



LEPROVOST DAMES & MOORE

A DAMES & MOORE COMPANY

Ningaloo Marine Park (Commonwealth Waters)

Literature Review

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1. INTRODUCTION

1.1 BACKGROUND

The Ningaloo Marine Park is located on the continental shelf and slope to the west of the Cape Range peninsula, Western Australia, and includes portions under Commonwealth and State control (Figure 1). As part of the process of reviewing the Plan of Management for the Ningaloo Marine Park (Commonwealth Waters), the Marine Group, Environment Australia has commissioned LeProvost Dames & Moore (LDM) to undertake a review of literature relevant to the Ningaloo Marine Park and those adjacent areas which might potentially impact on the Marine Park. Accordingly, the area covered by the review has been extended some distance beyond the boundaries of the Marine Park (Commonwealth Waters) to include the Ningaloo Marine Park (State Waters), Cape Range, the northern part of Exmouth Gulf, and the deeper waters of the outer continental shelf and continental slope to the west of the Park.

This report presents a summary of the known marine resources of the Ningaloo Marine Park and their sensitivity to existing and potential impacts based on published information and the experience of the authors.

1.2 SYNOPSIS

The Ningaloo Marine Park encompasses the majority of the Ningaloo Reef, the largest fringing-barrier reef in Australia and one of the longest fringing coral reefs in the world. The Ningaloo reef system extends for 260 km along the west coast of the Cape Range peninsula, stretching from about 21°50'S to 23°35'S.

It is also one of the most accessible coral reefs, as only a shallow, narrow lagoon, averaging 2-4 m in depth and ranging in width from 200 m to in excess of 6 km, separates the reef from the mainland. Seaward of the reef crest, the reef drops gently to a depth of about 8-10 m and has a well-developed spur and groove structure. The bottom then falls more gently to the 100 m isobath some 5-6 km outside the reef edge, becoming progressively more sandy. There are breaks in the reef every few kilometres where water depth ranges from 6-8 m (Ayling & Ayling 1987).

The reef features a great diversity of corals (more than 200 species), reef fish (more than 460 species), molluscs, crustaceans and other reef plants and animals. Sea turtles, dugongs and dolphins are common within the lagoon, while the waters immediately beyond the reef play host each year to migrating Humpback Whales and Whale Sharks.

Created to protect the reef's scenic, conservation and recreational values, the Ningaloo Marine Park extends from Point Murat in Exmouth Gulf to Amherst Point, south of Coral Bay on Western Australia's north-west coast. It is located approximately 1,200 km north of Perth. The Park was established under Commonwealth and State legislation and is vested in the Western Australian Marine Parks and Reserves Authority (State Waters) and Environment Australia (Commonwealth Waters). The Park is managed under an agreement between the Commonwealth and the State jointly by the Western Australian Department of Conservation and Land Management (CALM) and Fisheries Western Australia. CALM is the principal management agency for the Marine Park while Fisheries WA is responsible for the management of fish and fishing within the Park.

Covering an area of 4,566 km², the Marine Park spans the area from the shoreline to the continental slope. In much of the northern part of the Park the continental shelf is very narrow

and the break which marks the descent onto the continental slope in places occurs within the Park boundaries. In conjunction with the adjoining Cape Range National Park, the representation of habitats in the combined reserves is extended to include the coastal features and rugged arid hinterland. Cape Range National Park has an area of 50,581 ha and extends inland from the beaches, dunes and rocky shores of the comparatively narrow western coastal plain inland to the highly dissected Cape Range which rises to over 300 m in height.

Most of the commercial, educational and recreational resources identified in the Park occur permanently (mangroves, corals, seagrasses, dugongs), congregate in (whale sharks, turtles) or migrate through (whales), the nearshore zone, including the area immediately seaward of the Ningaloo Reef and shallow (<20 m) waters of the Rowley Shelf and Exmouth Gulf.

The species of ecological significance which occur in the Commonwealth Waters of the Marine Park are typically the more mobile species such as whales, whale sharks, turtles and seabirds, mostly occurring in low numbers and widely dispersed.

The Park provides opportunities for sight seeing, coral viewing, diving, snorkeling and photography, Humpback Whale, Whale Shark and turtle watching, and fishing, which is the most popular recreational activity undertaken within the Park.

The Milyering Visitor Centre provides interpretative information on the Ningaloo Marine Park and Cape Range National Park through an array of models, graphic displays, videos and a library. The Centre is located in the northern part of the Cape Range National Park, 52 km by road from Exmouth.

Accommodation is provided in Exmouth and Coral Bay and there are camping areas with basic facilities in the Marine Park/Cape Range National Park and bush campsites on some parts of the adjoining pastoral leases to the south of the Park.

1.3 INFORMATION SOURCES

The authors wish to thank the following individuals and organisations who have provided assistance and information which has been used in this report:

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1.4 THIS DOCUMENT

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The diagrams were produced by Environmental Drafting Services and the cover photograph was taken at Coral Bay by Clay Bryce.

2. LOCATION AND CLASSIFICATION OF NINGALOO MARINE PARK

2.1 LOCATION AND BOUNDARIES

The Ningaloo Marine Park is located on the north-west coast of Western Australia between latitudes 21°40' S and 23°34' S (Figure 1). The Park extends northward from Amherst Point along the western coastline of the Cape Range peninsula, and thence eastward around North West Cape and southward past Point Murat to include a small portion of the western side of Exmouth Gulf encompassing Bundegi Reef, a coastline length of approximately 260 km. The State portion also includes a narrow, 40 m wide strip of land extending northward from Amherst Point to Winderabandi Point.

The State Waters portion of the Marine Park extends three nautical miles (3 nm = approximately 5.5 km) seaward of the Baseline, which follows approximately the line of the reef crest (outer edge of the reef). The State Waters portion of the Park thus comprises the narrow terrestrial strip from Amherst Point to Winderabandi Point, the reef and back reef lagoon which lie adjacent to the land, and extends approximately 3 nm seaward of the reef crest to the State Territorial Waters boundary.

Beyond this lies the Commonwealth Waters portion of the Marine Park which extends seaward of the State Territorial Waters boundary a further 6 to 15 km, becoming wider to the south of Point Cloates.

The two portions of the Marine Park are generally complementary and parallel, with the Park averaging approximately 18.5 km (10 nm) in width. However, there are two areas that are presently excluded from the Commonwealth Waters portion of the Park. These are a triangular area bounded on two sides by Commonwealth Waters and on the third by State Waters located to the north of Winderabandi Point, and a complete break in the Commonwealth Waters portion of the Park opposite Milyering (Figure 2). These excisions are due to the prior presence of petroleum exploration permits (WA-24-P R4 [Parts 2 and 3]) which under Commonwealth legislation could not be proclaimed part of the Marine Park. It is intended that, on relinquishment, the relevant parts of the affected permits be included within the Marine Park. A third area, comprising part of petroleum lease WA-155-P, originally excluded for the same reason, was proclaimed part of the Park on 21 July 1992 following its relinquishment.

