Heritage Area. The Ningaloo Coast is a World Heritage–listed site, in recognition that it is one of the most outstanding natural places in the world. It is recognised for its biological diversity, aggregations of marine life and stunning contrast between rich coral reefs and arid landscapes. The Ningaloo Coast is also on the Australian National Heritage List as it is considered to have outstanding heritage value to the nation due to its extraordinary natural qualities and Indigenous significance. Places listed on the World Heritage List and the National Heritage List are protected under the EPBC Act. The Act requires that approval be obtained before any action takes place that could have a significant impact on the world heritage and/or national heritage values of a listed place. For information on the specific world heritage and national heritage values of the Ningaloo Coast visit the Australian Heritage Database at **www.environment.gov.au/heritage**.

Actions that have a real chance or possibility of causing one or more of the world heritage and/or national heritage values to be lost, degraded, damaged, or notably altered, modified, obscured or diminished, have a **high risk** of significant impact on the Ningaloo Coast World Heritage Area.

S2.1.5: Actions in Commonwealth marine reserves

Commonwealth marine reserves (also called marine protected areas) in the North-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:

- Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve
- Mermaid Reef Marine National Nature Reserve
- Ningaloo 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 North-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 North-west Marine Region.

Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve

Ashmore Reef National Nature Reserve (Ashmore) is located on Australia's North West Shelf in the Indian Ocean, about 450 nautical miles (840 kilometres) west of Darwin, 330 nautical miles (610 kilometres) north of Broome and 60 nautical miles (110 kilometres) south of the Indonesian island of Roti. Ashmore covers 583 square kilometres and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows and a large reef flat covering an area of 239 square kilometres. Within Ashmore are three small islands known as East, Middle and West islands. The reserve includes the seabed and substrata to a depth of 1000 metres and the airspace to a height of 3000 metres. Ashmore is the largest of only three emergent oceanic reefs present in the north-east Indian Ocean and is the only oceanic reef in the region with vegetated islands.

Cartier Island Marine Reserve (Cartier) is located 25 nautical miles (45 kilometres) south-east of Ashmore Reef. Covering an area of 167 square kilometres, Cartier includes an unvegetated sand island (Cartier Island) and the area within a 4 nautical mile radius of the centre of the island, to a depth of 1 kilometre below the sea floor. The area around the island contains a variety of habitats including a mature reef flat, a small submerged pinnacle known as Wave Governor Bank and two shallow pools to the north-east of the island.

These two reserves are located in Australia's external territory of Ashmore and Cartier islands and are also within an area subject to a memorandum of understanding between Indonesia and Australia (see Figure S2.2).

Ashmore and Cartier support large numbers of marine species including sea snakes, dugongs, reef-building corals, fish and other marine invertebrate fauna. The reserves also provide important seabird and marine turtle nesting sites, and provide staging points and feeding areas for large populations of migratory shorebirds. Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large colonies of breeding seabirds. It is also listed on Australia's Commonwealth Heritage List. Ashmore and Cartier are both located on the Ashmore Terrace on the continental slope.

Most of Ashmore Reef National Nature Reserve, which is assigned the International Union for Conservation of Nature (IUCN) Category Ia, is closed to the public. The remaining area is managed mainly for ecosystem conservation and recreation and provides for public access. All of Cartier Island Marine Reserve is closed to the public. For more information on these reserves, visit **www.environment.gov.au/coasts/mpa/ashmore**.

Mermaid Reef Marine National Nature Reserve

Mermaid Reef Marine National Nature Reserve (Mermaid) covers 540 square kilometres and surrounds Mermaid Reef, which is located about 150 nautical miles (290 kilometres) north-west of Broome. Mermaid is located near the edge of Australia's continental slope and is surrounded by waters that extend to depths of more than 500 metres. Mermaid Reef is 14.5 kilometres long, 7.6 kilometres wide and the average depth of its lagoon is 20 metres. It is the most north-easterly of three reef systems forming the Rowley Shoals. Mermaid Reef is totally submerged at high tide and therefore falls under Australian Government jurisdiction. As the other two reefs of the Rowley Shoals, Clerke Reef and Imperieuse Reef, include permanent sandy cays above the high water mark, they are managed by the Western Australian Government as the Rowley Shoals Marine Park.

The Rowley Shoals, including Mermaid Reef, have an abundance and variety of marine wildlife that is in a relatively undisturbed condition, as well as spectacular and unusual underwater topography. All three reefs are similar in shape, size, orientation and distance from each other. Each has a large lagoon area containing small sand cays or islands, narrow lagoon entrance channels on the eastern side and an outer reef edge dropping off relatively steeply into oceanic waters 500–700 metres deep. Oval in shape, the reefs follow a southwest to northeast alignment along the edge of the continental shelf and lie 30–40 kilometres apart. Mermaid Reef is also listed on Australia's Commonwealth Heritage List.

For more information on Mermaid, visit **www.environment.gov.au/coasts/mpa/mermaid**.

Ningaloo Marine Park (Commonwealth waters)

Ningaloo Marine Park (Commonwealth waters) stretches approximately 300 kilometres along the west coast of the Cape Range Peninsula near Exmouth, approximately 1200 kilometres north of Perth. The total area of the reserve is 2435 square kilometres. Ningaloo Reef, the longest fringing barrier reef in Australia, and the only example in the world of extensive fringing coral reef on the west coast of a continent, is adjacent to the reserve and is protected by the Ningaloo Marine Park (State waters), which lies between the reserve and the Western Australian coast. The combined state and Commonwealth waters of the Ningaloo Marine Park cover an area of 5070 square kilometres. The reserve is located in a transition zone between tropical and temperate waters and sustains tropical and temperate plants and animals, with many species at the limit of their distribution. One of the key features of the reserve is its annual visitors, the whale sharks, who visit the reserve each year between March and June.

For more information on Ningaloo, visit **www.environment.gov.au/coasts/mpa/ningaloo**.

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

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

All cetaceans (whales, dolphins and porpoises) are protected under the EPBC Act in the Australian Whale Sanctuary[17] (and, to some extent, beyond its outer limits). Of the 45 cetacean species recorded in Australian waters, 21 occur regularly in the waters of the North-west Marine Region, including 8 species of whale and 13 species of dolphin. A further 12 species of cetacean occur infrequently in the North-west Marine Region. Please refer to the conservation values report card—cetaceans, for a complete list of cetaceans and additional information (**www.environment.gov.au/marineplans/north-west**).

A number of cetaceans known to occur in the North-west Marine Region are listed as threatened and/or migratory species under the EPBC Act, including the pygmy blue whale, humpback whale, Indo-Pacific humpback dolphin and snubfin dolphin. 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 along the Western Australian coast. Their abundance estimate, based on acoustic data recorded in 2004, is between 662 to1559 whales.The pygmy blue whale was not, however, subject to a pressure analysis or biologically important area mapping in the North-west Marine Region as part of this plan's preparation. Biologically important area information has been identified for three species (Table S2.3) and the following advice relates only to those species.

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

Species	Listing status
Humpback whale (*Megaptera novaeangliae*)	Vulnerable, migratory
Indo-Pacific humpback dolphin (*Sousa chinensis*)	Migratory
Australian snubfin dolphin (*Orcaella heinsohni*)	Migratory

17 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**.

Key considerations in relation to significant impacts on humpback whales, Indo-Pacific humpback dolphins and Australian snubfin dolphins in the North-west Marine Region

Population status and ecological significance

Humpback whales are showing strong signs of recovery in Australian waters, with populations growing at approximately 10 per cent per year (DEH 2005a). The size of the Australian west coast population of humpback whale is estimated to be 28 830 (Hedley et al. 2011).

The population status of **Australian snubfin dolphins** is unknown in Australian waters. The species has been recorded in shallow estuarine and coastal waters of northern Australia, from central Queensland (Fitzroy River–Keppel Bay) to Coral Bay, Western Australia (Jacob 2009). Despite its wide distribution, populations of snubfin dolphin appear to be uncommon in most areas and those that are known are thought to be localised and discrete (Parra & Arnold 2008). There are insufficient data to estimate past or potential future declines in occurrence or in areas of occupancy by snubfin dolphins in the North-west Marine Region. Given the small, geographically (and there is evidence to suggest genetically) localised nature of snubfin populations in Australia, the populations occurring in the North-west Marine Region and adjacent waters should be considered ecologically important.

The total population size of the **Indo-Pacific humpback dolphin** in Australian waters is unknown. However, populations of this species elsewhere are known to be highly localised and occur in small, genetically distinct subpopulations (Cagnazzi et al. 2011; Cagnazzi & Harrison 2010; Corkeron et al.1997; Parra et al. 2006).

The importance of the Indo-Pacific humpback dolphin and Australian snubfin dolphin as top predators may assist in regulating abundance and 'symmetry' of the food chain, which in turn helps to maintain ecological complexity (Rooney et al. 2006).

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.[18]

For the purpose of determining the significance of impacts of proposed actions on **Indo-Pacific humpback** and **Australian snubfin dolphins**, both migratory listed species, there is currently insufficient information available to determine whether an ecologically significant proportion of each population occurs in the North-west Marine Region. However, it should be taken into consideration that these species generally exhibit small population sizes (less than 100 individuals), high site fidelity and geographic isolation with low gene flow between populations, and as such removal (i.e. anthropogenic mortality) of a very small percentage of mature animals from the population may cause a population decline leading to local extinction.

Species distribution and biologically important areas

The North-west Marine Region is particularly important for the Western Australian population of **humpback whales**. Their known breeding and calving grounds are between Lacepede Islands and the northern end of Camden Sound (DEH 2005a; Jenner et al. 2001). Humpbacks are thought to feed only opportunistically while visiting the region.

Humpback whales migrate north from their Antarctic feeding grounds around May each year, reaching the waters of the North-west Marine Region in early June. Immature individuals and lactating females arrive first in the mating and calving grounds, followed by non-pregnant mature females and adult males. Pregnant females arrive last. The exact timing of the migration period can vary from year to year dependent upon water temperature, sea ice, predation risk, prey abundance and the location of the feeding ground last used (DEWR 2007). Breeding and calving takes place between mid-August and early September. Humpback whales migrate south to Antarctic feeding grounds from late August to October (cow and calf migration can occur for up to four weeks before and after these migration periods). On their southern migration, humpback whales stop to rest in Exmouth Gulf, Shark Bay and adjacent areas.

18 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. 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 may be impacted; for listed migratory species, consideration should be given to whether an 'ecologically significant proportion of the population' may be impacted.

The Western Australian population of humpbacks (known as the Group IV population) is genetically distinct from the eastern Australian population, with very little genetic exchange between the two, even in their Antarctic feeding grounds (Baker et al. 1993).

The following biologically important areas have been identified for humpback whales:

- resting area in Shark Bay for humpback whales migrating north and south—it is particularly important for cows and calves on their southward migration
- resting area in Exmouth Gulf for migrating humpback whales, with very high densities of nursing cows with calves during the southern migration
- breeding and calving in the Kimberley coast from the Lacepede Islands to north of Camden Sound. This is the main calving area for the Western Australian population of humpback whales. Large concentrations of humpbacks are observed in Camden Sound and Pender Bay between July and October each year
- migration corridor from the southern border of the North-west Marine Region to the breeding and calving grounds in the north of the Kimberley. The migration corridor represents the route for northern and southern migrating humpback whales.

Pygmy blue whales are known to migrate between warm water (low-latitude) breeding grounds and cold water (high-latitude) feeding grounds. The migratory pathway of pygmy blue whales along the Western Australian coast is now reasonably well understood (McCauley and Jenner 2010). On their northern migration pygmy blue whales come into the Perth Canyon in the period January to May, and then move 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. They tend to pass along the shelf edge at depths of 500m out to 1000 m, moving faster on the southern migration and coming in close to the coast in the Exmouth–Montebello Islands area. (McCauley and Jenner 2010).

