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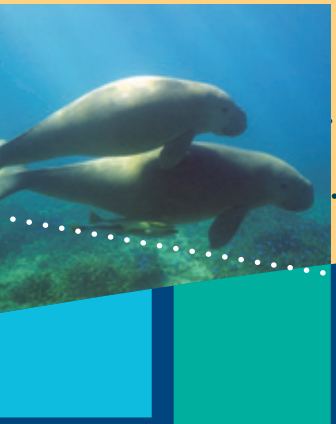



Marine bioregional plan for the North Marine Region

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

Images:
Hawksbill Turtle – Paradise Ink, Yellowstripe Snapper – R.Thorn and DSEWPaC, A gorgonian with polyps extended – Geoscience Australia, Snubfin dolphin – D.Thiele, Dugongs – Lochman Transparencies, Hard corals – A.Heyward and M.Rees, Cat shark – A.Heyward and M.Rees, Morning Light – I.Kiessling, Soft corals – A.Heyward and M.Rees, Bridled Tern – B.Furby

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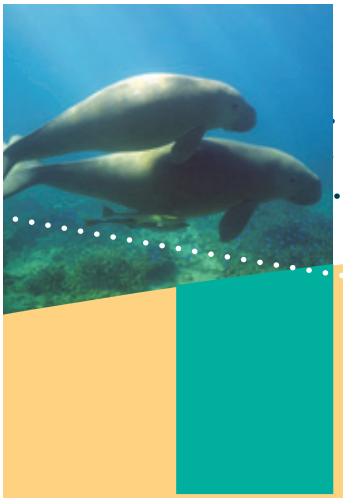

Marine bioregional plan for the North Marine Region

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MINISTERIAL FOREWORD

North 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 Marine Region includes the Commonwealth waters of the Gulf of Carpentaria, Arafura Sea and the Timor Sea extending as far west as the Northern Territory-Western Australian border.

It provides a globally important stronghold for threatened species including turtles and sawfish. Six of the seven species of marine turtle are known to live in the region. Northern Australian waters support the last healthy populations of sawfish species found anywhere in the world. The region is inhabited by the Australian snubfin dolphin, which is only found in the waters of the Australian continental shelf. The region also supports one of the six most important dugong habitats in Australia.

These plans have been prepared 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 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 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 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 to 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 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 opportunities.

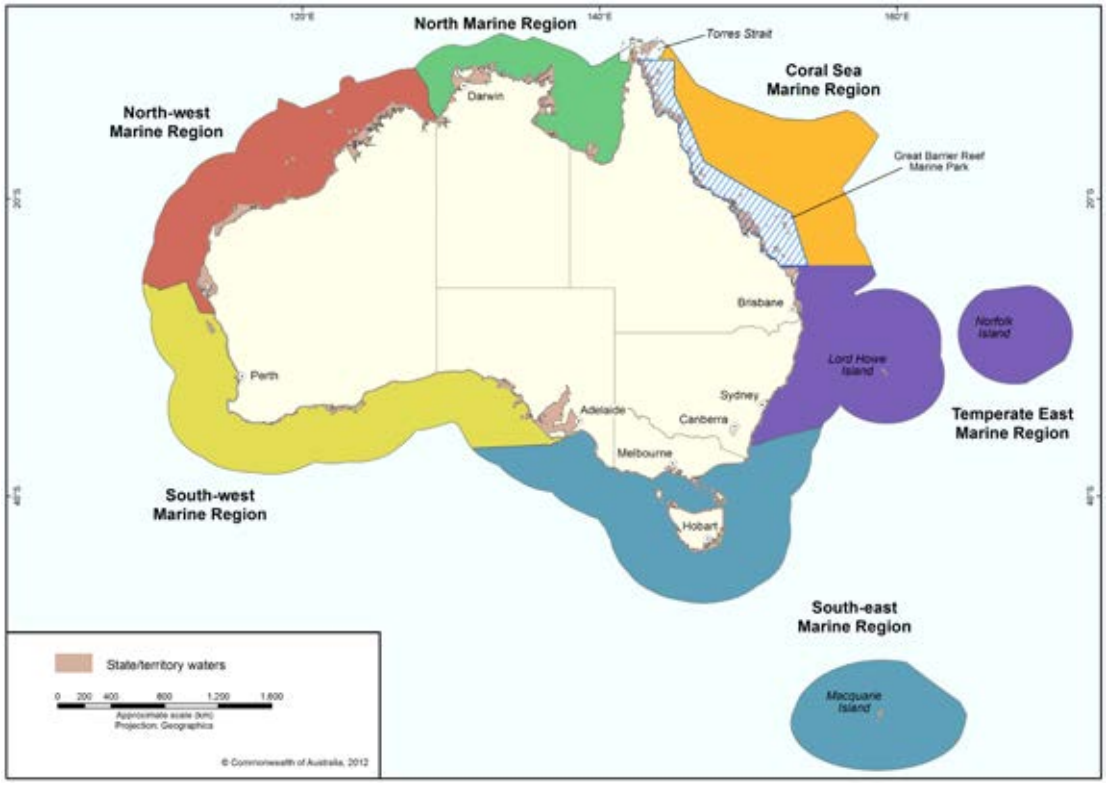


Figure 1.1 Australia's Marine Regions

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

1.3 Application of the plan

This plan is for the North Marine Region, which covers the Commonwealth marine area (Box 1.3) extending from west Cape York Peninsula to the Northern Territory–Western Australia border (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.

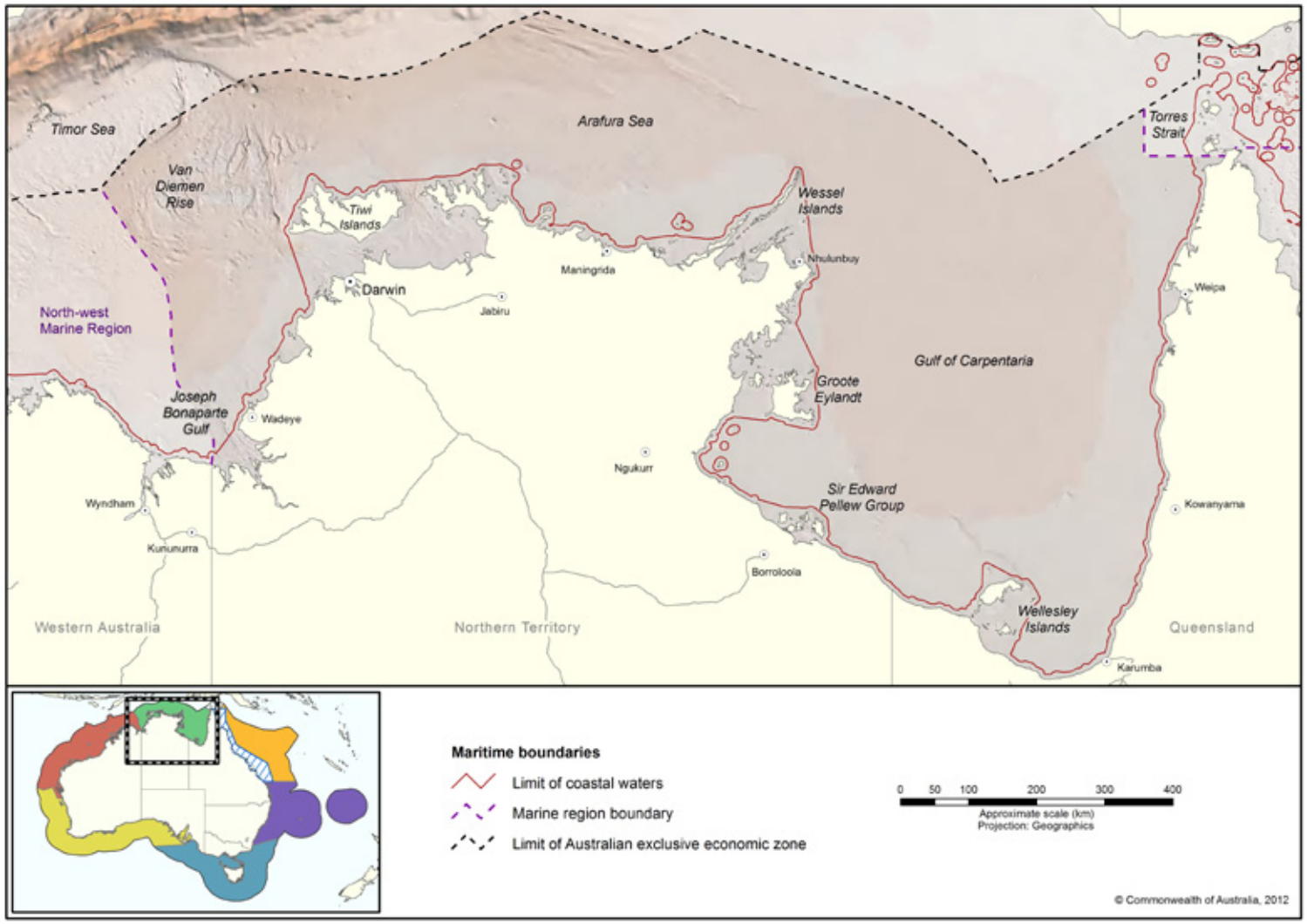


Figure 1.2: North Marine Region

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

Box 1.3 Commonwealth marine areas

The Australian Government is responsible for the Commonwealth marine area (also known as Commonwealth waters) as defined in section 24 of the EPBC Act (glossary **www.environment.gov.au/marineplans**). Commonwealth marine areas extend 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.

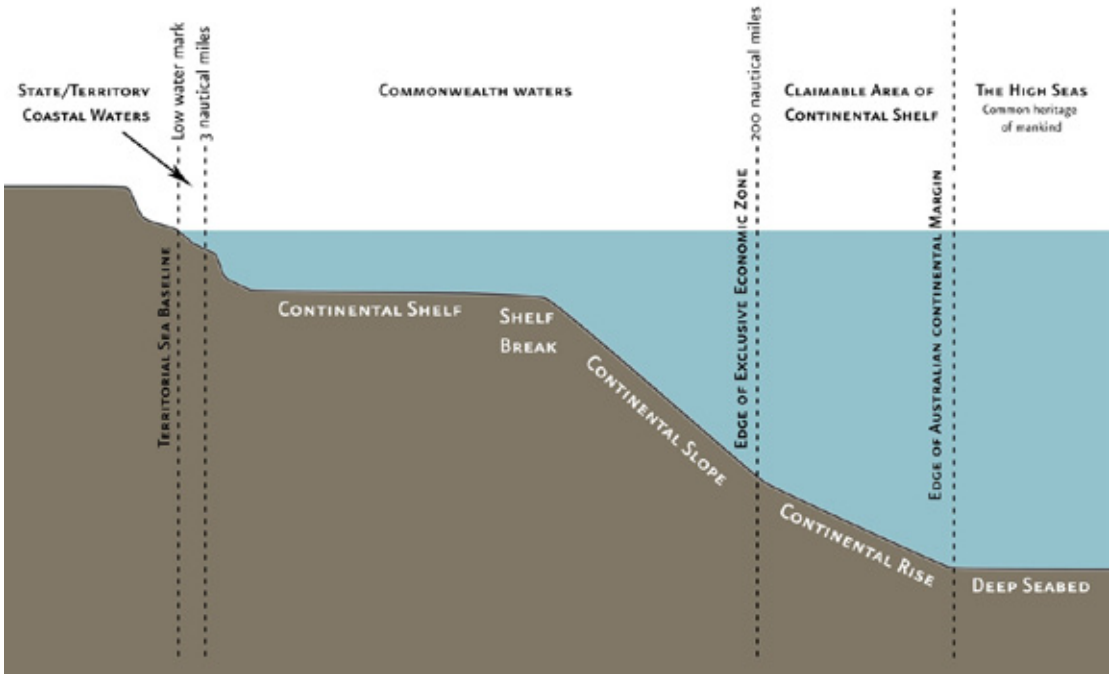


Figure 1.3: Australia's maritime zones

1.4 Key elements of the plan and supporting information

There were five key steps in the preparation 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 prepared 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 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 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 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**. 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 Marine Region are available at **www.environment.gov.au/marineplans/north**.

1.5 Who will use the plan?

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

The North 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 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 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 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 MARINE REGION AND ITS CONSERVATION VALUES

The North Marine Region comprises Commonwealth waters from west Cape York Peninsula to the Northern Territory–Western Australia border (Figure 1.2). The region covers approximately 625 689 square kilometres of tropical waters in the Gulf of Carpentaria and Arafura and Timor seas, and abuts the coastal waters of Queensland and the Northern Territory.

The main physical features of the region are:

- a wide continental shelf with water depths generally less than 70 metres, although water depths range from approximately 10 metres to a maximum known depth of 357 metres
- the Van Diemen Rise, characterised by complex geomorphology with features including shelves, shoals, banks, terraces and valleys like the Malita Shelf Valley, which provides a significant connection between the Joseph Bonaparte Gulf and the Timor Trough
- to the north of the region, a series of shallow canyons approximately 80–100 metres deep and 20 kilometres wide that lead into the Arafura Depression, which consists mainly of calcium carbonate–based sediments (e.g. carbonate sand and subfossil shell fragments)
- numerous limestone pinnacles up to tens of kilometres in length and width, which lie within the Bonaparte Basin
- the Arafura Shelf, an area of continental shelf up to 350 kilometres wide and mostly 50–80 metres deep that is characterised by sea-floor features such as canyons, terraces, the Arafura Sill and the Arafura Depression
- submerged patch and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria and provide complex habitats in an otherwise largely featureless basin
- the Gulf of Carpentaria coastal zone—waters up to 20 metres deep that are characterised by comparatively high levels of productivity and biodiversity driven by nutrient inflow from rivers and the Gulf of Carpentaria Gyre
- currents driven largely by strong winds and tides, with only minor influences from oceanographic currents such as the Indonesian Throughflow and the South Equatorial Current
- complex weather cycles and a tropical monsoonal climate, with high temperatures, heavy seasonal yet variable rainfall and cyclones, alternated with extended rain-free periods

- complex tidal regimes, with two tides in some parts, one tide in other parts, huge tidal ranges in some areas and almost no tidal range in others
- high levels of cyclonic activity that are both destructive (loss of seagrass and mangroves) and constructive (run-off from heavy rains mobilises large quantities of sediment into coastal habitats and recharges aquifers).

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 has been identified in the North Marine Region. Conservation values are defined as those elements of the region that are:

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

2.2 Conservation values—the Commonwealth marine environment

Biodiversity

By global standards, the marine environment of the North Marine Region is known for its high diversity of tropical species but relatively low endemism (i.e. species that are found nowhere else in the world) in contrast with the relatively isolated southern Australian marine fauna, which has high species endemism. Regions particularly rich in biodiversity include the Gulf of Carpentaria coastal zone, plateaux and saddle north-west of the Wellesley Islands, and the submerged coral reefs of the Gulf of Carpentaria.

Several factors contribute to the high level of biodiversity and low endemism in the region. These factors include the vast species-rich biogeographic ocean zone stretching from the western Pacific to the east coast of Africa where, apart from small stretches of deep ocean in the Arafura and Timor seas, there are thought to be few physical barriers to species dispersal. Most species endemic to the region lack a long-lived pelagic (open sea) larval stage that enables them to cross deeper waters.

The North Marine Region is increasingly recognised as an area of global conservation significance for marine species and as an aggregation area and staging point for migratory birds. Waters in and/or adjacent to the region provide important bird, marine turtle and dugong breeding, feeding and nursery sites. Six of the world's seven species of marine turtle are found in the region and all are listed as endangered or vulnerable under the EPBC Act. The Australian snubfin dolphin, a resident in the region, is endemic to the Australian continental shelf and is found along the Northern Territory coastline. Other protected species known to occur in the region include sawfish, 28 of the 35 known Australian species of sea snakes, the saltwater crocodile, and a vast array of seahorse and pipefish species. The coral reef systems of the region support some endemic species, however, flora and fauna are generally typical of oceanic reefs in the Indo–west Pacific region. Coral, invertebrates and phytoplankton are all highly diverse, while fish such as snapper, emperor and grouper are common higher-order predators of coral and rocky reef habitats.

The most significant known influence on ecosystem structure and function in the North Marine Region is the sea level across the region, which has periodically oscillated during recent geological times. Around 20 000 years ago much of the Gulf of Carpentaria was a shallow brackish lake. Present ocean levels became relatively stable only in the past 6000 years. As a consequence, the region is a relatively new marine environment and many species may still be colonising it. Today, the Gulf of Carpentaria is a semi-enclosed sea bordered by the Torres Strait to the east and by a sill extending from the Wessel Islands in the west to Papua New Guinea in the north, both of which limit the movement of water between the Gulf and the neighbouring Coral and Arafura seas. The Gulf of Carpentaria seabed is mostly flat with waters increasing in depth gradually by about one metre every kilometre, creating a shallow coastal zone up to 20 kilometres wide. Other factors that influence the ecosystems in the Gulf of Carpentaria include complex and varied winds and tides and striking seasonal weather patterns.

The North Marine Region is influenced primarily by tidal flows and less by ocean currents. The net tidal flows that occur over time drive longer-term transport patterns through the region. The movement of tidal waters across the northern Australian marine environment is complex due to the barrier of islands and submerged reefs in the Torres Strait that hinder tidal energy entering from the Coral Sea. Currents that have some minor influence in the region include the Indonesian Throughflow and the South Equatorial Current. The Indonesian Throughflow brings warm water of lower salinity from the tropical western Pacific Ocean between the Indonesian islands to the Indo-Australian basin in the north-west of the region. The influence of the South Equatorial Current in the region is marginal, although the strength of its influence varies with the season.

Key ecological features

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

The criteria used to identify KEFs in the region are:

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

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

Eight key ecological features have been identified in the North Marine Region (see 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**). Understanding of KEFs may evolve as new scientific information emerges.

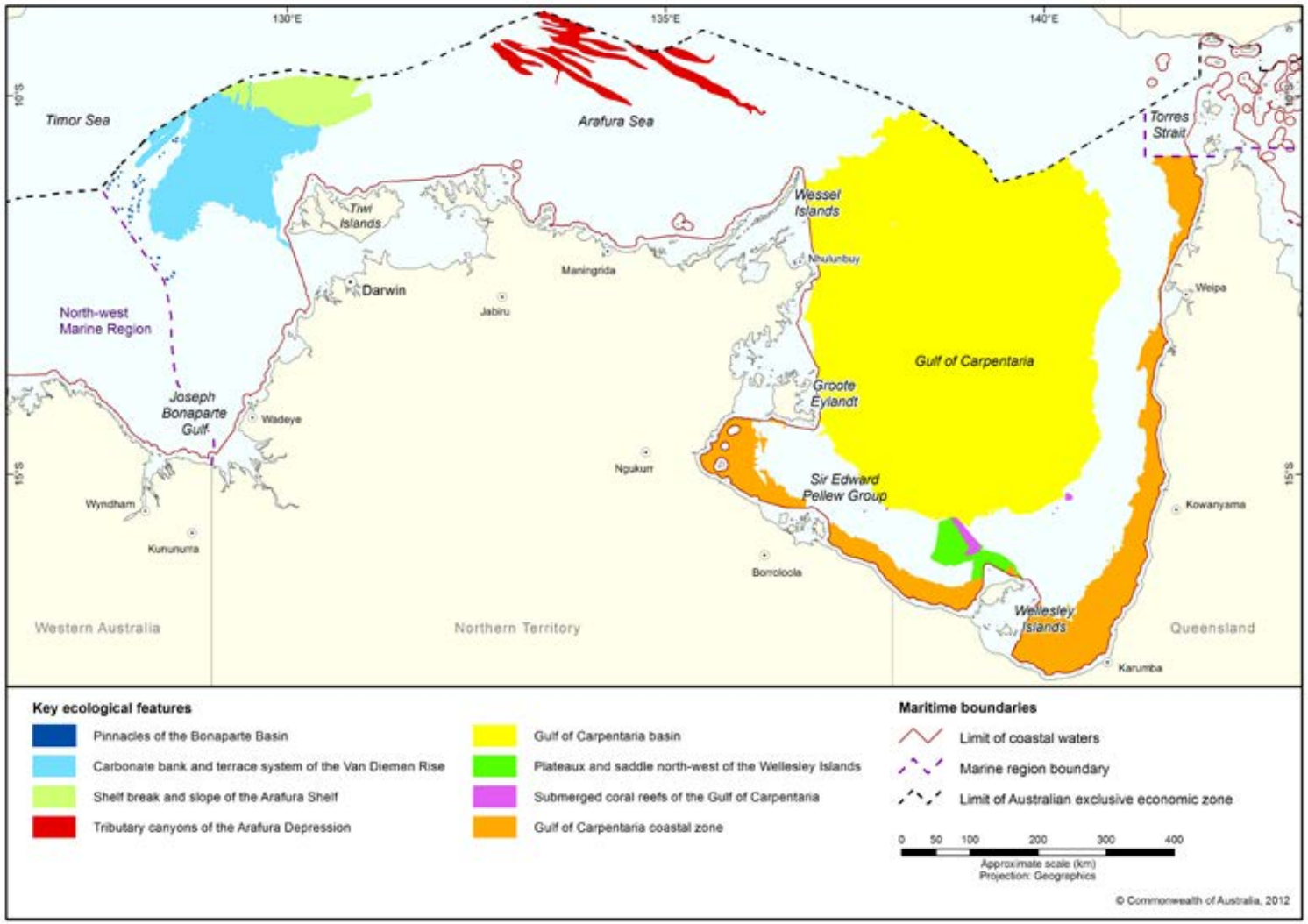


Figure 2.1: Key ecological features of the North Marine Region

Table 2.1: Key ecological features of the North Marine Region

Feature	Values	Description
Pinnacles of the Bonaparte Basin	Unique sea-floor feature with ecological properties of regional significance	Covering more than 520 km^2 within the Bonaparte Basin, this feature contains the largest concentration of pinnacles along the Australian margin. The pinnacles of the Bonaparte Basin are thought to be the eroded remnants of underlying strata; it is likely that the vertical walls generate local upwelling of nutrient-rich water, leading to phytoplankton productivity that attracts aggregations of planktivorous and predatory fish, seabirds and foraging turtles.
Carbonate bank and terrace system of the Van Diemen Rise	Unique sea-floor feature with ecological properties of regional significance	The bank and terrace system of the Van Diemen Rise is part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east; it is characterised by terrace, banks, channels and valleys. The variability in water depth and substrate composition may contribute to the presence of unique ecosystems in the channels. Species present include sponges, soft corals and other sessile filter feeders associated with hard substrate sediments of the deep channels; epifauna and infauna include polychaetes and ascidians. Olive ridley turtles, sea snakes and sharks are also found associated with this feature.
Shelf break and slope of the Arafura Shelf	Unique sea-floor feature with ecological properties of regional significance	The shelf break and slope of the Arafura Shelf is characterised by continental slope and patch reefs and hard substrate pinnacles. The ecosystem processes of the feature are largely unknown in the region; however, the Indonesian Throughflow and surface wind-driven circulation are likely to influence nutrients, pelagic dispersal and species and biological productivity in the region. Biota associated with the feature is largely of Timor–Indonesian Malay affinity.
Tributary canyons of the Arafura Depression	Unique sea-floor feature with ecological properties of regional significance	The tributary canyons are approximately 80–100 m deep and 20 km wide. The largest of the canyons extend some 400 km from Cape Wessel into the Arafura Depression, and are the remnants of a drowned river system that existed during the Pleistocene era. Sediments in this feature are mainly calcium-carbonate rich, although sediment type varies from sandy substrate to soft muddy sediments and hard, rocky substrate. Marine turtles, deep sea sponges, barnacles and stalked crinoids have all been identified in the area.