The present area of the Marine Park (State and Commonwealth Waters) is 4,566 km². The Commonwealth Waters portion occupies an area of 2,326 km² while the State Waters component has an area of 2,240 km². The terrestrial strip has an area of 5.6 km².

Proposed future additions to the Marine Park include the two areas described above, subsequent to their relinquishment (Commonwealth Waters), and an extension southward from Amherst Point to Gnaraloo Bay (within State Waters) (Figure 2).

2.2 MARINE PARK CLASSIFICATION

The Commonwealth Waters portion of the Ningaloo Marine Park was proclaimed as a Marine Park under the *National Parks and Wildlife Conservation Act 1975* on 7 May 1987 with the second stage being declared on 21 July 1992.

The State Portion of the Ningaloo Marine Park was proclaimed as a Marine Park under the *Conservation and Land Management Act* 1984 and the *Land Act* 1933. Initially, both sections were vested in the National Parks and Nature Conservation Authority. Following an amendment to the CALM Act in 1997 [the *Acts Amendment (Marine Reserves) Act* 1997] to create a Marine Parks Authority, the State portions of the park were vested in the Western Australian Marine Parks and Reserves Authority (MPRA).

2.3 STATUS AS A PROTECTED AREA

Both the Commonwealth and State Waters portions of the Ningaloo Marine Park are secured as marine park under the appropriate Commonwealth and State legislation.

The Ningaloo Marine Park (State and Commonwealth Waters) is cooperatively managed by CALM and Environment Australia under separate but complementary plans of management prepared by CALM for the State Waters portion and the Marine Group, Environment Australia for the Commonwealth Waters portion.

Under a Memorandum of Understanding reached between the Commonwealth and the State, CALM is responsible for the administration and day-to-day management, while Fisheries WA is responsible for the management of recreational and State-managed commercial fishing in the Marine Park. The Australian Fisheries Management Authority (AFMA) is responsible for the management of pelagic fisheries beyond the State Territorial Waters boundary and demersal fisheries beyond the 200 m isobath.

3. OVERVIEW OF LEGISLATION AND AGREEMENTS AFFECTING THE NINGALOO MARINE PARK

The Marine Park lies across both Commonwealth and State waters and is therefore subject to Commonwealth and/or State jurisdiction.

The environment and marine focused Commonwealth and State Acts, State policies and international agreements to which Australia is signatory and that may have application to the management of the Park are described in the following sections.

3.1 COMMONWEALTH LEGISLATION

National Parks and Wildlife Conservation Act 1975

The *National Parks and Wildlife Conservation Act 1975* applies to all External Territories and Commonwealth waters. The Act is concerned with general protection of flora and fauna, both within National Parks and throughout Australian Territory. It facilitates the declaration and management of national parks and nature reserves on both land and sea. Upon the declaration of a park, any interest held by the Commonwealth in respect of the land (including any seabed or subsoil) within the Park, but not in respect of any minerals, becomes vested in the Director of National Parks and Wildlife by force of subsection 7(7).

The Ningaloo Marine Park was proclaimed under this Act which has application to the Commonwealth Waters portion of the Marine Park.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* received royal assent on 16 July 1999 and will commence no later than 16 July 2000. The Act, and associated *Environmental Reform (Consequential Provisions) Act 1999*, will replace the *Environment Protection (Impact of Proposals) Act 1974*, the *National Parks and Wildlife Conservation Act 1975*, the *Endangered Species Protection Act 1992*, the *Whale Protection Act 1980* and the *World Heritage Properties Conservation Act 1983*.

The Act provides for the protection of the environment in land and waters under control of the Commonwealth. The revised Ningaloo Marine Park (Commonwealth Waters) Plan of Management will be prepared in accordance with, and conform to, the requirements of this Act which will come into force prior to the finalisation of the revised Ningaloo Marine Park (Commonwealth Waters) Plan of Management.

Environment Protection (Impact of Proposals) Act 1974

The Commonwealth Environment Protection Act is triggered where a Commonwealth action (including a decision) is likely to have a significant environmental impact. The Act requires that environmental concerns be addressed in formulating proposals, carrying out works and projects and in making decisions and recommendations. Under the Act the Minister for Environment may require an Environmental Impact Assessment (EIA) to be undertaken if it is deemed that a decision or proposal is likely to have a significant effect on the environment. This act will be replaced by the *Environment Protection and Biodiversity Conservation Act* in July 2000.

Endangered Species Protection Act 1992

The *Endangered Species Act 1992* provides for the protection of endangered and vulnerable species and ecological communities in Commonwealth areas, including marine areas. It is concerned with the protection of fauna and flora species that are included on the Commonwealth endangered species list.

In respect of the Ningaloo Marine Park, it includes a number of species that occur in, on or above the Commonwealth Waters portion of the Marine Park.

Wildlife Protection (Regulation of Exports and Imports) Act 1982

The *Wildlife Protection (Regulation of Exports and Imports) Act 1982* regulates the export and import of wildlife (animals and plants) in Australia and its External Territories and gives effect to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to which Australia is signatory. Schedule 1 of the Act lists species threatened with extinction, with the exception of cetacea, which are or may be threatened by trade. Schedule 2 lists, with the exception of cetacea, species that are not necessarily threatened with extinction, but could become so unless subject to strict regulation. Controls on the import and export of cetacea (and parts thereof) are set out in Schedule 3 of the Act.

Export of species listed in Schedule 1 of the Act, such as all species of marine turtle, is strictly regulated to prevent them becoming further endangered. Export of species listed in Schedule 2, such as clams, can only be taken under an approved management program.

The Ningaloo Marine Park contains a significant number of marine species that are protected under this Act.

Whale Protection Act 1980

The Whale Protection Act regulates the taking, killing, injuring or interfering with all species of cetaceans in the Australian Fishing Zone. In addition to the taking of cetaceans, which is banned in Australian waters, the Act has direct application to the management of whale watching activities.

In addition to a number of species of dolphin which frequent the waters of the Park, the western Humpback Whale population passes close to shore through the waters of the Ningaloo Marine Park during its annual migration and is a major tourist attraction. The Act has direct application to the protection of cetaceans in the Park from undue interference from tourism activities.

Native Title Act 1993

Native title is defined under section 223(1) of the *Native Title Act 1993* as “the communal, group or individual rights and interests of Aboriginal people or Torres Strait Islanders in relation to land or waters where:

3. Overview of Activities, Legislation and Agreements Affecting the Ningaloo Marine Park

- a) the rights and interests are possessed under the traditional laws acknowledged, and the traditional customs observed, by the Aboriginal people or Torres Strait Islanders; and
- b) the Aboriginal people or Torres Strait Islanders, by those laws and customs, have a connection with the land and waters; and
- c) the rights and interests are recognised by the common law of Australia.”