Indo-Pacific humpback dolphins are known to occur in the North-west Marine Region off the Buccaneer Archipelago and from Cape Leveque to Roebuck Bay. They are generally found in depths of less than 20 metres although some have been recorded in waters up to 40 metres deep and 55 kilometres offshore. This species generally inhabits river mouths, mangroves, tidal channels and inshore reefs (Karczmarski et al. 2000; Parra et al. 2006). Although found predominantly in state inshore waters, Indo-Pacific humpback dolphins are likely to migrate through and forage in the North-west Marine Region. The Indo-Pacific humpback dolphin is known to form resident groups at sites in coastal waters where foraging, breeding and calving occur.

Biologically important areas have been identified for the Indo-Pacific humpback dolphin and include:

- breeding, calving and foraging in Roebuck Bay
- breeding, calving and foraging in Willie Creek
- breeding, calving and foraging in the Prince Regent River
- foraging and breeding (likely) in King Sound (north), Yampi Sound and Talbot Bay
- foraging and breeding (likely) in Camden Sound area (Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island [Kuri Bay])
- foraging around Maret and Biggee islands
- foraging in King Sound, southern sector
- foraging in Vansittart Bay, Anjo Peninsula.

Indo-Pacific humpback dolphins use these biologically important areas year round.

The **Australian snubfin dolphin** (formerly known in Australian waters as the Irrawaddy dolphin) is a newly described species and may be endemic to Australian waters (Beasley et al. 2005). The species is found predominantly in nearshore state waters along the coast from Cape Londonderry south to Roebuck Bay, with records of vagrants as far south as Exmouth Gulf. Roebuck Bay is the only known area where relatively large numbers of snubfin dolphins congregate and as such is a key area for this species, which is generally found in very low numbers within a fragmented coastal distribution (Thiele 2005). It is likely that this species feeds and migrates through the North-west Marine Region in the following areas: off the eastern and western sides of Cambridge Gulf, to the north and north-west of Cape Londonderry and Cape Talbot, west of Augustus Island, west and north-west of the Buccaneer Archipelago, and in Commonwealth waters adjacent to the coast between Cape Leveque and Broome.

The following biologically important areas have been identified for the Australian snubfin dolphin. These areas are used for breeding, calving and foraging year round.

- Roebuck Bay
- Cambridge Gulf
- Camden Sound area (Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island [Kuri Bay])
- King Sound (south)
- King Sound (north), Yampi Sound and Talbot Bay
- Maret and Biggee islands
- Admiralty Gulf and Parry Harbour
- Bougainville Peninsula
- Vansittart Bay, Anjo Peninsula
- Napier Broome Bay and Deep Bay
- Prince Regent River
- King George River and Cape Londonderry
- Ord River.

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

> Table S2.4 should be considered in assessing the risk of significant impact on each of the three species within and outside known biologically important areas.

Table S2.4: Advice on the risk of significant impact on humpback whale, Indo-Pacific humpback dolphin and Australian snubfin dolphin[19]

Species	Action in, or affecting, biologically important areas	Action outside biologically important areas	Temporal considerations[21]
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,[20] biologically important areas for humpback whales and, in the case of seismic activities, undertaken in accordance with EPBC Act Policy Statement 2.1, have a low risk of significant impact on this species.	In the North-west Marine Region from late November to May, 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.
Indo-Pacific humpback dolphin	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 outside, and not affecting, biologically important areas for Indo-Pacific humpback dolphins, have a low risk of significant impact on this species.	Indo-Pacific humpback dolphins use biologically important areas all year.
Australian snubfin dolphin	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 outside, and not affecting, biologically important areas for Australian snubfin dolphins have a low risk of significant impact on this species.	Australian snubfin dolphins use biologically important areas all year.

19 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.

20 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.

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

Nature of the proposed action

Anthropogenic 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 North-west Marine Region is in the conservation values report card—cetaceans.

Noise pollution as a result of seismic surveys is a *pressure of potential concern* for humpback whales. Oil and gas exploration and other geophysical surveys involve the use of seismic air guns to generate a reflected noise. This low-frequency noise signal has the potential to cause physical and physiological injury to humpback whales that are close to the noise source, and to disrupt biologically important behaviours such as calving, resting or feeding. Noise pollution may 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.

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 acoustic noise that whales may be exposed to by imposing distance restrictions and modifying operations (e.g. soft start or shut-down procedures) when whales are in the vicinity of seismic activity. Less is known about the potential for behavioural effects from exposure to a noise source where, although the sound may be at a level too low to cause physical damage, it is still audible to the whale. Potential behavioural effects are managed by avoidance of biologically important areas and their surroundings during biologically important periods.

The following pressures are *of potential concern* for humpback whales, Australian snubfin dolphin and Indo-Pacific humpback dolphin:

- Noise pollution associated with construction activities (e.g. pile-driving or blasting) and shipping traffic, particularly when carried out in close proximity to these species. Modelling of the sound frequencies generated by pile-driving suggests that they are within the frequencies to which dolphins are sensitive (Kent et al. 2009). However, there have been few studies on the effects of construction noise on cetaceans.
- Collision with vessels (including small recreational craft in the case of dolphins).

Pressures *of potential concern* for the Australian snubfin and Indo-Pacific humpback dolphins are:

- oil pollution resulting from an oil spill, particularly if oil reaches important breeding and calving areas. Oil pollution may disrupt the breeding cycle, increase mortality and/or reduce calving
- nutrient and chemical pollution from onshore activities given that the species' primary habitats occur in inshore waters

- physical habitat modification (e.g. dredging and onshore construction that may result in the loss of key habitat). Their small, localised populations and reliance on coastal inshore habitats for important biological activities (feeding, socialising, breeding and resting) suggest that these species are particularly susceptible to habitat degradation and displacement as a result of physical habitat modification
- changes in hydrological regimes associated with land-based activities. The disruption of freshwater input into nearshore marine environments has the potential to adversely affect ecological processes and productivity upon which these species depend
- human presence at sensitive sites (e.g. tourism, recreational fishing). Increasing tourism in the Kimberley region and recreational fishing in important areas such as Roebuck Bay may adversely affect these species by disrupting important biological and social behaviours.

Other pressures *of potential concern* for the Australian snubfin and Indo-Pacific humpback dolphins are marine debris, bycatch in commercial fisheries and climate change.

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

Actions have a **high** risk of significant impact on humpback whales if there is a real chance or possibility that those actions increase the rate of ship strike within biologically important areas (e.g. construction of ports or expansion in port facilities, leading to greater shipping traffic, or construction of facilities leading to increased use of recreational watercraft).

Actions such as seismic surveys, shipping, pile-driving and blasting have a **high risk** of significant impact on humpback whales if there is a real chance or possibility that those actions will increase relevant noise[22] above ambient levels in biologically important areas when this species is present.

When seismic actions are undertaken in accordance with Part A and, where relevant, Part B of *EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales*, the **risk** of a significant impact to the species can be considered **low**.

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

Actions have a **risk** of a significant impact on the Australian snubfin and Indo-Pacific humpback dolphins when there is a real chance or possibility that those actions will:

- introduce a new source from which a severe oil spill or chemical contamination (e.g. construction of new oil or gas wells; construction of ports or expansion in port facilities, leading to greater shipping traffic) has a reasonable potential of arising in biologically important areas and potentially disrupting the lifecycle (e.g. breeding, feeding).
- lead to an increased rate of ship strike in biologically important areas for these species when the species are present (e.g. construction of ports or expansion in port facilities, leading to greater shipping traffic, or construction of facilities leading to increased use of recreational watercraft).
- substantially modify, destroy or isolate habitat (e.g. dredging, changes to hydrological regimes) in a biologically important area in the North-west Marine Region.
- increase relevant noise above ambient levels (e.g. actions resulting in substantial increase in ship noise) in any of the biologically important areas for inshore dolphins when the species are present.

Actions that have a real chance or possiblity of introducing marine debris within a biologically important area have a **risk** of significant impact on the Australian snubfin and Indo-Pacific humpback dolphins.

For the three species of inshore dolphin, given the currently incomplete knowledge of the population distribution of these species, there is a **risk** of a significant impact for the actions described above outside known biologically important areas and within the distribution and seasonal range in the region.

Ecotourism operations in biologically important areas for, Indo-Pacific humpback and Australian snubfin dolphins and in accordance with the *Australian national guidelines for whale and dolphin watching 2005* (DEH 2005b) have a **low risk** of significant impact on these species. The national guidelines allow for stricter management measures to be applied in areas where whale and inshore dolphin watching operations might be *of concern* (e.g. locations with a high number of operators). In instances where stricter management measures may be required, early advice should be sought from the Australian Government environment department.

Advice for preparing a referral with respect to impacts on humpback whale, Australian snubfin and Indo-Pacific humpback dolphins in the North-west Marine Region

A 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 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 humpback whale, Indo-Pacific humpback dolphin and Australian snubfin dolphin, consideration of the following matters is recommended:

- If the action proposed is in 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.
- 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 *EPBC Act Policy Statement 2.1: Interaction between offshore seismic exploration and whales*.
- 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 noise-generating activities, 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 environment department.
- If planning recreational and/or tourism operations, the *Australian national guidelines for whale and dolphin watching 2005* (DEH 2005b) provides 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 conservation values 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 for the presence of the humpback whale, Australian snubfin dolphin and Indo-Pacific humpback dolphin and improve the ability to assess and mitigate impacts. It is recommended that early advice be sought from the Australian Government environment department.

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Schedule 2.3 Dugong of the North-west Marine Region

The dugong (*Dugong dugon*) is the only living member of the family Dugongidae and is listed as migratory under the EPBC Act. Some of the coastal waters adjacent to the North-west Marine Region support significant populations of dugongs, including Shark Bay, which has an estimated population of around 10 000 individuals. Dugongs also occur in Exmouth Gulf and offshore on the North West Shelf, in and adjacent to Ningaloo Reef, in coastal waters close to Broome and along the Kimberley coast, and on the edge of the continental shelf at Ashmore Reef (DEWHA 2008). Dugongs are highly migratory and are capable of moving over relatively large distances with the maximum recorded movement of more than 400 kilometres in around 40 days (Preen & Marsh 1995; Sheppard et al. 2006). Although the patterns of dugong movement in Western Australia are not well understood, it is thought that dugongs move in response to availability of seagrass (Marsh et al. 1994; Preen et al. 1997) and water temperature. Dugongs inhabit seagrass meadows in coastal waters, estuarine creeks and streams, and offshore at Ashmore Reef.

Key considerations in relation to significant impacts on dugong in the North-west Marine Region

Population status and ecological significance

Population estimates of dugong abundance in Shark Bay are 7230–11,080 individuals (Hodgson et al. 2008). Approximately 1000 individuals have been recorded in the Exmouth Gulf–Ningaloo Reef area (Marsh et al. 2002). It is thought that these populations are stable. The waters adjacent to the Dampier Peninsula (from Cape Leveque to Lagrange Bay) contain a dugong population of approximately 930–1774 dugongs (RPS Group 2010). Dugongs are known to occur throughout the Kimberley to the Western Australia–Northern Territory border and at Ashmore Reef; however, population estimates for these areas are not available.

The small population of dugongs at Ashmore Reef is likely to be isolated from other known populations by long distances to the south and deep water to the north. The genetic structure of the dugongs from Ashmore Reef and from the greater Sahul Banks region has not been thoroughly investigated, although it has been suggested that the Ashmore Reef population is more closely related to Asian dugongs than Australian dugongs (Whiting 1999). Given the isolation and low numbers of the dugong population at Ashmore Reef, dugongs there may be more vulnerable to anthropogenic pressures than other populations in the North-west Marine Region.

The population biology of dugongs renders them particularly vulnerable to mortality as adults (Marsh et al. 2011). Dugongs are long lived, mature late and have long gestation periods. These characteristics contribute to a low reproductive potential, which has implications for the vulnerability of the species to anthropogenic mortality and the rate at which populations, once depleted, can recover.

For the purpose of determining the significance of impacts of proposed actions on dugongs, a migratory listed species, it should be assumed that an ecologically significant proportion of the population[23] occurs in and adjacent to the North-west Marine Region.