Feature	Values	Description
Gulf of Carpentaria basin	Regional importance for biodiversity and aggregations of marine life	The Gulf of Carpentaria basin is one of the few remaining near-pristine marine environments in the world. Primary productivity in the Gulf of Carpentaria basin is mainly driven by cyanobacteria that fix nitrogen, but is also strongly influenced by seasonal processes. The soft sediments of the basin are characterised by moderately abundant and diverse communities of infauna and mobile epifauna dominated by polychaetes, crustaceans, molluscs and echinoderms. The basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, with top predators such as shark, snapper, tuna and mackerel.
Plateaux and saddle north-west of the Wellesley Islands	High aggregations of marine life, biodiversity and endemism	Abundance and species density are high in the plateaux and saddle as a result of increased biological productivity associated with habitats rather than currents. Submerged reefs support corals that are typical of northern Australia, including corals that have bleach-resistant zooxanthellae; and particular reef fish species that are different to those found elsewhere in the Gulf of Carpentaria. Species present include marine turtles and reef fish such as coral trout, cod, mackerel and shark. Seabirds frequent the plateaux and saddle, most likely due to the presence of predictable food resources for feeding offspring.
Submerged coral reefs of the Gulf of Carpentaria	High aggregations of marine life, biodiversity and endemism	The submerged coral reefs of the Gulf of Carpentaria are characterised by submerged patch, platform and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria basin, rising from the sea floor at depths of 30–50 m. These reefs provide breeding and aggregation areas for many fish species including mackerel and snapper, and offer refuges for sea snakes and apex predators such as sharks. Coral trout species that inhabit the submerged reefs are smaller than those found in the Great Barrier Reef and may prove to be an endemic subspecies.
Gulf of Carpentaria coastal zone	High productivity, aggregations of marine life, biodiversity and endemism	Nutrient inflow from rivers adjacent to the North Marine Region generates higher productivity and more diverse and abundant biota within the Gulf of Carpentaria coastal zone than elsewhere in the region. The coastal zone is near pristine and supports many protected species such as marine turtles, dugongs and sawfish. Ecosystem processes and connectivity remain intact; river flows are mostly uninterrupted by artificial barriers and healthy, diverse estuarine and coastal ecosystems support many species that move between freshwater and saltwater environments.

2.3 Conservation values—protected species

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

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

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

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

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 Marine Region are:

- cetaceans (3 species)
- dugong
- marine turtles (6 species)
- river sharks (2 species)
- saltwater crocodile
- sawfishes (3 species)
- seabirds (11 species)
- seahorses and pipefishes (30 species)
- sea snakes (19 species).

The species group report cards describe the protected species and include detailed information about species distribution and ecology in the North Marine Region (**www.environment.gov.au/marineplans/north**).

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 behaviour is also present. The selection of species for which biologically important areas have been identified was informed by the availability of scientific information, the conservation status of listed species and the importance of the region for the species. The range of species for which biologically important areas are identified will continue to expand as reliable spatial and scientific information becomes available.

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

Biologically important area maps and descriptions are available in the North 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*. 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*.

There is one historic shipwreck in the region (Figure 2.2):

- *Florence D*: a merchant ship destroyed on 19 February 1942 by Japanese air raids on Darwin. The shipwreck currently lies at depths of 12–20 metres. A no-entry protection zone has been established around the Florence D under the Historic Shipwrecks Act.

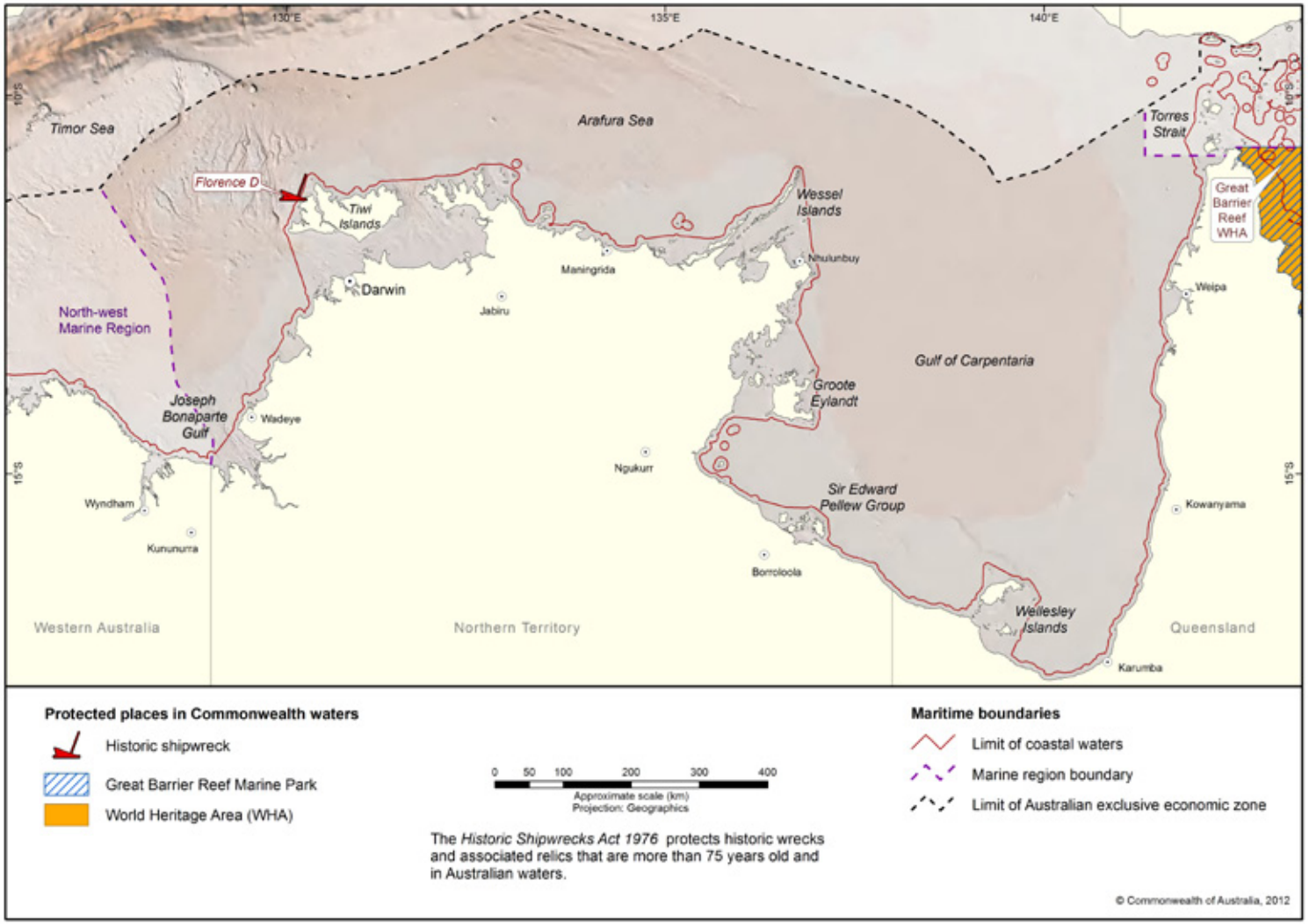


Figure 2.2: Protected places in the North Marine Region as of May 2012

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 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, sawfishes, river sharks, seabirds, seahorses and pipefishes. 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 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 known occurrence in the region, their general occurrence in waters >20 m deep, and their listing as marine species under the EPBC Act.	**Big-head seahorse** **Hedgehog seahorse** **High-crown seahorse** **Kellogg's seahorse** **Northern spiny seahorse** **Three-spot seahorse** **Western spiny seahorse or narrow-bellied seahorse** **Winged seahorse** **Yellow seahorse or spotted seahorse** **Banded pipefish or ringed pipefish** **Blue-finned ghost pipefish or robust ghost pipefish** **Brock's pipefish** **Cleaner pipefish or Janss' pipefish** **Double-ended pipehorse or alligator pipefish** **Girdled pipefish** **Harlequin ghost pipefish or ornate ghost pipefish** **Indonesian pipefish or Günther's pipehorse** **Long-nosed pipefish or straight stick pipefish** **Mud pipefish or Gray's pipefish** **Pacific short-bodied pipefish** **Pallid pipehorse or Hardwick's pipehorse** **Pig-snouted pipefish** **Red-banded pipefish or Fijian pipefish** **Reef-top pipefish** **Ribboned seadragon or ribboned pipefish** **Ridge-nose pipefish, red-hair pipefish or Duncker's pipefish** **Short-pouch pygmy pipehorse** **Three-keel pipefish** **Tidepool pipefish** **Yellow-banded pipefish**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Cetaceans	Species were selected on the basis of their occurrence in the region, their listing as migratory species under the EPBC Act, and the importance of the region to their survival. The three inshore dolphin species selected, although generally coastal species, also occur in the Commonwealth marine environment of the North 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. In some areas, they are found within 6 km of the coast. Indo-Pacific bottlenose dolphins tend to occur in deeper, more open coastal waters, primarily in continental shelf waters (less than 200 m deep), including coastal areas around oceanic islands.	**Australian snubfin dolphin** **Indo-Pacific bottlenose dolphin** **Indo-Pacific humpback dolphin**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Dugong	Dugongs were selected on the basis of their occurrence in the North Marine Region, their listing as a migratory species under the EPBC Act, and the importance of the region and adjacent coastal waters for their survival. Dugongs migrate through the region and, in a 2007 aerial survey of populations along the Northern Territory coast of the Gulf of Carpentaria, almost 40 per cent of dugong sightings were in Commonwealth waters	**Dugong**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Marine reptiles	Crocodile and sea snake species were selected on the basis of their occurrence in the region, and their listing under the EPBC Act as marine or migratory species. Saltwater crocodiles are known to traverse the North Marine Region, and sea snakes are commonly found in the region. 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 feeding sites for the species in the region. In particular, the region supports globally significant breeding populations of green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and flatback (*Natator depressus*) turtles. Additionally, large immature and adult-sized loggerhead turtles from eastern Australian populations are known to forage in the eastern Arafura Sea, the Gulf of Carpentaria and the Torres Strait.	**Saltwater crocodile** **Flatback turtle** **Green turtle** **Hawksbill turtle** **Leatherback turtle** **Loggerhead turtle** **Olive ridley turtle** **Beaked seasnake** **Black-headed seasnake** **Dwarf seasnake** **Dubois's seasnake** **Elegant seasnake or bar-bellied seasnake** **Fine-spined seasnake** **Horned seasnake** **Large-headed seasnake** **Olive seasnake** **Olive-headed seasnake** **Ornate seasnake or ornate reef seasnake** **Plain seasnake** **Plain-banded seasnake** **Small-headed seasnake** **Spectacled seasnake** **Spine-bellied seasnake** **Spine-tailed seasnake** **Stokes's seasnake** **Yellow-bellied seasnake**

Species group	Group-specific considerations for selection	Species selected for detailed pressure analysis
Sawfishes and river sharks	Species were selected on the basis of their occurrence in the region, their listing as threatened species under the EPBC Act and the importance of the region to their survival.	**Dwarf sawfish** **Freshwater sawfish** **Green sawfish** **Northern river shark** **Speartooth shark**
Seabirds	Species were selected on the basis of their occurrence in the region, their listing as migratory and/or marine species under the EPBC Act, and the presence of important feeding sites for the species in the region. All 11 species selected forage in the North Marine Region, and 10 of the 11 species breed in areas adjacent to the region. Offshore islands within foraging range of the region host internationally and nationally significant breeding sites for significant numbers of colonially nesting terns, in particular the crested tern, bridled tern, roseate tern and black-naped tern.	**Brown booby** **Lesser frigatebird** **Streaked shearwater** **Black-naped tern** **Caspian tern** **Crested tern** **Bridled tern** **Lesser crested tern** **Little tern** **Roseate tern** **Common noddy**

3.2 Outcome of pressure analysis

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

A number of sources of pressures nevertheless exist in the region. The main drivers and sources of 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, and storm frequency and intensity)
- harvesting of living resources
- increasing industrial development in areas adjacent to the region
- growth in marine industries and infrastructure.

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

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 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 Marine Region priorities

This plan identifies 12 regional priorities for the North Marine Region: 6 conservation values and 6 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 Marine Region

	Conservation value	Rationale	Strategies and actions identified to address the priority (Section 4.2)
1	**Marine turtles** *Flatback turtle* *Green turtle* *Hawksbill turtle* (EPBC Act listed as vulnerable, migratory and marine) *Leatherback turtle* *Loggerhead turtle* *Olive ridley turtle* (EPBC Act listed as endangered, migratory and marine)	Six of the seven species of marine turtle in the world are known to inhabit the North Marine Region. All six species are listed as threatened under the EPBC Act, and have important breeding, nesting and/or feeding areas in or adjacent to the North Marine Region. In particular, the region supports globally significant populations of green, hawksbill and flatback turtles. In the North Marine Region, the pressures assessed as *of concern* for marine turtles are invasive species and marine debris. The pressures assessed as *of potential concern* for marine turtles are sea level rise, changes in sea temperature, bycatch (commercial fishing), extraction of living resources (Indigenous harvest), noise pollution (seismic exploration) and light pollution (offshore activities). The conservation status of marine turtles, the significance of the North 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 and 6 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Action 1 and 4 Strategy E, Actions 1 and 3 Strategy G, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (Section 4.2)
2	**Inshore dolphins** *Australian snubfin dolphin* *Indo-Pacific humpback dolphin* (EPBC Act listed as cetacean and migratory) *Indo-Pacific bottlenose dolphin* (EPBC Act listed as cetacean and migratory [Arafura/Timor Sea populations])	The Australian snubfin dolphin, Indo-Pacific humpback dolphin and Indo-Pacific bottlenose dolphin are known to occur in the North Marine Region. All three species are listed as migratory and cetacean under the EPBC Act. These species rely on the waters of the North Marine Region and adjacent coastal areas for breeding and foraging. 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. Indo-Pacific bottlenose dolphins tend to occur in deeper, more open coastal waters, primarily in continental shelf waters (up to 200 m deep), including coastal areas around oceanic islands. The species' vulnerability to pressures is intensified due to their life history characteristics (they are long-lived, females take many years to reach sexual maturity and they have a low rate of reproduction) and their small and fragmented populations. In the North Marine Region, the pressure assessed as *of concern* for inshore dolphins is physical habitat modification (onshore construction). The pressures assessed as *of potential concern* for inshore dolphins are bycatch (commercial fishing), marine debris, noise pollution (onshore and offshore construction; shipping), changes in sea temperature, ocean acidification, sea level rise (Australian snubfin dolphin only), chemical pollution (onshore and offshore mining) and physical habitat modification (dredging and offshore construction). The conservation status of inshore dolphins, the significance of the North Marine Region to their survival (especially given their limited and fragmented ranges) and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Actions 3 and 6 Strategy B, Action 1 Strategy C, Action 3 Strategy D, Action 1 and 4 Strategy E, Action 3

	Conservation value	Rationale	Strategies and actions identified to address the priority (Section 4.2)
3	**Sawfishes and river sharks** *Dwarf sawfish* *Freshwater sawfish* *Green sawfish* (EPBC Act listed as vulnerable) *Northern river shark* (EPBC Act listed as endangered) *Speartooth shark* (EPBC Act listed as critically endangered)	Five species of sawfish and river shark listed under the EPBC Act are known to occur in the North Marine Region. While relatively little is known about the distribution and abundance of sawfishes and river sharks in northern Australian waters, the North Marine Region is considered an important area for the species group as the region and adjacent waters contain nationally and globally significant populations of sawfish and river shark species. Biologically, sawfishes and river sharks are characterised by their late age at maturity, slow growth rate, low fecundity, longevity and low rate of natural mortality, all of which result in low rates of reproduction and capacity to withstand human-induced pressures. In the North Marine Region, the pressures assessed as *of concern* for sawfishes and river sharks are bycatch (commercial fishing; recreational fishing), extraction of living resources (illegal, unreported and unregulated fishing) and changes in hydrological regimes. The pressures assessed as *of potential concern* for sawfishes and river sharks are sea level rise, changes in sea temperature, marine debris, extraction of living resources (commercial fishing [freshwater sawfish only]; Indigenous harvest) and chemical pollution (onshore and offshore mining). Research into the distribution, population size, population trends and factors influencing recovery of these species has been undertaken but significant gaps in knowledge on sawfish and river shark species in northern Australia remain. These knowledge gaps, along with the conservation status of sawfishes and river sharks, the significance of the North 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 and 6 Strategy B, Action 1 Strategy D, Action 1 Strategy E, Actions 1, 2 and 3

	Conservation value	Rationale	Strategies and actions identified to address the priority (Section 4.2)
4	**Dugong** (EPBC Act listed as migratory and marine)	A significant proportion of the world's dugongs occur in the North Marine Region and adjacent coastal waters. Dugongs are vulnerable to human-induced impacts as a result of their biological characteristics, such as their longevity (up to 70 years), long gestation (12–14 months), litter sizes of one, long intervals between births (up to 2.5 years) and late age at sexual maturity (6–17 years). In the North Marine Region, the pressures assessed as *of potential concern* for dugong are bycatch (commercial fishing), extraction of living resources (Indigenous harvest; illegal, unreported and unregulated fishing), marine debris, sea level rise, changes in sea temperature and physical habitat modification (storm events). The conservation status of dugongs, the significance of the North Marine Region to their survival and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Actions 3 and 6 Strategy B, Action 1 Strategy D, Action 1 Strategy E, Actions 1 and 3 Strategy G, Action 1
5	**Sea snakes** (EPBC Act listed as marine)	The North Marine Region is an important area for sea snakes. Nineteen species are known to occur in the region; all are listed as marine species under the EPBC Act. Sea snakes are vulnerable to human-induced pressures because of their slow growth rates and low fecundity. In the North Marine Region, the pressure assessed as *of concern* for sea snakes is bycatch (commercial fishing). The pressures assessed as *of potential concern* for sea snakes are physical habitat modification (dredging), changes in sea temperature and ocean acidification. The conservation status of sea snakes, the significance of the North Marine Region to their survival and the pressures facing them in the region make the species a priority for conservation effort.	Strategy A, Actions 3 and 6 Strategy B, Action 1 Strategy D, Action 1

	Conservation value	Rationale	Strategies and actions identified to address the priority (Section 4.2)
6	**Gulf of Carpentaria coastal zone** (Key ecological feature)	The Gulf of Carpentaria coastal zone is a key ecological feature of the North Marine Region due to its productivity, presence of aggregations of marine life (including several endemic species) and comparatively high biodiversity. Nutrient inflow from rivers leads to higher productivity and more diverse and abundant biota in this area than elsewhere in the North Marine Region. In the North Marine Region, the pressure assessed as *of concern* for the Gulf of Carpentaria coastal zone is marine debris. The pressures assessed as *of potential concern* for the Gulf of Carpentaria coastal zone are physical habitat modification (offshore construction), extraction of living resources (illegal, unreported and unregulated fishing), changes in hydrological regimes, sea level rise, changes in sea temperature, ocean acidification and physical habitat modification (storm events). The Gulf of Carpentaria coastal zone is a priority for conservation efforts because it is a key ecological feature that supports diverse marine life, that is facing pressures assessed as *of concern* and *of potential concern*, and about which there is a lack of data.	Strategy A, Actions 3 and 4 Strategy B, Action 1 Strategy C, Action 3 Strategy F, Action 1

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

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
7	**Marine debris**	Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris is a listed key threatening process under the EPBC Act. In the North Marine Region, interactions with marine debris are assessed as *of concern* for marine turtles, the Gulf of Carpentaria basin, plateaux and saddle north-west of the Wellesley Islands, and the Gulf of Carpentaria coastal zone. Interactions with marine debris are assessed as *of potential concern* for inshore dolphins, dugongs, sawfishes and river sharks, seabirds and the submerged reefs of the Gulf of Carpentaria. Marine debris is a priority for conservation efforts in the North Marine Region because it is considered *of concern* or *of potential concern* for multiple conservation values, because of the vulnerability of the region to the pressure and because it is listed under the EPBC Act as a key threatening process.	Strategy A, Action 5 Strategy B, Action 2 Strategy E, Action 4 Strategy G, Action 1
8	**Bycatch**	In the North Marine Region, interactions with bycatch are assessed as *of concern* for sawfishes and river sharks and sea snakes. Interactions with bycatch are assessed as *of potential concern* for flatback turtles, olive ridley turtles, loggerhead turtles, dugongs, inshore dolphins, ribboned sea dragons, pallid pipehorse,Gunther's pipehorse and long-nosed pipefish. Bycatch is a priority for conservation effort in the North Marine Region because it is *of concern* or *of potential concern* for multiple conservation values, and because the region is vulnerable to the widespread pressure.	Strategy A, Action 5 Strategy B, Action 2 Strategy D, Action 1

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
9	**Extraction of living resources (illegal, unreported and unregulated fishing)**	In the North Marine Region, extraction of living resources (illegal, unreported and unregulated fishing) is assessed as *of concern* for sawfishes and river sharks. Extraction of living resources (illegal, unreported and unregulated fishing) is assessed as *of potential concern* for dugongs and all eight key ecological features of the region. Extraction of living resources is a priority for conservation effort in the North Marine Region because it is *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 G, Action 1
10	**Physical habitat modification**	In the North Marine Region, physical habitat modification is assessed as *of concern* for inshore dolphins, and *of potential concern* for dugongs, sea snakes, seahorses and pipefishes, the tributary canyons of the Arafura Depression and the Gulf of Carpentaria coastal zone. Physical habitat modification is a priority for conservation effort in the North 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 value.	Strategy A, Action 5 Strategy B, Action 2 Strategy C, Action 2

	Pressure	Rationale	Strategies and actions identified to address the priority (see Section 4.2)
11	**Climate change**	Climate change-related pressures including changes in sea temperature and oceanographic processes, ocean acidification, sea level and storm intensity, are predicted to increase in the North Marine Region, with the potential to impact most conservation values to varying extents. In the North Marine Region, pressures related to climate change are assessed as *of potential concern* for sawfishes and river sharks, sea snakes, marine turtles, dugongs, inshore dolphins, seabirds, the *Florence D* shipwreck and all eight key ecological features of the region. Climate change is a priority for conservation effort in the North Marine Region because it is assessed as *of potential concern* for multiple conservation values, pressures associated with it are likely to increase and because there is a significant gap in knowledge about how the pressure will impact the conservation values of the region.	Strategy A, Actions 3 Strategy B, Action 2
12	**Changes in hydrological regimes**	The North Marine Region is vulnerable to changes in hydrological regimes due to its reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline. 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 cues between estuary and offshore waters. In the North Marine Region, changes in hydrological regimes are assessed as *of concern* for sawfishes and river sharks and *of potential concern* for the Gulf of Carpentaria coastal zone. Changes in hydrological regimes are a priority for conservation effort in the North Marine Region because it is assessed as *of potential concern* for multiple conservation values and is likely to increase in the region and in areas adjacent to the region.	Strategy A, Action 5 Strategy B, Action 2

4.2 Strategies and actions

The North 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 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 understranding 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 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, sawfishes and river sharks (regional priorities 1 and 3—short 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 1–6, 11—medium to long term).
4. Improve knowledge of the processes driving biodiversity and ecosystem functioning of priority key ecological features of the North Marine Region (regional priority 6—medium to long term).
5. Improve knowledge on the pressures of marine debris, bycatch, extraction of living resources (illegal, unregulated and unreported fishing), physical habitat modification and changes in hydrological regimes in the North Marine Region (regional priorities 7–10, 12—short to medium term).

6. Improve information on biologically important areas for protected species and species considered under pressure within the North 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 and river sharks (regional priority 3—short to medium term)
   - dugong (regional priority 4—short to medium term)
   - sea snakes (regional priority 5—short to medium term).

Strategy B: Establish and manage a Commonwealth marine reserve network in the North 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 1-6–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 Marine Region (regional priorities 7–12—medium to long term).

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

1. Improve access to information, particularly spatial data, on the region's key ecological features and protected species and the pressures on them (short to medium term).
2. Assess the need for—and, if appropriate, promote—strategic assessments under the EPBC Act of coastal and inshore marine environments adjacent to the region that are expected to experience rapid change and have the potential to increase pressure on the Commonwealth marine environment (regional priority 10—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 (see Schedule 2) (regional priorities 1, 2, 6—immediate).
4. Evaluate the role of the plan and its supporting information resources in streamlining decision-making under the EPBC Act at all levels (i.e. the environment minister, the environment department, or persons proposing to take actions likely to impact on matters of national environmental significance in the North Marine Region) (short to medium term).

Strategy D:
Increase collaboration with relevant industries to improve understranding 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 marine turtles, inshore dolphins, sawfishes, river sharks, dugong, sea snakes, sea horses 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, 2, 4, 5, 8—short to medium term; regional priority 3—medium term).
2. 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).
3. Pursue, where feasible, collaborative agreements authorising the shared use of industry-gathered marine information, particularly spatial data (short to medium term).
4. Collaborate with industry to improve understanding of the effects of increased noise on marine turtles; increased light on flatback, green, hawksbill and olive ridley turtles; and increased noise on inshore dolphins (regional priorities 1 and 2—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 marine turtles, sawfishes, river sharks and dugong and assess their effectiveness in reducing the risk to the species' recovery (regional priorities 1 and 4—short term; regional priority 3—medium term).
2. Foster research and monitoring in relation to sawfishes and river sharks to assess and monitor population and recovery rates and increase the ability to support the species' recovery through better knowledge of ecology, genetics and population dynamics (regional priority 3—medium term).