Both the Commonwealth and State waters portions of the Ningaloo Marine Park are subject to a registered native title claim (the Gnulli claim).

Australian Heritage Commission Act 1975

The *Heritage Commission Act* establishes the Register of the National Estate on which areas of identifies heritage value may be entered. Under the Act, any Commonwealth Department or Agency proposing an action significantly affecting a place listed on the Register of the National Estate is required to refer the proposal to the Heritage Commission for consideration. If there are no feasible or prudent alternatives to that action, all reasonable measures must be taken by the department or agency to minimise any damaging effects.

Both Commonwealth and State sections of the Park are listed, together with adjacent parts of the mainland. Actions proposed by Commonwealth departments or agencies within the Ningaloo Marine Park are therefore subject to the provisions of this Act.

Historic Shipwrecks Act 1976

The *Historic Shipwrecks Act 1976* provides protection for all shipwrecks and relics that have lain for seventy-five years or more in waters under Commonwealth responsibility and for specific wrecks declared under sections 5 or 6 of the Act. Under section 7 of the Act, protected zones may be declared around historic shipwreck sites to prevent unauthorised access.

There are no known historic shipwreck sites within the Commonwealth Waters portion of the Ningaloo Marine Park.

Fisheries Administration Act 1991 and Fisheries Management Act 1991

The purpose of the *Fisheries Management Act 1991* is to regulate the commercial operations of all persons and vessels, and the non-commercial activities of persons on foreign registered vessels, in respect of the taking of swimming fish in the Australian Fishing Zone. The Australian Fisheries Management Authority established under the Act is responsible for the management of fisheries within the Australian Fishing Zone (AFZ) under Commonwealth control.

Under agreements made under the Offshore Constitutional Settlement, the Western Australian *Fisheries Act 1905* (subsequently replaced by the *Fish Resources Management Act 1994*), provides for management by the State of fisheries on the continental shelf, from the shoreline to the 200 m isobath and, in some instances, to the 200 nm limit of the AFZ.

There are a number of fisheries, including both trawl and line fisheries, which presently are, or are potentially able to operate under Commonwealth or State jurisdiction within the waters of the Ningaloo Marine Park.

Petroleum (Submerged Lands) Act 1967

The *Petroleum (Submerged Lands) Act 1967* and directions issued under the Act, the:

- Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production (1995); and
- Petroleum (Submerged Lands) (Management of Environment) Regulations 1999;

regulate petroleum exploration and production in Commonwealth waters, including environmental performance.

The principal objective of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999, which came into effect on 1 October 1999, is to ensure that offshore petroleum operations are performed in a way that is consistent with the principles of environmentally sustainable development through an accepted Environment Plan with agreed environmental performance objectives, standards and criteria for determining environmental performance. It is intended that Environment Plans will become legally binding agreements between government regulators and operators, and that plans will apply to all offshore activities including decommissioning.

By agreement, the Western Australian (WA) government, through the Western Australian Department of Minerals and Energy (DME), administers applications relating to offshore petroleum activities in Commonwealth waters offshore Western Australia. Proposals may be referred to Commonwealth and WA authorities by the DME as deemed appropriate.

There are no current petroleum leases issued under this Act over the Commonwealth Waters of the Ningaloo Marine Park, however, there are a number of leases covering adjacent waters.

Offshore Minerals Act 1994

The purpose of the *Offshore Minerals Act 1994* is to regulate exploration for, and the extraction of, minerals other than petroleum on the continental shelf beyond the Territorial Sea.

Environmental Protection (Sea Dumping) Act 1981

The *Environment Protection (Sea Dumping) Act 1981* regulates the dumping of waste and all other materials in Australian waters. The Act enables Australia to meet its international obligations under the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (the London Convention) and the United Nations Convention on the Law of the Sea 1982. The Act covers the dumping of material at sea and the loading of material for the purpose of dumping. It applies from the low water mark to the outer edge of the AFZ and to those parts of the continental shelf that are beyond the limit of the AFZ.

The Act would therefore apply to any proposal to undertake dumping in the Marine Park (Commonwealth Waters).

Protection of the Sea (Prevention of Pollution from Ships) Act 1983

The *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and the *Navigation (Protection of the Sea) Amendment Act 1983* and orders made under those Acts, the:

- Protection of the Sea (Prevention of Pollution from Ships) Regulations (Orders 1994/468); and
- Marine Orders, Part 91 (Marine Pollution Prevention – Oil) Order No.1 of 1998;

give effect to the International Convention for the Prevention of Pollution from Ships (MARPOL) which came into effect internationally in October 1983. The Act provides for the regulation of discharges of oil and noxious chemicals from merchant ships and discharges of garbage, including plastic material, from all Australian ships.

Navigation Act 1912

This act requires that ships carrying oil and chemical tankers conform to Annex 1 of the MARPOL convention for the Prevention of Pollution from Ships.

The Coastal Waters (States Powers) Act 1980 and Coastal Water (States Titles) Act 1980

The States Powers Act gives the States power over ‘coastal waters’ - the territorial sea to a distance of 3 nm from the territorial sea baselines (established in 1990 under the *Seas and Submerged Lands Act 1973* in accordance with the United Nations Convention on the Law of the Sea), and the waters on the landward side of the baselines that are not part of the ‘internal waters’ of the States. The *Coastal Water (States Titles) Act 1980* gave the States title to the seabed of coastal waters and fixtures attached to the seabed. Rights (but not ownership) were also given in the water column.

The boundary between the Commonwealth and State Waters portions of the Ningaloo Marine Park is established under this Act.

3.2 STATE LEGISLATION

Conservation and Land Management Act 1984

The *Conservation and Land Management Act* provides for the administration and management of conservation reserves within the State of Western Australia and for the management of marine parks and reserves in State waters. The portion of the Ningaloo Marine Park that occurs in Commonwealth Waters is also managed by CALM under a joint agreement between the Commonwealth and WA governments.

Acts Amendment (Marine Reserves) Act 1997

The *Acts Amendment (Marine Reserves) Act* of 1997 amended the *Conservation and Land Management Act* 1984 to provide for the establishment of a Marine Parks and Reserves Authority to oversee the management of Western Australia's marine parks and nature reserves, including the Ningaloo Marine Park.

Land Act 1933 and the Land Administration Act 1997

The *Land Act* previously provided for the administration of land title within the State of Western Australia. The 40 m coastal strip adjacent to the Marine Park was established as a reserve under the *Land Act* and subsequently vested in the NPNCA. The Act also provided for the granting and administration of pastoral leases. All pastoral leases granted under the *Land Act* will expire on 30 June 2015.