Species distribution and biologically important areas

A significant proportion of the world's dugong population occurs in coastal waters from Shark Bay in Western Australia to Moreton Bay in Queensland (Marsh et al. 2011). The total dugong population in Australia is estimated at more than 80 000 individuals (Saalfeld & Marsh 2004). Waters adjacent to the region include dugong aggregation areas that are considered internationally significant. Shark Bay is considered to be home to more than 10 per cent of the world's dugongs (Hodgson 2007).

Biologically important areas have been identified for dugongs in the North-west Marine Region and include:

- foraging and nursing in Exmouth Gulf and Ningaloo Reef year round
- foraging and nursing in Shark Bay year round and breeding during summer months
- foraging in Roebuck Bay, Broome.

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

Nature of the proposed action

Anthropogenic activities in coastal environments and offshore have the potential to significantly impact dugongs. An overview of the vulnerabilities and pressures on dugongs in the North-west Marine Region is in the conservation values report card—dugong.

Pressures rated *of potential concern* on dugongs in the North-west Marine Region are:

- physical habitat modification from activities such as dredging associated with port construction. As dugongs are dependent on seagrasses for food, any loss or degradation of seagrass due to anthropogenic activities in these habitats could adversely affect this species. The degradation of inshore waters used by dugongs as nursery and breeding areas could also affect juvenile survival

23 A definition of 'ecologically significant 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. In accordance with Policy Statement 1.1, for listed migratory species, consideration should be given to whether an 'ecologically significant proportion of the population' may be impacted.

- actions that increase the risk or incidence of vessel collisions
- marine debris as a result of derelict fishing gear and other materials
- oil pollution resulting from an oil spill. Oil pollution may decrease the availability of preferred seagrass species and disrupt breeding cycles, increase mortality and/or reduce calving
- extraction of living resources from Indigenous harvest
- invasive species
- sea level rise and changes in ocean temperatures as a result of climate change.

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

Actions have a **high risk** of significant impact on dugongs when there is a real chance or possibility that those actions:

- result in a substantial loss or modification of seagrass habitat
- result in significant changes to water quality that potentially introduce contaminants into important seagrass habitat in dugong foraging areas
- substantially increase the likelihood of vessel collision in biologically important areas.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in (e.g. drilling activities, oil rigs, increased shipping) or affecting important biologically important areas have a **risk** of a significant impact on dugongs.

Actions that have a real chance or possiblity of introducing marine debris within a biologically important area have **a risk** of significant impact on dugongs.

Advice for preparing a referral with respect to impacts on dugongs in the North-west Marine Region

A 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 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 dugongs, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area for dugongs, 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 how 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 dugongs 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 dugong, the particular life history characteristics of the dugong (e.g. low reproductive rate and longevity) and the proportion of the regional population affected. The conservation values report card—dugong (**www.environment.gov.au/marineplans/north-west**) provides information on current pressures on the species within the North-west Marine Region.

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Schedule 2.4 Marine reptiles of the North-west Marine Region

Six marine turtle species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are known to occur in the North-west Marine Region and all are listed as threatened and migratory under the Act. Of the 31 species of true sea snakes in Australian waters (Wilson & Swan 2003), 25 species are found in the waters of, or adjacent to, the North-west Marine Region (Guinea 2007). Of these, the leaf-scaled seasnake (*Aipysurus foliosquama*) and the short-nosed seasnake (*Aipysurus apraefrontalis*) are listed as critically endangered under the EPBC Act and are endemic to the North-west Marine Region.

The following advice relates to the marine turtles listed in Table S2.5 for which there is biologically important area information. Advice is also provided for the two critically engangered species of sea snake listed in Table S2.5 which are found within the North-west Marine Region, but for which there is no biologically important area information at this stage. Please refer to the conservation values report card—marine reptiles (**www.environment.gov.au/marineplans/north-west**) for a complete list of reptiles and additional information.

Table S2.5: Marine reptiles listed as threatened and/or migratory in or adjacent to the North-west Marine Region

Species	Listing status
Flatback turtle (*Natator depressus*)	Vulnerable, migratory, marine
Green turtle (*Chelonia mydas*)	Vulnerable, migratory, marine
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable, migratory, marine
Loggerhead turtle (*Caretta caretta*)	Endangered, migratory, marine
Olive ridley or Pacific ridley (*Lepidochelys olivacea*)	Endangered, migratory, marine
Leaf-scaled seasnake (*Aipysurus foliosquama)*	Critically endangered, marine
Short-nosed seasnake (*Aipysurus apraefrontalis)*	Critically endangered, marine

Key considerations in relation to significant impacts on marine reptiles in the North-west Marine Region

Population status and ecological significance

The **flatback turtle** is listed as vulnerable under the EPBC Act and is a matter of national environmental significance. The total population of flatback turtles in the North-west Marine Region is unknown and data on population trends are unavailable, although it is known that there are two genetically distinct populations—the North West Shelf stock and the western Northern Territory stock.

The **green turtle** is listed as vulnerable under the EPBC Act and is a matter of national environmental significance. In the North-west Marine Region there are three genetically distinct populations: the North West Shelf stock, the Scott Reef stock and the Ashmore stock (Dethmers et al. 2006). The North West Shelf stock is estimated at approximately 20 000 individuals (DSEWPaC 2011). Population estimates are not available for the Ashmore Reef or Scott Reef stocks, although annual breeding numbers are thought to be in the hundreds (Whiting et al. 2000; Woodside 2009).

The **hawksbill turtle** is listed as vulnerable under the EPBC Act and is a matter of national environmental significance. The total population of hawksbill turtles in the North-west Marine Region is unknown. The Western Australian breeding stock is genetically distinct from the northern Great Barrier Reef, Torres Strait and Arnhem Land stocks. The total nesting population is estimated in the thousands—it is the largest in the Indo-Pacific region and one of the largest in the world (DEC 2009).

The **loggerhead turtle** is listed as endangered under the EPBC Act and is a matter of national environmental significance. The population in the North-west Marine Region is part of the western Australian stock, which is genetically distinct from, and larger in size than the eastern Australian stock. The total Western Australian population of loggerhead turtle nesting annually is estimated to be 3000 females (Baldwin et al. 2003). There are no data on the population trends for the western Australian genetic stock.

The **olive ridley turtle** is listed as endangered under the EPBC Act and is a matter of national environmental significance. The total population of olive ridley turtle in the North-west Marine Region is unknown. There is one Australian genetic stock of this species that is centred on rookeries in Queensland and the Northern Territory. Although the olive ridley turtle has been recorded nesting in Western Australia, its numbers are reported to be very low compared to other rookeries in the Northern Territory (Limpus 2004). This species forages in the region as far south as the Dampier Archipelago–Montebello Islands.

The **leaf-scaled seasnake** and **short-nosed seasnake** are listed as critically endangered under the EPBC Act and are matters of national environmental significance. The populations of leaf-scaled seasnake and short-nosed seasnake are unknown. The leaf-scaled seasnake has only been recorded at Ashmore and Hibernia reefs (Guinea & Whiting 2005), indicating it has a very limited distribution. The short-nosed seasnake has a broader distribution, having been recorded from Exmouth Gulf to the reefs of the Sahul Shelf, although most records come from Ashmore and Hibernia reefs.

Leaf-scaled and **short-nosed seasnakes** were regularly recorded from Ashmore Reef in surveys undertaken from 1994 to 1998, but they have been absent from surveys since 2001 despite an increase in survey intensity (Guinea 2006, 2007; Guinea & Whiting 2005). Ashmore Reef was once renowned for its diversity and abundance of sea snake species. However, all sea snake species are now generally rare at Ashmore Reef. The reason for this decline is unknown.

Generally, sea snakes are long lived and slow growing with small broods and high juvenile mortality (Fry et al. 2001). These life history traits make sea snakes vulnerable to human-induced pressures.

For the purposes of determining the significance of impacts of proposed actions on the five marine turtle species and two sea snake species listed above, note that:

- for loggerhead and olive ridley turtle, both listed as endangered, it is known that populations of these species occur in and adjacent to the North-west Marine Region
- for flatback, green and hawksbill turtle, all listed as vulnerable; it is known that populations of these species occur in and adjacent to the North-west Marine Region
- for the purposes of determining the significance of proposed actions on the critically endangered leaf-scaled and short-nosed seasnakes, it is known that populations of these species occur in the North-west Marine Region.

Species distribution and biologically important areas

The **flatback turtle** is endemic to northern Australian waters and two breeding stocks are known to occur in the region. The southern (North West Shelf) stock nests from Exmouth to the Lacepede Islands in summer (commences in late November–December, peaks in January and finishes by February–March). Important rookeries include Thevenard Island, Barrow Island, the Montebello Islands, Varanus Island, the Lowendal Islands, islands of the Dampier Archipelago, coastal areas around Port Hedland, along much of Eighty Mile Beach and inshore islands of the Kimberley region where suitable beaches occur. The northern stock nests at Cape Domett (and adjacent areas in the Northern Territory) year round with a peak in winter (Limpus 2004). Cape Domett and the North West Shelf stocks are two of the largest nesting flatback stocks in the world, with annual abundance of several thousand individuals (Pendoley 2005; Whiting et al. 2008).

Flatback turtles that nest on the Pilbara coast disperse to feeding areas extending from Exmouth Gulf to the Tiwi Islands in the Northern Territory. The species has also been recorded foraging on the carbonate banks of the Joseph Bonaparte Gulf and around the pinnacles of the Bonaparte Basin (DEWHA 2007; Donovan et al. 2008).

Biologically important areas for flatback turtles have been identified for nesting, internesting, mating and foraging areas. These include:

- nesting on beaches to the west of Cape Lambert during summer with an 80 kilometre internesting buffer
- nesting on Intercourse Island during summer with an 80 kilometre internesting buffer
- nesting on Dixon Island during summer with an 80 kilometre internesting buffer
- nesting on Cape Thouin, Mundabullangana, and Cowrie Beach during summer with a 80 kilometre internesting buffer
- nesting on Paradise Beach, Port Hedland during summer with an 80 kilometre internesting buffernesting on Eighty Mile Beach during summer with an 80 kilometre internesting buffer
- nesting at Cape Dommett year round with a peak in winter, with an 80 kilometre internesting buffer foraging in the De Grey River area to Bedout Island
- foraging at islands between Cape Preston and Onslow and inshore of Barrow Island
- mating and nesting on Barrow Island with an 80 kilometre internesting buffer
- foraging, mating and nesting at Montebello Islands during summer with an 80 kilometre internesting buffer
- foraging and mating at Dampier Archipelago (islands to the west of the Burrup Peninsula)
- nesting on the Dampier Archipelago (islands to the west of the Burrup Peninsula) during summer months with an 80 kilometre internesting buffer
- foraging and nesting (summer) on Legendre Island and Huay Island with an 80 kilometre internesting buffer

- foraging and nesting (summer) on Delambre Island with an 80 kilometre internesting buffer
- foraging in the Joseph Bonaparte Depression
- foraging in waters adjacent to James Price Point
- nesting on the Lacepede Islands with an 80 kilometre internesting buffer.

The waters off Western Australia support one of the largest remaining **green turtle** populations in the world, estimated to be in the tens of thousands of adult turtles. Green turtles are the most common marine turtle breeding in the North-west Marine Region. Green turtles breed extensively throughout the region and along the coastal (state) areas adjacent to it (Limpus 2009). The principal rookeries are the Lacepede Islands, some islands of the Dampier Archipelago, Barrow Island and the Montebello Islands, and North West Cape and the Muiron Islands. Smaller rookeries adjacent to the Kimberley region include the Maret Islands, Browse Island, Cassini Island and other islands of the Bonaparte Archipelago, and Sandy Islet at Scott Reef. Ashmore Reef is also a significant breeding area for green turtles, providing critical nesting and internesting habitat (EA 2003), as well as large and significant feeding aggregations of green turtles.

There are three distinct genetic stocks of green turtles in the region: the North West Shelf stock, the Scott Reef stock and the Ashmore stock (Dethmers et al. 2006). On Barrow Island, the green turtle nesting season begins in November, peaks in January–February and ends in April (Pendoley Environmental 2005). This seasonal profile is likely to be similar for other rookeries of the North West Shelf stock. The re-nesting interval for these female green turtles is approximately every five years (Hamann et al. 2002). Green turtles nest at Sandy Islet at South Scott Reef year round; peak nesting occurs during the summer months (Smith et al. 2004). Similarly, nesting occurs at Ashmore Reef and Cartier Island year round with a mid-summer peak (DSEWPaC 2011).