3. Collaborate with the Queensland and Northern Territory governments and coastal communities to develop protection measures to limit disturbances during the nesting season for marine turtles, the breeding season for inshore dolphins, the pupping season for sawfishes and river sharks, and in foraging areas for dugongs, focusing on areas in proximity to inhabited areas or areas where sources of disturbance exist or are emerging (regional priorities 1, 2 and 4—short to medium term; regional priority 3—medium term).
4. 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 Marine Region (regional priority 7—short to medium term).

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

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

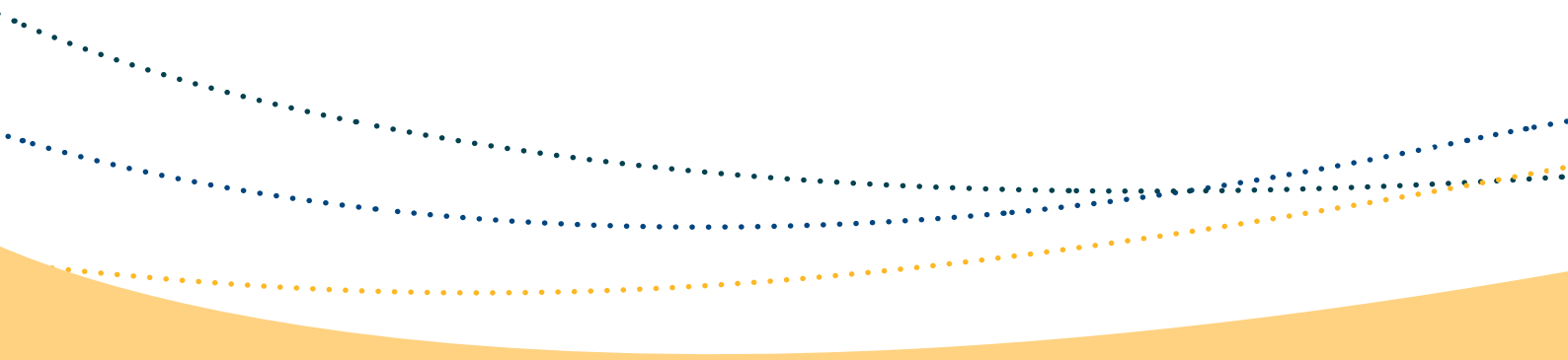
   Key ecological features to be investigated are:

   – Gulf of Carpentaria basin
   – Plateaux and saddle north-west of the Wellesley Islands
   – Submerged coral reefs of the Gulf of Carpentaria.

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, 4, 7, 9, 11—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 Marine Region.



SCHEDULE 1

Analysis of pressures affecting conservation values of the North Marine Region

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

This schedule summarises the methods and findings of the regional pressure analysis undertaken for the North 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 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 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 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

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

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

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

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

Levels of concern for the interactions between pressures and conservation values

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

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

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

- there is evidence that it interacts with the conservation value within the region and there are reasonable grounds to expect that it may result in a **substantial impact** (Box 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 pressure operating outside of the region is having a substantial impact on a region's conservation value, consideration has been given to it.

Only those interactions between conservation values and pressures assessed as being *of concern* and *of potential concern* are described in this Schedule. Further information on the findings of the pressure analyses can be found in the conservation value report cards.

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 Marine Region is presented in Table S1.2. A summary of the pressure analysis findings on selected protected species in the North 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 Marine Region
  - Pressures *of concern*—Table S1.4
  - Pressures *of potential concern*—Table S1.5
- Selected cetaceans species
  - Pressures *of concern*—Table S1.6
  - Pressures *of potential concern*—Table S1.7
- Dugongs
  - Pressures *of potential concern*—Table S1.8
- Selected reptile species
  - Pressures *of concern*—Table S1.9
  - Pressures *of potential concern*—Table S1.10
- Selected sawfish and river shark species
  - Pressures *of concern*—Table S1.11
  - Pressures *of potential concern*—Table S1.12
- Selected seabird species
  - Pressures *of potential concern*—Table S1.13
- Selected seahorse and pipefish species
  - Pressures *of potential concern*—Table S1.14
- Historic shipwrecks of the North 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 Marine Region

Key ecological feature	Pressure[5]								
	Sea level rise	Changes in sea temperature	Changes in oceanography	Ocean acidification	Chemical pollution/ contaminants	Nutrient pollution	Marine debris	Noise pollution	Light pollution
1. Pinnacles of the Bonaparte Basin	not of concern	of potential concern	data deficient or not assessed	of potential concern	not of concern	data deficient or not assessed	of less concern	not of concern	not of concern
2. Carbonate bank and terrace system off the Van Diemen Rise	not of concern	of potential concern	data deficient or not assessed	of potential concern	not of concern	data deficient or not assessed	of less concern	not of concern	not of concern
3. Shelf break and slope of the Arafura Shelf	not of concern	of potential concern	data deficient or not assessed	of potential concern	not of concern	data deficient or not assessed	of less concern	not of concern	not of concern
4. Tributary canyons of the Arafura Depression	not of concern	of potential concern	data deficient or not assessed	of potential concern	not of concern	data deficient or not assessed	of less concern	not of concern	not of concern
5. Gulf of Carpentaria basin	not of concern	of potential concern	data deficient or not assessed	of potential concern	of less concern	data deficient or not assessed	of concern	not of concern	not of concern
6. Plateaux and saddle north-west of the Wellesley Islands	of less concern	of potential concern	data deficient or not assessed	of potential concern	of less concern	data deficient or not assessed	of concern	of less concern	data deficient or not assessed
7. Submerged coral reefs of the Gulf of Carpentaria	of less concern	of potential concern	data deficient or not assessed	of potential concern	of less concern	data deficient or not assessed	of potential concern	not of concern	not of concern
8. Gulf of Carpentaria coastal zone	of potential concern	of potential concern	data deficient or not assessed	of potential concern	of less concern	data deficient or not assessed	of concern	not of concern	data deficient or not assessed
Historic Shipwrecks									
Florence D 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	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 heritage places 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 Marine Region

Key ecological feature	Pressure[5]							
	Physical habitat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Invasive species	Changes in hydrological regimes
1. Pinnacles of the Bonaparte Basin								
2. Carbonate bank and terrace system off the Van Diemen Rise								
3. Shelf break and slope of the Arafura Shelf								
4. Tributary canyons of the Arafura Depression								
5. Gulf of Carpentaria basin								
6. Plateaux and saddle north-west of the Wellesley Islands								
7. Submerged coral reefs of the Gulf of Carpentaria								
8. Gulf of Carpentaria coastal zone								
Historic Shipwrecks								
Florence D shipwreck								

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

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

Species group	Protected species	Pressures[6]									
		Sea level rise	Changes in sea temperature	Changes in oceanography	Ocean acidification	Chemical pollution/ contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Cetaceans	Australian snubfin dolphin										
	Indo-Pacific bottlenose dolphin										
	Indo-Pacific humpback dolphin										
Dugong	Dugong										
Marine reptiles	Saltwater crocodile										
Crocodiles	Flatback turtle										
Marine turtles	Green turtle										
	Hawksbill turtle										
	Leatherback turtle										
	Loggerhead turtle										
	Olive ridley turtle										
Sea snakes	Sea snakes[7]										
Sawfishes and river sharks	Dwarf sawfish										
	Green sawfish										
	Freshwater sawfish										
	Northern river shark										
	Speartooth shark										

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 key ecological features and heritage places can be found in the conservation value report cards.

7 Nineteen 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 sea snake species report card.

8 Thirty species of seahorse and pipefish were selected for analysis. These species were assessed as having the same ratings for all pressures considered, except for *bycatch*. *Bycatch from commercial fishing* was assessed as *of potential concern* for four of the species and as *not of concern* for the other species. The higher rating for the pressure has been listed in this table. More information on the seahorse and pipefish pressure analysis can be found in the seahorse and pipefish report card.

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

Species group	Protected species	Pressures[6]								
		Physical hab itat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Disease	Invasive species	Changes in hydrological regimes
Cetaceans	Australian snubfin dolphin	of concern	not of concern	of less concern	of potential concern	of less concern	of less concern	of less concern	data deficient or not assessed	data deficient or not assessed
	Indo-Pacific bottlenose dolphin	of concern	not of concern	of less concern	of potential concern	of less concern	of less concern	of less concern	data deficient or not assessed	data deficient or not assessed
	Indo-Pacific humpback dolphin	of concern	not of concern	of less concern	of potential concern	of less concern	of less concern	of less concern	data deficient or not assessed	data deficient or not assessed
Dugong	Dugong	of potential concern	not of concern	of potential concern	of potential concern	not of concern	of less concern	data deficient or not assessed	not of concern	data deficient or not assessed
Marine reptiles	Saltwater crocodile	data deficient or not assessed	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed	not of concern	of potential concern	data deficient or not assessed
Crocodiles	Flatback turtle	of less concern	of less concern	of potential concern	of potential concern	of less concern	of less concern	of less concern	of concern	data deficient or not assessed
Marine turtles	Green turtle	of less concern	of less concern	of potential concern	of less concern	of less concern	of less concern	of less concern	of concern	data deficient or not assessed
	Hawksbill turtle	of less concern	of less concern	of potential concern	of less concern	of less concern	of less concern	of less concern	of concern	data deficient or not assessed
	Leatherback turtle	of less concern	of less concern	not of concern	of less concern	of less concern	of less concern	of less concern	of less concern	data deficient or not assessed
	Loggerhead turtle	of less concern	of less concern	of less concern	of potential concern	of less concern	of less concern	of less concern	not of concern	data deficient or not assessed
	Olive ridley turtle	of less concern	of less concern	of potential concern	of potential concern	of less concern	of less concern	of less concern	of concern	data deficient or not assessed
Sea snakes	Sea snakes[7]	of potential concern	data deficient or not assessed	not of concern	of concern	of less concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed
Sawfishes and river sharks	Dwarf sawfish	data deficient or not assessed	data deficient or not assessed	of concern	of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern
	Green sawfish	data deficient or not assessed	data deficient or not assessed	of concern	of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern
	Freshwater sawfish	data deficient or not assessed	data deficient or not assessed	of concern	of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern
	Northern river shark	data deficient or not assessed	data deficient or not assessed	of concern	of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern
	Speartooth shark	data deficient or not assessed	data deficient or not assessed	of concern	of concern	of less concern	data deficient or not assessed	data deficient or not assessed	data deficient or not assessed	of concern

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 key ecological features and heritage places can be found in the conservation value report cards.

7 Nineteen 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 sea snake species report card.

8 Thirty species of seahorse and pipefish were selected for analysis. These species were assessed as having the same ratings for all pressures considered, except for *bycatch. Bycatch from commercial fishing* was assessed as *of potential concern* for four of the species and as *not of concern* for the other species. The higher rating for the pressure has been listed in this table. More information on the seahorse and pipefish pressure analysis can be found in the seahorse and pipefish report card.

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

Species group	Protected species	Pressures[6]									
		Sea level rise	Changes in sea temperature	Changes in oceanography	Ocean acidification	Chemical pollution/ contaminants	Nutrient pollution	Changes in turbidity	Marine debris	Noise pollution	Light pollution
Seabirds	Brown booby										
Boobies and frigatebirds	Lesser frigatebird										
Shearwaters	Streaked shearwater										
Terns and noddies	Black-naped tern										
	Bridled tern										
	Caspian tern										
	Crested tern										
	Lesser crested tern										
	Little tern										
	Roseate tern										
	Common noddy										
Seahorses and pipefishes	Seahorses and pipefishes[8]										

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

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

Species group	Protected species	Pressures[6]								
		Physical hab itat modification	Human presence at sensitive sites	Extraction of living resources	Bycatch	Oil pollution	Collision with vessels	Disease	Invasive species	Changes in hydrological regimes
Seabirds	Brown booby									
Boobies and frigatebirds	Lesser frigatebird									
Shearwaters	Streaked shearwater									
Terns and noddies	Black-naped tern									
	Bridled tern									
	Caspian tern									
	Crested tern									
	Lesser crested tern									
	Little tern									
	Roseate tern									
	Common noddy									
Seahorses and pipefishes	Seahorses and pipefishes[8]									

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 key ecological features and heritage places can be found in the conservation value report cards.

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

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Marine Debris	Gulf of Carpentaria basin Plateaux and saddle north-west of the Wellesley Islands Gulf of Carpentaria coastal zone	Marine debris such as derelict fishing nets are an increasing global threat to marine life (MacFadyen et al. 2009). In northern Australia, debris have entangled sharks, cetaceans, large piscivorous fishes and turtles (Kiessling 2003). Much of the marine debris found along the northern Australian coastline, including derelict fishing nets, is believed to be of foreign origin (Roeger et al. 2005). Northern Australia is especially vulnerable to marine debris given the proximity of intensive legal and illegal fishing operations, difficulties in surveillance and enforcement of existing management arrangements, and ocean circulation patterns that are likely to concentrate floating debris before dumping it on coastlines and beaches (Kiessling 2003). Reports suggest a high number of marine species are being harmed and killed by debris while at sea, or as a result of injuries onshore (Chatto 1995 in Kiessling 2003). For example, turtle mortality associated with ghost nets in the Gulf of Carpentaria is unquantified, but is likely to amount to many hundreds of turtles per year (Limpus 2009). Marine debris may disrupt the breeding cycles of individual animals and compromise foraging habitats. Monofilament is highly persistent in the marine environment and has been documented as a major source of coral mortality in heavily fished localities (Smith et al. 2006). Marine species such as seabirds are also vulnerable to injury and mortality from marine debris through ingestion of lost or discarded plastics and other rubbish. In addition, marine debris such as derelict fishing gear can impact the Gulf of Carpentaria basin and coastal zone, and the plateaux and saddle north-west of the Wellesley Islands, through physically scouring or damaging the sea floor. A threat abatement plan was prepared in 2009 (DEWHA 2009b).

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

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Sea level rise (climate change)	Gulf of Carpentaria coastal zone	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 potentially reduce critical nursery habitats such as seagrass and mangroves, particularly in the southern Gulf of Carpentaria (Hill et al. 2002 cited in Hobday et al. 2006), for many marine species (Hobday et al. 2008). Declines in coastal seagrass and mangrove habitats could lead to changes in ecosystem structure, processes and connectivity between inshore and offshore habitats. Nutrients and organic matter sourced from productive coastal environments could be disrupted, as could ontogenetic (lifecycle) movements by fish and crustaceans between inshore habitats and the offshore Commonwealth marine environment (Haywood & Kenyon 2009).

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Changes in sea temperature (climate change)	Pinnacles of the Bonaparte Basin Carbonate bank and terrace system of the Van Diemen Rise Shelf break and slope of the Arafura Shelf Tributary canyons of the Arafura Depression Gulf of Carpentaria basin Plateaux and saddle north-west of the Wellesley Islands Submerged coral reefs of the Gulf of Carpentaria Gulf of Carpentaria coastal zone	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). This projected temperature change is expected to exceed the threshold for inducing coral bleaching on an annual basis (Hoegh-Guldberg 1999, 2005 cited in Hobday et al. 2006). Increases in sea temperature is expected to impact on the key ecological features of the North Marine Region, particularly through changes to the distribution, abundance, physiology, morphology and behaviour of zooplankton and pelagic, benthic and demersal fishes (Hobday et al. 2006). Extended periods of elevated temperature in shallow estuarine and coastal waters within the Gulf of Carpentaria coastal zone are likely to impact the distribution of fish and prawn nursery habitats, such as estuarine and coastal seagrasses and mangroves (Hobday et al. 2008). Coastal fringing coral reef communities are expected to be affected (Hoegh-Guldberg 2011); however, any likely impacts on corals within the submerged reefs of the Gulf of Carpentaria, and the plateaux and saddle north-west of the Wellesley Islands are unknown. Coral reefs and their associated fauna are especially vulnerable to impacts connected to changes in sea temperature through coral bleaching and mortality. Any decreases in coral abundance could lead to changes in ecosystem structure, processes and connectivity between coral reefs and adjacent waters. Nutrients and organic matter sourced from dynamic reef complexes and ontogenetic (lifecycle) movements of fish and crustaceans may be disrupted (Haywood & Kenyon 2009). Epifauna such as sponges, algae and coralline algae may also be impacted by elevated seawater temperatures (Brooke et al. 2009). Habitat declines are likely to have implications for marine species aggregations and biodiversity within the Gulf of Carpentaria coastal zone through disruption of ecosystem processes and connectivity between coastal and offshore ecosystems (Blaber 2009; Haywood & Kenyon 2009). During an El Niño event in the 1990s, for example, the supply and survival of reef-fish larvae within coral reef habitats was impacted by elevated sea temperature, causing declines in reef fish communities (Lo-Yat et al. 2011).

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Ocean acidification (climate change)	Pinnacles of the Bonaparte Basin Carbonate bank and terrace system of the Van Diemen Rise Shelf break and slope of the Arafura Shelf Tributary canyons of the Arafura Depression Gulf of Carpentaria basin Plateaux and saddle north-west of the Wellesley Islands Submerged coral reefs of the Gulf of Carpentaria Gulf of Carpentaria coastal zone	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 is of particular concern for those key ecological features of the North Marine Region that have coral formations. Acidification of corals is likely to alter the distribution and abundance of corals generally (Hobday et al. 2006), and atmospheric CO_2 levels above 500 parts per million will severely compromise coral viability (Hobday et al. 2006). The acidification of the ocean will impair the ability of species with calcareous shells such as echinoderms, crustaceans and molluscs to maintain shell integrity, resulting in reductions in the abundance and biodiversity of these species (Lawrence et al. 2007). For the plateaux and saddle north-west of the Wellesley Islands and the submerged coral reefs of the Gulf of Carpentaria, a decrease in coral abundance could lead to changes in ecosystem structure, processes and connectivity between the plateaux and reef waters. Nutrients and organic matter sourced from dynamic reef complexes could also be disrupted. For the Gulf of Carpentaria coastal zone, changes in dissolved CO_2 levels represent a threat to calcifying organisms such as corals, pteropods and coccolithophores (Poloczanska et al. 2007). Growth of mangroves and seagrasses may increase with elevated levels of atmospheric and dissolved CO_2, but any rises in sea level could at the same time compromise mangrove and seagrass habitats that support a diversity of marine life (Hill et al. 2002 cited in Hobday et al. 2006). Any decline in the ecological health of coral reef, mangrove and seagrass habitat within the coastal waters of the Gulf of Carpentaria will have a direct impact on ecosystem processes and biodiversity within adjacent offshore Commonwealth waters (Blaber 2009). This is because nutrients and organic matter exported from dynamic inshore complex habitats to offshore environments, as well as ontogenetic (lifecycle) movements of fish and crustacea between inshore and reef systems and offshore waters, are likely to be disrupted (Haywood & Kenyon 2009). Ocean acidification may also cause changes to the composition of ecological community structures dependent on hard substrate environments, which may in turn impact on food sources for higher trophic-level species.

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Marine Debris	Submerged coral reefs of the Gulf of Carpentaria	Marine debris such as derelict fishing nets are an increasing global threat to marine life (MacFadyen et al. 2009). In northern Australia debris have entangled sharks, cetaceans, large piscivorous fishes and turtles (Kiessling 2003). Much of the marine debris found along the northern Australian coastline, including derelict fishing nets, is believed to be of foreign origin (Roeger et al. 2005). Ocean circulation patterns are likely to concentrate floating debris in the Gulf of Carpentaria before dumping it on coastlines and beaches (Kiessling 2003).
Physical habitat modification (offshore construction)	Tributary canyons of the Arafura Depression Gulf of Carpentaria coastal zone	Although there is currently no extraction of oil or gas occurring within the North Marine Region, nine exploration wells have been drilled in the Arafura Basin adjacent to the tributary canyons of the Arafura Depression (DRET 2011) and two exploration permits cover much of the area. In addition, there are a number of offshore basins that are considered highly prospective for economically viable extraction of oil and gas deposits (Cadman & Temple 2003; Earl et al. 2006). The potential for pressures associated with oil and gas exploration and extraction in the Arafura Basin is therefore high. Physical habitat modification caused by offshore construction associated with these developments has the potential to cause temporary ecological impacts on the tributary canyons and the Gulf of Carpentaria coastal zone, and localised impacts on a broad range of benthic species. There are mining tenements to the west and north-west of Groote Eylandt for submarine mining of manganese ore (Groote Resources Ltd 2010). Although any activities associated with these tenements will occur in Northern Territory waters, they have the potential to impact ontogenetic (lifecycle) movements of crustacean and fish species from inshore to offshore Commonwealth waters (Haywood & Kenyon 2009). There are also mining tenements in Commonwealth waters south of Groote Eylandt.

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Physical habitat modification (storm events)	Gulf of Carpentaria coastal zone	Storms and cyclones have heavily modified marine habitats in the North Marine Region, and their intensity is predicted to increase (Hyder Consulting 2008). Present indications are that modest to moderate (up to 20 per cent) increases in average and maximum cyclone intensities are expected by the end of the century in some regions (Walsh & Ryan 2000). Cyclone activity can destroy seagrass beds and impact mangrove habitats (Hobday et al. 2008). For example, in 1985, Cyclone Sandy removed approximately 20 per cent of the seagrass beds in the Gulf of Carpentaria, which have taken approximately 10 years to recover (Hill et al. 2002 cited in Hobday et al. 2006). Shallow habitats including mangroves are most at-risk from severe weather. Intensive storms can cause very high levels of damage, and increased frequency of storms means that habitats and communities have less time to recover between storm events. Habitat loss will occur when the frequency and intensity of severe weather events exceed the habitat's ability to recover from one event to the next (Chin & Kyne 2007). Impacts associated with storms and cyclones include declines in coral reef, mangrove and seagrass communities located in nearshore waters, which can lead to changes in ecosystem processes and connectivity within adjacent offshore Commonwealth waters (Blaber 2009). Nutrients and organic matter exported from dynamic inshore complex habitats may be disrupted. Ontogenetic (lifecycle) movements by fish and crustacea between inshore and offshore waters are also likely to be disrupted (Haywood & Kenyon 2009).

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Extraction of living resources (IUU fishing)	Pinnacles of the Bonaparte Basin Carbonate bank and terrace system of the Van Diemen Rise Shelf break and slope of the Arafura Shelf Tributary canyons of the Arafura Depression Gulf of Carpentaria basin Plateaux and saddle north-west of the Wellesley Islands Submerged coral reefs of the Gulf of Carpentaria Gulf of Carpentaria coastal zone	In recent years, foreign illegal, unregulated and unreported (IUU) fishing has been a considerable issue across northern Australian waters for the threat it poses to target and bycatch species, border security, quarantine concerns and conservation of the marine environment more generally (Vince 2007). For example, in 2005, 13 018 illegal foreign fishing vessels were observed in Australian waters, and of those, only 600 were apprehended by Australian officials (Vince 2007). The number of foreign IUU fishing vessels sighted in northern Australian waters has declined significantly since 2005. However, although the total number of IUU vessels observed may have declined, there is some concern that fewer numbers of more powerful and sophisticated IUU fishing vessels may now be targeting Australian stocks (Lack & Sant 2008). IUU fishing has the potential to adversely affect widespread populations of multiple species, possibly with long-term, permanent impacts. Illegal foreign fishers have tended to target sharks for the valuable fin market, although the full extent of IUU fishing for shark in northern Australia is largely unquantified. Selected shark stocks targeted by foreign IUU fishers have declined or are overfished (Heupel & McAuley 2007). IUU catch of sharks is estimated to be twice that of reported legal catch (Heupel & McAuley 2007).

Key ecological features assessed = 8		
Pressure	**KEF**	**Rationale**
Oil pollution (oil rigs, onshore and offshore mining operations)	Shelf break and slope of the Arafura Shelf Tributary canyons of the Arafura Depression	Australia has a strong system for regulating industry activity that is the potential source of oil spills and this system has been strengthened further in response to the Montara oil spill. While oil spills are unpredictable events and their likelihood is low based on past experience, their consequences, especially for threatened species at important areas, could be severe. A number of the key ecological features of the region have characteristics that make their ecosystems and communities vulnerable to the effects of an oil spill; for example, features that include localised areas of high productivity, which attract large aggregations of marine life. The intensity and distribution of activities implicated in oil spills—such as oil production and transport—are likely to increase in the region.
Changes In hydrological regimes	Gulf of Carpentaria coastal zone	Changes in flows and characteristics of fresh water entering the Gulf of Carpentaria coastal zone have the potential to impact higher trophic species and commercial fishery species due to a reduction in the transport of terrigenous nutrients (sediments derived from land erosion and carried out to sea by rivers) to coastal habitats, loss of food availability and changes to triggers, such as flooding, that are emigration cues for key marine species (Burford et al. 2010). Impacts on key ecological features in the North Marine Region related to changes in hydrological regimes may be of greater concern if there is significant growth in agricultural and water resource development in adjacent coastal areas (CSIRO 2009).