In 1997 the *Land Act* was repealed and replaced by the *Land Administration Act* 1997, which has similar functions but, amongst other changes, provides for greater flexibility in the administration of leasehold land, including recognition of the need to provide for the requirements of tourism in remote areas.

Fish Resources Management Act 1994

The objects of the *Fish Resources Management Act* are to conserve fish and protect their environment, to manage their exploitation through fishing, aquaculture and ecotourism in a sustainable manner. The Act is used to manage the commercial and recreational exploitation of all fishes in State Waters and demersal fisheries on the continental shelf to the 200 m isobath.

The exploitation of fish, both recreational and commercial, in the State Waters portion and part of the Commonwealth Waters portion (part of the demersal fishery) of the Marine Park are managed by Fisheries Western Australia under the Act.

The Whale Sharks in the Ningaloo Marine Park (and elsewhere in State Waters) are protected under the *Fish Resources Management Act* and the *Wildlife Conservation Act* (Fisheries WA 1998).

Wildlife Conservation Act 1950

Within Western Australia and State Waters, flora and fauna, including marine species occurring in State waters, are protected under the *Wildlife Conservation Act*. Special provisions apply to those species which are listed under schedules to the Act as rare or endangered or otherwise in need of special protection.

Aboriginal Heritage Act 1972

The *Aboriginal Heritage Act* provides for the protection of Aboriginal cultural materials and places of significance.

Maritime Archaeology Act 1973

The *Maritime Archaeology Act* provides for the preservation of historic shipwrecks and relics located in State waters.

Petroleum Act 1967

The *Petroleum Act* regulates petroleum exploration and production, including environmental performance, in coastal waters inshore of the baseline and on land under the control of the State.

Petroleum (Submerged Lands) Act 1982

The Western Australian *Petroleum (Submerged Lands) Act* and regulations:

- Schedule of Specific Requirements as to Offshore Petroleum Exploration and Production (1995); and
- Petroleum (Submerged Lands) (Management of Environment) Regulations (upon promulgation);

are complementary to the Commonwealth Act and regulations, and regulate petroleum exploration and production, including environmental performance, in State Territorial waters.

3.3 STATE GOVERNMENT POLICY

In 1994 the Government of Western Australia released a strategy for marine management in Western Australia, titled *New Horizons in Marine Management*. The key elements of the strategy were:

- the establishment of a Marine Parks Authority in which marine conservation reserves would be vested;
- a three tiered approach to the categorisation of marine conservation reserves (marine nature reserves, marine parks and marine management areas) in order to preserve representative ecosystems and provide for the management of the various uses of marine reserves;
- access guidelines for petroleum explorers and developers in marine conservation reserves;
- prohibition on drilling for petroleum in Ningaloo Marine Park; and
- release of a report on a comprehensive marine reserve system for Western Australia (which included a proposed southward extension of the Ningaloo Marine Park to Gnaraloo Bay).

(Government of Western Australia 1994)

3.4 INTERNATIONAL AGREEMENTS AND CONVENTIONS

Japan Australia Migratory Birds Agreement (JAMBA)

This agreement between Japan and Australia is concerned with the protection of migratory birds and, in particular, species that migrate between Australia and Japan, the protection of birds in danger of extinction and their environment. A number of migratory birds listed under this agreement have been observed within the Marine Park.

China Australia Migratory Birds Agreement (CAMBA)

This agreement is similar to JAMBA, but in this case is concerned with the protection of bird species that migrate between Australia and the Republic of China.

Convention on Biological Diversity (1992)

The aims of the Convention, ratified by Australia in 1993, are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

The establishment of marine parks and protected areas are key elements in Australia's contribution to the conservation of biological diversity.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979)

The aim of the Bonn Convention is to conserve terrestrial, marine and avian species over the whole of their migratory range. The convention commits 'Range States' to take action to conserve migratory species over the whole of their migratory range, especially those under threat.

Ningaloo Marine Park provides protection to part of the range of a number of species that regularly migrate through the Park, including whales, Whale Sharks and sea turtles.

International Convention for the Regulation of Whaling (1946)

The purpose of the Convention is to conserve whale stocks and permit the orderly development of the whaling industry. However, due to over-exploitation, a moratorium was placed on all commercial whaling in 1986. Whaling is presently restricted to subsistence whaling by traditional aboriginal hunters and to scientific whaling. The International Whaling Commission (IWC) was set up under the Convention.

Australia's commitments under the Convention are presently met through the *Whale Protection Act* 1980 and will, on its commencement, be met in the future through the *Environment Protection and Biodiversity Conservation Act* 1999.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The purpose of CITES is to regulate the international trade in endangered species in order to assist in the conservation of those species by managing their commercial exploitation. Species under CITES control are listed in three appendices, as follows:

Appendix I – Species threatened with extinction which are or may be threatened by trade. These species are, with the exception of cetacea, listed in Schedule 1 of the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*.

Appendix II – Species not necessarily threatened with extinction, but could become so unless subject to strict regulation. Species in Appendix II are, with the exception of cetacea, listed in Schedule 2 of the Act.

Appendix III – Species which any CITES Party identifies as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation, and needing the cooperation of other countries in the control of trade. These species are listed in Schedule 2A of the Act.

The Convention has application to the export of endangered species for any purpose from the Park (and elsewhere within Australia), and includes transactions involving museums, zoos, scientific institutions, commercial organisations, tourists and the general public.

United Nations Convention on the Law of the Sea 1982

The Convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources including pollution from the land, from the atmosphere, from vessels and from dumping.

The Law of the Sea Convention came into effect in 1994 and was ratified by Australia in that year. It aims to protect the interests of coastal States by recognising maritime zones over which such States exercise jurisdiction, and to clarify the rights and duties of all States with regard to ocean related activities.

The Convention formalised the concepts of the 12 nautical mile territorial sea and the 200 nautical mile Exclusive Economic Zone (Tsamenyi and Herriman 1996). However, these jurisdictions do not confer total power over coastal States and there are rights to passage and in some cases economic exploitation where resources are not fully exploited by the adjacent State. The Convention also confers on the State the responsibility to the protection and management of the resources. These include fisheries conservation and management, protection and preservation of the marine environment, marine scientific research and mining of the deep seabed.

Under the Convention, Australia is obliged to:

- protect and preserve the marine environment and harness its marine resources in accordance with this duty;

- cooperate globally and regionally to establish international rules and procedures to protect and preserve the marine environment; and
- ensure ecologically sustainable management of the zone's resources that does not permanently damage the environment. This means managing a wide range of interests – recreation, tourism, fishing, aquaculture, environment protection, the oil and gas industries, chemicals, mining and substances of pharmaceutical value developed from marine resources (IMCRA 1998).