Adults display a high level of philopatry (a tendency to return to a specific area for different parts of their lifecycle) both to their natal nesting areas and to their feeding areas throughout their lives, irrespective of the distance between them. Tagging studies by Limpus et al. (1992) showed that distances between nesting and feeding areas can be 2–2600 kilometres.

Biologically important areas for green turtles have been identified and include the following nesting, internesting and foraging areas:

- nesting on Barrow Island and Middle Island from November to April with a peak in January–February with a 20 kilometre internesting buffer
- foraging inshore areas of Barrow Island
- nesting on Lacepede Islands during summer with a 20 kilometre internesting buffer
- foraging at Montgomery Reef
- nesting on Montebello Islands during summer with a 20 kilometre internesting buffer

- foraging at Montebello Islands
- foraging at Dixon Island
- nesting on Cassini Island with a 20 kilometre internesting buffer
- nesting on North West Cape during summer with a 20 kilometre internesting buffer
- nesting on North and South Muiron islands during summer with a 20 kilometre internesting buffer
- nesting on Ashmore Reef year round with a 20 kilometre internesting buffer
- foraging around Ashmore Reef
- nesting on Cartier Island year round with a 20 kilometre internesting buffer
- nesting on Sandy Islet, Scott Reef during summer with a 20 kilometre internesting buffer
- foraging at Seringapatam Reef and Scott Reef
- foraging in the De Grey River area to Bedout Island
- foraging around the islands between Cape Preston and Onslow and inshore of Barrow Island
- foraging around Dampier Archipelago (islands to the west of the Burrup Peninsula)
- nesting on the Dampier Archipelago (islands to the west of the Burrup Peninsula) during summer with a 20 kilometre internesting buffer
- foraging at Legendre Island and Huay Island
- nesting on Legendre Island and Huay Island during summer with a 20 kilometre internesting buffer
- foraging and nesting (summer peak in January) on Delambre Island with a 20 kilometre internesting buffer
- foraging in the Joseph Bonaparte Gulf
- foraging in waters adjacent to James Price Point.

The **hawksbill turtle** breeds extensively throughout the region and along the adjacent coastal (state) areas. There is a single stock in the region—the Western Australian stock—which is centred on the Dampier Archipelago. It is the largest stock of hawksbills in the Indo-Pacific region (Limpus 2002) and one of the largest in the world. The most significant breeding areas include Rosemary Island within the Dampier Archipelago, Varanus Island in the Lowendal group, and some islands in the Montebello Island group. Hawksbill turtles nest in the region year round with a peak between October and January.

Hawksbill turtles are generally associated with rocky and coral reef habitats, foraging on algae, sponges and soft coral (Pendoley Environmental 2005). Reefs west of Cape Preston and south to Onslow are important feeding grounds for the species (Pendoley 2005). Individuals may migrate up to 2400 kilometres between their nesting and foraging grounds.

Biologically important areas for hawksbill turtles have been identified and include the following nesting, internesting and foraging areas:

- nesting on the Lowendal Island group in spring and early summer (peak October) with a 20 kilometre internesting buffer
- foraging around the Lowendal Island group
- nesting on the Montebello Islands (including Ah Chong and South East islands) in spring and early summer (peak October) with a 20 kilometre internesting buffer
- nesting on Rosemary Island (peak in spring and early summer) with a 20 kilometre internesting buffer
- foraging and nesting on Delambre Island (peak in spring and early summer) with a 20 kilometre internesting buffer
- nesting on Barrow Island (peak October to December) with a 20 kilometre internesting buffer
- foraging around Dixon Island
- foraging in the De Grey River area to Bedout Island
- foraging around the islands between Cape Preston and Onslow and inshore of Barrow Island
- nesting on Barrow Island with a 20 kilometre internesting buffer
- nesting at Varanus Island and Thevenard Island with a 20 kilometre internesting buffer
- nesting on islands of the Dampier Archipelago (to the west of the Burrup Peninsula) (peak October to December) with a 20 kilometre internesting buffer
- foraging around the islands of the Dampier Archipelago (to the west of the Burrup Peninsula)
- nesting on the Ningaloo coast and Jurabi coast with a 20 kilometre internesting buffer
- foraging and nesting on Ashmore Reef with a 20 kilometre internesting buffer
- nesting on Sandy Islet at Scott Reef with a 20 kilometre internesting buffer.

The **loggerhead turtle** is considered to comprise two distinct genetic stocks in Australia —the eastern and western Australian genetic stocks (Dutton et al. 2002). In the North-west Marine Region, loggerhead turtles are widely distributed and forage across a range of habitats including rocky and coral reefs, seagrass pastures and estuaries (Limpus & Chatto 2004). Shark Bay is a critical feeding habitat for loggerhead turtles (EA 2003). The species is known to forage on the carbonate banks of the Joseph Bonaparte Gulf and around the pinnacles of the Bonaparte Depression (DEWHA 2007; Donovan et al. 2008). Loggerhead turtles are migratory and have been known to travel over 2600 kilometres between foraging and nesting areas (Limpus 2008).

Dirk Hartog Island, near Shark Bay, is the principal breeding ground for loggerhead turtles. This location is considered to contain critical nesting and internesting habitats for loggerhead turtles (EA 2003) and may accommodate up to 75 per cent of the Western Australian breeding population (Prince 1994). Loggerhead turtles also breed along the Gnaraloo and Ningaloo coast to North West Cape and the Muiron Islands region in the north; there have also been occasional nesting records from Varanus and Rosemary islands in the Pilbara and as far north as Ashmore Reef. The annual nesting population in the region is thought to be several thousand females (Limpus 2004). In Australia, loggerhead turtles generally breed from November to March with a peak in late December – early January (Limpus 2008).

Biologically important areas for loggerhead turtles have been identified and include the following nesting, internesting, mating and foraging areas:

- nesting on Dirk Hartog Island from December to March with a 20 kilometre internesting buffer
- nesting on Muiron Islands (peak late December – early January) with a 20 kilometre internesting buffer
- nesting along the Ningaloo and Jurabi coasts (peak late December – early January) with a 20 kilometre internesting buffer
- nesting on Montebello Islands (peak late December – early January) with a 20 kilometre internesting buffer
- nesting on Lowendal Island (peak late December – early January) with a 20 kilometre internesting buffer
- nesting on Rosemary Island (peak late December – early January) with a 20 kilometre internesting buffer
- nesting at Gnaraloo Station from November to February with a 20 kilometre internesting buffer
- foraging in the De Grey River area to Bedout Island
- foraging on the Western Joseph Bonaparte Depression
- foraging in the waters adjacent to James Price Point.

There are no major nesting locations for the **olive ridley turtle** in the North-west Marine Region although occasional nesting and hatchlings have been reported (Limpus 2004; NAILSMA 2008). The species has been recorded breeding at low densities on Northern Territory beaches outside the North-west Marine Region.

Olive ridley turtles use the region for foraging and they have been recorded as far south as the Dampier Archipelago–Montebello Islands area, as well as around the pinnacles of the Bonaparte Depression (DEWHA 2007; Donovan et al. 2008). Olive ridley turtles are primarily carnivorous, feeding on gastropod molluscs and small crabs from soft-bottom habitats in depths of 6–35 metres. Olive ridley turtles may also forage in pelagic waters.

Biologically important areas for olive ridley turtles include:

- foraging in the western Joseph Bonaparte Depression and Gulf
- foraging in the Dampier Archipelago (islands to the west of the Burrup Peninsula).

The **leaf-scaled seasnake** is endemic to the North-west Marine Region. Within the region, the species has a highly limited distribution and has only been recorded from Ashmore and Hibernia reefs. At Ashmore Reef, the leaf-scaled seasnake occurs on the reef flat during both high and low tides. It is found in exposed tidal pools during low tide, and has behavioural adaptations that enable it to tolerate the high water temperatures in pools (Guinea & Whiting 2005). The leaf-scaled seasnake forages by searching in fish burrows on the reef flat (Guinea & Whiting 2005).

Biologically important areas have not been identified for this species, although the species has been observed breeding, pupping, foraging and resting at Ashmore and Hibernia reefs (M Guinea, Charles Darwin University, pers. comm., 2010). As Ashmore and Hibernia reefs are the only known locations of this species within the region, it can be assumed that the waters within the boundary of the Ashmore Reef National Nature Reserve and Hibernia Reef are important for this species.

The **short-nosed seasnake** is also endemic to the North-west Marine Region. It has been recorded from Exmouth Gulf to the reefs of the Sahul Shelf, with most records coming from Ashmore and Hibernia reefs. At Ashmore Reef, the species prefers the reef flats or shallow waters along the outer reef edge in depths to 10 metres (Cogger 2000). As for the leaf-scaled seasnake, it can be assumed that the waters within the boundary of the Ashmore Reef National Nature Reserve and Hibernia Reef are important for this species. Behaviours observed at these locations include breeding, pupping and foraging (M Guinea, Charles Darwin University, pers. comm., 2010).

Additional information on the biologically important areas of marine turtles can be found in the Norh-west Conservation Values Atlas.

Nature of the proposed action—marine turtles

The life history attributes of marine turtles (i.e. long lived and slow to mature) mean they are susceptible to anthropogenic pressures and high annual survivorship is required to maintain population viability (Lutz et al. 1997). Marine turtles face pressures in both marine and onshore environments and at all stages in their lifecycle, both in the North-west Marine Region and adjacent waters and other parts of their range. The conservation values report card—marine reptiles provides an overview of the vulnerabilities and pressures on protected marine turtles in the North-west Marine Region.

Pressures *of concern* and *of potential concern* on marine turtles in and adjacent to the North-west Marine Region are as follows:

- Light pollution from onshore activities (e.g. petroleum facilities, ports and urban development) is a pressure *of concern* for flatback, green, hawksbill and loggerhead turtles.
- Marine debris from a range of sources is a pressure *of concern* for all marine turtle species.
- Human presence at sensitive sites (e.g. tourism) and invasive species (e.g. foxes and feral pigs) is a pressure *of concern* for flatback, green and loggerhead turtles.
- Physical habitat modification through dredging is a pressure *of concern* for the flatback turtle and *of potential concern* for green, hawksbill, loggerhead and olive ridley turtles. Dredging associated with port developments and the expansion of the petroleum and minerals industries occurs extensively in the coastal areas adjacent to the region. Dredging may result in direct mortality of turtles or indirect mortality through habitat modification. Physical habitat modification as a result of fishing gear is a pressure *of potential concern* for flatback, loggerhead and olive ridley turtles.
- Noise pollution is a pressure *of potential concern* for all marine turtles. There are limited data on the potential impacts of noise pollution on marine turtles. However, there is widespread industrial development within the region and noise generated through operations such as seismic surveys and construction (e.g. pile-driving, blasting) may adversely impact marine turtles.
- Bycatch as a result of commercial fishing activities is a pressure *of potential concern* for green, flatback, hawksbill and loggerhead turtles.
- Extraction of living resources from Indigenous harvest is a pressure *of potential concern* for flatback, green and hawksbill turtles.
- Nutrient pollution as a result of industrial and coastal development and agricultural activities is a pressure *of potential concern* for green turtles.
- Vessel collision is a pressure *of potential concern* for green, hawksbill and loggerhead turtles. Growing urban and industrial development in the region is leading to an increase in recreational vessels and shipping in areas frequented by marine turtles.
- Increases in sea temperature is *of potential concern* for all species of turtles in the region as it may cause shifts in species distribution that may either increase or decrease species range; alter life history characteristics and reduce prey availability. For species that nest in the region, higher sand temperatures may lead to increasing female bias in the sex ratio of hatchlings.

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

The following actions have a **very high risk** of a significant impact:

- Actions that have a real chance or possibility of increasing lighting at important nesting sites for loggerhead turtles during breeding seasons. Examples of such actions include onshore petroleum processing facilities and ports.
- Actions that have a real chance or possibility of increasing human disturbance at loggerhead turtle nesting sites during breeding seasons or that lead to the introduction of invasive species to loggerhead nesting sites.