Table S1.6: Pressures *of concern* to selected cetaceans in the North Marine Region

Species assessed = 3		
Pressure	**Species**	**Rationale**
Physical habitat modification (onshore)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Increased physical habitat modification associated with onshore construction is expected in and adjacent to the North Marine Region due to the rise in commercial development in the area As part of the Inpex Browse Ltd project, an onshore liquefaction (LNG) and fractionation (LPG) facility will be constructed at Blaydin Point, Darwin. All three inshore dolphin species are known to inhabit this area. The construction activities will impact the marine environment of Darwin Harbour, with the most significant impacts expected during the construction phase (NRETAS 2011). In order to monitor the impacts on inshore dolphins, a research project is being developed to identify particular habitats and provide a baseline estimate of inshore dolphin abundance (Inpex 2012). Construction activities that physically modify the marine environment have the potential to displace populations of dolphins that rely on specific characteristics of an area. As populations of Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins are small and localised, they are particularly susceptible to habitat degradation and displacement from construction activities (Corkeron et al. 1997; Parra et al. 2006; Ross 2006). Although the long-term impacts of habitat loss and degradation on cetaceans in Australia are largely unknown, globally, many cetacean populations have been significantly affected by changes to their habitat (CMS 2011; Elliot et al. 2009; IUCN 2010; Jefferson et al. 2009). Habitat modification from coastal development is considered one of the greatest threats to inshore dolphins (Corkeron et al. 1997; Parra et al. 2006; Ross 2006).

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

Species assessed = 3		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Australian snubfin dolphin	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 expected to produce long-term impacts in areas adjacent to the North Marine Region, including mangrove habitats and seagrass beds, which are important habitats for dolphins and their prey species (Parra et al. 2002; Parra & Corkeron 2001; Robertson & Arnold 2009). Although the impacts of sea level rise on Australian snubfin dolphins 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 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 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, sea temperature changes are predicted to have a significant impact on the distribution and abundance of benthic fishes and demersal fishes (Hobday et al. 2006), which are primary prey species for inshore dolphins, and the zooplankton and associated biological communities upon which these prey species rely (Hobday et al. 2006). Any impacts on Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphin prey availability may affect the species across their range, both in coastal and offshore waters.

Species assessed = 3		
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 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. 2007). Indo-Pacific humpback and Indo-Pacific bottlenose dolphins consume reef species where their habitat includes islands and reefs, and Australian snubfin dolphins are also found in habitat complexes that include reefs. If reef species are adversely affected by ocean acidification as is anticipated, Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins in the North Marine Region may experience reduced prey availability.
Chemical pollution/ contaminants (onshore and offshore mining operations)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Although chemical pollution is relatively rare in the North Marine Region, mining operations in and adjacent to the region have the potential to introduce chemicals into the Commonwealth marine environment. For example, in 2010, a chemical spill at a mine and refinery in Nhulunbuy, about 1000 km east of Darwin, released approximately 88 tonnes of alumina into Gove Harbour, adjacent to the region (Rebgetz et al. 2010). Chemical pollution may increase as mining operations in the region expand (Bannister et al. 1996). Cetaceans that frequent nearshore areas, such as Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins, 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 Australia's 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 adverse physiological effects on a variety of vertebrates. These effects—which include immunosuppression, hepatotoxicity, carcinogenesis, reproductive and developmental toxicity, dermal toxicity and neurotoxicity—can lead to impaired fertility, reduced fecundity and increased mortality.

Species assessed = 3		
Pressure	**Species**	**Rationale**
Marine debris	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Marine debris accumulates in high concentrations along the coasts of north-western Cape York, Groote Eylandt, north-east Arnhem Land and the far north Great Barrier Reef (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). Dolphins have been recorded entangled in derelict fishing gear around Australia's coasts (Chatto & Warneke 2000). The Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins can also be impacted by marine debris through ingestion of lost or discarded plastics and other refuse. Since 1998, there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion, with the majority (92.2 per cent) relating to entanglement. Between 1990 and 2008, the death or injury of 14 species can be directly attributed to interactions with plastic debris (Ceccarelli 2009). Studies and personal observations have recorded Indo-Pacific humpback dolphins and other unidentified species either dead or alive in fishing nets (Kiessling 2003). However, the degree of impact of marine debris on inshore dolphins is largely unknown. There may be interactions between dolphins and marine debris at sea that go unrecorded, such as dolphins becoming entangled in marine debris when targeting prey species that are attracted to floating debris. Entanglement can cause drowning, suffocation, strangulation, starvation and injuries for cetaceans (DEWHA 2009a). Ingestion can cause blocking or perforation of the digestive tract, resulting in injury or death (Ceccarelli 2009). It is reasonable to expect that marine debris may substantially impact inshore dolphins as the effectiveness of management of this issue is uncertain.

Species assessed = 3		
Pressure	**Species**	**Rationale**
Noise pollution (shipping, vessels (other))	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Shipping is expected to increase in the North Marine Region due to the expansion of oil and gas operations and associated seismic activity, onshore and offshore mining, the development of Darwin Harbour and the associated export trade, and increasing cruise ship activity. The potential impacts on inshore dolphins of elevated noise levels from activities such as shipping include limiting the detection of natural sounds, disturbing normal behaviour resulting in possible displacement from areas, and physical trauma causing death and/or temporary or permanent physical damage to sensory systems (Di Iorio & Clark 2010; Nowacek et al. 2007; NRC 2005; Richardson et al. 1995). In addition, inshore dolphins rely on acoustic signals to maintain contact with each other and vessel noise can mask communication (Van Parijs & Corkeron 2001). Given cetaceans' sensitive hearing and the known effects of underwater noise, it can be inferred that disturbance and displacement of inshore dolphins occurs when exposed to even low levels of underwater noise. In particular, both the Australian snubfin dolphin and the Indo-Pacific humpback dolphin are expected to exhibit vessel avoidance behaviour in response to vessel traffic noise (DSEWPaC 2011a, 2011b) because they produce whistles at a frequency that overlaps with the frequencies emanating from vessel traffic.
Noise pollution (onshore and offshore construction)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Oil and gas operations, onshore and offshore mining, and the development of Darwin Harbour and the associated export trade all have the potential to increase ocean noise. Although there is a lack of specific data on the effects of noise pollution on small cetaceans in the North Marine Region, noise pollution from anthropogenic sources has the potential to adversely impact small cetaceans (Nowacek et al. 2007). 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). The potential effects of elevated noise levels from activities such as pile-driving can also include limiting the detection of natural sounds and disturbing normal behaviour, resulting in possible displacement from areas (Nowacek et al. 2007; Richardson et al. 1995). Kent et al. (2009) found that high-sensitivity frequencies of marine mammals overlap with the higher frequencies of pile-driving noise levels (10 Hz to 5 kHz).

Species assessed = 3		
Pressure	**Species**	**Rationale**
Physical habitat modification (dredging and offshore construction)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	The likelihood of dredging and offshore construction activity in the North Marine Region is increasing due to a rise in industrial development in locations such as Darwin Harbour and Weipa in the western Gulf of Carpentaria (DEWHA 2008a), and manganese mining near Groote Eylandt. There are also mining tenements in Commonwealth waters south of Groote Eylandt. As populations of Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins are small and localised, they are particularly susceptible to habitat degradation and displacement (Corkeron et al. 1997; Parra et al. 2006; Ross 2006), both of which can be caused by dredging and offshore construction activities. Dredging is more likely to have substantial impacts on Australian snubfin dolphins due to their preference for localised, shallow-water habitat and residency. Dredging for major developments can occur at considerable scale and over a number of years, particularly with port developments. These activities are likely to result in local-scale change in the composition, structure and function of habitat, and increase the potential for a wide range of pressures, including direct removal of 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 populations of cetaceans (Bannister et al. 1996).

Species assessed = 3		
Pressure	**Species**	**Rationale**
Bycatch (commercial fishing)	Australian snubfin dolphin Indo-Pacific bottlenose dolphin Indo-Pacific humpback dolphin	Bycatch predominantly results in drowning of cetacean species and may cause changes to species distribution and population health. 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). Diet studies of Australian snubfin dolphins and Indo-Pacific humpback dolphins by Heinsohn (1979), Marsh et al. (1989) and Parra and Jendensjö (2009) indicate that coastal–estuarine waters are important foraging habitats for these species and, as a result, they are at greater risk of directly or indirectly interacting with fisheries operating in coastal waters (Parra & Jendensjö 2009). Indo-Pacific bottlenose dolphins share a similar distribution. All three species also occur offshore in the North Marine Region, and are therefore vulnerable to fisheries operating in Commonwealth waters. Gillnets are likely to impact small cetaceans (Read et al. 2006; Reeves et al. 2003; Reeves & Brownell 2009; Slooten 2007). In the Northern Territory, the distribution of both Australian snubfin and Indo-Pacific humpback dolphins often coincides with the commercial Northern Territory barramundi gillnet fisheries and coastal net fishing areas (DPIFM 2005). However, there are few recent records of interactions between fisheries and inshore dolphins in the North Marine Region (DPIFM 2005, 2006; DRDPIFR 2008, 2009, 2010).

Table S1.8: Pressures *of potential concern* to dugongs in the North Marine Region

Species assessed = 1		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Dugong	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 at the seagrass canopy 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 the survival of seagrasses. The effect of seagrass loss or dieback on dugongs is twofold. Some dugongs remain in the affected area but lose body condition, reduce breeding and suffer increased mortality, while others move hundreds of kilometres with uncertain consequences (Marsh & Kwan 2008; Preen & Marsh 1995). It is possible that new seagrass habitats will develop as low-lying coastal areas become intertidal; however, the overall effect of sea level rise on dugong habitats in the North Marine Region is uncertain.
Changes in sea temperature (climate change)	Dugong	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). Increases in sea temperature as a result of climate change are 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 temperature has the potential to affect dugongs through loss of suitable feeding habitat. Dugongs in areas with decreasing seagrass availability are either likely to remain in the area but lose body condition, reduce 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	Dugong	Marine debris, including lost or discarded fishing nets, accumulates in high concentrations along the coasts adjacent to the North Marine Region, especially along the coasts of north-western Cape York, Groote Eylandt and north-east Arnhem Land (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). There are records of dugongs being stranded as a result of marine debris in Numbulwar (1996–98) and Northern Cape York (2001) (Kiessling 2003). In Queensland, there are annual reports of dugongs killed by ingestion of, or entanglement in, lost or discarded fishing gear (e.g. Greenland et al. 2003). Marine debris is likely to cause injury or death to individual dugongs.
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 per cent) increases in average and maximum cyclone intensities are expected by the end of the century in some regions (Walsh & Ryan 2000). Lawler et al. (2007) note that 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. Episodic losses of hundreds of square kilometres of seagrass can be associated with extreme weather events such as cyclones and floods (Poiner & Peterkin 1996; Preen & Marsh 1995). Seagrass availability can also be affected by storm events through decreased light availability and increased sediment deposits. Furthermore, storm surges can lead to the direct mortality of dugongs by dumping animals above the high-tide level (Marsh 1989).
Extraction of living resources (Indigenous harvest)	Dugong	Indigenous harvest of dugongs occurs in many communities adjacent to the North Marine Region. The level of harvest, and thus the sustainability of this harvest, is unknown. However, the low reproductive rate, long generation time and large investment in offspring make dugongs vulnerable to overexploitation. Marsh et al. (2002) note that the maximum rate of increase of the dugong population under optimum conditions when natural mortality is low would be around 5 per cent 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**
Extraction of living resources (IUU fishing)	Dugong	Illegal, unreported and unregulated (IUU) fishing occurs in the North Marine Region, primarily due to the region's proximity to the edge of Australia's exclusive economic zone. Incursions into the region by fishing vessels from south-east Asia are frequently recorded. There is anecdotal evidence of dugong mortality in the North Marine Region due to foreign fishing vessels operating illegally in the region, and illegal harvesting of dugongs for use as bait in crab pots (Marsh et al. 2002). However the species-level impacts on dugongs are unknown.
Bycatch (commercial fishing)	Dugong	Bycatch of dugongs in gillnets has been reported (NTDR 2011) but is largely unquantified as a cause of dugong mortality throughout the species' range, including in the North Marine Region (Marsh et al. 2002). For example, Coates (2002, cited in PWS 2003) reported that over a 15-month period approximately 42 per cent of the total mortality of dugongs in the Borroloola region was from non-Indigenous human activities such as commercial fishing. A range of fisheries management measures are in place to reduce bycatch of dugongs (Saalfeld & Marsh 2004; Zeroni & Wood 2004, NTDR 2011). For example, a Dugong Protection Area has been established in the south-western Gulf of Carpentaria to minimise dugong interaction as part of the management arrangements for the Northern Territory Barramundi Fishery. However, there is still overlap between commercial fishing areas and dugong habitat and the overall effectiveness of existing measures is still to be assessed. Bycatch therefore remains *of potential concern*, especially as dugongs are highly mobile.

Table S1.9: Pressures *of concern* to marine reptiles in the North Marine Region

Species assessed = 26		
Pressure	**Species**	**Rationale**
Marine debris	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Olive ridley turtle	Marine debris, including lost or discarded fishing nets, or 'ghost nets', accumulates in high concentrations along the coasts adjacent to the North Marine Region, especially of north-western Cape York, Groote Eylandt and north-east Arnhem Land (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). Ingesting lost or discarded plastic or other debris (e.g. plastic bags, styrofoam beads, packing tape and rope fragments) can cause internal blockage, ulcers, poisoning and suffocation in marine turtles (DSEWPaC 2011c). Turtles may also be injured or killed if they become entangled in debris (DSEWPaC 2011c). Floating debris particularly affects juvenile turtles, as they spend their first years drifting in convergences, such as rips, fronts and drift lines formed by ocean currents (DSEWPaC 2011c). Debris on nesting beaches can interfere with a turtle's ability to dig an egg chamber to deposit eggs or may prevent hatchlings from reaching the sea (Hutchinson & Simmonds 1991).

Species assessed = 26		
Pressure	**Species**	**Rationale**
Bycatch (commercial fishing)	Elegant seasnake Horned seasnake Large-headed seasnake Olive seasnake Olive-headed seasnake Ornate seasnake Small-headed seasnake Spectacled seasnake Spine-bellied seasnake Spine-tailed seasnake Stoke's seasnake	Bycatch of sea snakes during prawn trawling is the major pressure on sea snake populations (Heatwole 1999) in the North Marine Region. Over a period of 30 days in November 2007, a single prawn trawler in the western Gulf of Carpentaria caught 289 sea snakes, of which 139 were released alive from the vessel (Northern Territory Museum, unpublished records). In 2009, 7369 sea snakes were reported in logbook records as caught in the Northern Prawn Fishery (Wilson et al. 2010). Past research has indicated that approximately 50 per cent of the sea snakes caught as bycatch in trawls died by drowning or being crushed by the weight of the catch (Wassenberg et al. 2001). 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). Openings in the top of the nets are successful in reducing the bycatch of sea snakes (Milton 2001; Milton et al. 2009). Pressure on sea snakes by commercial fishing has been reduced through technological innovations such as bycatch reduction devices which, if adopted and installed appropriately, reduce the mortality of captured sea snakes by 50 per cent (Heales et al. 2008; Milton et al. 2009).

Species assessed = 26		
Pressure	**Species**	**Rationale**
Invasive species	Flatback turtle Green turtle Hawksbill turtle Olive ridley turtle	Egg predation by introduced species is a significant issue for marine turtle populations. Of particular concern to populations within the North Marine Region is egg predation by feral pigs, foxes and dogs at nesting sites adjacent to the region, which could have significant adverse impacts on marine turtle stocks, as it has in the East and the North-west Marine regions for the loggerhead turtle (Limpus & Limpus 2003; Limpus & Parmeter 1985; Tisdell et al. 2004). In western Cape York Peninsula, pigs destroy a high proportion of the limited number of hawksbill turtle clutches laid on these mainland rookeries, as well as those laid by olive ridley and flatback turtles (National Oceans Office 2004). Elsewhere, predation by foxes can be as high as 70 per cent on some beaches (DEWHA 2008b). Once nests have been disturbed, remaining eggs or hatchlings are likely to be consumed by other predators or die from exposure. Threat abatement plans have been prepared under the EPBC Act for pigs and foxes (DEH 2005a; DEWHA 2008c).

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

Species assessed = 26		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Olive ridley turtle	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 implications of sea level rise for turtles include an increased risk of tidal inundation or destruction of turtle nests, an increased selection of suboptimal nesting zones and an increased risk of nest destruction by other nesting turtles associated with higher nesting densities (Hamann et al. 2007; Poloczanska et al. 2010). Collectively, these impacts may reduce a turtle population's reproductive success. Sea level rise may also impact on turtle foraging by decreasing growth rates in benthic plants such as seagrasses, thus reducing foraging areas (Poloczanska et al. 2010).
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 °C between 1910–1929 and 1989–2008, and current projections estimate ocean temperatures will be 1 °C warmer by 2030 (Lough 2009). Increasing sea temperature have the potential to impact on 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); and reduced prey availability (Chaloupka et al. 2008 cited in Fuentes et al. 2009). Little is known of the thermal requirements and tolerances of sea snakes and how increased temperature will affect their behaviour and ecology (Hamann et al. 2007). However, predicted changes in sea temperature are thought to affect the availability of sea snake food species and alter their seasonal movements for either breeding or feeding (Fuentes et al. 2009; Hamann et al. 2007).

Species assessed = 26		
Pressure	**Species**	**Rationale**
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. However, the species-level impacts of ocean acidification on sea snakes remain uncertain (Hamann et al. 2007).
Marine debris	Loggerhead turtle	Marine debris, including lost or discarded fishing nets, or 'ghost nets', accumulates in high concentrations along the coasts adjacent to the North Marine Region, especially of north-western Cape York, Groote Eylandt and north-east Arnhem Land (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). Ingesting lost or discarded plastic or other debris (e.g. plastic bags, styrofoam beads, packing tape and rope fragments) can cause internal blockage, ulcers, poisoning and suffocation in marine turtles (DSEWPaC 2011c). Turtles may also be injured or killed if they become entangled in debris (DSEWPaC 2011c). Floating debris particularly affects juvenile turtles, as they spend their first years drifting in convergences, such as rips, fronts and drift lines formed by ocean currents (DSEWPaC 2011c). Debris on nesting beaches can interfere with a turtle's ability to dig an egg chamber to deposit eggs or may prevent hatchlings from reaching the sea (Hutchinson & Simmonds 1991).
Noise pollution (seismic exploration)	Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Olive ridley turtle	Marine turtles can detect low-frequency noise and are influenced by it. Green and loggerhead turtles have shown behavioural responses to tests on the effects of air gun seismic arrays used in seismic surveying (McCauley et al. 2000). Although seismic surveys, which produce noise pollution in the water, are unlikely to cause the death of turtles, they may cause changes in their foraging, internesting, courting or mating behaviour. The danger of gross physiological damage is relatively low, and apparently an issue only at very close range (and possibly in unusual topographic situations). There are clear avoidance responses in all marine turtle species at ranges of one to several kilometres; it is likely that the sounds are audible and may mask important communication or perceptual cues at much greater ranges (Cummings & Brandon 2004).

Species assessed = 26		
Pressure	**Species**	**Rationale**
Light pollution (offshore activities)	Flatback turtle Green turtle Hawksbill turtle Olive ridley turtle	Although there are few existing light pollution issues in the North Marine Region, light pollution from offshore activities poses a potential threat to marine turtles. An emerging issue is light pollution from shipping, particularly within the Arafura Sea where there is an increasing probability of interactions between key marine turtle sites and shipping traffic. Although the volume of shipping traffic is not currently considered significant, shipping routes through the Arafura Sea are busy, and the volume of shipping traffic is likely to increase (Darwin Port Corporation 2010). Artificial lighting can disorientate foraging turtles and may divert them from their usual route as they move to and from rookeries. Boats that anchor at night adjacent to major rookeries with deck lights on have trapped dispersing hatchlings in the glow of the lights for an extended time (EPA Turtle Conservation Project, unpublished data in Limpus 2009). Intense predation of these concentrations of light-trapped hatchlings can occur (Limpus 2009).
Physical habitat modification (dredging)	Sea snakes	With increasing coastal development adjacent to the North Marine Region, and anticipated increases in industrial activities in the region, the likelihood of interactions between sea snakes and dredging activities is expected to increase (Guinea et al. 2004). No data are available on the impact of dredging activities on sea snakes. However, potential impacts include removal of habitat of prey species, increased turbidity impacting on those species that rely on vision for feeding and the covering of foraging habitat with dredge spoil. Data on sea snakes from elsewhere indicate that they do not recolonise reefs in which populations have decreased (Burns & Heatwole 1998; Lukoschek et al. 2007).
Extraction of living resources (Indigenous harvest)	Flatback turtle Green turtle Hawksbill turtle Olive ridley turtle	The Indigenous harvest of marine turtles has occurred for millennia, with turtles being taken for their meat and to make a range of products, including leather, cosmetics, jewellery and other ornaments (Limpus 2009). Indigenous harvest continues across the North Marine Region under the provisions outlined in section 211 of the *Native Title Act 1993*. Green turtles tend to be preferentially taken for meat, and eggs of most species are harvested. In two surveys of an 11 km beach at Nanydjaka, 87–95 per cent of eggs laid by all four marine turtle species in that area were taken (Limpus 2009).

Species assessed = 26		
Pressure	**Species**	**Rationale**
Bycatch (commercial fishing)	Flatback turtle Loggerhead turtle Olive ridley turtle Beaked seasnake Black-headed seasnake Dubois seasnake Dwarf seasnake Fine-spined seasnake Plain seasnake Plain-banded seasnake Yellow-bellied seasnake	Globally, bycatch of turtles is considered to be one of the most significant threats to their ongoing survival (Lewison et al. 2004). Typically, bycatch interactions result in the drowning of individual turtles. Turtles are particularly vulnerable to trawl, gillnet and longline fishing gear. All three gear types are used across the North Marine Region, and interactions of marine turtles with them have been recorded in northern Australia (DPIFM 2005, 2006; DRDPIFR 2008, 2009, 2010). The introduction of turtle excluder devices in the Northern Prawn Fishery and Torres Strait Trawl Fishery has significantly addressed this pressure on olive ridley and flatback turtles. Loggerhead turtles have a greater propensity than other marine turtles to consume baited longline hooks (Witzell 1998). Bycatch of sea snakes during prawn trawling is the major pressure on sea snake populations (Heatwole 1999) in the North Marine Region. Over a period of 30 days in November 2007, a single prawn trawler in the western Gulf of Carpentaria caught 289 sea snakes, of which 139 were released alive from the vessel (Northern Territory Museum, unpublished records). In 2009, 7369 sea snakes were reported in logbook records as caught in the Northern Prawn Fishery (Wilson et al. 2010). In addition to those species that are regularly caught in trawl fisheries, a number of unidentified sea snake species have been caught in commercial prawn trawls (Milton et al. 2008; Wassenberg et al. 2001). Past research has indicated that approximately 50 per cent of the sea snakes caught as bycatch in trawls died by drowning or being crushed by the weight of the catch (Wassenberg et al. 2001). 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). Openings in the top of the nets are successful in reducing the bycatch of sea snakes (Milton 2001; Milton et al. 2009). Pressure on sea snakes by commercial fishing has been reduced through technological innovations such as bycatch reduction devices which, if adopted and installed appropriately, reduce the mortality of captured sea snakes by 50 per cent (Heales et al. 2008; Milton et al. 2009).

Species assessed = 26		
Pressure	**Species**	**Rationale**
Invasive species	Saltwater crocodile	Crocodile habitat and available nesting areas may be reduced by introduced species such as buffalos and pigs. In Arnhem Land, Northern Territory, feral animals such as buffalo destroy the wetland habitat of crocodiles by increasing drainage and reducing vegetation (Webb et al. 1984, 1987). Recently, it has been reported that numbers of feral buffalo and pig are increasing, which could lead to adverse impacts on saltwater crocodiles through damage to nesting vegetation (Leach et al. 2009). There is also anecdotal evidence that saltwater crocodiles are affected by introduced plants, such as *Mimosa pigra*, invading freshwater wetlands, which can reduce the availability of nesting habitat (Leach et al. 2009).