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) 1982

The purpose of the Convention is to prevent pollution of the sea from dumping of waste and other matter that is liable to create hazards to human life, to harm living resources and marine life, and to damage amenities or interfere with other legitimate uses of the sea. Under the Convention, dumping means the disposal at sea of material and substances of any kind from vessels, aircraft and platforms or other man-made structures at sea as well as the disposal of vessels, aircraft, platforms or other man-made structures at sea. It does not include operational discharges. Australia acceded to the Convention in 1985.

Convention for the Prevention of Marine Pollution from Ships (International) (1973) and Protocol (1978) (MARPOL 73/78)

MARPOL is concerned with operational discharges of pollutants from ships. It deals with oil, noxious liquid substances, harmful packaged substances, sewage and garbage. It details the extent to which (if at all) such substances can be released in different sea areas.

4. LAND TENURE AND LEASES

4.1 NINGALOO MARINE PARK - COMMONWEALTH WATERS

The Commonwealth Waters portion of the Marine Park was proclaimed a park [Ningaloo Marine Park (Commonwealth Waters)] under sub-section 7 of the *National Parks and Wildlife Conservation Act 1975* by then Governor-General Sir Ninian Stephen, and gazetted on 20 May 1987.

The northernmost of the three areas originally excluded from the Marine Park due to the presence of pre-existing petroleum leases, was proclaimed part of the Park by then Governor-General Bill Hayden, and gazetted on 21 July 1992.

4.2 NINGALOO MARINE PARK – STATE PORTION

The State Waters portion of the Ningaloo Marine Park was gazetted on 3 April 1987 and vested in the National Parks and Nature Conservation Authority (NPNCA) under the provisions of the *Conservation and Land Management Act 1984*.

The 40 m wide terrestrial strip extending inland from HWM between Amherst Point and Winderabandi Point was reserved under the *Land Act 1933*. It was gazetted for the purpose of Marine Park and vested in the NPNCA on 3 July 1987.

4.3 CAPE RANGE NATIONAL PARK

The first part of the Cape Range National Park, covering an area of 13,424 ha, was gazetted a ‘C’ class reserve for the purpose of National Park on 9 October 1964 and was subsequently vested in the National Parks Board.

In 1969 the park area was extended to 50,581 ha with the inclusion of the southern part of the Yardie Creek pastoral lease, occupying the western side of the peninsula between Tantabiddi Well and the northern boundary of Lyndon Location 97, the RAAF weapons range.

The status of the reserve was upgraded to ‘A’ class in 1974. It was vested in the NPNCA in 1985 on replacement of the National Parks Board (CALM 1987).

4.4 DEFENCE ESTATE

Two areas of the Defence Estate abut the Marine Park. These are Location 97, bombing range, located between Ningaloo Station and the Cape Range National Park, and the Harold E. Holt Communications Station at North West Cape.

The jetty and surrounding waters at Point Murat, where a jetty is located servicing the Communications Station, is declared a prohibited area under the *Defence (Special Undertakings) Act*.

3. Overview of Activities, Legislation and Agreements Affecting the Ningaloo Marine Park

4.5 TOWNSITES

There are two gazetted townsite areas located adjacent to the Marine Park. These are Coral Bay and Mauds Landing, located either side of Point Maud and bounded by Cardabia Station and the Marine Park. Present development is largely confined to Coral Bay, however, there are existing proposals to develop tourist and residential facilities at Point Maud.

4.6 PASTORAL LEASES

Three pastoral leases, Ningaloo, Cardabia and Warroora Station, share boundaries with the Marine Park. These are Pastoral Leases established under the *Land Act 1933* and due to expire in 2015.

4.7 PETROLEUM LEASES

Petroleum leases in Commonwealth waters outside the Marine Park are made under the *Petroleum (Submerged Lands) Act 1967* (Commonwealth legislation).

Petroleum exploration permits and production licences in State Territorial waters and on land and coastal waters (landward of the baseline) are granted under the *Petroleum (Submerged Lands) Act 1982* (State legislation) and the *Petroleum Act 1967* (State legislation), respectively. Petroleum leases may co-exist with the State Waters of the Marine Park.

Details of the current permits in the region are provided below.

Permit Number	Lease Type	Location	Expiry Date	Registered Holders
WA-12-R	Retention	C/wealth	12/10/2003	Ampolex Limited BHP Petroleum (Australia) Pty Ltd
WA-271-P	Exploration	C/wealth	11/08/2003	Woodside Energy Ltd
WA-24-P R4	Exploration	C/wealth	07/03/2000	Chevron Asiatic Limited Chevron Overseas Petroleum Limited Mobil Australia Resources Company Pty Limited Shell Development (Australia) Proprietary Limited Texaco Australia Pty Ltd
TP/3 R2	Exploration	State Territorial waters	21/10/2003	Chevron Asiatic Limited Chevron Overseas Petroleum Limited Mobil Australia Resources Company Pty Limited Shell Development (Australia) Proprietary Limited Texaco Australia Pty Ltd
TP/9	Exploration	State Territorial waters	31/05/2000	Apache Northwest Pty Ltd Boral Energy Resources Limited Carnarvon Petroleum NL Gulf (Aust) Resources NL Premier Petroleum (Australia) Limited Southern Diamond Resources (EP342/TP9) Pty Ltd
EP 342 R1	Exploration	State lands and coastal waters	19/07/1999	Apache Northwest Pty Ltd Boral Energy Resources Limited Carnarvon Petroleum NL Gulf (Aust) Resources NL Premier Petroleum (Australia) Limited Southern Diamond Resources (EP342/TP9) Pty Ltd

3. Overview of Activities, Legislation and Agreements Affecting the Ningaloo Marine Park

Table 1 (cont'd)				
Current Petroleum Permits Overlapping or Adjoining the Ningaloo Marine Park				
Permit Number	Lease Type	Location	Expiry Date	Registered Holders
EP 325 R2	Exploration	State lands and coastal waters	03/08/2004	Amity Oil NL Kestrel Energy Inc Mobil Exploration & Producing Australia Pty Ltd Omega Oil NL Petroz NL Rothschild Australia Petroleum NL Santos Offshore Pty Ltd Sun Resources NL Tapstew Pty Ltd Victoria Petroleum Pty Ltd
EP 359 R1	Exploration	State lands and coastal waters	06/04/2004	Kestrel Energy Inc Lansvale Oil & Gas Pty Ltd Pace Petroleum Pty Ltd Perthshire Petroleum Ltd Petroz NL Phoenix Energy Pty Limited Sun Resources NL
EP 412	Exploration	State lands and coastal waters	18/03/2004	Flare Petroleum NL

4.8 NATIVE TITLE CLAIM

The whole of the Ningaloo Marine Park is subject to a native title claim registered with the National Native Title Tribunal (Figure 3). The following information on the native title application over the area that includes the Ningaloo Marine Park is taken from the Register Extract for Claimant Application (extract printed on 28 January 2000).