The following actions have a **high risk** of a significant impact:

- Actions that have a real chance or possibility of resulting in an increase in lighting at important nesting sites of green, flatback or hawksbill turtles during breeding seasons. Examples of such actions include onshore sources of lighting (e.g. petroleum processing facilities, ports).
- Actions that have a real chance or possibility of increasing human disturbance at flatback or green turtle nesting sites during breeding seasons or that lead to the introduction of invasive species to flatback or green turtle nesting sites.
- Actions, such as dredging, that have a real chance or possibility of modifying, destroying or decreasing the availability of habitat of a population of flatback, green, hawksbill, olive ridley or loggerhead turtle.
- Actions that have a real chance or possibility of changing the water quality of, or introducing contaminants into, biologically important areas for green turtles.
- Actions that have a real chance or possibility of increasing vessel strike in biologically important areas for green, hawksbill and loggerhead turtles.
- Actions that have a real chance or possibility of increasing noise above ambient levels within any of the biologically important areas for green, flatback, hawksbill, loggerhead or olive ridley turtles when those species are present.

Actions that have a real chance or possiblity of introducing marine debris within a biologically important area have **a risk** of significant impact on marine turtles.

Nature of the proposed action—sea snakes

The life history attributes of sea snakes (i.e. long lived, slow growing, and with low fecundity) mean that they are susceptible to anthropogenic pressures. An overview of the vulnerabilities and pressures on sea snakes in the North-west Marine Region is in the conservation values report card—marine reptiles (**www.environment.gov.au/marineplans/north-west**).

Bycatch from commercial fishing is a pressure *of concern* for sea snake species in the North-west Marine Region. Sea snake bycatch has been recorded in trawl and trap fisheries in the region.

Pressures rated as *of potential concern* on sea snakes in and adjacent to the North-west Marine Region include:

- oil pollution as a result of oil spills—sea snakes are vulnerable to oil spills (AMSA 2010; Watson et al. 2009) as they are air breathers and obligate bottom feeders, and in the event of an oil spill, hydrocarbons, residues and any dispersants used to treat oil spills may be inhaled or ingested (Gagnon 2009)
- bycatch from commercial fishing
- physical habitat modification and/or a reduction in water quality as a result of onshore and offshore construction activities
- changes in sea temperature and ocean acidification as a result of climate change.

People planning to undertake actions in Ashmore Reef or Hibernia Reef should carefully consider the potential for their action to have a significant impact on sea snakes. For actions proposed outside these areas and that do not have a real chance or possibility of affecting waters within the marine reserve or Hibernia Reef, the risk of significant impact on leaf-scaled seasnakes and short-nosed seasnakes is likely to be lower.

Actions that have a real chance or possibility of resulting in water quality changes and/or modification or loss of habitat at Ashmore Reef or Hibernia Reef through the release of sediments or contaminants have a **high risk** of a significant impact on leaf-scaled and short-nosed seasnakes.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising in (e.g. drilling activities, oil rigs, increased shipping) Ashmore Reef and/or Hibernia Reef have a **risk** of a significant impact on leaf-scaled and short-nosed seasnakes.

Advice for preparing a referral with respect to impacts on marine turtles and the leaf-scaled and short-nosed seasnakes in the North-west Marine Region

A 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 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 marine turtles and leaf-scaled and short-nosed seasnakes, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area for flatback, green, hawksbill, loggerhead or olive ridley turtles, 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 marine turtles and leaf-scaled and short-nosed seasnakes 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 marine turtles and leaf-scaled and short-nosed seasnakes and the particular life history characteristics of the species (e.g. long lived, slow to mature). The conservation values report card—marine reptiles provides information on current pressures on these species within the North-west Marine Region.

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Schedule 2.5 Seabirds and migratory shorebirds of the North-west Marine Region

Forty-one seabird species listed under the EPBC Act are known to occur within the North-west Marine Region. Of these, the region is considered to be particularly important for nine species (Table S2.6) as substantial proportions of their populations use the region and adjacent waters for breeding, foraging and other life history phases.

Thirty seven species of shorebird listed as migratory under the EPBC Act occur regularly in Australia and 30 of these have been recorded in the North-west Marine Region at Ashmore Reef. These species migrate within the East Asian–Australasian Flyway (the Flyway). Of the 30 migratory shorebird species recorded at Ashmore Reef, thirteen are known to occur there in significant numbers. Ashmore Reef is considered a site of international and national importance for migratory shorebirds. Internationally significant sites are those considered to support at least 1 per cent of the estimated Flyway population of a species (i.e. internationally significant numbers) and/or areas where 20 000 or more shorebirds have been recorded (Ramsar Convention Bureau 2000, Bamford et al. 2008). Nationally important sites for migratory shorebirds are defined as those that support at least 0.1 per cent of the Flyway population of a species (i.e. nationally significant numbers), 2000 birds, or 15 species (DEWHA 2009a).

Table S2.6: Seabird and shorebird species listed as threatened and/or migratory within the North-west Marine Region and for which biologically important area information is available.

Species	Listing status
Seabirds	
Brown booby (*Sula leucogaster*)	Migratory, marine
Red-footed booby (*Sula sula*)	Migratory, marine
Great frigatebird (*Fregata minor*)	Migratory, marine
Lesser frigatebird (*Fregata ariel*)	Migratory, marine
Wedge-tailed shearwater (*Ardenna Pacifica* formerly known as *Puffinus pacificus*)	Migratory, marine
Fairy tern (Australian) (*Sternula nereis nereis* formerly known as *Sterna nereis*)	Vulnerable, marine
Little tern (*Sternula albifrons sinensis* formerly known as *Sterna albifrons*)	Migratory, marine
Roseate tern (*Sterna dougallii*)	Migratory, marine

Species	Listing status
White-tailed tropicbird (Indian Ocean) (*Phaethon lepturus lepturus*)	Migratory, marine
Shorebirds	
Present In internationally significant numbers	
Bar-tailed godwit (*Limosa lapponica)*	Migratory, marine
Common greenshank (*Tringa nebularia*)	Migratory, marine
Greater sand plover (*Charadrius leschenaultii leschenaultii*)	Migratory, marine
Grey plover (*Pluvialis sauatarola*)	Migratory, marine
Grey-tailed tattler (*Heteroscelus brevipes*)	Migratory, marine
Ruddy turnstone (*Arenaria interpres interpres*)	Migratory, marine
Sanderling	Migratory, marine
Present in nationally significant numbers	
Great knot	Migratory, marine
Pacific golden plover	Migratory, marine
Curlew sandpiper	Migratory, marine
Terek sandpiper	Migratory, marine
Red-necked stint	Migratory, marine
Whimbrel	Migratory, marine

The following advice only relates to those species listed in Table S2.6. Please refer to the conservation values report card—seabirds and migratory shorebirds for a complete list of these species and additional information (**www.environment.gov.au/marineplans/north-west**).

No specific advice is provided for birds that fly over but do not breed or feed within the Commonwealth marine area of the North-west Marine Region. A complete list of birds that are known to overfly the North-west Marine Region is provided in the conservation values report card—seabirds and migratory shorebirds.

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

Key considerations in relation to significant impacts on nine species of seabird and thirteen species of migratory shorebirds in the North-west Marine Region

Population status and ecological significance—seabirds

Each of the nine species of seabirds listed in Table S2.6 has a substantial proportion of its Australian breeding population nesting in coastal areas or islands in or adjacent to the North-west Marine Region. All rely on the waters of the North-west Marine Region for important parts of their lifecycle.

The **brown booby** is the most abundant species of the Sulidae family and inhabits all tropical oceans. In 1996–97, the total breeding population of the brown booby in the Australian region was estimated to be 59 940–73 900 birds (WBM Oceanics & Claridge 1997). The breeding season varies, with egg-laying recorded throughout the year in many locations (Marchant & Higgins 1990). The colonies at Ashmore Reef and Adele Island tend to have peak breeding periods from May to July (Burbidge et al. 1987; Johnstone & Storr 1998; Mustoe & Edmunds 2008). Birds may be present during the non-breeding season.

Within the North-west Marine Region there are large colonies on offshore islands, including Ashmore Reef. In the Kimberley region, the brown booby breeds on a number of islands including Lacapedes (one of the largest colonies in the world of around 17 000 nests), Adele, Bedout and White islands (Mustoe & Edmunds 2008).

The brown booby is a specialised plunge diver and often forages closer to land than other booby species (Marchant & Higgins 1990). A study of the marine distribution of Christmas Island seabirds found that the brown booby foraged within 250 kilometres of the island (Dunlop et al. 2001). It feeds on a large range of fish species and some cephalopods.

The **red-footed booby** is an abundant species generally only found in tropical waters. In Australia, the species has been recorded in many tropical areas including within the North-west Marine Region, on the Great Barrier Reef, on Coral Sea islands and islands off Cape York. The species lays eggs mainly from April to June.

Within the region, the species has been recorded on Adele Island (approximately 17 breeding pairs) and Ashmore Reef (approximately 1380–4990 breeding pairs) (Ross et al. 1996). It is a plunge diver, usually feeding in groups. It mostly feeds on fish (especially flying fish) and cephalopods (Marchant & Higgins 1990).

The **great frigatebird** is widespread and breeds on numerous tropical islands (Nelson 2005) including Adele Island (2–300 pairs) and Ashmore Reef (small numbers). Breeding mostly occurs between March and November. The species is pelagic, although breeding birds probably forage within 100–200 kilometres of the colony during the early stages of the breeding season (Nelson 2005).

The **lesser frigatebird** is usually observed in tropical or warmer waters around the coast of northern Western Australia, the Northern Territory, Queensland and northern New South Wales. It remains further out to sea during the day and in the inshore waters during rough weather or in the late evening (Chatto 2001). Within or adjacent to the North-west Marine Region it is known to breed on Ashmore Reef and Adele, Bedout, West Lacapede and Cartier islands (Marchant & Higgins 1990; Mustoe & Edmunds 2008). It breeds from March through to September and may also be present during the non-breeding season.

It feeds on fish and sometimes on cephalopods, and all food is taken while the bird is in flight (Marchant & Higgins 1990). It forages by scooping up marine organisms from the surface of the water, or taking flying fish from just above the surface (Marchant & Higgins 1990). The lesser frigatebird generally forages close to breeding colonies (Jaquemet et al. 2005).

The **wedge-tailed shearwater** is widely distributed in the tropical Pacific and Indian oceans and has an estimated total population of five million (Brooke 2004). It is a common breeding and non-breeding visitor to the North-west Marine Region (Marchant & Higgins 1990). Breeding birds arrive in mid-August and depart the Pilbara in April and Shark Bay in mid-May.

Breeding locations within or adjacent to the region include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, the Lowendal Islands, islands off Barrow Island (Mushroom, Double and Boodie islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron, and Locker islands), islands in Freycinet Estuary and islands in south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin islands) (Marchant & Higgins 1990).

Wedge-tailed shearwaters forage by contact-dipping, dipping, surface-seizing and subsurface pursuit mainly in offshore and pelagic waters (Burger 2001; Nicholson 2002). They feed on fish, squid and crustaceans and have been recorded diving to depths of 66 metres, although most dives are to depths of less than 20 metres (Burger 2001). They are partially dependent on predatory fish, particularly tuna, to herd prey to the ocean’s surface. Off Western Australia, large flocks have been observed feeding in association with tuna (Marchant & Higgins 1990).

The **fairy tern (Australian)** occurs on the coasts of New South Wales (Dunn & Harris 2009), Victoria, Tasmania, South Australia and on the Western Australia coast as far north as the Dampier Archipelago (Blakers et al. 1984; Higgins & Davies 1996). The total Australian population is estimated at less than 3000 breeding pairs (Garnett et al. 2011). The largest population of 1800–3200 mature birds is found in and adjacent to the region (Garnett et al. 2011). It breeds on the north-west coast, in Shark Bay, and also on the shores of Lake McLeod, north of Carnarvon, and at Low Point. The fairy tern mostly breeds from July to September and may be present during the non-breeding season.