Table S1.11: Pressures *of concern* to sawfishes and river sharks in the North Marine Region

Species assessed = 5		
Pressure	**Species**	**Rationale**
Extraction of living resources (IUU fishing)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Although the full extent of illegal, unregulated and unreported (IUU) fishing in northern Australia is largely unquantified, sawfishes and river sharks are considered to be vulnerable to both domestic and foreign IUU fishing. In 2005, it was estimated that illegal shark catches by foreign fishers in the Gulf of Carpentaria were at least equivalent to those caught legally by Australian fishers (Pascoe et al. 2008). The high-quality and high-value fins of sawfish make the species particularly attractive to foreign IUU fishers. A market also exists for sawfish rostra (Lack & Sant 2008). Sawfish have been documented among confiscated foreign IUU catches. Illegal fishing has also been identified as a threat to the green sawfish in the Threatened Species Listing Advice for that species (Garrett 2008). There is evidence that the level of illegal foreign fishing effort has decreased by as much as 80 per cent since 2005. However, while the number of illegal vessels sighted per day has declined since that time, there is concern that more powerful vessels with more sophisticated equipment are now being used (Lack & Sant 2008).
Bycatch (commercial fishing)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Commercial fishing has been identified as the major pressure on all sawfish and river shark (*Glyphis*) species in Australia, and substantial declines in several species have been attributed to it (Pillans et al. 2008; Stevens et al. 2005, 2008). In particular, 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). Some species, including dwarf sawfish and green sawfish, have limited tidally influenced movements and are vulnerable to net fishing operations when actively feeding on mud and sand flats (Stevens et al. 2008). Dwarf sawfish have been recorded as trawl bycatch in the Northern Prawn Fishery when operating in the North Marine Region (Stobutzki et al. 2002). Mortality rates for sharks caught as bycatch are high. For example, mortality rates of dwarf sawfish and green sawfish caught as bycatch in gillnets in the Northern Territory Barramundi Fishery have been about 50 per cent (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).

Species assessed = 5		
Pressure	**Species**	**Rationale**
Bycatch (recreational and charter fishing)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	The ranges of sawfish and *Glyphis* species overlap with popular recreational fishing locations in some parts of the North Marine Region and adjacent areas. Recreational fishing continues to grow in popularity in the region, and with a growing population, improvements in technology, larger boats and an increase in fishing tour operators (DRDPIFR 2010), more remote areas of the region are now becoming more accessible to recreational fishing. Observations of dead, discarded sawfish and *Glyphis* species from recreational fishing highlight that mortality occurs as a direct result of capture and discarding (Stevens et al. 2005; Thorburn et al. 2003). Given the species' suspected small population sizes and restricted habitats—dwarf sawfish, green sawfish and speartooth shark have all be shown to repeatedly use restricted areas of habitat (Pillans et al. 2010; Stevens et al. 2008)—these species are all vulnerable to localised depletion from bycatch. The correct identification of *Glyphis* is an ongoing issue for fishers and may result in unintentional mortality. Damage from capture and handling or from retained fishing line and hooks may cause post-release mortality in sawfish and *Glyphis* species. The rostra of sawfish present a tempting curio, the attainment of which results in mortality (Thorburn et al 2003).

Species assessed = 5		
Pressure	**Species**	**Rationale**
Changes in hydrological regimes	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Neonate and juvenile sawfish and *Glyphis* species use estuarine and/or freshwater environments (Pillans et al. 2010; Stevens et al. 2005), as well as offshore environments. Freshwater environments are important nursery areas for freshwater sawfish. It is thought that pupping in all northern Australian sawfish species and *Glyphis* species coincides with the monsoonal wet season (Peverell 2005; Pillans et al. 2010; Whitty et al. 2008). Wet-season freshwater flows have been suggested as 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. The alteration of flow could change the timing of sawfish and *Glyphis* reproduction and levels of recruitment. Barriers and impoundments can cause siltation and a reduction in saltwater intrusion, and restrict movements of sawfish and *Glyphis* species. Dredge and fill activities can reduce light penetration by increasing turbidity; alter tidal exchange, mixing and circulation; reduce nutrient outflow from marshes and swamps; increase saltwater intrusion; and create 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 S1.12: Pressures *of potential concern* to sawfishes and river sharks in the North Marine Region

Species assessed = 5		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Global sea levels have risen by 20 cm between 1870 and 2004 and predictions estimate a further rise of 5–15 cm by 2030, relative to 1990 levels (Church et al. 2009). Longer term predictions estimate increases of 0.5 m to 1.0 m by 2100, relative to 2000 levels (Climate Commission 2011). Sea level rise will have significant effects on the habitat of some sawfish and river shark (*Glyphis*) species, including increasing salinity in estuaries and the lower reaches of creeks and rivers. Mangroves may decline in some areas (Chin & Kyne 2007). Sawfish and *Glyphis* 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 the distributions of northern Australian sharks (Thorburn et al. 2003). In particular, freshwater sawfish, speartooth sharks, dwarf sawfish and green sawfish have been assessed as having high exposure to the effects of rising sea levels (Chin et al. 2010).
Changes in sea temperature (climate change)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth 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 may result in changes in metabolism, behaviour and movement patterns in elasmobranchs (Chin & Kyne 2007). Increased temperature will also result in lower dissolved oxygen concentrations in the water, which may cause respiratory stress and increased metabolic rates in sharks (Chin & Kyne 2007). There is little evidence that the occurrence or severity of disease in sharks has changed due to anthropogenic factors, including climate change. However, future increases in temperature may increase the incidence of disease by facilitating the spread of warm-water parasites, and increasing the parasites' growth rate and reproductive output (Chin & Kyne 2007).

Species assessed = 5		
Chemical pollution/ contaminants (onshore and offshore mining operations)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Although chemical pollution is relatively rare in the North Marine Region, industrial point-source pollution can introduce compounds toxic to elasmobranchs and their prey into the marine environment, and mining in and adjacent to the region can introduce heavy metal pollutants and radioactive isotopes into the environment. For example, in 2010, a chemical spill at a mine and refinery in Nhulunbuy, about 1000 km east of Darwin, released approximately 88 tonnes of alumina into Gove Harbour, adjacent to the region (Rebgetz et al. 2010). Organochlorines can lead to feminisation and other compounds toxic to elasmobranchs and their prey, can lead to a reduction in prey biomass and possibly in elasmobranch biomass (Clark et al. 1985; Mearns et al. 1988).
Marine debris	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	Marine debris accumulates in high concentrations along the coasts adjacent to north-western Cape York, Groote Eylandt and north-east Arnhem Land (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). Because of their saw-like rostrum, sawfish may be especially susceptible to entanglement in marine debris. Entanglement has been reported in a number of types of marine debris, including polyvinyl chloride (PVC) piping, elastic bands, and various types of fishing line and bait nets (Kiessling 2003; Seitz & Poulakis 2006). Such entanglement can cause serious or fatal injury (Thorburn et al. 2004). The likelihood of interaction between marine debris and *Glyphis* species is unknown; however, the occurrence of sawfish and *Glyphis* species in popular recreational fishing locations may expose them to lost or discarded fishing line and other debris. Offshore, they may interact with larger marine debris.

Species assessed = 5		
Extraction of living resources (commercial fishing)	Freshwater sawfish	The take of listed sawfish and *Glyphis* species is generally prohibited in Northern Territory, Queensland and Commonwealth waters. There is however a limited harvest of freshwater sawfish (*Pristis microdon*) permitted in Queensland and the Northern Territory for exhibition in domestic aquaria. Given the vulnerable status of freshwater sawfish in Australian waters, significant uncertainties regarding current populations, and the current level of anthropogenic mortality from all sources (including commercial, recreational, Indigenous, domestic and international illegal, unregulated and unreported fishing), DSEWPaC has found that, at this stage, 'it is not possible to conclude with a reasonable level of certainty that any harvest of freshwater sawfish for export purposes would not be detrimental to the survival or recovery of the species' (DEWHA 2010). Although a number of management measures have been implemented, without population data it is unknown whether these measures have been effective in contributing to any recovery of the species.
Extraction of living resources (Indigenous harvest)	Dwarf sawfish Green sawfish Freshwater sawfish Northern river shark Speartooth shark	The level of Indigenous harvest of sawfish and *Glyphis* is unknown and therefore the impact on sawfish and *Glyphis* populations is unclear. However, both are fished, and sawfish have traditionally been an important source of food and cultural significance to Indigenous communities in northern Australian (McDavitt 1996; Thorburn et al. 2004). Given their suspected small population sizes and restricted habitats—dwarf sawfish, green sawfish and speartooth shark have all be shown to repeatedly use restricted areas of habitat (Pillans et al. 2010; Stevens et al. 2008)—these species are vulnerable to localised depletion from harvest. The dry-season riverine habitat of freshwater sawfish often retracts into a series of isolated pools, which can make them more susceptible to harvest, as they are concentrated in smaller areas of habitat.

Table S1.13: Pressures *of potential concern* to seabirds in the North Marine Region

Species assessed = 11		
Pressure	**Species**	**Rationale**
Sea level rise (climate change)	Brown booby Lesser frigatebird Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	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 foraging areas and low-lying nesting habitats of seabirds may be altered or lost if the sea level rises (Hobday et al. 2006). Even a relatively small rise in sea level could have major impacts on low-lying islands and, in particular, on surface-nesting species (Chambers et al. 2009). Seabirds that prefer to nest on offshore islands are particularly vulnerable to this pressure.
Changes in sea temperature (climate change)	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	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 temperature is expected to expand or shift seabird and seabird 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). There is also recent evidence that sea temperature variation at smaller within-season and day-to-day timescales significantly impacts seabird foraging success, growth patterns and reproductive output (Johnson & Marshall 2007).

Species assessed = 11		
Pressure	**Species**	**Rationale**
Changes in oceanography (climate change)	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	Oceanographic changes have been related to changes in seabird breeding participation and success, mortality and shifts in distribution (Chambers et al. 2009). Alteration of currents is predicted to impact on the distribution, migration and foraging of seabirds (Hobday et al. 2006).
Ocean acidification (climate change)	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	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). Acidification has the potential to adversely affect many organisms that use calcium carbonate for their skeletons and shells, including corals, molluscs and some phytoplankton species (Hobday et al. 2006; Scientific Committee on Ocean Research 2009). This impact may have flow-on effects for seabirds that rely on food sources such as fish that are dependent on coral reef habitats.

Species assessed = 11		
Pressure	**Species**	**Rationale**
Marine debris	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	Injury and fatality to vertebrate marine life caused by ingestion of or entanglement in harmful marine debris was listed in 2003 as a key threatening process under the EPBC Act (DEWHA 2009a). Marine debris accumulates in high concentrations along the coast of north-western Cape York, Groote Eylandt and north-east Arnhem Land (DEWHA 2009a, 2009b; Limpus 2009; Roelofs et al. 2005). Marine debris can affect seabird species through ingestion or entanglement (Baker et al. 2002). Seabirds sometimes ingest plastic that they mistake for food. Ingestion of marine debris can cause physical damage, perforation, mechanical blockage or impairment of the digestive system, resulting in starvation as well as potentially being a source of ingested toxic pollutants (Baker et al. 2002). Accumulated chemicals from plastic debris can poison seabirds when ingested. These chemicals are known to compromise immunity and cause infertility in animals (Kiessling 2003). Some seabirds have been found dead with up to 35 pieces of plastic in their stomachs (DNRETA 2006). Adult seabirds can regurgitate ingested marine debris to their chicks, which can have a large impact on chick survival due to their high rates of ingestion and low frequency of regurgitation of indigestible material (Baker et al. 2002). Entanglement in marine debris can constrict growth and circulation, leading to asphyxiation, and can affect an animal's ability to forage or to avoid predators (Baker et al. 2002).

Species assessed = 11		
Pressure	**Species**	**Rationale**
Human presence at sensitive sites	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	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). Other potential impacts from human presence at sensitive sites include transfer of invasive pests, such as mice or weeds, via humans; habitat loss through wildfire caused by human visitation; and habitat degradation through inappropriate disposal of refuse. The driving of four-wheel drive vehicles on beaches is a potential threat for beach-nesting species such as the little tern (National Oceans Office 2004).

Species assessed = 11		
Pressure	**Species**	**Rationale**
Invasive species	Brown booby Lesser frigatebird Streaked shearwater Black-naped tern Bridled tern Caspian tern Crested tern Lesser crested tern Little tern Roseate tern Common noddy	Invasive species impact on seabird populations by preying on adults and nest contents (eggs and chicks), destroying nests and modifying habitat (DEH 2005a). For example, cats and rats directly impact seabirds through predation of eggs, chicks and adults, and rabbits damage vegetation leading to loss of breeding habitat (Baker et al. 2002). Some or all of the known invasive species (such as cats, dogs, pigs and rats) are present on many of the larger islands in the North Marine Region, but they have not yet been found on the smaller seabird-nesting islands, except Rocky Island, which has black rats (National Oceans Office 2004). Breeding colonies of seabirds could also be threatened by the introduction of invasive ant species like the yellow crazy ant (*Anoplolepis gracilipes*), which has colonised parts of Arnhem Land (Northern Territory Government 2009). Threat abatement plans have been prepared under the EPBC Act for cats, rodents and tramp ants (DEH 2006; DEWHA 2008d; DEWHA 2009c). Seabirds are especially vulnerable to alien mammalian predation due to their lack of effective antipredator behaviour; habit of most species nesting at ground level and leaving chicks unattended during long-range foraging; and low annual productivity (DEH 2005a). Exotic plant species can also affect seabird breeding by reducing nesting habitat, eroding burrowing substrate, giving cover to predators, and reducing cover and shade for chicks (WBM Oceanics & Claridge 1997). For example, the environmental stability of the Wellesley Islands in the southern Gulf of Carpentaria is at risk from nationally significant weeds including rubber vine and calotrope (DEWHA 2009a).

Table S1.14: Pressures *of potential concern* to selected seahorses and pipefishes in the North Marine Region

Species assessed = 30		
Pressure	**Species**[a]	**Rationale**
Physical habitat modification (dredging)	Big-head seahorse Hedgehog seahorse High-crown seahorse Kellogg's seahorse Northern spiny seahorse Three-spot seahorse Western spiny seahorse Winged seahorse Yellow seahorse Banded pipefish Blue-finned ghost pipefish Brock's pipefish Cleaner pipefish	The likelihood of dredging activity in the North Marine Region is increasing due to a rise in industrial development in locations such as Darwin Harbour and Weipa in the western Gulf of Carpentaria (DEWHA 2008a), and manganese mining near Groote Eylandt. Although any activities associated with mining tenements to the west and north-west of Groote Eylandt will occur in Northern Territory waters, they will have the potential to impact ontogenetic (lifecycle) movements of fish species from inshore to offshore Commonwealth waters (Haywood & Kenyon 2009). There are also mining tenements in Commonwealth waters south of Groote Eylandt. Dredging activities associated with such offshore mining operations have the potential to cause degradation and loss of seahorse and pipefish habitat. This may lead to a minor decline in some seahorse and pipefish populations, particularly for endemic species, which have few, if any, alternative habitats (DEWHA 2008a). Syngnathids associated with soft-bottom substrates, such as the big-head seahorse, are particularly vulnerable to the effects of dredging and trawl activity (Pogonoski et al. 2002). As most syngnathid species are more localised or reliant on a particular area of habitat than previously thought, preserving habitats is one of the most important factors in protecting the species for the future (Kuiter 2001). For example, Hippocampus and Solegnathus species are among the site-associated fish genera and for this reason are more likely to be vulnerable to habitat damage (Martin-Smith & Vincent 2006; Pogonoski et al. 2002; Vincent et al. 2005).

Species assessed = 30		
Pressure	**Species**[a]	**Rationale**
Physical habitat modification (dredging)	Double-ended pipehorse Girdled pipefish Harlequin ghost pipefish Indonesian pipefish Long-nosed pipefish Mud pipefish Pacific short-bodied pipefish Pig-snouted pipefish Pallid pipehorse Red-banded pipefish Reef-top pipefish	The likelihood of dredging activity in the North Marine Region is increasing due to a rise in industrial development in locations such as Darwin Harbour and Weipa in the western Gulf of Carpentaria (DEWHA 2008a), and manganese mining near Groote Eylandt. Although any activities associated with mining tenements to the west and north-west of Groote Eylandt will occur in Northern Territory waters, they will have the potential to impact ontogenetic (lifecycle) movements of fish species from inshore to offshore Commonwealth waters (Haywood & Kenyon 2009). There are also mining tenements in Commonwealth waters south of Groote Eylandt. Dredging activities associated with such offshore mining operations have the potential to cause degradation and loss of seahorse and pipefish habitat. This may lead to a minor decline in some seahorse and pipefish populations, particularly for endemic species, which have few, if any, alternative habitats (DEWHA 2008a). Syngnathids associated with soft-bottom substrates, such as the big-head seahorse, are particularly vulnerable to the effects of dredging and trawl activity (Pogonoski et al. 2002). As most syngnathid species are more localised or reliant on a particular area of habitat than previously thought, preserving habitats is one of the most important factors in protecting the species for the future (Kuiter 2001). For example, *Hippocampus* and *Solegnathus* species are among the site-associated fish genera and for this reason are more likely to be vulnerable to habitat damage (Martin-Smith & Vincent 2006; Pogonoski et al. 2002; Vincent et al. 2005).

Species assessed = 30		
Pressure	**Species**[a]	**Rationale**
Physical habitat modification (dredging)	Ribboned seadragon Ridge-nose pipefish Short-pouch pygmy pipehorse Three-keel pipefish Tidepool pipefish Yellow-banded pipefish	The likelihood of dredging activity in the North Marine Region is increasing due to a rise in industrial development in locations such as Darwin Harbour and Weipa in the western Gulf of Carpentaria (DEWHA 2008a), and manganese mining near Groote Eylandt. Although any activities associated with mining tenements to the west and north-west of Groote Eylandt will occur in Northern Territory waters, they will have the potential to impact ontogenetic (lifecycle) movements of fish species from inshore to offshore Commonwealth waters (Haywood & Kenyon 2009). There are also mining tenements in Commonwealth waters south of Groote Eylandt. Dredging activities associated with such offshore mining operations have the potential to cause degradation and loss of seahorse and pipefish habitat. This may lead to a minor decline in some seahorse and pipefish populations, particularly for endemic species, which have few, if any, alternative habitats (DEWHA 2008a). Syngnathids associated with soft-bottom substrates, such as the big-head seahorse, are particularly vulnerable to the effects of dredging and trawl activity (Pogonoski et al. 2002). As most syngnathid species are more localised or reliant on a particular area of habitat than previously thought, preserving habitats is one of the most important factors in protecting the species for the future (Kuiter 2001). For example, *Hippocampus* and *Solegnathus* species are among the site-associated fish genera and for this reason are more likely to be vulnerable to habitat damage (Martin-Smith & Vincent 2006; Pogonoski et al. 2002; Vincent et al. 2005).

Species assessed = 30		
Pressure	**Species**[a]	**Rationale**
Bycatch (commercial fishing)	Indonesian pipefish or Günther's pipehorse Long-nosed pipefish or straight stick pipefish Pallid pipehorse or Hardwick's pipehorse Ribboned seadragon or ribboned pipefish	There are records of syngnathid species caught as bycatch in the trawl operations of the Northern Prawn Fishery (NPF) in the North Marine Region (Stobutzki et al. 2000). There are two known species of syngnathids caught in the NPF: the ribboned seadragon and the long-nosed pipefish. Griffiths et al. (2004) have identified two species caught as bycatch in trawl fisheries, including the pallid pipefishand Gunther's pipehorse. Bycatch is assessed as of potential concern for three of these four species. Syngnathid species taken as bycatch in deep water 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 (Pogonoski et al. 2002).

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

Heritage places assessed = 1		
Pressure	**Heritage place**	**Rationale**
Changes in sea temperature (climate change)	*Florence D* shipwreck	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). Shifts in temperature can impact the long-term preservation of shipwrecks, especially those such as the *Florence D* that are located in shallow waters. Increases in sea temperature may hasten the decay of wrecks, with the rate of deterioration dependent on vessel composition. The *Florence D* shipwreck was only located in 2009, and the extent to which natural variability in sea temperature has already affected its current condition is not yet known (Steinberg 2009).

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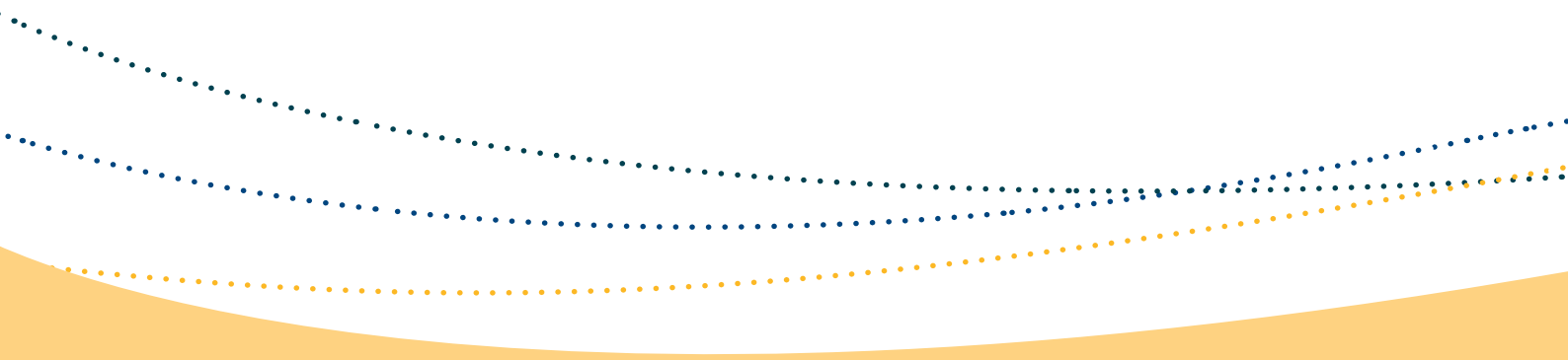

SCHEDULE 2

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 (refer to 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 Marine Bioregional Plan has been prepared under the EPBC Act. It contains information about matters of national environmental significance within the North 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 Marine Region) and should not be regarded as definitive in relation to those matters for which advice is provided. However, where advice is provided, this should be taken as an indication that the information is of sufficient quality to be taken into account in decision-making in relation to these matters of national environmental significance.

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

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

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

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

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

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

Using the regional advice

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

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

Considerations underpinning the rating of a risk include:

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

Commonwealth marine environment: Section 24 of the EPBC Act defines a Commonwealth marine area (see glossary for further details). 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 Marine Region
- protected species that occur in the North 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 *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 Marine Region

The Commonwealth marine environment, including the North 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.[9]

The North Marine Region covers the Commonwealth waters from the western side of Cape York Peninsula to the Northern Territory–Western Australia border, 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.

9 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.

The EPBC Act Policy Statement 1.1 outlines criteria to assist in determining the significance of impacts on the Commonwealth marine environment. Specifically, an action is likely to have a significant impact on the 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
- 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 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.

S 2.1.1 Establishment of marine pest species

A number of introduced marine species are known to occur in the North Marine Region, but as yet none have established as pest species[10] in the Commonwealth marine environment.

For Northern Territory and Queensland waters adjacent to the North Marine Region there are no recorded established marine pest populations. However, the National Introduced Marine Pest Information System lists 26 species that pose a potential threat to Queensland waters and seven species that are a potential threat to Northern Territory waters (NIMPIS 2011).

There are two recorded incursions of introduced marine pests in coastal waters adjacent to the North Marine Region. One incursion was by the black-striped mussel and the other by a tube worm. Both species were found in Darwin Harbour and are believed to have been introduced on yacht and fishing vessel hulls. The black-striped mussel was eradicated by poisoning and the Northern Territory Government has a program to prevent further marine pest incursions through ongoing monitoring. Queensland is undertaking similar monitoring for invasive marine species at the port of Weipa. As part of the National System for the Prevention and Management of Marine Pest Incursions, a 'trigger list' comprising species that may become invasive if introduced is maintained through an Emergency Marine Pest Plan.[11]

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

The introduction of marine pests is a particularly important issue for the North Marine Region given the high levels of sea transport to and through the region, the presence of drilling rigs, supply boats and illegal fishing vessels, and the shallow nature of much of the marine environment.

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10 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.