A native title application has been registered (NNTT File No. WC97/28, Federal Court No. WAG 6161/98) on behalf of the Gnulli native title application group which is comprised of the Ingaarda-Teddei, Baiyungu and Talangi peoples. The application was filed on 14 July 1997 and passed National Native Title Tribunal registration on 19 July 1999. The registered claimants are Ronald Crowe, Ruby McIntosh and Sharon Crowe, Sydney Dale, Mary Franklin, Laurence Cooyoo and Gwen Cooyoo. The following additional names are listed on the Department of Land Administration (DOLA) Land Claim Mapping Unit print-out as appearing on the amended claim: E. Edney, B. Roberts, S. Peck, P. Salmon and R. Dodd.

The address for service of the applicant is listed as:

C/- David Ritter
Legal officer
Yamatji Land and Sea Council
Suite 1, 3rd Floor
8 Victoria Avenue
PERTH WA 6000

The area claimed in the application includes the whole of the Ningaloo Marine Park (Commonwealth and State Waters), and surrounding waters including the proposed extensions to the national Park, together with Exmouth Gulf, the Cape Range peninsula and

extensive areas inland, in total some 338,000 km². There are a number of classes of exclusion to the claim relating to existing leases and extinguishing acts that apply to terrestrial areas within the boundaries of the claim.

The rights over the area sought include the rights:

- to possess, occupy, use and enjoy the area;
- make decisions about the use and enjoyment of the area;
- of access to the area;
- to control the access of others to the area;
- to use and enjoy the resources of the area;
- to control the use and enjoyment of others of the resources of the area;
- to maintain and protect places of importance under traditional laws, customs and practices in the area; and
- to maintain, protect and prevent the misuse of cultural knowledge of the common law holders associated with the area.

With respect to the offshore area of the claim, the rights and interests sought “are not to the exclusion of other rights and interests validly created by a law of the Commonwealth or State of Western Australia or accorded under international law in relation to the whole or any part of the offshore place.”

5. DESCRIPTION OF THE PHYSICAL ENVIRONMENT

5.1 CLIMATE

The following description of the climate of the Ningaloo Marine Park is based largely on climatic averages obtained from the Bureau of Meteorology for the station closest to the Park, Vlaming Head, and from data collected in association with other studies carried out within or adjacent to the Park. The presence of Cape Range is reported to cause variations in the climate between the western and eastern sides of the peninsula due to the effect of the Range on prevailing winds, and hence data from Learmonth, the other meteorological station in the region, has limited application to the Marine Park.

5.1.1 Rainfall and Evaporation

The hinterland to the Marine Park is arid, with rainfall on the coast at Vlamingh Head, averaging only 294 mm per annum. Rainfall is highest in the late autumn/early winter months (May and June, 53.6 and 61.7 mm, respectively) with significant rainfall also being received in late summer/early autumn (February and March, 37.8 and 54.2 mm, respectively). The driest months are September, October and November, which each average less than 5 mm (Bureau of Meteorology 1999). Extreme rainfall events, most frequently associated with the passage of tropical cyclones, may result in monthly falls exceeding the annual average.

Evaporation rates in the region are very high, between 2,800 and 3,200 mm per annum (Bureau of Meteorology 1998), and as a result surface water is only present immediately following periods of heavy rainfall.

5.1.2 Humidity

The coastal region experiences relatively humid conditions with the mean relative humidity along the Ningaloo coast in summer (January) ranging from 60% in the morning (9 am) to 40-50% in the afternoon (3 pm). In winter (July) humidity is higher, ranging from 60-70% in the morning and 40-50% in the afternoon (Bureau of Meteorology 1998).

At Vlamingh Head, the average relative humidity varies between 52% in November and 70% in June in the mornings (9 am readings), with humidity in the afternoon tending to be slightly higher. The higher afternoon humidity values in what is a typically arid terrestrial environment are a reflection of the coastal location of the Vlamingh Head monitoring station.

5.1.3 Temperature

Summer temperatures are hot with the mean daily maximum temperature on the coast at Vlamingh Head being 33.6 °C and the minimum 23.5 °C in the two hottest months (February and March). Winter temperatures are more moderate, with a daily mean maximum of 22.9 °C and minimum of 14.6 °C in July, the coolest month (Bureau of Meteorology 1999). Temperatures on the western side of the peninsula are reported to be milder than those occurring on the Exmouth side (CALM 1989).

Temperatures offshore are generally less extreme, reflecting the moderating influence of the ocean.

5.1.4 Wind/Cyclones

Winds in spring and summer are predominantly from the south-west with wind speeds to 35 km/h. Wind direction in winter is more variable but dominated by winds from the south, with speeds again up to 35 km/h. Autumn is a transitional period with winds from any direction, although dominated by winds from the south-eastern quarter. Calm periods occur most commonly during the autumn and winter months.

Both wind and rainfall are significantly influenced by tropical cyclones which occur most frequently in the months January to March, but have been recorded in this region as early as November and as late as May. The region generally experiences two to three cyclones per season, with the southern parts of the Park less influenced by cyclonic activity.

Winds generated in tropical cyclones that pass through the region may exceed 200 km/h and rainfall events exceeding 200 mm in a 24 hour period have been recorded. The maximum recorded wind speed in cyclones Olivia, which passed over the Montebello and Lowendal Islands in 1996, and Vance, which impacted on North West Cape in March 1999, was 267 km/h. While Exmouth was devastated by Cyclone Vance, wind speed on the western side of the peninsula was much lower and the resulting impact less severe, demonstrating the sheltering effect of the ranges.

Other notable cyclones to have affected the North West Cape area are Katie (1964), Mavis (1965), Glynis (1970), Beverley (1975), Karen (1977), Hazel (1979) and Neil (1981) (Bureau of Meteorology 1998).

The rapid onset of cyclones and other storm events resulting in strong winds and high seas has been responsible for a number of the shipwrecks and fatalities that have occurred along this coast over the past two hundred years of recorded history.

5.2 OCEANOGRAPHY

5.2.1 Astronomical (Lunar) Tides and Currents

The daily tidally driven currents are the most obvious expression of the local current regime. Tides at the northern end of the Park are described as semi-diurnal with two high and two low tides per day, with a mean spring tidal range (Mean High of the Higher Water to Mean Low of the Lower Water) of one and a half metres at Point Murat (Department of Defence 1999). Tidal influence decreases to the south and tides in the southern part of the Park may be more accurately described as mixed, with either semi-diurnal or diurnal (i.e. one high and one low tide per day) tidal patterns predominating. Along the western shoreline of the Cape Range peninsula, tides at Tantabiddi, Norwegian Bay and Coral Bay range from 1.0 m (Tantabiddi) to 1.2 m (Norwegian Bay and Coral Bay) (Department of Defence 1999).