The fairy tern forages in inshore waters, around island archipelagos and on the mainland. It feeds almost entirely on fish (Higgins & Davies 1996). It catches fish by plunging into water and has been observed diving from heights of up to 5 metres (Birds Australia 2011).

The **little tern** is widespread in Australia, with breeding sites widely distributed from north-western Western Australia, around the northern and eastern Australian coasts to south-eastern Australia and Tasmania (Higgins & Davies 1996).

In areas adjacent to the North-west Marine Region, the species breeds in small numbers on the islands of north and west Kimberley, on the Dampier Peninsula and along Eighty Mile Beach. Breeding commences in the autumn months (Mustoe & Edmunds 2008). The little tern usually forages close to breeding colonies in the shallow water of estuaries, coastal lagoons and reefs (Higgins & Davies 1996). It mainly feeds on small fish but also on crustaceans, insects, annelids and molluscs (Higgins & Davies 1996).

The **roseate tern** is found in Australia's northern waters around offshore coral and continental islands and only near the mainland if associated with inshore breeding islands (Higgins & Davies 1996). Northern populations of roseate terns breed in summer and winter on offshore islands, cays and banks, mainly of sand, coral or rocks (Higgins & Davies 1996). All populations move away from breeding areas when not breeding (Higgins & Davies 1996).

Breeding populations have been recorded at Ashmore Reef, Napier Broome Bay, Bonaparte Archipelago, Lacepede Island, Bedout Island, Dampier Archipelago, the Lowendal Islands, Frazer Island, Koks Island, Mary Anne Island and Meade Island. North-east and North-west Twin Islets, near the entrance of King Sound, are the major breeding areas in the Kimberley, as well as Low Rocks and Stern Island in Admiralty Gulf (Mustoe & Edmunds 2008). The species has been observed feeding around the mouth of King Sound (G Swann, Kimberley Birdwatching, pers. comm., cited in Mustoe & Edmunds 2008), and this area may be a locally important foraging habitat for this species.

The roseate tern's diet consists predominantly of small pelagic fish although it will also take insects and marine invertebrates such as crustaceans (del Hoyo et al. 1996 in IUCN 2010; Urban et al. 1986).

In the eastern Indian Ocean, the **white-tailed tropicbird** mainly occurs on Christmas Island where about 20 000 pairs are known to breed (Garnett & Crowley 2000). Within the region, a small population nests on Bedwell Island (on Clerke Reef at the Rowley Shoals) with fewer than 20 pairs breeding on Ashmore Reef (RE Johnstone, pers. comm 2009, Watson et al. 2009). Breeding has been recorded from May through to October, with birds dispersing away from the breeding colonies outside the breeding season.

Tropicbirds are predominantly pelagic species, rarely coming to shore except to breed. The white-tailed tropicbird forages in warm waters and over long distances, moving up to 1500 kilometres from breeding sites. It feeds on fish and cephalopods by plunge-diving (Marchant & Higgins 1990).

Population status and ecological significance—migratory shorebirds

The migratory shorebirds listed in Table S2.6 have internationally and nationally significant proportions of their populations occurring in the North-west Marine Region at Ashmore Reef. They utilise the area for feeding, foraging, to rest and restore energy reserves. The adjacent Cartier island may also be important for these species given similarities between it and Ashmore Reef. However, due to insufficient surveying, the significance of Cartier Island to these species has not been established.

Present in internationally significant numbers

Bar-tailed godwits are large shorebirds with very long up-turned bills. Two sub-species are recognised and both occur within Australia, but only *L. lapponica menzbieri* occurs within the North-west Marine Region (Bamford et al. 2008). Bar-tailed godwits are primarily found on inter-tidal mudflats and rarely far from the coast when they reach the Australian mainland; they have been reported from much of Australia's coast feeding in shallow water and exposed mudflats. Bar-tailed godwits are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef with a recent count of 4560 representing more than 1 per cent of the Flyway population recorded on Ashmore Reef (Bamford et al. 2008; Clarke 2010).

Common greenshanks are present in the North-west Marine Region in internationally significant numbers, with a recent count of 590 representing approximately 1 per cent of the Flyway population recorded from Ashmore Reef (Clarke 2010). It is believed that different migratory routes are used for the southward (into Australia) and northward (return to breeding sites) migrations. Current population estimates for the Flyway are considered conservative given the species' low densities and their widespread distribution in Australia (Bamford et al. 2008).

Greater sand plovers are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef with a recent count of 2559 recorded on Ashmore Reef representing more than 2 per cent of the East Asian–Australasian Flyway population (Bamford et al. 2008; Clarke 2010).

Grey plovers, are medium-sized migratory shorebirds that breed in Alaska and the northern Siberian tundra and migrate at the start of the Southern Hemisphere summer to many coastal areas of Australia, including Ashmore Reef. They are typically found on intertidal sand-flats and feed on polychaetes and crustaceans. It is believed that most grey plovers in Australia are females, due to the differential migration between males and females (Geering et al. 2007). Grey plovers are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef with a recent count of 1511 recorded on Ashmore Reef representing more than 1 per cent of the Flyway population (Bamford et al. 2008; Clarke 2010).

Grey-tailed tattler The global population of grey-tailed tattlers is confined to the East Asian–Australasian Flyway, and more than 90 per cent of the global population is present in Australia during the non-breeding period (Bamford et al. 2008). Grey-tailed tattlers are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef, with a recent count of 1790 on Ashmore Reef representing between 3 and 4 per cent of the Flyway population recorded (Bamford et al. 2008; Clarke 2010).

Ruddy turnstones are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef, with a recent count of 1708 representing almost 5 per cent of the Flyway population recorded on Ashmore Reef (Bamford et al. 2008, Clarke 2010). These species may occur at Ashmore Reef on their southern and northern migration.

Sanderling are among the smallest species of migratory shorebirds found in the North-west Marine Region. They are present in the North-west Marine Region in internationally significant numbers at Ashmore Reef, with a recent count of 1132 representing more than 5 per cent of the flyway population recorded on Ashmore Reef (Bamford et al. 2008, Clarke 2010).

Present in nationally significant numbers

The global population of **great knots** is confined to the East Asian–Australasian Flyway, and approximately 95 per cent of the global population is present in Australia during the non-breeding period. Great knots are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 1592 at Ashmore Reef representing approximately 0.4 per cent of the Flyway population (Bamford et al. 2008, Clarke 2010).

Pacific golden plovers are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 746 at Ashmore Reef representing approximately 0.8 per cent of the Flyway population (Bamford et al. 2008, Clarke 2010).

Approximately 13 per cent of the global population of **curlew sandpipers** are present within the East Asian–Australasian Flyway, and the majority of these are present in Australia during the non-breeding period. The population of curlew sandpipers appears to have decreased significantly since the 1980s, with decreases in excess of 80 per cent recorded at some sites. It is believed that there are differences between the northward and southward migration routes, and northern Australia is important for curlew sandpipers on their entry to Australia. Curlew sandpipers are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 850 at Ashmore Reef representing approximately 0.5 per cent of the Flyway population (Bamford et al. 2008, Clarke 2010).

Terek sandpipers are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 536 at Ashmore Reef representing approximately 0.4 per cent of the Flyway population (Bamford et al. 2008; Clarke 2010).

The northwest of Australia is an important area for the **Red-necked stints** on their southward migration, and birds fly from the northwest to the southeast of Australia. Red-necked stints are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 1530 at Ashmore Reef representing approximately 0.5 per cent of the Flyway population (Bamford et al. 2008; Clarke 2010).

Whimbrels are widely distributed globally and there are six subspecies recognised, of which only one, *Numenius phaeopus variegatus* occurs within the East Asian–Australasian Flyway and in Australia. Whimbrels appear to migrate southward into Australia via northern Australia. Whimbrels are present in the North-west Marine Region in nationally significant numbers at Ashmore Reef, with a recent count of 536 representing approximately 0.5 per cent of the Flyway population recorded on Ashmore Reef (Bamford et al. 2008; Clarke 2010).

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

- fairy tern populations in the North-west Marine Region should be considered important populations
- brown booby, red-footed booby, great frigatebird, lesser frigatebird, wedge-tailed shearwater, little tern, roseate tern and white-tailed tropicbird in the North-west Marine Region should be considered ecologically significant proportions of these species' populations[24].

For the purpose of determining the significance of impacts of proposed actions on the thirteen migratory shorebird species listed above, note that

- all species occurring in the North-west Marine Region should be considered ecologically significant proportions of these species' populations.

Species distribution and biologically important areas—seabirds

Of the nine species of seabirds, six can be found breeding or foraging across most of the region. Their breeding seasons and habits are summarised in Table S2.7. The occurrence of the brown booby and lesser frigatebird is concentrated in the north of the region from Karratha to the Northern Territory border. The occurrence of the red-footed booby and great frigatebird in the region is more limited, with breeding only occurring on Browse Island and Ashmore Reef and foraging in the waters surrounding these breeding colonies.

24 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. In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, such as fairy tern (Australian), consideration should be given to whether an important population may be impacted; for listed migratory species, consideration should be given to whether an ecologically significant proportion of a population may be impacted.

Table S2.7: Seabird species breeding season and habits

Species	Breeding season and habits
Seabirds	
Brown booby (*Sula leucogaster*)	Breeding recorded from February to October (but mainly in autumn). Population may disperse in non-breeding season (northwards dispersal recorded for east Australian birds).
Red-footed booby (*Sula sula*)	Breeds year round, with most egg-laying between April and June. Population may disperse after breeding, but migration and dispersal areas unknown.
Great frigatebird (*Fregata minor*)	Breeding recorded from March to November. Population may disperse in non-breeding season, with some large movements recorded outside its normal range.
Lesser frigatebird (*Fregata ariel*)	Egg-laying from March to September. Birds may disperse in non-breeding season, with some large movements recorded.
Wedge-tailed shearwater (*Ardenna pacifica* formerly known as *Puffinus pacificus*)	Breeding birds arrive at colonies in mid-August and leave during April in Pilbara and mid-May in Shark Bay. Population migrates north of equator in non-breeding season.
Fairy tern (Australian) (*Sternula nereis nereis* formerly known as *Sterna nereis*)	Breeding from July to late September. Population disperses in non-breeding season.
Little tern (*Sternula albifrons sinensis* formerly known as *Sterna albifrons*)	Breeding December through March. Population migrates or disperses during non-breeding season.
Roseate tern (*Sterna dougallii*)	Breeding from mid-March to July. Population migrates or disperses in non-breeding season.
White-tailed tropicbird (Indian Ocean) (*Phaethon lepturus lepturus*)	Breeding recorded in May through to October. Population apparently disperses widely in non-breeding season.

Biologically important areas for seabirds include:

- breeding areas (that encompasses breeding sites and areas where the species is likely to forage)
- resting areas.

Further information on these areas is found in the North-west Conservation Values Atlas (**www.environment.gov.au/cva**) and in the conservation values report card—seabirds and migratory shorebirds.

People planning to undertake actions in biologically important areas for seabirds when the species are known to be present should carefully consider the potential for their action to have a significant impact on these species. For actions proposed outside biologically important areas for seabirds, the risk of significant impact on the species is likely to be lower.

Seabirds generally disperse or migrate outside their breeding season. Actions undertaken within the biologically important areas for seabird species outside of their breeding season may have a **lower risk** of significant impact on these species. This might not apply to actions that involve ongoing effects (e.g. permanent installation of lights, loss of breeding habitat), or where large non-breeding aggregations occur. As changes have been observed in breeding times in response to climate-related changes, surveys of breeding colonies can assist with verifying the presence of nesting birds.

Species distribution and biologically important areas—migratory shorebirds

Of the thirteen migratory shorebird species, all can be found foraging, feeding and roosting at Ashmore Reef. Species have also been recorded at neighbouring Cartier Island, however population numbers and habits have not been established. Migratory shorebirds migrate each year during the Northern Hemisphere summer and autumn to Australia, where they spend up to six months before returning north in March and April. At Ashmore Reef, numbers of shorebirds are highest between October and April, though large numbers of shorebirds are present year round as many species 'over winter' in their first years of life (Clarke 2010).