11 **www.marinepests.gov.au**

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

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

There is a **low risk** of marine pests becoming established in the Commonwealth marine environment or affecting its biodiversity values and/or ecological integrity as a result of these actions when appropriate **mitigation measures are adopted**. Mitigation measures consistent with the National System for the Prevention and Management of Marine Pest Incursions, the Australian Ballast Water Management Requirements, the *National biofouling management guidelines for commercial vessels*[12] *and the National biofouling management guidelines for recreational vessels*[13] 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**.

S2.1.2 Adverse impacts on marine ecosystem functioning and integrity

The North 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.

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

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

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

The advice here 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.

There are eight areas and/or types of habitats that are considered key ecological features in the North Marine Region (see Figure S2.1). Further information on these key ecological features is provided in the North Commonwealth marine environment report card (**www.environment.gov.au/marineplans/north**).

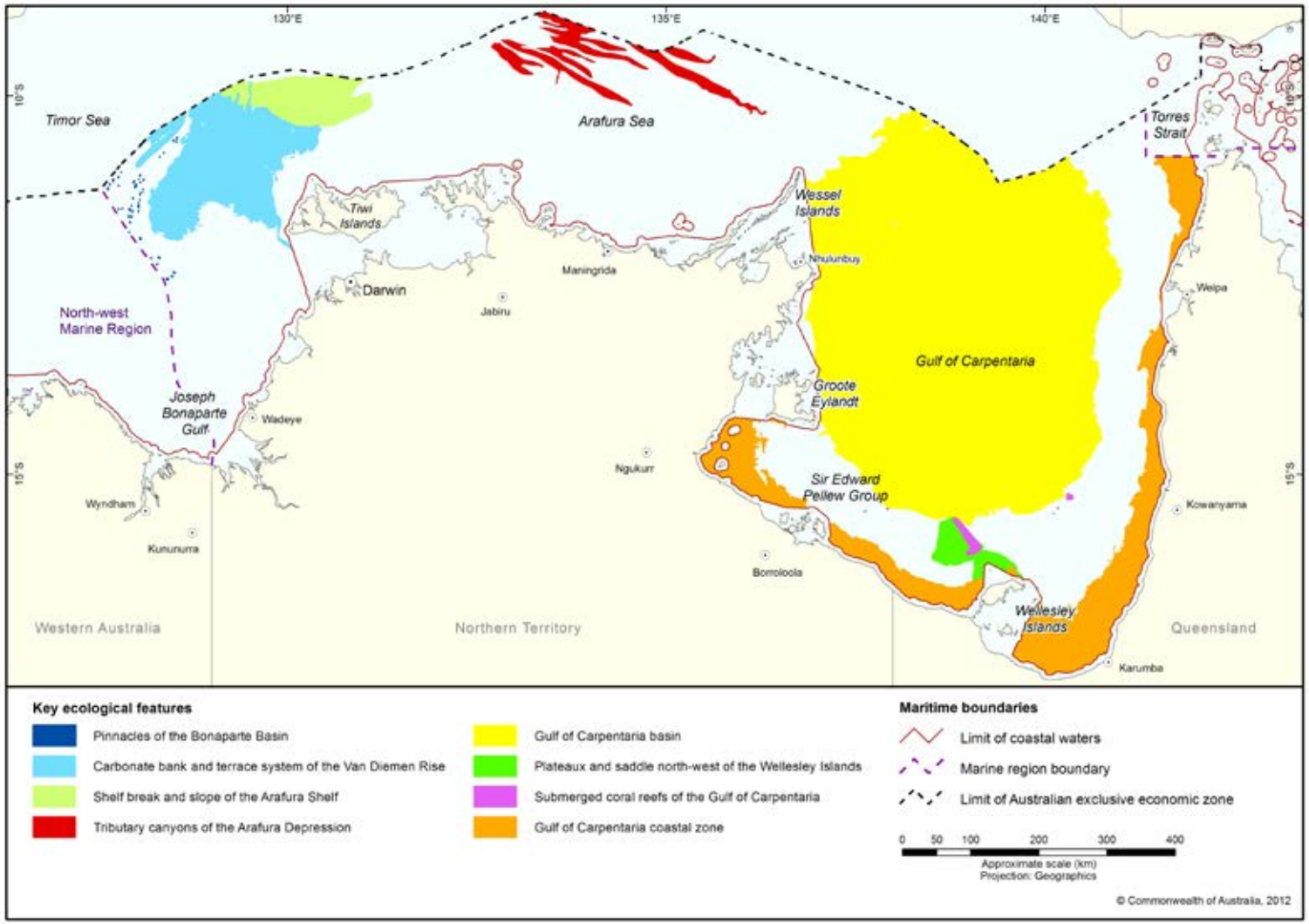

Figure S2.1: Key ecological features in the North Marine Region

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.

Pinnacles of the Bonaparte Basin: This key ecological feature is recognised for its biodiversity values.

The limestone pinnacles of the Bonaparte Basin lie next to the carbonate banks in the Bonaparte Depression of the Joseph Bonaparte Gulf. They occur on the mid-outer shelf and are characterised by soft sediments and little other seabed structure. The pinnacles can be up to 50 metres high and 50–100 kilometres long (Baker et al. 2008) and are thought to be the eroded remnants of the underlying strata (van Andel & Veevers, cited in Harris et al. 2005; Marshall et al., cited in Harris et al. 2005). As the pinnacles provide areas of hard substrate in an otherwise relatively featureless environment they are presumed to support a high number of species; however, the species richness and diversity of these structures is generally poorly understood (Brewer et al. 2007). Communities associated with the pinnacles are thought to include sessile benthic invertebrates such as hard and soft corals and sponges, and aggregations of demersal fish species such as snapper, emperor and grouper. Marine turtles including flatback, olive ridley and loggerhead turtles are known to forage around the pinnacles (Donovan et al. 2008; Whiting et al. 2007).

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

- illegal, unregulated and unreported foreign fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change alter localised productivity and/or community structures through shifts in marine species distribution.

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

Carbonate bank and terrace system of the Van Diemen Rise: This key ecological feature is recognised for its presumed ecological role in enhancing biodiversity and local productivity, relative to its surrounds.

The bank and terrace system of the Van Diemen Rise is part of a larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. It is characterised by terrace, banks, channels and valleys. Channel systems range from approximately 60–150 metres to 10–40 metres in depth (Anderson et al. 2011). The variability in water depth and substrate composition across the feature may contribute to the presence of unique ecosystems in the channels (Heap et al. 2010). The Indonesian Throughflow transports warmer oligotrophic waters of lower salinity into the area from the tropical western Pacific Ocean. The extent to which this supports ecological functioning and biodiversity in the area is largely unknown. Epibenthic communities such as sponges found in channels are likely to support first- and second-order consumers. Biophysical maps associated with clustering analysis (Ellis & Pitcher 2009) suggest greater environmental variability within this feature compared to other areas of the North Marine Region.

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

- illegal, unregulated and unreported foreign fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Generally, most actions in or adjacent to the North Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the carbonate bank and terrace system of the Van Diemen Rise.

Shelf break and slope of the Arafura Shelf: This key ecological feature is recognised for its ecological functioning and integrity (productivity). It also forms part of a unique biogeographic province (biodiversity).

The shelf break and slope of the Arafura Shelf is characterised by continental slope and the presence of patch reefs and hard substrate pinnacles (Harris et al. 2005). Ecosystem processes operating in this area are largely unknown, but oceanographic processes, possibly associated with the Indonesian Throughflow and surface wind–driven circulation resulting from the north-west monsoon, are thought to be of strong influence (DEWHA 2007). The Indonesian Throughflow transports warm waters from the western Pacific Ocean through the Indonesian

archipelago into the Timor and Arafura seas. This is likely to influence pelagic dispersal of nutrients, species and biological productivity. Pelagic dispersal in turn drives long-term patterns of transport and dispersal of larvae, juvenile and migrating adult organisms across the area. The shelf break and slope of the Arafura Shelf is situated in a major biogeographic crossroad where biota is largely affiliated with the Timor–Indonesian–Malay region (Hooper & Ekins 2005). Primary production of phytoplankton is likely to form the basis for offshore food webs (DEWHA 2007).

Pressures *of potential concern* on ecosystem functioning and integrity of this key ecological feature include:

- illegal, unregulated and unreported foreign fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- activities associated with marine infrastructure development, which have the potential to increase risks of oil spills and chemical contamination
- increased shipping traffic, which has the potential to increase the likelihood of oil pollution
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Actions that introduce a new source from which a severe oil spill has a reasonable potential of arising (e.g. increased shipping and drilling) in the area of the shelf break and slope of the Arafura Shelf have a **risk** of a significant impact on the Commonwealth marine environment of the North Marine Region.

Tributary canyons of the Arafura Depression: This key ecological feature is recognised for its presumed ecological functioning and integrity (productivity) and biodiversity values. Values apply to both the benthic and the pelagic habitats within the feature.

Almost all canyons in the North Marine Region are located within this key ecological feature and endemic benthic species are believed to occur there (Wilson 2005). Primary productivity in this key ecological feature is likely to be associated with movements of water through the canyons and surface water circulation driven by seasonal north-west monsoon winds. Surveys in the area have identified at least 245 macroscopic species, including a diverse variety of invertebrates (e.g. sponges, corals, sea anemones, tunicates, worms, crustaceans, brittle stars and feather stars) and six small fish species. It is estimated that a further 500 species could be identified from samples collected from the area (Wilson 2005).

Pressures *of potential concern* on ecosystem functioning and integrity of this key ecological feature include:

- illegal, unregulated and unreported foreign fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- activities associated with marine infrastructure development, which have the potential to increase risks of oil spills increased shipping traffic, which has the potential to increase the likelihood of oil pollution physical modification and/or destruction of the sea floor as a result of offshore construction and installation of infrastructure, at a scale that alters habitat integrity and/or structure of benthic communities
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of the tributary canyons of the Arafura Depression such that an adverse impact on marine ecosystem functioning or integrity results have a **high risk** of a 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 the tributary canyons of the Arafura Depression 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. increased shipping and drilling) in the area of the tributary canyons of the Arafura Depression have a **risk** of a significant impact on the Commonwealth marine environment of the North Marine Region.

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

The Gulf of Carpentaria basin is characterised by gently sloping soft sediments and water varying in depth from around 45 metres to 80 metres. The waters in the Gulf of Carpentaria mix little with waters of the Arafura and Coral seas (Condie & Dunn 2006; Forbes 1984), so that they form a distinct semi-enclosed system with limited inputs from either oceanographic or terrestrial sources. The soft sediments of the Gulf of Carpentaria basin are characterised by benthic invertebrates including echinoids (e.g. heart urchins, sand dollars), sponges, solitary corals, molluscs, decapods, bryozoans, sea cucumbers and sessile tunicates (Haywood et al. 2005; Long et al. 1995). Deposit-feeding epifauna in the soft sediments are more abundant than suspension-feeding epifauna (Long et al. 1995). The Gulf of Carpentaria basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, and top predators such as shark, snapper, tuna and mackerel (Smith et al. 2006). The Gulf of Carpentaria is also an important migratory route for seabirds, shore birds and marine turtles.

Pressures *of potential concern* on ecosystem functioning and integrity of this key ecological feature include:

- illegal, unregulated and unreported foreign fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- marine debris
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Generally, most actions in or adjacent to the North Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the Gulf of Carpentaria basin.

Actions with a real chance or possibility of introducing a new source of marine debris into the Gulf of Carpentaria basin have a **risk** of a significant impact on the Commonwealth marine environment.

Plateaux and saddle north-west of the Wellesley Islands: This key ecological feature is recognised for its ecological functioning and integrity (high productivity) values.

The plateaux and saddle north-west of the Wellesley Islands is characterised by two hard substrate plateaux separated by a narrow saddle. Isolated living patch reefs occur on the broad, flat-topped plateaux which extend north-east from Mornington Island at depths of 15–30 metres (P Rothlisberg, pers. comm., May 2011). Strong tidal influences occur in this area (S Condie, pers. comm., May 2011). Abundance and species diversity is higher in the sandy sediments of the east and south-east of the Gulf of Carpentaria (Long & Poiner 1994) and in coastal waters that receive nutrients from river flows (NOO 2003). However, biological activity around the plateaux and saddle is believed to be associated more with habitat type than with productivity or oceanic processes (P Rothlisberg, pers. comm., May 2011). The species found in the plateaux and saddle north-west of the Wellesley Islands differ from those found in other areas of the Gulf of Carpentaria. Reef fish species found in this key ecological feature in particular, differ from those found elsewhere in the Gulf (S Blaber, pers. comm., May 2011). Higher trophic species present in the area include hawksbill, olive ridley, green and flatback turtles (Robbins et al. 2002). Fish such as snapper, cod and emperor occur around reefs (DEEDI 2009), and Spanish mackerel is concentrated to the north and west of the Wellesley Islands. Seabird species known to occur in the area include frigates, boobies and shearwaters that most likely rely on the area's predictable food sources (C Limpus, pers. comm., 8 November 2009). Corals present in the area are likely to include typical northern Australian coral reef fauna such as octocorals, sponges, ascidians and gorgonians.

Pressures *of potential concern* on ecosystem functioning and integrity of this key ecological feature include:

- illegal, unregulated and unreported fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- marine debris
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Generally, most actions in or adjacent to the North Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the plateux and saddle north-west of the Wellesley Islands.

Actions with a real chance or possibility of introducing a new source of marine debris into the plateux and saddle north-west of the Wellesley Island have a **risk** of a significant impact on the Commonwealth marine environment.

Submerged coral reefs of the Gulf of Carpentaria: This key ecological feature is recognised for its biodiversity values (aggregations of marine life).

The submerged coral reefs of the Gulf of Carpentaria are characterised by submerged patch, platform and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria basin. The coral reefs exhibit flat-topped path reef morphology and rise from sea-floor depths of 30–50 metres. Reef platforms occur at depths of around 18–30 metres and reef tops or crests lie at depths of up to 20 metres (Harris et al. 2008). Relict reef structures support typical northern Australian coral reef fauna including octocorals, sponges, ascidians, gorgonians and reef fish. The submerged reefs also provide breeding and aggregation areas for many fish species including mackerel and large commercially fished snapper. They offer refuges for sea snakes and apex predators such as sharks (DEWHA 2007), and they sustain invertebrates such as crustaceans and polychaete worms, invertivorous fish and turtles (Marshall & Schuttenberg 2006). Coral trout species that inhabit Gulf reefs are smaller than those found in the Great Barrier Reef and may prove to be an endemic subspecies (DEWHA 2007).

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

- illegal, unregulated and unreported fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- marine debris
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter community structures through shifts in marine species distributions.

Generally, most actions in or adjacent to the North Marine Region are unlikely to impact adversely on the ecosystem functioning and integrity of the submerged coral reefs of the Gulf of Carpentaria.

Actions with a real chance or possibility of introducing a new source of marine debris into the submerged reefs of the Gulf of Carpentaria have a **risk** of significant impact on the Commonwealth marine environment.

Gulf of Carpentaria coastal zone: This key ecological feature is recognised for its ecological functioning and integrity values (high productivity) and biodiversity values (aggregations of marine life, biodiversity and endemism).

The Gulf of Carpentaria coastal zone key ecological feature occurs in Commonwealth waters that extend from the outer boundary of Queensland–Northern Territory waters (generally 3 nautical miles from the coast) to a contour at a depth of 20 metres. The feature stretches from west Cape York Peninsula to Limmen Bight in the south-west Gulf of Carpentaria. Waters in the feature are well mixed throughout the year but are more heavily influenced by freshwater flows during the monsoon (Burford & Rothlisberg 1999). Mixing of freshwater flows and ocean currents tend to trap nutrients within the coastal zone (Wolanski & Ridd 1990), leading to high productivity and diverse and abundant marine life in this area (NOO 2003). A large proportion of the coastal waters of the Gulf of Carpentaria lie within the jurisdictions of Queensland and the Northern Territory. These inshore waters support mangroves, seagrasses and coral reefs, which help to drive primary production and diversity in contiguous offshore Commonwealth waters (Poiner et al. 1987; Wightman et al. 2004). They are also the source of organic matter found in Commonwealth waters that is transported through ontogenetic migration of fish and crustaceans (Brewer et al. 1991; Kenyon et al. 2004; Salini et al. 1990).

Pressures *of potential concern* on ecosystem functioning and integrity of this key ecological feature include:

- illegal, unregulated and unreported fishing, which may lead to overexploitation of marine species and the introduction of marine debris
- marine debris
- activities associated with coastal and marine infrastructure development, which have the potential to increase risks of alteration of hydrological flows
- physical modification and/or destruction of the sea floor as a result of offshore construction and installation of infrastructure, at a scale that alters habitat integrity and/or structure of benthic communities
- climate change, which has the potential to alter the ecological values of this feature. Changes to sea temperature and ocean acidification associated with climate change may alter localised productivity and/or community structures through shifts in marine species distributions.

Actions that, irrespective of where they occur, have a real chance or possibility of resulting in modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of the Gulf of Carpentaria coastal zone such that an adverse impact on marine ecosystem functioning or integrity results have a **high risk** of a 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 Gulf of Carpentaria coastal zone 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 with a real chance or possibility of introducing a new source of marine debris into the Gulf of Carpentaria coastal zone have a **risk** of a significant impact on the Commonwealth marine environment.

S2.1.3 Adverse impacts on populations of a marine species or cetacean (excluding those listed as threatened or migratory)[14]

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 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 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 does not imply that they are the only species 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 in a way that results in a significant impact on the Commonwealth marine environment.

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

Sixty-seven species protected under Part 13 of the EPBC Act (but not listed as threatened or migratory) are currently known to occur in the North 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. Four species are of known importance in the context of the region's biodiversity and/or ecological functioning. These species are described below to assist in the interpretation of the significant impacts criteria of EPBC Act Policy Statement 1.1.

14 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 2.4. (Listed threatened species that are conservation dependent and are not, of themselves, matters of national environmental significance are discussed here).

Crested tern *(Sterna bergii)* are widespread and numerous along the coastline of the Northern Territory. Chatto (2001) has reported 20 crested tern breeding colonies in the Northern Territory. Many of these colonies are in excess of 5000 birds and two colonies are in excess of 50 000 birds (Seagull Island and Urquhart Islet) and are considered globally significant. Colonies are distributed around the Northern Territory coast from Melville Island in the north-west to the Sir Edward Pellew Islands in the south-east, although they are mainly grouped in the north-west, north-east and south-east. All breeding colonies are on small islands, except for the larger North-West Crocodile Island, which is well out to sea (Chatto 2001). Foraging around breeding colonies extends into the North Marine Region. Biologically important areas have been identified for this species (see the North Marine Region Conservation Values Atlas at **www.environment.gov.au/cva**). Non-breeding crested tern aggregations are present all year round in the North Marine Region, but between March and July move to breeding colonies around the Northern Territory coast. Larger colonies of breeding crested terns tend to remain faithful to a single island (Chatto 2001). Potential pressures on crested terns include climate change, marine debris, human presence at breeding sites and introduced species in breeding areas on islands.

Actions that have a real chance or possibility of increasing human disturbance at breeding colonies or in a substantial increase in incidence of nuisance or introduced species have a **high risk** of a substantial adverse impact on the population of this species.

Thirty species of the family Syngnathidae or Solenostomidae are known to occur in the North Marine Region (see Table A appended to this schedule and the conservation value report card—seahorses and pipefishes at **www.environment.gov.au/marineplans/north**). Habitat that supports syngnathid populations is generally patchy, hence populations of syngnathid species may be dispersed and fragmented (CITES 2001). In the North Marine Region, some species appear to be widely distributed and common, whereas other species, such as the **big-head seahorse** *(Hippocampus grandiceps)* are apparently rare and localised. The big-head seahorse appears to be restricted to the Gulf of Carpentaria, Queensland. This species is mainly known from prawn trawl and dredge collections in shallow waters to 18 metres, most likely in association with soft bottom substrates. Its limited geographic range may be a reflection of its unique habitat preferences. Biologically important areas have not been identified for this species.

Pressures *of potential concern* on syngnathids include bycatch in commercial fisheries and physical habitat modification associated with trawling and dredging activities.

Actions that have a real chance or possibility of substantially modifying, destroying or isolating habitat where the big-head seahorse occurs have a **high risk** of a substantial adverse impact on the population of this species.

Nineteen species of sea snake from the family Hydrophiidae and Laticaudae are known to occur in the North Marine Region (see Table A appended to this schedule and the conservation value report card—marine reptiles at **www.environment.gov.au/marineplans/north**). Outside of data obtained from commercial prawn trawling, little is understood about distribution, abundance and diversity of sea snakes in the region. The **large-headed seasnake** is highly vulnerable to trawling, is restricted to the Gulf of Carpentaria and nearby regions and has a particularly low reproductive rate (due to its late age at maturity) (Milton 2001).

Pressures *of potential concern* on sea snakes include climate change, bycatch in commercial fisheries and physical habitat modification associated with dredging activities.

Actions that have a real chance or possibility of substantially modifying, destroying or isolating habitat where the large-headed seasnake occurs have a **high risk** of a substantial adverse impact on the population of this species.

Seven species of cetaceans known to occur in the North Marine Region (see Table A appended to this schedule) are protected within the Australian Whale Sanctuary[15]. The information currently available for many of these cetacean species in the North Marine Region is insufficient to provide separate regional advice.

The **Indo-Pacific (coastal) bottlenose dolphin** *(Tursiops aduncus)* is listed as cetacean and protected under the EPBC Act. The Arafura Sea–Timor Sea populations are also listed as migratory under the Act; however, distinction between the populations in the North Marine Region has not occurred to date (M Jedensjö, pers. comm., 17 June 2011). Biologically important areas are defined for this species **www.environment.gov.au/cva**. The Indo-Pacific bottlenose dolphin was only recently recognised and is considered taxonomically distinct to the common

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

bottlenose dolphin. Whereas the common bottlenose dolphin is found throughout offshore waters of the region, Indo-Pacific bottlenose dolphins occur in riverine and coastal waters, over shallow coastal waters on the continental shelf and around oceanic islands. This species is vulnerable to physical habitat modification associated with onshore construction. *Pressures of potential concern* include climate change, physical habitat modification associated with dredging and off-shore construction, bycatch, marine debris, noise pollution, and chemical pollution or contaminants.

Actions that have a real chance or possibility of increasing the likelihood of chemical contamination in biologically important areas of Indo-Pacific (coastal) bottlenose dolphin have a **risk** of a substantial adverse effect on populations of this species.

Actions that have a real chance or possibility of substantially modifying, destroying or isolating habitat in biologically important areas of the Indo-Pacific (coastal) bottlenose dolphin have a **risk** of a substantial adverse impact on the population of this species.

Actions that have a real chance or possibility of increasing relevant noise above ambient levels within any of the biologically important areas for Indo-Pacific (coastal) bottlenose dolphin have a **risk** of substantial adverse effect on populations of this species. Examples of such actions include pile-driving, blasting and increased vessel traffic.

Actions that have a real chance or possibility of introducing a new source of marine debris into the biologically important areas of the Indo-Pacific (coast) bottlenose dolphin have of a **risk** of substantial adverse impact on the population of this species.

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

Marine ecosystems comprise a large number of species linked to each other through a complex web of interrelationships (assemblages). In most instances, we do not have the knowledge necessary to understand the role that each individual species plays in maintaining ecosystem structure, overall biological diversity and processes. Some 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.

No species or species assemblages have been identified as key ecological features in the North Marine Region.

S2.1.4 Adverse impacts on heritage values

Historic shipwrecks

One historic shipwreck, the *Florence D*, is known to be located in the North Marine Region (Figure S2.2). The conservation value report card - protected places provides further information: **www.environment.gov.au/marineplans/north**. 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.