Although much reduced in comparison to the tides that occur further north in the Pilbara and Kimberleys, at Ningaloo the funneling of the ebb tide through the narrow openings in the reef produces locally strong currents which make navigation through the passages difficult and pose a hazard to swimmers and snorkelers.

5.2.2 Barometric Tides and Currents

Variations in atmospheric pressure due to the passage of high and low pressure systems cause localised responses in sea level, commonly referred to as barometric tides. These act to reinforce (magnify) or reduce the astronomical tides, depending on the nature and direction of the pressure system and the state of the tide.

Thus a low-pressure system, which is accompanied by an elevation in sea level, will magnify the height of the high tide but the tidal fall on low tide will be less. The opposite effect occurs during the passage of a high-pressure system.

Typical barometric tides may cause a variation in sea level of plus or minus 300 mm.

5.2.3 Wind-driven Currents

Open ocean wind-driven currents typically move at about 3% of the sustained surface wind speed. Under conditions typically experienced at Ningaloo, with ambient winds of up to 40 km/h and less than 48 hours duration, surface wind-driven currents of approximately 1 km/h can be generated. During storms, wind-driven currents can be significantly larger, reaching speeds of 4 km/h in a cyclone with wind speeds of up to 180 km/h.

5.2.4 Drift or Residual Currents

Oceanic drift currents are driven by ocean scale, horizontal pressure gradients, and have seasonal or larger time scales. The most significant such current affecting the Marine Park is the Leeuwin Current which flows southward along the edge of the continental shelf (Figure 4), particularly during the months of March and April when maximum speeds of 1 km/h to the south-west have been detected. Flow continues through the winter months but at reducing velocities and is at its weakest in summer (Pearce and Cresswell 1997).

The Leeuwin Current is significant in that it is a warm, relatively low salinity, low nutrient, southward flowing current as opposed to the cool, northward flowing currents which occur off the west coasts of South America (Humboldt Current) and southern Africa (Benguela Current). It is responsible for both the southward transport of tropical marine species and for modifying the water temperature such that it is suitable for the survival of these species in what would otherwise be temperate conditions.

The origin of the Leeuwin Current is the area to the north-west of North West Cape. The warm, relatively low salinity source of the Leeuwin Current is broad (400 km) and shallow (50 m). Further south adjacent to the Ningaloo coast, the shelf is narrow and the current tapers to a width of 50 to 100 km and deepens to 200 m as it moves southward along the edge of the shelf. In this area the current speed may increase to over 1 knot (Cresswell 1991; Pearce 1991). Beneath the Leeuwin Current there is a northward flowing counter-current, with a strong thermocline marking the boundary between the two water masses. A section made across the continental shelf by HMAS *Diamantina* in August 1971 at a latitude of 26°S (west of Shark Bay) shows the Leeuwin Current extending to a depth of about 250 m, but by 300 m the temperature had decreased to 12-14°C. (Thompson 1984; Cresswell 1991; Pearce 1991). The shallow-water tropical marine fauna in the North West Cape area, as in other parts of the tropical oceans, is thus limited to upper portions of the water column.

During late summer and early autumn, a northward current, termed the Ningaloo Current, passes along the front of the reef and is a counter current to the southward flowing Leeuwin Current which occurs further offshore at the shelf break (Figure 5). The Ningaloo Current is predicted to determine the dispersal of coral larvae following the autumn mass spawning and play an important part in retaining planktonic biomass within the Ningaloo ecosystem (Taylor and Pearce 1999).

The Leeuwin and Ningaloo currents thus play a significant part in transporting tropical organisms into the Marine Park, modifying conditions (warming) such that they are suitable for their existence (Leeuwin Current) and recirculating nutrients within the system (Ningaloo Current), such that an essentially low nutrient system is able to sustain relatively high productivity.

5.2.5 Waves

Waves are composed of both a sea and a swell component. Sea waves, which are usually short period (1-10 second) waves, are generated by local synoptic winds and reflect their directionality. Persistent sea waves arrive from the south-western quadrant in summer and the eastern quadrant in winter. The bigger seas typically occur during the winter, from June to August. The period of calmest seas occurs during the period from April to May.

Long period south-westerly swell waves are a predominant feature of the open ocean, occurring throughout the year. Larger swell waves generally persist through the winter months, however, tropical cyclones occurring during the summer months may generate extreme swells, generally from the north-eastern quadrant.

5.2.6 Sea Temperatures

Regional sea surface temperatures range from 26-31°C in summer and 19-24°C in winter (Steedman Science & Engineering 1991), decreasing southwards. Measurements of sea surface temperature seaward of the Ningaloo Reef front taken in 1985 ranged between 22 °C and 27 °C (Simpson and Masini 1986). In winter the water on the continental shelf is almost isothermal (well mixed), but by late summer becomes strongly stratified. Offshore, sea temperatures at depths of 200 m are 10-12 °C.

Lagoonal temperatures are more variable, with variations occurring at scales which range from daily, over periods of several days and seasonally. Simpson & Masini (1986) found that the average daily mean variation within the lagoon was 3°C, with the minimum occurring around sunrise and the maximum in mid-afternoon. Fluctuations over periods of several days were concluded to be associated with tides and other factors affecting the exchange of water between the lagoon and the open ocean beyond. The measured seasonal range (August to December) was 12 °C. In summer, if flushing is constrained, temperatures may occasionally reach lethally high levels, resulting in the death of susceptible marine organisms, such as corals.

5.2.7 Salinity

Seawater salinity in the Marine Park varies from 35 to 35.5 parts per thousand. Inside the lagoon, salinities can be expected to be similar with slight increases due to evaporation in confined pools and localised decreases in salinity following relatively rare occurrences of surface discharge of rainwater at the shoreline.

5.2.8 Turbidity

With the general absence of freshwater input to the area, the waters of the Marine Park are typically clear and with a low turbidity. However, strong south-westerly winds can disturb bottom sediments in shallow nearshore waters, resulting in temporary increases in turbidity in the Ningaloo lagoon.

Occasional surface flows following heavy rains can also result in nearshore turbidity.

A study of water quality in Bills Bay conducted in 1994 showed increased light attenuation which was attributed to nutrient entering the Bay via the groundwater (Simpson and Field 1995).

5.2.9 Nutrients

As a consequence of aridity and low runoff from the adjacent land, nutrient levels in the waters of the Marine Park are regarded as low. Recent studies indicate that the main source of nutrients within the system is recycling due to the occurrence of the Ningaloo counter current, rather than up-welling, for which no evidence has been found (Taylor and Pearce 1999). The availability of food in the form of zooplankton in the period following coral spawning is considered responsible for the observed aggregations of fish, including whale sharks.