Ashmore Reef National Nature Reserve has been identified as a biologically important area for migratory shorebirds in the North-west Marine Region.

People planning to undertake actions within the boundaries of Ashmore Reef National Nature Reserve when migratory shorebirds are known to be present should carefully consider the potential for their action to have a significant impact on these species. For actions proposed outside the boundaries of Ashmore Reef National Nature Reserve, the risk of significant impact on the species is likely to be lower.

This might not apply to actions that involve ongoing effects (e.g. permanent installation of light emitting infrastructure).

Nature of the proposed action—seabirds

The conservation values report card—seabirds and migratory shorebirds provides an overview of the pressures on protected seabirds and migratory shorebirds in the North-west Marine Region, and a summary of their vulnerability. Anthropogenic activities in coastal environments and offshore areas have the potential to impact on seabirds and migratory shorebirds.

Pressures *of potential concern* on seabirds in the region are:

- human presence at sensitive sites—disturbance of colonies during the breeding season and modification of nesting habitat may affect the reproduction of some populations; some seabird species are likely to abandon their nesting sites if disturbed; ground-nesting species in particular, such as **fairy, little and roseate terns**, are susceptible to human disturbance during the breeding season
- invasive species—pest species, such as foxes, cats and rats, can substantially reduce the reproductive success of ground-nesting seabirds
- light pollution, particularly for species such as the **wedge-tailed shearwater** that have nocturnal habits
- oil pollution, particularly for those species that feed by diving or plunging into the water, including the **brown** and **red-footed booby, wedge-tailed shearwater**, **tern** species and the **white-tailed tropicbird**
- climate change (changes in sea temperature, sea level rise and ocean acidification).

The following actions have a **high risk** of a significant impact on the nine seabird species:

- Actions that have a real chance or possibility of increasing lighting and flaring at, and around, breeding areas. Both onshore (e.g. petroleum and mining facilities) and offshore (e.g. vessels, floating petroleum production facilities, oil rigs) activities may be sources of this increased lighting.
- Actions that have a real chance or possibility of increasing human disturbance at breeding colonies or of increasing substantially the incidence of nuisance or introduced species.

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) within or affecting biologically important areas have a **risk** of a significant impact on the nine seabird species listed in Table S2.6.

Nature of the proposed action—migratory shorebirds

Pressures *of potential concern* on migratory shorebirds in the region are:

- climate change (changes in sea temperature, sea level rise, ocean acidification and physical habitat modification from increasing storm intensity and frequency)
- light pollution (onshore and offshore infrastructure)
- oil pollution
- invasive species
- human presence at sensitive sites—disturbance of important areas can impact on birds' feeding activities or cause disturbance to roosting birds, and deplete energy reserves otherwise to be used for migration.

The following actions have a **high risk** of a significant impact on the 13 migratory shorebird species:

- Actions which have a real chance or possibility of increasing lighting and flaring such that migration, foraging or roosting behaviours are seriously disrupted. Both onshore (e.g. petroleum and mining facilities) and offshore (e.g. vessels, floating petroleum production facilities, oil rigs) activities may be sources of this increased lighting.
- Actions that have a real chance or possibility of increasing human disturbance at foraging and/or roosting sites or of increasing substantially the incidence of nuisance or introduced species.

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) within or affecting biologically important areas have a **risk** of a significant impact on the thirteen migratory shorebird species listed in Table S2.7.

Advice for preparing a referral with respect to impacts on nine species of seabirds and thirteen species of migratory shorebirds in the North-west Marine Region

A 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 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 nine species of seabirds and thirteen species of migratory shorebirds considered here, consideration of the following matters is recommended:

- If a proposed action is within a biologically important area classified as a breeding and/or foraging and/or resting area, information about: alternative locations for the proposed action outside the area, 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 significant impacts will be mitigated, considering the advice provided above on likely significant impacts to seabirds and migratory shorebirds. 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 migratory shorebirds and the particular life history characteristics of the species. The conservation values report card—seabirds and migratory shorebirds provides information on the current understanding of the range of pressures on seabirds and migratory shorebirds addressed in this regional advice.

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Schedule 2.6 Sharks and sawfishes of the North-west Marine Region

The North-west Marine Region has a rich shark and sawfish fauna (cartilaginous fish) owing to the diversity of marine environments found within and adjacent to it. Of the approximately 500 shark and sawfish species found worldwide, 94 are found in the region—19 per cent of the world's shark species (DEWHA 2008).

Six species of sharks and sawfishes listed under the EPBC Act are known to occur in the North-west Marine Region:

- green sawfish (*Pristis zijsron*)
- grey nurse shark (west coast population) (*Carcharias taurus*)
- longfin mako shark (*Isurus paucus*)
- shortfin mako shark (*Isurus oxyrinchus*)
- whale shark (*Rhincodon typus*)
- white shark (*Carcharodon carcharias*).

One other species of listed sharks and sawfishes may occur infrequently in the region:

- freshwater sawfish (*Pristis microdon*).

Biologically important areas have been identified for three of these species: whale shark, green sawfish and freshwater sawfish (Table S2.8) and the following advice in this schedule relates to these species. Please refer to the conservation values report card–sharks and sawfishes, for a complete list of sharks and sawfishes additional information (**www.environment.gov.au/marineplans/north-west**).

Table S2.8: Sharks and sawfishes listed as threatened and/or migratory with biologically important areas identified within the North-west Marine Region

Species	Listing status
Whale shark (*Rhincodon typus*)	Vulnerable, migratory. Listed under CITES (Appendix II) and CMS (Appendix II).
Green sawfish (*Pristis zijsron*)	Vulnerable. Listed under CITES (Appendix I).
Freshwater sawfish (*Pristis microdon*)	Vulnerable. Listed under CITES (Appendix II).

Key considerations in relation to significant impacts on listed sharks and sawfishes in the North-west Marine Region

Population status and ecological significance

Biologically, sharks and sawfishes are characterised by their 'limited' life history (late age at maturity, slow growth rate, low fecundity, longevity, low rate of natural mortality), which results in restricted productivity. Subsequently, they have a limited capacity to withstand human-induced pressures and to recover from population depletion as a result of these pressures.

Sawfishes are large, top-level predators, occupying a high trophic level in their environment, while the whale shark is one of only a few planktivorous sharks. All these species are viviparous, giving birth to well-developed live young, but there are many gaps in our knowledge of population dynamics, particularly for the sawfishes. This precludes assessments of the species' productivity and hence resilience to depletion.

The whale shark is listed as vulnerable and migratory under the EPBC Act and is a matter of national environmental significance. Ningaloo Marine Park is one of the few places in the world where whale sharks are known to aggregate regularly. The seasonal aggregation of whale sharks at Ningaloo Reef has been estimated at 300–500 individuals although the status of the population in the North-west Marine Region is unknown.

Green and **freshwater sawfish** are listed as vulnerable under the EPBC Act and are matters of national environmental significance. There is limited information available on the population status of the two species in the North-west Marine Region. Although population estimates are unknown, assemblages have greatly declined throughout their documented range, including on the east coast of Australia (Pogonoski et al. 2002; Stevens et al. 2000). Northern and north-west Australia appears to be one of the last regions with viable populations (Pogonoski et al. 2002).

Studies on freshwater sawfish in Australia indicate that there are genetic differences between assemblages found in the Gulf of Carpentaria and the west coast and that there is negligible maternal gene flow between these two regions (Phillips et al. 2008). The reduction or loss of a population in one area may not be offset by immigration from another location. Further, given the suggested male dispersal pattern, population reductions in one area may also result in reductions in other areas.

For the purposes of determining the significance of impacts of proposed actions on whale shark, green and freshwater sawfish species it should be assumed that the North-west Marine Region contains important populations of these species.[25]

Species distribution and biologically important areas

The **whale shark** has a widespread distribution in tropical and warm temperate seas, both oceanic and coastal (Last & Stevens 2009). It is widely distributed in Australian waters, most commonly at Ningaloo Marine Park which is the main known aggregation site of whale sharks in Australian waters. It is also found to a lesser extent at Christmas Island and in the Coral Sea. The species is generally encountered close to or at the surface, as single individuals or occasionally in schools or aggregations of up to hundreds of sharks. Whale sharks also dive to great depths (at least 980 metres; Wilson et al. 2006). Whale sharks are migratory and undergo seasonal movements that have been associated with productivity pulses, ocean circulation and water temperatures, and they regularly appear where seasonal food pulses are known to occur. The North-west Marine Region supports seasonal aggregations of the species, particularly around Ningaloo Reef, where the species aggregates between March and July each year to feed on krill and baitfish associated with mass coral spawning (Wilson et al. 2006). The North-west Marine Region is therefore important to whale sharks for foraging. Satellite tracking of whale sharks from around Ningaloo Reef have been shown to move in a northerly, north-easterly or north-westerly direction towards or into Indonesian waters (Sleeman et al. 2010; Wilson et al. 2006).

There appears to be spatial and seasonal segregation of whale shark populations according to size and sex, and coastal aggregations, such as that at Ningaloo Reef, contain a high frequency of immature males (Meekan et al. 2006). Whale shark aggregations around Ningaloo Reef are generally greatest during La Niña years and are associated with the intensification of the Leeuwin Current in March (DEWHA 2008).

It is unknown when and where whale sharks breed. Biologically important areas for whale shark in the North-west Marine Region are therefore related to key foraging areas and include:

- foraging (high density) in Ningaloo Marine Park and adjacent Commonwealth waters, particularly in depths of 60–100 metres (March–July)
- foraging northward from Ningaloo Marine Park along the 200-metre isobath (July–November).

25 Definitions of 'important 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. In accordance with Policy Statement 1.1, for threatened species listed as vulnerable, consideration should be given to whether an important population may be impacted.

The **green sawfish** is wide ranging in the Indo-west Pacific. Important areas for green sawfish adjacent to the North-west Marine Region include Cape Keraudren (Stevens et al. 2008; Thorburn et al. 2003, 2007, 2008). Green sawfish have been recorded predominantly in inshore coastal areas, including estuaries and river mouths with a soft substrate. Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced (Stevens et al. 2008). However, there have also been records offshore in depths up to 70 metres (Stevens et al. 2005). This species does not penetrate into freshwater habitats.

Biologically important areas for green sawfish are related to foraging, pupping and nursing of young. These areas are considered important year round (unless otherwise specified):

- pupping, nursing and foraging in Cape Keraudren (pupping occurs in summer in a narrow area adjacent to shoreline)
- pupping in Willie Creek
- foraging and pupping in Roebuck Bay
- foraging and pupping in Cape Leveque
- pupping and nursing in waters adjacent to Eighty Mile Beach
- foraging and pupping (likely) in Camden Sound.

The **freshwater sawfish** also occurs in the North-west Marine Region and adjacent waters. Freshwater sawfish occur in Indo-west Pacific waters, however, given considerable declines in the global (and Australian range) of sawfishes, northern and north-west Australia may contain the last significant populations of this sawfish.

The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated waterholes), estuaries and marine environments (Stevens et al. 2005). The species appears to have an ontogenetic shift in habitat use—neonates and juveniles primarily occur in the freshwater reaches of rivers and in estuaries while most adult animals have been recorded in marine and estuarine environments (Peverell 2005; Thorburn et al. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas. Riverine reaches can fragment into a series of pools in the dry season, reducing the available habitat (Stevens et al. 2005).

Biologically important areas for freshwater sawfish are related to foraging, pupping and nursing of young, and to areas frequented by juveniles. These areas are considered important year round (unless otherwise specified):

- foraging and pupping (January to May) in the mouth of the Fitzroy River—this area may act as connecting habitat between the marine and freshwater environments
- foraging and nursing in the Fitzroy River main channel, Snake Creek, and the Margaret and Diamond River gorges
- foraging and nursing (likely) in King Sound
- foraging, pupping (January–May) and nursing in Roebuck Bay
- foraging and pupping (likely) in waters adjacent to Eighty Mile Beach.