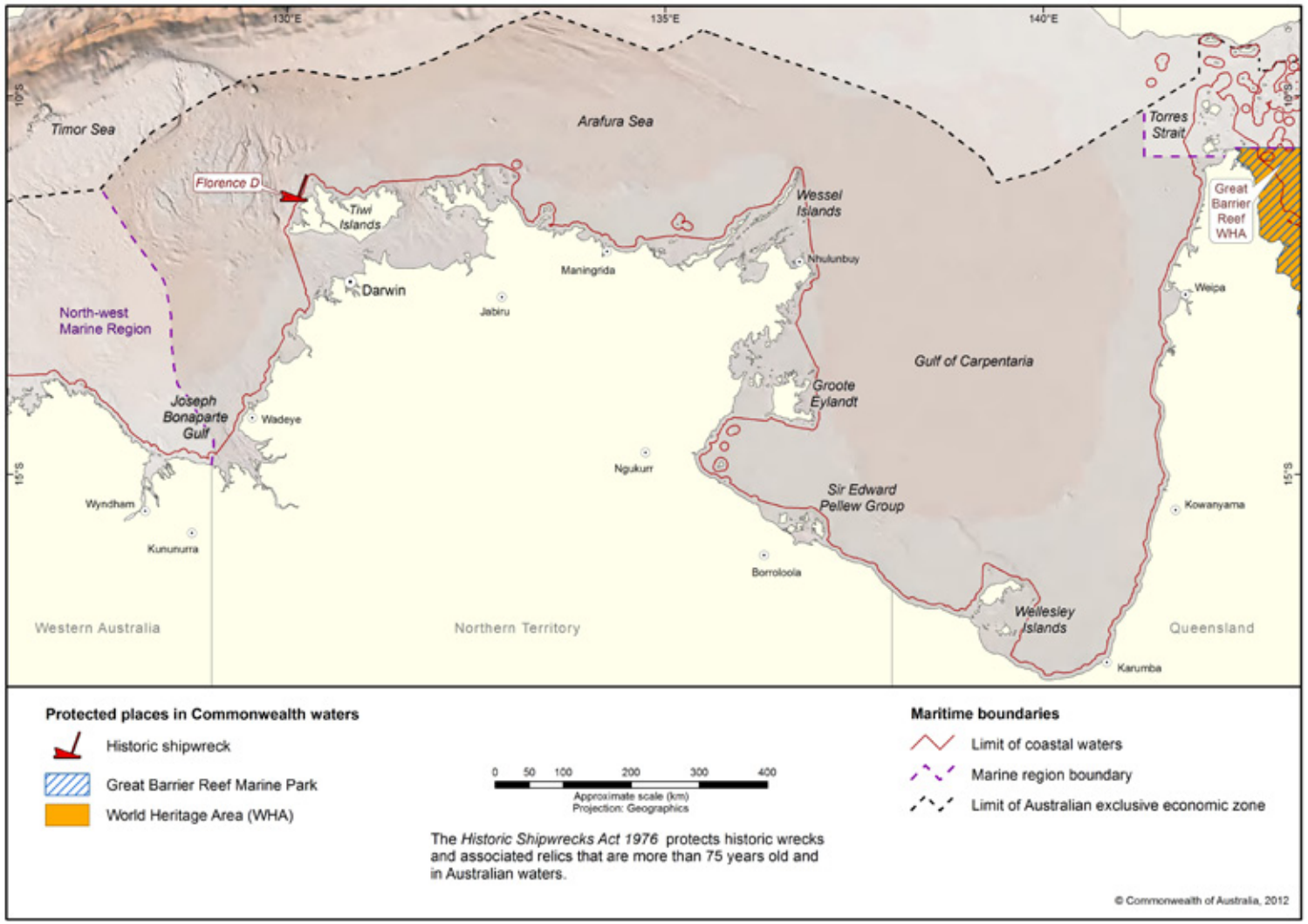

Figure S2.2: Heritage places in the North Marine Region as of May 2012

S2.1.5 Actions in Commonwealth marine reserves

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

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.

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

Advice for preparing a referral with respect to impacts on the Commonwealth marine environment of the North 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 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.
- Fo 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 website: **www.nopsema.gov.au**.

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Schedule 2.2 Cetaceans of the North Marine Region

All cetaceans are protected under the EPBC Act in the Australian Whale Sanctuary[16] (and, to some extent, beyond its outer limits). Of the 45 cetacean species (whales, dolphins and porpoises) recorded in Australian waters, 9 are known to occur in the North Marine Region and a further 15 species may occur infrequently in the region (see conservation values report card—cetaceans for a complete list and additional information (**www.environment.gov.au/marineplans/north**).

Three species of dolphins known to occur in the North Marine Region are listed as migratory species under the EPBC Act (Table S2.1). Cetaceans that occur in the North Marine Region but are not listed as threatened or migratory species under the EPBC Act are protected under the Act by virtue of the Australian Whale Sanctuary and are considered in Schedule 2.1.

Table S2.1: Cetaceans listed as threatened and/or migratory with known biologically important areas in or adjacent to the North Marine Region

Species	Listing status
Australian snubfin dolphin (*Orcaella heinsohni*)	Migratory
Indo-Pacific bottlenose dolphin [Arafura Sea–Timor Sea population] (*Tursiops aduncus*)	Migratory
Indo-Pacific humpback dolphin (*Sousa chinensis*)	Migratory

The species that infrequently occur in the North Marine Region do not regularly feed, aggregate or migrate through the region or are considered outside their normal range. The North Marine Region does not appear to be a part of the usual migratory pathway for humpback whales, although they have been sighted traversing the western part of the Arafura Sea between their breeding areas in the tropical and subtropical waters and their feeding areas in the Antarctic.

16 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**.

Generally, and based on current patterns of distribution, actions taken in the North Marine Region have a **low risk** of a significant impact on species that infrequently occur in the North Marine Region.

The following advice relates only to those species listed in Table S2.1 for which it has been possible to identify biologically important areas.

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

Population status and ecological significance

In two years of systematic surveys over 2500 kilometres in Darwin Harbour, only 31 **Australian snubfin dolphins** have been sighted (equating to 0.01 per square kilometre) (C Palmer, pers. comm., 4–5 May 2010). Surveys over 1600 kilometres in Cobourg Marine Park have sighted 213 snubfin dolphins (equating to 0.13 per square kilometre). It is likely that populations of Australian snubfin dolphins have been reduced off Queensland, Western Australia and the Gulf of Carpentaria, primarily related to continued incidental capture in gillnets, shark nets and habitat degradation (DSEWPaC 2011a). The distribution of Australian snubfin dolphins is severely fragmented, placing the species at increased risk of extinction (Cagnazzi 2010; Caughley & Gunn 1996; Parra et al. 2006a, 2006b). This species exhibits site fidelity and long-term associations between individuals.

Population estimates for the **Indo-Pacific bottlenose dolphin** are unknown. There are no specific population estimates for this species in the North Marine Region. Populations of this species may also be fragmented across some parts of its range. This species also exhibits site fidelity and long-term associations between individuals.

The Australian population status of the **Indo-Pacific humpback dolphin** is unknown. It is likely that the Indo-Pacific humpback dolphin occurs as one population within Australia (DSEWPaC 2011c). Population levels for the North Marine Region are unknown, predominantly due to the remoteness of the area. Outside the North Marine Region, regional population levels are likely to be in the order of low thousands on the east coast of Queensland. Evidence suggests that Indo-Pacific humpback dolphin distribution is severely fragmented (Parra et al. 2006a, 2006b). This species exhibits site fidelity and long-term associations between individuals.

For the purpose of determining the significance of impacts of proposed actions on Australian snubfin and Indo-Pacific humpback 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 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. 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 Australian snubfin dolphin, Indo-Pacific bottlenose dolphin and Indo-Pacific humpback dolphin are found in marine offshore and coastal waters; however, each species differs in its broader range of preferred habitat types. Knowledge of the seasonal movements, migrations and breeding seasonality of these inshore dolphin species is lacking for the North Marine Region. As other areas in the North Marine Region have not been extensively surveyed, there is uncertainty about species behaviour and the importance of other areas in the region aside from biologically important areas identified below. Maps detailing the location and spatial extent of identified biologically important areas are accessible via the Conservation Values Atlas (**www.environment.gov.au/cva**).

Australian snubfin dolphins occurs only in waters off the northern half of Australia, from Roebuck Bay, Western Australia, to the Fitzroy River–Keppel Bay area, Queensland. Preliminary data suggests it occurs in small, localised populations. The Australian snubfin dolphin has been recorded out to 23 kilometres offshore, although surveys indicate it is found primarily in waters less than 20 metres deep. Most sightings occur at less than 10 metres depth, close to river and creek mouths and also upstream in some tidal rivers (Palmer 2009; Parra 2006a, 2006b). Australian snubfin dolphins have been observed socialising year round in Cleveland Bay, Queensland, and Roebuck Bay, Western Australia, suggesting they may mate year round (G Parra pers. comm. in DSEWPaC 2011; D Thiele pers. comm. in DSEWPaC 2011a). Gestation for Irrawaddy dolphins, which is considered very similar to the Australian snubfin dolphin, lasts 14 months and calves are born in August or September. Snubfin dolphin calves are seen year round in Cleveland Bay (DSEWPaC 2011a), although whether this is similar in the North Marine Region is yet to be confirmed. The Australian snubfin dolphin is considered a generalist feeder, preying on bottom-dwelling and pelagic fish and cephalopods (Parra & Jedensjö 2009).

Biologically important areas have been identified for the Australian snubfin dolphin and include:

- foraging, feeding and breeding in Darwin Harbour; seen in low numbers in Darwin Harbour and behaviour not observed beyond mouth of harbour (C Palmer, pers. comm., 4 May 2011); species observed year round
- foraging, feeding and breeding at Cobourg Peninsula; species observed year round
- foraging, feeding and breeding in East Alligator River region; species observed year round
- foraging, feeding and breeding in South Alligator River region; distribution tends not to be further than the north-easterly and north-westerly point of Field Island.

The **Indo-Pacific bottlenose dolphin** (also referred to as spotted bottlenose dolphin) mainly occurs in four regions around Australia: Eastern Indian Ocean, Tasman Sea, Coral Sea and Arafura–Timor seas (DSEWPaC 2011b). Only the Arafura Sea–Timor Sea populations are considered migratory, with other populations around Australia listed as cetacean. Indo-Pacific bottlenose dolphins tend to occur in deeper, more open coastal waters, primarily in continental shelf waters (less than 200 metres deep), including coastal areas around oceanic islands, and tend to forage across a wider range of habitats. Calving peaks occur in spring and summer or spring and autumn (Mann et al. 2000; Möller & Harcourt 1998; Ross 2006).

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

- foraging (provisioning of young), feeding and breeding in Darwin Harbour; mostly present during the dry season (April–November); breeding and foraging behaviour not seen beyond mouth of harbour (C Palmer, pers. comm., 4 May 2011)
- foraging (provisioning of young), feeding and breeding at Cobourg Peninsula; mostly present during the dry season (April–November).

Indo-Pacific humpback dolphins are known to occur along the northern coastline, extending to Exmouth Gulf on the west coast, and the Queensland–New South Wales border region on the east coast (Corkeron et al. 1997). Although there are few records between the Gulf of Carpentaria in the north and Exmouth Gulf in the west, this is probably due to a lack of research effort and the remoteness of the area (Bannister et al. 1996; Parra et al. 2002). Indo-Pacific humpback dolphins usually occur close to the coast in depths of less than 20 metres but have been seen 55 kilometres offshore (Corkeron et al. 1997; Jefferson 2000) in open coastal waters around islands and coastal cliffs in association with rock and/or coral reefs (Palmer 2009; Parra 2006a, 2006b; Thiele 2008). Near the region, Indo-Pacific humpback dolphins occur in coastal lagoons and enclosed bays with mangrove forests and seagrass beds (Palmer 2009; Parra 2006a, 2006b; Thiele 2008). Calves may be born throughout the year, but spring and summer peaks are reported for many parts of their range (Jefferson & Karczmarski 2001).

Seasonality of calving is not known for most parts of the species' range in Australia. The Indo-Pacific humpback dolphin, like the snubfin dolphin, is a generalist feeder, preying upon bottom-dwelling and pelagic fish and cephalopods associated with coastal and estuarine waters (Parra & Jendensjö 2009).

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

- foraging, feeding and breeding in Darwin Harbour; numbers tend to be greater during the wet season (November–March)
- foraging, feeding and breeding at Port Essington, Cobourg Peninsula; numbers tend to be greater during the wet season (November–March)
- foraging, feeding and breeding in the East Alligator River region; numbers tend to be greater during the wet season (November–March)
- foraging, feeding and breeding in the South Alligator River region; numbers tend to be greater during the wet season (November–March); distribution tends not to be further than the north-easterly and north-westerly point of Field Island.

Nature of the proposed action

Inshore dolphins are particularly vulnerable to impacts from human activities because their distribution overlaps with the areas of highest human use in the marine environment. Anthropogenic activities in coastal environments have the potential to result in significant impacts on inshore dolphins. An overview of the vulnerabilities and pressures on inshore dolphins in the North Marine Region is available in the conservation values report card—cetaceans.

Physical habitat modification associated with onshore construction is a pressure *of concern* for the Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins.

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

- chemical pollution from onshore and offshore activities. Species that primarily inhabit inshore waters are more susceptible to high levels of chemical pollutants than pelagic species
- 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.

- physical habitat modification (e.g. dredging and offshore 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.

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

The following actions have a **risk** of a significant impact on the Australian snubfin, Indo-Pacific bottlenose and Indo-Pacific humpback dolphins:

- actions that have a real chance or possibility of introducing chemical contamination within biologically important areas. Examples of such actions may include construction of new oil or gas wells; construction of ports or expansion in port facilities, leading to greater shipping traffic)
- actions that have a real chance or possibility of substantially modifying, destroying or isolating habitat (e.g. dredging or onshore/offshore construction) within a biologically important area
- actions that have a real chance or possibility of increasing relevant noise[17] above ambient levels within any of the biologically important areas for inshore dolphins at times when the species are present. An example is actions resulting in substantial increase in ship noise
- actions that have a real chance or possibility of introducing a new source of marine debris into the biologically important areas.

Given the currently incomplete knowledge of the population distribution of these three species of inshore dolphin, 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.

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

Advice for preparing a referral with respect to impacts on Australian snubfin, Indo-Pacific bottlenose and Indo-Pacific humpback dolphins in the North 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 Australian snubfin dolphin, Indo-Pacific bottlenose dolphin or Indo-Pacific humpback dolphin, consideration of the following matters is also recommended:

- If the action proposed is within a biologically important area, information about any alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- If planning recreational and/or tourism operations, the *Australian national guidelines for whale and dolphin watching* (DEH 2005) provide standards on approach distances and operating procedures.
- Referrals should be supported by scientifically credible information that places the proposal in the context of advice on existing pressures on cetaceans and the particular life history characteristics of the species. The conservation values report card—cetaceans provides additional information on current understanding of the range of pressures on cetaceans addressed in this regional advice.
- For areas earmarked for long-term development involving noise-generating activities, passive acoustic monitoring programs (e.g. installation of sonobuoys) might assist in gaining the necessary understanding of the finer-scale spatial and temporal patterns of presence of some cetaceans and improve the ability to assess and mitigate impacts. It is recommended that early advice be sought from the Australian Government department responsible for the environment.

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Schedule 2.3
Marine turtles of the North Marine Region

Six marine turtle species listed under the EPBC Act are known to occur in the North Marine Region (Table S2.2) and all are listed as threatened and migratory under the Act. Of these, *Dermochelys coriacea* and all species in the family Cheloniidae are also listed as marine under Part 13 of the EPBC Act.

Table S2.2: Marine turtles listed as threatened and/or migratory with known biologically important areas in or adjacent to the North 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
Leatherback turtle *(Dermochelys coriacea)*	Endangered, migratory, marine
Olive ridley or Pacific ridley *(Lepidochelys olivacea)*	Endangered, migratory, marine

The flatback, green, hawksbill and olive ridley turtles are the species most commonly found in the North Marine Region, with all four species nesting extensively along the Queensland and Northern Territory coasts, as well as foraging in the region. Limited leatherback turtle nesting has been recorded adjacent to the region. The offshore islands of the region are important breeding, nesting and foraging sites for a number of marine turtle species. While loggerhead turtles are found in the North Marine Region, evidence suggests they do not breed in the coastal areas adjacent to the region.

The following advice relates only to those species listed above, which have biologically important area information. Please refer to the conservation values report card—marine reptiles (**www.environment.gov.au/marineplans/north**) for a complete list of marine reptiles and additional information.

Key considerations in relation to significant impacts on marine turtles in the North Marine Region

Population status and ecological significance

Population modelling suggests that for species which are long-lived and slow growing, including marine turtles, high survival rates of large juveniles, subadults and adults are necessary for maintaining stable populations (Heppel at al. 2003). Marine turtles also exhibit strong fidelity to foraging areas and nesting beaches.

The **flatback turtle** is listed as vulnerable and migratory under the EPBC Act. At least four separate stocks are recognised for flatback turtle nesting in Australia (Dutton et al. 2002; Limpus 2009)—the Gulf of Carpentaria stock and western Northern Territory stock occur in the North Marine Region. There are no estimates of population size for the flatback turtle. Genetic variation within the flatback turtle population is low (compared to other marine turtle species) and limited gene flow between the rookeries has been reported (Dutton et al. 2002).

The **green turtle** is listed as vulnerable and migratory under the EPBC Act. The North Marine Region supports nesting green turtles from the Gulf of Carpentaria breeding unit (Limpus & Chatto 2004; Limpus 2009; Kennett et al. 1998). Although the status of the Gulf of Carpentaria breeding unit has not been quantitatively assessed, a preliminary estimate of the size of the green turtle nesting population from the east Arnhem Land rookeries is thousands of females annually (Limpus 2009). It appears that all foraging areas linked to the east Arnhem Land breeding assemblage of this Gulf of Carpentaria breeding unit lie within the Gulf of Carpentaria (Limpus 2009). Green turtles from the northern Great Barrier Reef breeding unit also forage in the Gulf of Carpentaria (Limpus 2009). The green turtles nesting in the western Northern Territory have not been identified to a breeding stock (Limpus 2009).

The **hawksbill turtle** is listed as vulnerable and migratory under the EPBC Act. Within Australia, there is one genetic breeding unit that incorporates the rookeries of the northern Great Barrier Reef, Torres Strait and Arnhem Land and that is independent of a second breeding unit that breeds at rookeries on the north-western shelf of Western Australia (Broderick et al. 1994). Preliminary estimates suggest that the annual nesting population of hawksbill turtles for eastern Arnhem Land (based on 1997 survey data) in the North Marine Region is more than 2500 females annually (Limpus et al. 2000). The species is highly migratory, moving up to 2400 kilometres between foraging areas and nesting beaches (DSEWPaC 2011d). There is little interbreeding between populations in north-eastern and Western Australia (Limpus 2009).

The **leatherback turtle** is listed as endangered and migratory under the EPBC Act. No large leatherback turtle rookeries have been recorded in Australia. It has not been established whether leatherback turtle nesting in the Northern Territory is from the same genetic stock as those that nest in southern Indonesia (Sumatra), West Papua or Papua New Guinea. Regardless, only very small numbers of nests are laid per year in the Northern Territory and thus would be only a minor contributor to the global population (Hamann et al. 2006).

The **olive ridley** turtle is listed as endangered and migratory under the EPBC Act. Australia appears to support the largest breeding population of this species remaining in the South-East Asia–western Pacific region (Limpus 2009). Australian nesting populations of olive ridley turtles are recognised as genetically different from populations in Malaysia, India and the eastern Pacific (Bowen et al. 1998). Aerial survey data are predominantly used to estimate the size of the Australian nesting population (Limpus 1995) which, while thought to be around 500–1000 in 1995 (Limpus 1995), has been revised upward by Taylor and colleagues (2006) to between 1000 and 5000 in the Northern Territory and by Limpus (2009) to several thousand nesting females (Limpus 2009) in Australia.

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

- for the flatback, green and hawksbill turtles, all listed as vulnerable species, it is known that populations of these species occur in and adjacent to the North Marine Region
- for the leatherback turtle and olive ridley turtle, both listed as endangered, it is known that populations of these species occur in and adjacent to the North Marine Region.

Species distribution and biologically important areas

The **flatback turtle** is one of only two marine turtle species that has a restricted, as opposed to global, distribution and all recorded rookeries occur within Australia (Limpus 2009). The North Marine Region has breeding turtles from the Gulf of Carpentaria and western Northern Territory breeding units (genetic stocks). Some nesting occurs all year round within this population, but reaches a peak in July (Limpus 2009).

Unlike other marine turtle species, post-hatchling flatback turtles do not have an oceanic dispersal phase; instead they remain within the relatively shallow Australian continental shelf waters (Salmon et al. 2009). For the North Marine Region, important foraging areas include

the Sir Edward Pellew Group and the east coast of the Gulf of Carpentaria. The species feeds mainly in subtidal, soft-bottomed habitats where they feed principally on soft-bodied invertebrates including soft corals, sea pens, sea cucumbers and jellyfish (Limpus 2009). Flatback turtles foraging in the region predominately belong to the breeding units present in the North Marine Region, but may also belong to the north-west shelf breeding unit.

Biologically important areas have been identified for the flatback turtle, and include:

- an internesting buffer of 80 kilometres surrounding nesting at north-west Arnhem Land (including Cobourg Peninsula, Melville and Bathurst islands)
- an internesting buffer of 80 kilometres surrounding nesting at north-east Arnhem Land (the Wessel Islands)
- an internesting buffer of 80 kilometres surrounding nesting at the Sir Edward Pellew Group
- an internesting buffer of 80 kilometres surrounding nesting at the Wellesley Islands
- an internesting buffer of 80 kilometres surrounding nesting at Crab Island (and nearby islands in western Torres Strait).

Green turtles are a global species that generally live in tropical environments, but are occasionally known to enter temperate waters. The North Marine Region supports green turtles from at least two distinct breeding units: one from the Gulf of Carpentaria nesting and foraging in the Gulf, and another from the northern Great Barrier Reef also foraging in the Gulf. The Gulf of Carpentaria supports two main green turtle rookeries: one in the Wellesley Group (Bountiful, Pisonia and Rocky islands) and one in the eastern Arnhem Land, Groote Eylandt and Sir Edward Pellew Islands area. In the Gulf of Carpentaria, nesting occurs year round with a mid-winter peak (Limpus 1995). Low-density green turtle nesting also occurs in north and west Arnhem Land and nearby islands (Chatto 1998; Hope & Smit 1998; Limpus & Preece 1992). However, the breeding unit to which these turtles belong has not been investigated.

After the post-hatching and juvenile stages, green turtles move to shallow benthic foraging habitats such as coral and rocky reefs, seagrass beds and algal mats, where they feed primarily on seagrass and algae. Foraging areas for green turtles have been identified on the basis of known seagrass habitats in and adjacent to the region.

Biologically important areas have been identified for the green turtle and include:

- an internesting buffer of 20 kilometres surrounding nesting at the Tiwi
- an internesting buffer of 20 kilometres surrounding nesting at Cobourg Peninsula
- an internesting buffer of 20 kilometres surrounding nesting on the offshore islands including Croker Island, Goulburn Island and islands between these
- an internesting buffer of 20 kilometres surrounding nesting at the Wessel and English islands

- an internesting buffer of 20 kilometres surrounding nesting between Nhulunbuy and northern Blue Mud Bay (east Arnhem Land)
- an internesting buffer of 20 kilometres surrounding nesting at Groote Eylandt
- an internesting buffer of 20 kilometres surrounding nesting at the Sir Edward Pellew Islands
- an internesting buffer of 20 kilometres surrounding nesting at the Wellesley Islands (Rocky Island, Pisonia Island, North and South Bountiful islands)
- an internesting buffer of 20 kilometres surrounding nesting at western Cape York Peninsula
- foraging at Albatross Bay
- foraging at Kurumba
- foraging at Wellesly Islands
- foraging at Sir Edward Pellew Islands
- foraging at north-east Arnhem Land (Maria Island, Blue Mud Bay, Elco Island and Maningrida)
- foraging at Goulburn Island
- foraging at Field Island.

The **hawksbill turtle** has a worldwide circumtropical and subtropical distribution, with Australia supporting the largest remaining stocks of breeding turtles in the Indian Ocean–western Pacific Ocean region (Limpus 2009). Australia's population is considered to comprise two distinct stocks, identified on the basis of genetic variability: one in the north-east of Australia and the other in Western Australia (Limpus 2009). Due to significant differences in the timing of the breeding season across the north-eastern stock, it is considered as two separate subpopulations for the purposes of management on the basis that interbreeding is highly unlikely (Limpus 2009). Of these subpopulations, one falls within the North Marine Region, referred to as the Arnhem Land subpopulation. Hawksbill turtles breed throughout the year but the peak nesting period in north-eastern Arnhem Land is in winter and early spring (approximately July to October) (Gow 1981; Limpus & Preece 1992; Limpus et al. 2000).

Little is known about the early life phase of the hawksbill turtle. They are rarely recorded in inshore waters during the first five-year post-hatchling period (DEWHA 2009; Limpus 2009) and it is presumed that during this time they follow an oceanic, planktonic life. As adults and immature turtles, the hawksbill turtle is most frequently encountered in tidal and subtidal coral and rocky reef habitats throughout tropical Australia and in warm temperate areas as far south along the east coast as northern New South Wales (Limpus 2009). They are omnivorous and are believed to feed predominantly on algae, sponges and seagrass (Limpus 2009).