Nature of the proposed action

Sharks and **sawfishes** have life history traits which make them particularly vulnerable to anthropogenic pressures. These species are generally late to mature, have slow growth rates, low fecundity and are long lived, which results in restricted productivity. They therefore have a limited capacity to recover from population depletion. Pressures *of potential concern* on whale shark, green sawfish and freshwater sawfish in and adjacent to the North-west Marine Region include:

- extraction of living resources as a result of international commercial fishing (for whale shark)
- changes to hydrological regimes (e.g. installation of weirs), which may restrict species movement and limit the availability of suitable habitat for green and freshwater sawfish
- bycatch as a result of commercial and recreational fishing and marine debris—the saw-like rostrum of sawfish makes these species extremely susceptible to capture in fishing gear and entanglement in marine debris
- changes in sea temperature and sea level rise as a result of climate change.

People planning to undertake actions in biologically important areas for whale shark and sawfishes when the species are present should carefully consider the potential for their action to have a significant impact on these species. For actions proposed outside the biologically important areas, the risk of significant impact on the species is likely to be lower.

Actions which have a real chance or possibility of changing hydrological regimes in tidal creeks and bays within biologically important areas of green and freshwater sawfish have a **high risk** of significant impact on the green and freshwater sawfish.

Actions that have a real chance or possiblity of introducing marine debris within a biologically important area have **a risk** of significant impact on green and freshwater sawfish.

Given the lack of survey effort in the region and the status of sawfish populations throughout their range, actions that result in changes to hydrological regimes in tidal creeks and bays where the species may occur outside biologically important areas have **a risk** of significant impact on green and freshwater sawfish.

Advice for preparing a referral with respect to impacts on whale shark, green sawfish and freshwater sawfish in the North-west Marine Region

A 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 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 green sawfish, whale shark or freshwater sawfish, consideration of the following matters is recommended:

- If the action is proposed within a biologically important area for these species, 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 these species 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 these species and their particular life history characteristics (e.g. low reproductive rate, longevity). The conservation values report card—sharks and sawfishes provides information on current pressures on the species within the North-west Marine Region.

Additional information on the biologically important areas of sharks and sawfish can be found in the North-west Conservation Values Atlas.

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Table A: Listed marine and cetacean species known to occur in the North-west Marine Region[26]

Species (common/scientific name)	Conservation status
Bony fishes—Seahorses and pipefishes	
Banded pipefish, ringed pipefish (*Doryrhamphus dactyliophorus)*	Marine
Barbed pipefish, corrugated pipefish (*Bhanotia fasciolata)*	Marine
Bentstick pipefish (*Trachyrhamphus bicoarctatus)*	Marine
Bluestripe pipefish, Pacific blue strip pipefish (*Doryrhamphus melanopleura)*	Marine
Brock's pipefish, tasselled pipefish (*Halicampus brocki)*	Marine
Glittering pipefish (*Halicampus nitidus)*	Marine
Long-nosed pipefish, straight stick pipefish (*Trachyrhamphus longirostris)*	Marine
Messmate pipefish, banded pipefish (*Corythoichthys intestinalis)*	Marine
Mud pipefish, Gray's pipefish (*Halicampus grayi)*	Marine
Negros pipefish, flagtail pipefish (*Doryrhamphus negrosensis negrosensis)*	Marine
Pacific short-bodied pipefish (*Choeroichthys brachysoma)*	Marine
Red-banded pipefish, Fijian pipefish (*Corythoichthys amplexus)*	Marine
Reticulate pipefish, yellow-banded pipefish (*Corythoichthys flavofasciatus)*	Marine
Ridge-nose pipefish, red-hair pipefish, Duncker's pipefish (*Halicampus dunckeri)*	Marine
Robust ghost pipefish (*Solenostomus cyanopterus)*	Marine
Rough-ridge pipefish, Banner's pipefish (*Cosmocampus banneri)*	Marine
Schultz's pipefish, gilded pipefish (*Corythoichthys schultzi)*	Marine
Double-ended pipehorse, alligator pipefish (*Syngnathoides biaculeatus)*	Marine
Western pipehorse (*Solegnathus* sp.2)[27]	Marine

Species (common/scientific name)	Conservation status
Montebello seahorse, Monte Bello seahorse (*Hippocampus montebelloensis)*	Marine, listed under CITES (Appendix II)
Western spiny seahorse, narrow-bellied seahorse (*Hippocampus angustus)*	Marine, listed under CITES (Appendix II)
Winged seahorse (*Hippocampus alatus)*	Marine, listed under CITES (Appendix II)
Yellow seahorse, spotted seahorse *(Hippocampus kuda)**	Marine, listed under CITES (Appendix II)
Cetaceans	
Blainville's beaked whale, dense-beaked whale (*Mesoplodon densirostris*)	Cetacean, listed under CITES (Appendix II)
Bottlenose dolphin (*Tursiops truncates* s. str.)	Cetacean, listed under CITES (Appendix II)
Cuvier's beaked whale, goosebeaked whale (*Ziphius cavirostris*)	Cetacean, listed under CITES (Appendix II)
Dwarf minke whale (*Balaenoptera acutorostrata* subsp.)	Cetacean, listed under CITES (Appendix II)
Dwarf sperm whale (*Kogia simus*)	Cetacean, listed under CITES (Appendix II)
False killer whale (*Pseudorca crassidens*)	Cetacean, listed under CITES (Appendix II)
Fraser's dolphin or Sarawak dolphin *(Lagenodelphis hosei)*	Cetacean, listed under CITES (Appendix II)
Long-snouted spinner dolphin (*Stenella longirostris*)	Cetacean, listed under CITES (Appendix II)
Melon-headed whale (*Peponocephala electra*)	Cetacean, listed under CITES (Appendix II)
Pygmy killer whale *(Feresa attenuata)*	Cetacean, listed under CITES (Appendix II)
Pygmy sperm whale *(Kogia breviceps)*	Cetacean, listed under CITES (Appendix II)
Risso's dolphin, grampus (*Grampus griseus*)	Cetacean, listed under CITES (Appendix II)
Rough-toothed dolphin (*Steno bredanensis*)	Cetacean, listed under CITES (Appendix II)

Species (common/scientific name)	Conservation status
Short-beaked common dolphin (*Delphinus delphis*)	Cetacean, listed under CITES (Appendix II)
Short-finned pilot whale (*Globicephala macrorhynchus*)	Cetacean, listed under CITES (Appendix II)
Spotted dolphin, pantropical spotted dolphin (*Stenella attenuata*)	Cetacean, listed under CITES (Appendix II)
Striped dolphin, Euphrosyne dolphin (*Stenella coeruleoalba*)	Cetacean, listed under CITES (Appendix II)
Sea snakes	
Black-ringed seasnake (*Hydrelaps darwiniensis)*	Marine
Brown-lined seasnake (*Aipysurus tenuis)*	Marine
Dubois' seasnake (*Aipysurus duboisii)*	Marine
Dusky seasnake (*Aipysurus fuscus)*	Marine
Elegant seasnake (*Hydrophis elegans)*	Marine
Fine-spined seasnake (*Hydrophis czeblukovi)*	Marine
Horned seasnake (*Acalyptophis peronii)*	Marine
North-western mangrove seasnake (*Ephalophis greyi)*	Marine
Northern mangrove seasnake (*Parahydrophis mertoni)*	Marine
Olive seasnake (*Aipysurus laevis)*	Marine
Olive-headed seasnake (*Disteira major)*	Marine
Ornate seasnake (*Hydrophis ornatus)*	Marine
Shark Bay seasnake (*Aipysurus pooleorum)*	Marine
Slender-necked seasnake (*Hydrophis coggeri)*	Marine
Small-headed seasnake (*Hydrophis mcdowelli)*	Marine
Spectacled seasnake (*Disteira kingii)*	Marine
Spine-bellied seasnake (*Lapemis curtus)*	Marine
Spine-tailed seasnake (*Aipysurus eydouxii)*	Marine
Stokes' seasnake (*Astrotia stokesii)*	Marine
Turtle-headed seasnake (*Emydocephalus annulatus)*	Marine
Yellow-bellied seasnake (*Pelamis platurus)*	Marine

Species (common/scientific name)	Conservation status
Seabirds	
Australian pelican (*Pelecanus conspicillatus)*	Marine
Black noddy (*Anous minutus)*	Marine
Bulwer's petrel (*Bulweria bulwerii)*	Marine
Crested tern (*Thalasseus bergii)*	Marine
Fairy tern (*Sternula nereis)*	Marine, listed as vulnerable as *Sternula nereis nereis*
Gull-billed tern (*Gelochelidon nilotica)*	Marine
Hutton's shearwater (*Puffinus huttoni)*	Marine
Matsudaira's storm petrel (*Hydrobates matsudairae)*	Marine
Pacific gull (*Larus pacificus)*	Marine
Red-tailed tropicbird (*Phaethon rubricauda)*	Marine
Silver gull (*Chroicocephalus novaehollandiae)*	Marine
Sooty tern (*Onychoprion fuscata)*	Marine
Tahiti petrel (*Pseudobulweria rostrata)*	Marine
Shorebirds	
Australian pratincole (*Stiltia isabella*)	Marine

CITES = Convention on the International Trade of Endangered Species of Wild Flora and Fauna

26 Species listed as threatened and/or migratory under the EPBC Act are not listed in this table

27 Also known as *Solegnathus hardwickii* due to ongoing taxonomic discrepancies.

MAP DATA SOURCES

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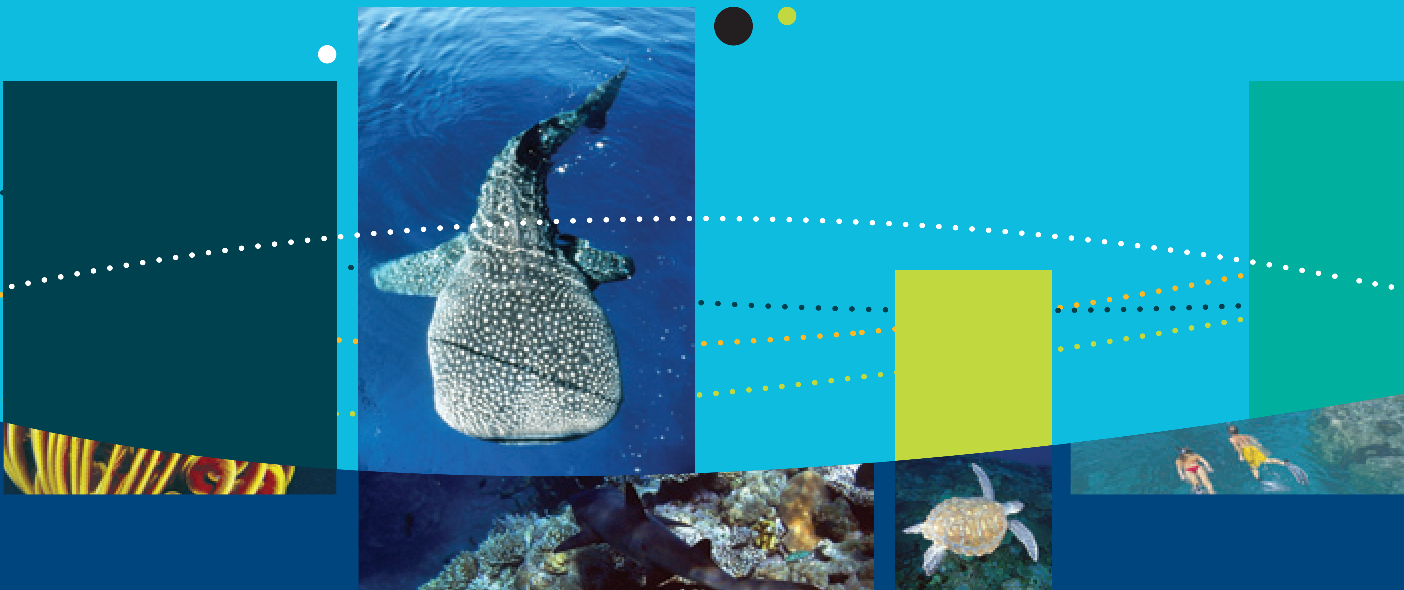

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