Biologically important areas have been identified for the hawksbill turtle and include:

- an internesting buffer of 20 kilometres surrounding nesting on the mainland coast of western Cape York Peninsula north of Cotterell River;
- an internesting buffer of 20 kilometres surrounding nesting at nesting on Arnhem Land, clustered at four main sites
  - outer islands of the English Company Islands area: Truant Island and Bromby Island
  - north-east Groote Eylandt area: North East Island, Hawke Island, Lane Island and the extreme north-eastern beaches of Groote Eylandt; this area appears to be the most significant area for hawksbill turtle nesting in the Northern Territory
  - north-western Groote Eylandt area: Hawknest Island, Bustard Island and the small island south-west of Bustard Island
  - south-east Groote Eylandt area: two small islands off Cape Beatrice and the south-east coast of Groote Eylandt.

The **leatherback turtle** has a worldwide distribution in tropical and temperate waters. It is less abundant in tropical waters off the northern Australian continental shelf but is occasionally sighted in the Gulf of Carpentaria and near Cobourg Peninsula (DSEWPaC 2011b). Low numbers of nesting females have been recorded at Cobourg Peninsula in north-west Arnhem Land (Chatto & Baker 2008). Breeding in Australia occurs mostly during December and January.

Large juveniles and adult leatherback turtles are found in both pelagic and coastal waters; foraging occurs throughout the water column (Gulko & Eckert 2004; Limpus 1984). Leatherback turtles are carnivorous and feed extensively on colonial tunicates, jellyfish and other soft-bodied invertebrates (Bone 1998; Limpus 1984; Limpus & McLachlan 1979).

Biologically important areas have been identified for the leatherback turtle and include:

- an internesting buffer of 20 kilometres surrounding nesting at Danger Point, Cobourg Peninsula (December–January).

The **olive ridley** turtle has a worldwide tropical and subtropical distribution, including northern Australia. The Australian breeding population of olive ridley turtle only nests adjacent to the North Marine Region from the Arnhem Land coast in the Northern Territory to the north-western coast of Cape York Peninsula in Queensland. Olive ridley turtles nest year round, although most nesting occurs during the dry season, from April to November (Chatto 1998; Cogger & Lindner 1969; Guinea 1990; Limpus & Preece 1992).

Australian populations of olive ridley turtles spend a substantial part of their immature and adult lives foraging over benthic habitats of the continental shelf (DSEWPaC 2011c). Immature and adult olive ridley turtles are carnivorous, feeding principally on gastropod molluscs and small crabs (Limpus 2009). Studies of migration behaviour of adult olive ridley turtles in the Northern Territory reveal that, after nesting, the turtles utilise various foraging areas including coastal, continental shelf and continental slope habitats and have been recorded migrating up to 1050 kilometres from nesting beaches (Whiting et al. 2007).

Biologically important areas have been identified for the olive ridley turtle and include:

- an internesting buffer of 20 kilometres surrounding nesting at north-west Arnhem Land (including Melville Island, Bathurst Island, Cobourg Peninsula, McCluer Island group and Grant Island)
- an internesting buffer of 20 kilometres surrounding nesting at north-east Arnhem Land (including the Sir Edward Pellew Group, Wessel Islands and Crocodile Islands)
- foraging in Fog Bay.

Maps detailing the location and spatial extent of identified biologically important areas for the five marine turtles listed above are accessible via the Conservation Values Atlas (**www.environment.gov.au/marineplans/north**).

Nature of the proposed action

The life history characteristics of marine turtles, including long life spans and late sexual maturity, make them vulnerable to a range of pressures in the marine environment. Marine turtles spend their life at sea, with females returning to beaches in their natal region to nest as adults (Chaloupka & Limpus 2001; FitzSimmons et al. 1997). They are highly migratory and occupy different habitats at different stages of their life.

The conservation values report card—marine reptiles provides a summary of the existing environment and pressures in the North Marine Region. Proposals for new actions should consider the existing environment, and vulnerabilities and pressures acting on marine turtles in the North Marine Region.

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

- climate change (impacts to habitat including changes to sea temperature, sea level rise and associated impact on breeding locations);
- marine debris from a range of sources is a pressure *of concern* for flatback, green, hawksbill, leatherback and olive ridley turtles; and is a pressure *of potential concern* for loggerhead turtles.
- extraction of living resources associated with Indigenous harvest (for flatback, green, hawksbill and olive ridley turtles);
- bycatch associated with commercial fishing practices (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 may adversely impact marine turtles.
- Light pollution associated with onshore and offshore activities (e.g. shipping or petroleum processing facilities) is a pressure *of potential concern* for flatback, green, hawksbill and olive ridley 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, sea level rise is *of potential concern* as it may lead to smaller areas of suitable nesting zones and inundation of turtle nests.
- invasive species from land-based activities is *of concern* for flatback, green, hawksbill and olive ridley turtles.

People planning to undertake actions in biologically important areas for marine turtles should carefully consider the potential for their actions 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.

Actions that have a real chance or possibility of introducing invasive species to olive ridley nesting sites have a **very high risk** of significant impact on this species.

Actions that have a real chance or possibility of increasing relevant noise above ambient levels in biologically important areas of the green, flatback, hawksbill, leatherback and olive ridley turtles when the species are present (e.g. internesting) have a **high risk** of significant impact.

Actions that have a real chance or possibility of increasing lighting at nesting sites during breeding seasons for green, flatback, hawksbill or olive ridley turtles have a **high risk** of significant impact. Examples of such actions include onshore (e.g. petroleum processing facilities, ports) and offshore (e.g. vessels, oil rigs) sources of lighting.

Actions that have a real chance or possibility of introducing invasive species to nesting sites of flatback, green or hawksbill turtles have a **high risk** of significant impact.

Actions that have a real chance or possibility of introducing a new source of marine debris into the biologically important areas of flatback, green, hawksbill and olive ridley turtles have a **risk** of significant impact on these species.

Advice for preparing a referral with respect to impacts on marine turtles in the North Marine Region

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

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

- If the action is proposed within a biologically important area classified in a nesting, internesting or foraging area, information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- Referrals should include information on how it is proposed that the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to any marine turtles. 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 marine turtles and the particular life history characteristics of the species. The conservation values report card—marine reptiles provides information on the current understanding of the range of pressures on marine turtles addressed in this regional advice.

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Schedule 2.4 Seabirds of the North Marine Region

At least 43 seabird species listed under the EPBC Act are known to occur in the North Marine Region.[18] Of these, the region is considered to be particularly important for four species (Table S2.3), as substantial proportions of their population use the region and adjacent waters for breeding, foraging and other life history phases. Regional advice for some seabird species not listed as threatened or migratory is included in the advice provided on the Commonwealth marine environment (Schedule 2.1).

Advice on the four seabird species for which biologically important areas have been identified in or adjacent to the region is provided.

18 Fifty-one species of bird are known to occur in the North Marine Region, with another 49 species that are infrequent to the region. All birds that occur naturally in the region (including the airspace) are protected under the EPBC Act as listed marine species. Seabirds are those birds that rely on and have an ecological association with the marine environment. Thus, not all of the birds that occur in the North Marine Region are seabirds (a complete list of all the birds known to occur in the region is provided in the species group report card—seabirds).

Table S2.3: Seabirds listed as threatened and/or migratory with known biologically important areas in the North Marine Region

Species	Listing status	Breeding season and habits
Bridled tern (*Onychoprion anaethetus*)	Migratory, marine	On some islands, or in some years, breeding is concentrated in a short season, but on other islands breeding has been recorded in most months Breeding occurs during March–June (low numbers) and September–December with a peak in November Dispersal/migration during non-breeding period.
Roseate tern (*Sterna dougallii*)	Migratory, marine	Breeding observed between April and June–July, but most between September and December–January
Brown booby (*Sula leucogaster*)	Migratory, marine	Breeding season varies with egg-laying occurring mostly year round Young birds especially may disperse/migrate when not breeding
Lesser frigatebird (*Fregata ariel*)	Migratory, marine	Breeding observed April–June Birds may disperse/migrate in non-breeding season, with some large movements recorded

No specific advice is provided here for birds that fly over but do not breed or feed in the North Marine Region. A complete list of birds that are known to overfly the region is provided in the conservation values report card—seabirds (**www.environment.gov.au/marineplans/north**).

Most actions would have a **low risk** of a 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 bridled tern, roseate tern, brown booby and lesser frigatebird in the North Marine Region

Population status and ecological significance

The **bridled tern** is widespread in the tropical and subtropical seas around Australia, breeding on islands, including vegetated coral cays, rocky continental islands and rock stacks (Chatto 2001; Higgins & Davies 1996). Bridled terns are difficult to census accurately because of their cryptic breeding habits—nests are often under rocks or bushes in steep terrain with dense vegetation. The breeding population in the Northern Territory has been estimated at up to 60 000 birds (Chatto 1998, 1999, 2001). This is larger than previous estimates for Australia (WBM Oceanics Australia & Claridge 1997). In the Northern Territory, most colonies consist of 100–500 birds with some containing 1000–5000 birds. The largest, on Three Hummocks Island, is estimated to have up to 30 000 birds, but possibly more than 50 000. On Higginson Islet, north-east Arnhem Land, several thousand pairs were estimated to be nesting during 1993 and 1997. On Low Rock, south-west Gulf of Carpentaria, more than 1000 birds were recorded in late September 1994 (Chatto 1998, 1999, 2001). If the majority of birds recorded at the larger Northern Territory colonies breed at these sites, this coast comprises nationally significant bridled tern breeding areas (Chatto 2001). On Higginson Islet, the breeding season is protracted with breeding recorded nearly all year, although mainly from April to June. On some islands, or in some years, breeding is concentrated in a short season, but on other islands breeding has been recorded in most months (Chatto 1998, 2001). The bridled tern feeds on a range of fish, crustaceans, cephalopods and insects (Higgins & Davies 1996).

In Australia, the number of nesting pairs of **roseate tern** is estimated to be 7218–13 370 (WBM Oceanics Australia & Claridge 1997), but this may be as high as 30 000–40 000 pairs (O'Neill et al. 2005). Around the Northern Territory coast, roseate tern breeding colonies vary in size from a few pairs in association with larger black-naped tern colonies to sites consisting of many thousands of nesting roseate terns (Chatto 2001). At some of the active breeding sites, high hundreds to low thousands of roseate terns have also been recorded roosting in non-breeding plumage (Chatto 2001). The number of breeding roseate terns around the Northern Territory coast has been roughly estimated at over 26 000 (Chatto 2001). The roseate tern diet consists mainly of small pelagic fish (del Hoyo et al. 1992; Urban et al. 1986), although it will also take insects and marine invertebrates such as crustaceans (del Hoyo et al. 1992; Urban et al. 1986). Roseate terns in Australia are found to feed primarily in the open sea and at greater distances from the colony (on average) than other similar species of inshore terns (Hulsman 1989). Large numbers of non-breeding Asian migrants may also be present in some areas during the summer months, as occurs on the Great Barrier Reef (O'Neill et al. 2005, 2008).

In 1996–97, the total breeding population of **brown booby** in Australia was estimated at 59 940–73 900 pairs (WBM Oceanics & Claridge 1997). Adjacent to the North Marine Region, there are two large breeding colonies located on the Wellesley Islands. A survey of nesting in 1991 estimated 1400 nests on Manowar Island and 4500–6000 nests (20 000–30 000 birds) on Rocky Island (Walker 1992). This is the largest brown booby breeding colony observed in Australia. The brown booby has been recorded in all months of the year around most of the Northern Territory coastline, except for the shallower, more turbid water areas such as the south-west, Van Diemen Gulf and the many mangrove-lined bays around the coast (Chatto 2001). The brown booby feeds on a large range of fish species and some cephalopods. It is a specialised plunge diver, and often forages closer to land than other booby species, which are considered more pelagic (Marchant & Higgins 1990).

Estimates of the Australian population of **lesser frigatebird** are around 18 680–19 430 breeding pairs (Ross et al. 1995). Manowar Island in the Wellesley Islands supports up to 3800 breeding pairs (O'Neill & White 2003). This species has a protracted breeding season that varies slightly between different localities, but in the region a breeding occupation of at least April to August is indicated (Marchant & Higgins 1990; Walker 1992). A frigatebird roost (non-breeding location) is recorded near Weipa, with up to 500 lesser frigatebirds observed (Mustoe 2008). The species is usually pelagic and is often found far from land, but is also found over shelf waters, in inshore areas and over continental coastlines (Marchant & Higgins 1990). It forages by scooping up marine organisms from the surface of the water, taking flying fish from just above the surface, or by harassing other seabirds to force them to disgorge some of their meal (Marchant & Higgins 1990). The lesser frigatebird appears to range relatively close to breeding colonies (Jaquemet et al. 2005), but some large movements have been recorded through band recoveries.

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

- bridled tern, roseate tern, brown booby and lesser frigatebird populations in the North Marine Region should be considered as constituting an ecologically significant proportion of the population.[19]

19 A definition of 'ecologically significant population' is provided in Part 1 of this plan 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 a population may be impacted

Species distribution and biologically important areas

The bridled tern, roseate tern, brown booby and lesser frigatebird forage in the North Marine Region and breed on islands adjacent to the region. The bridled tern and roseate tern are primarily distributed across Arnhem Land and the western and southern Gulf of Carpentaria, while the brown booby and lesser frigatebird occur mostly in the southern Gulf of Carpentaria.

Biologically important areas include:

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

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

People planning to undertake actions in biologically important areas classified as breeding areas (which includes foraging for provisioning young) or roosting sites for the species listed in Table S2.3, when the species are present, should carefully consider the potential for their action to have a significant impact on the species. Actions undertaken within biologically important areas but outside breeding seasons have a **low risk** of a significant impact on these species, as they migrate or disperse during the non-breeding season. This might not apply to actions that involve ongoing effects (e.g. permanent installation of lights, loss of breeding habitat). In light of observed changes in breeding times in response to climate-related shifts, surveys of breeding colonies can assist with verifying the presence of nesting birds.

Nature of the proposed action

The conservation values report card—seabirds provides an overview of the vulnerabilities and pressures on protected seabirds in the North Marine Region. Anthropogenic activities in coastal environments and offshore have the potential to impact significantly on seabirds.

Potential pressures on seabirds in the region include human presence at sensitive sites (e.g. breeding colonies), invasive species, climate change (changes in sea level rise, changes in sea temperature and oceanography, ocean acidification) and marine debris from a range of sources.

Disturbance of colonies during the breeding season and modification of nesting habitat may significantly affect the reproductive output of populations. Many seabird species are likely to abandon the nesting site if disturbed. Ground-nesting species, such as the roseate tern, are particularly susceptible to human disturbance during the breeding season. Pest species, such as cats, foxes, pigs and rats, can also substantially affect the reproductive success of ground-nesting seabirds.

Actions that have a real chance or possibility of increasing human disturbance at breeding colonies or of substantially increasing the incidence of nuisance or introduced species have a **high risk** of a significant impact on the seabird species listed in Table S2.3.

Advice for preparing a referral with respect to impacts on bridled tern, roseate tern, brown booby and lesser frigatebird in the North Marine Region

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

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

- If the action is proposed within a biologically important area classified in a breeding area (including breeding colonies and/or foraging areas that are likely to incorporate chick provisioning), information about alternative locations for the proposed action that would be outside the area and/or why the action is unlikely to have a significant impact or why any significant impact can be reduced to a level that is acceptable should be considered.
- Referrals should include information on how it is proposed that the likelihood of any significant impacts will be mitigated, considering the advice provided above on likely significant impacts to any seabirds. It is recommended that independent scientific assessments of any intended mitigation measures be sought before submitting a referral and that any such assessment is included in the referral.
- Referrals should be supported by scientifically credible information that places the proposal in the context of the advice on existing pressures on the seabirds and the particular life history characteristics of the species. The conservation values report card—seabirds provides information on the current understanding of the range of pressures on seabirds addressed in this regional advice.

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Table A Marine listed and cetacean species known to occur in the North Marine Region[20]

Species (common/scientific name)	Conservation status
Bony fishes	
Big-head seahorse *Hippocampus grandiceps*	Marine
Hedgehog seahorse *Hippocampus spinosissimus*	Marine
High-crown seahorse *Hippocampus procerus*	Marine
Kellogg's seahorse *Hippocampus kelloggi*	Marine
Northern spiny seahorse *Hippocampus multispinus*	Marine
Three-spot seahorse *Hippocampus trimaculatus*	Marine
Western spiny seahorse, narrow-bellied seahorse *Hippocampus angustus*	Marine
Winged seahorse *Hippocampus alatus*	Marine
Yellow seahorse, spotted seahorse *Hippocampus kuda*	Marine
Banded pipefish, ringed pipefish *Dunckerocampus dactyliophorus*	Marine
Blue-finned ghost pipefish, robust ghost pipefish *Solenostomus cyanopterus*	Marine
Brock's pipefish *Halicampus brocki*	Marine
Cleaner pipefish, Janss' pipefish *Doryrhamphus janssi*	Marine

Species (common/scientific name)	Conservation status
Double-ended pipehorse, double-end pipehorse, alligator pipefish *Syngnathoides biaculeatus*	Marine
Girdled pipefish *Festucalex cinctus*	Marine
Günther's pipehorse, Indonesian pipefish *Solegnathus lettiensis*	Marine
Harlequin ghost pipefish, ornate ghost pipefish *Solenostomus paradoxus*	Marine
Long-nosed pipefish, straight stick pipefish *Trachyrhamphus longirostris*	Marine
Mud pipefish, Gray's pipefish *Halicampus grayi*	Marine
Pacific short-bodied pipefish, short-bodied pipefish *Choeroichthys brachysoma*	Marine
Pallid pipehorse Hardwick's pipehorse *Solegnathus hardwickii*	Marine
Pig-snouted pipefish *Choeroichthys suillus*	Marine
Red-banded pipefish, brown-banded pipefish, Fijian banded pipefish, Fijian pipefish *Corythoichthys amplexus*	Marine
Reef-top pipefish *Corythoichthys haematopterus*	Marine
Ribboned seadragon, ribboned pipefish *Haliichthys taeniophorus*	Marine
Ridge-nose pipefish, ridgenose pipefish, red-hair pipefish, Duncker's pipefish *Halicampus dunckeri*	Marine

Species (common/scientific name)	Conservation status
Short-pouch pygmy pipehorse *Acentronura breviperula*	Marine
Three-keel pipefish *Campichthys tricarinatus*	Marine
Tidepool pipefish *Micrognathus micronotopterus*	Marine
Yellow-banded pipefish Corythoichthys flavofasciatus	Marine
Cetaceans	
Bottlenose dolphin *Tursiops truncatus*	Cetacean
False killer whale *Pseudorca crassidens*	Cetacean
Indo-Pacific bottlenose dolphin *Tursiops aduncus*	Cetacean
Melon-headed whale *Peponocephala electra*	Cetacean
Short-finned pilot whale *Globicephala macrorhynchus*	Cetacean
Seasnakes	
Beaked seasnake *Enhydrina schistosa*	Marine
Black-headed seasnake *Hydrophis atriceps*	Marine
Dubois' seasnake *Aipysurus duboisii*	Marine
Dwarf seasnake *Hydrophis caerulescens*	Marine

Species (common/scientific name)	Conservation status
Elegant seasnake, bar-bellied seasnake *Hydrophis elegans*	Marine
Fine spined seasnake *Hydrophis czeblukovi*	Marine
Horned seasnake *Acalyptophis peronii*	Marine
Large-headed seasnake *Hydrophis pacificus*	Marine
Olive seasnake *Aipysurus laevis*	Marine
Olive-headed seasnake *Hydrophis major*	Marine
Ornate seasnake, ornate reef seasnake *Hydrophis ornatus*	Marine
Plain seasnake *Hydrophis inornatus*	Marine
Plain-banded seasnake *Hydrophis vorisi*	Marine
Small-headed seasnake *Hydrophis mcdowelli*	Marine
Spectacled seasnake *Hydrophis kingii*	Marine
Spine-bellied seasnake *Lapemis hardwickii*	Marine
Spine-tailed seasnake *Aipysurus eydouxii*	Marine
Stokes' seasnake *Astrotia stokesii*	Marine
Yellow-bellied seasnake *Pelamis platurus*	Marine

Species (common/scientific name)	Conservation status
Seabirds	
Egrets, herons and ibis	
Little egret *Egretta garzetta*	Marine
Gulls and jaegers	
Silver gull *Chroicocephalus novaehollandiae*	Marine
Plovers	
Red-capped plover *Charadrius ruficapillus*	Marine
Raptors	
Brahminy kite *Haliastur indus*	Marine
Terns and noddies	
Crested tern *Thalasseus bergii*	Marine
Gull-billed tern *Gelochelidon nilotica*	Marine
Sooty tern *Onychoprion fuscata*	Marine
Whiskered tern *Chlidonias hybrida*	Marine
Other	
Australian pratincole *Stiltia isabella*	Marine
Beach stone-curlew *Esacus magnirostris*	Marine
Radjah shelduck *Tadorna radjah*	Marine

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

MAP DATA SOURCES

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DSEWPaC (2011): Key Ecological Features in the North Marine Planning Region
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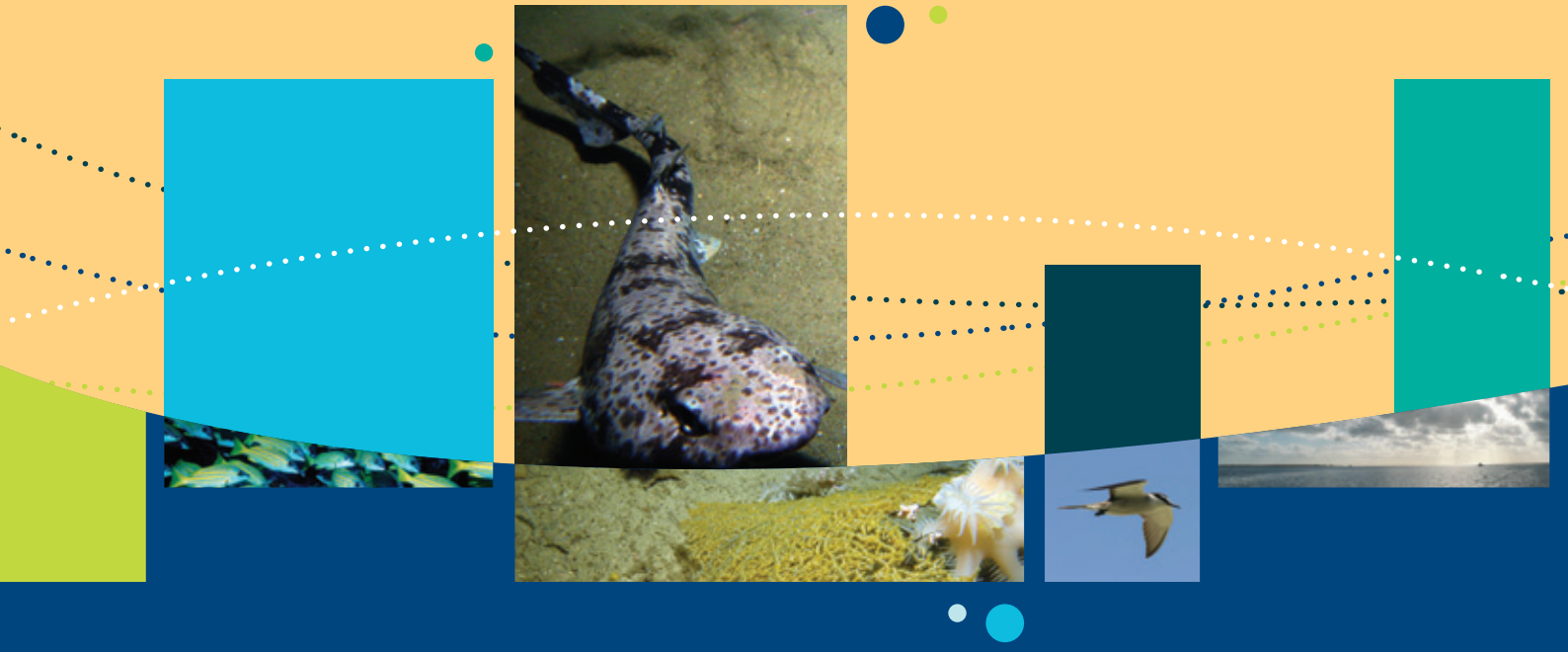

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