Localised increases in nutrient levels (inorganic nitrogen) have been detected within the semi-enclosed waters of Bills Bay which have been attributed to septic leachate entering the bay via the groundwater (Simpson and Field 1995).

5.2.10 Contaminants

Monitoring of the marine environment for contaminants resulting from human activities has not been extensive, however, some increased levels have been detected.

In addition to elevated nutrient concentrations, bacterial contamination attributed to the leaching of contaminated groundwater, was detected in the waters of Bills Bay 1995. Elevated concentrations of tributyltin, a man-made, highly toxic compound used in some forms of antifouling coatings, have also been found in the sediments of Bills Bay and in Coral Bay.

The heavy metals arsenic, chromium and manganese were found at elevated concentrations in sediment samples collected off Mauds Landing, the origin of which is believed to be associated with activities historically conducted at this site, e.g. whaling (Simpson and Field 1995).

5.3 BATHYMETRY AND TOPOGRAPHY

5.3.1 Bathymetry

Information on the bathymetry of the Marine Park is variable as the area is as yet incompletely surveyed. The information that is available is presented in various formats at differing scales and levels of detail.

Information used in this review and to prepare the bathymetric map presented in Figure 4 has been taken from the following sources:

- Commonwealth of Australia, National Bathymetric Map Series, 1:250,000 Bathymetric Survey Sheets:

SF-49-16	Minilya
SF-49-12	Ningaloo
SF-49-8	Jurabi Point
SF-50-5	Onslow

which have largely been used to provide bathymetric information on the Commonwealth Waters portion of the Marine Park;

- Commonwealth of Australia Navigation charts:

AUS 330	Point Cloates to Quobba, Scale 1:300,000
AUS 744	Exmouth Gulf and Approaches, Scale 1:150,000
AUS 745	North West Cape to Point Maude, Scale 1:150,000
AUS 72	Point Cloates, Point Maude and Norwegian Bay, Scale 1:40,000

which have been used to provide regional information; and

- Western Australian Department of Transport navigation charts which cover the northern tip of the Cape Range peninsula and surrounding waters (DMH 900 Exmouth), and Ningaloo and Coral Bay (DMH 612 Ningaloo and Coral Bay) used to provide information on the nearshore environment including bays.

The most detailed bathymetric mapping presently available is that done by the Western Australian Department of Transport.

The marine component of the Marine Park extends from high water mark to the upper continental slope with water depths ranging from intertidal to in excess of 500 m. Water depths within Commonwealth Waters range from ~30 m to in excess of 500 m (Figure 4).

At the southern end of the Park the continental shelf is relatively broad, exceeding 30 km in the vicinity of Amherst Point, but becoming much narrower to the north of Point Cloates. To the west of the Cape Range peninsula, the continental slope is steep and water depths increase rapidly. Between Point Cloates and Jurabi Point, depths of 100 m occur within 6 km of the shoreline and 500 m within 15 km. Further to the north, depths again increase more slowly, reaching 100 m at a distance of 15 km from the Muiron Islands and 200 m at a distance of 40 km offshore Serrurier Island.

To the east of North West Cape the marine environment comprises parts of the inner Rowley Shelf and Exmouth Gulf where depths rarely exceed 20 m and there are numerous shoals, reefs and islands rising above the general level of the seafloor.

5.3.2 Topography

The dominant feature of the terrestrial landscape is the Cape Range which runs in a south-easterly direction from Vlamingh Head, at the tip of the Exmouth Peninsula, to Point Cloates. The Range rises in parts to in excess of 300 m above sea level, but is heavily dissected and

contains numerous caves. The more humid caves support cockroaches, millipedes, slaters, spiders, micro-whip scorpions and pseudoscorpions (Watson et al. 1989). A narrow plain rising from sea level to approximately 50 m fringes the range on the western and north-eastern sides of the peninsula, gradually broadening to the south-east (Figure 4). Terraces, representing ancient sea-levels, are present in places along the Ningaloo coast. Caves are also present in the coastal limestone and these support blind shrimps, the gudgeon fish, *Milyeringa veritas*, and blind eel, *Ophisternom candidum* (Watson et al. 1989).

In comparison to Exmouth Gulf and the Rowley Shelf where there are numerous islands, some of which are relatively large and provide habitat for a wide range of birds and some mammals, few islands occur off the Ningaloo coast. Those that do occur are small and provide only limited habitat for birds.

5.4 GEOLOGY AND GEOMORPHOLOGY

The Marine Park lies across the boundary of the Northern and Southern Carnarvon Basins with the majority of the Park located in the Exmouth sub-basin of the northern Carnarvon Basin. The Cape Range Anticline is one of the major geological structures of the Exmouth sub-basin. The continental slope and shelf (comprising the Dirk Hartog Shelf to the west of the Cape Range peninsula, Rowley Shelf to the north-east and Exmouth Gulf to the east) are the dominant marine features. Cape Range is the dominant feature of the terrestrial landscape. To the north-east, the Muiron Islands are recognised as extensions of the anticline which gave rise to Cape Range.

The Cape Range peninsula and adjacent marine areas (Ningaloo Reef and Exmouth Gulf) are underlain by some thousands of metres of sedimentary rocks. The extensive sedimentary sequence ranges from Palaeozoic to Holocene in age (Van De Graaff et al. 1980). The outcropping strata of the area are limestones and calcareous sandstones ranging in age from Oligocene to Holocene. The oldest is the Mandu Calcarene, a chalky limestone layer approximately 240 m thick. This is overlain by Tulki Limestone, a hard crystalline rock layer approximately 120 m thick and with a well-developed karst system. This is in turn overlain by Trealla Limestone and more recent deposits. To the east of the Range, the floor of Exmouth Gulf and the Rowley Shelf are comprised of Recent, mainly sandy sediments, with occasional exposures of the underlying Pleistocene limestone in the form of pavements, reefs, platforms and islands. The adjacent sandy beaches and coastal dunes are comprised of Holocene sand deposits, which also cap most of the islands in the region.

On the west coast there are four marine terraces of Pleistocene age, believed to have been formed during the Quaternary interglacial high sea level stands. The oldest are aged at somewhere between 250,000 and 500,000 years ago and the youngest about 120,000 years ago. The coastal strip comprises a narrow system of dunes and swales, limestone plains, wave cut platforms, and sand or pebble beaches. The youngest deposits are contemporary coral reef deposits represented by the Ningaloo Reef Tract and numerous smaller reef structures. There are frequent blow-outs in the coastal dunes.

Further offshore, the continental shelf and slope have relatively fewer distinctive features. Carrigy & Fairbridge (1954) recognised a distinct inner and outer shelf, with the break between the two occurring at a depth of approximately 100 m. The outer shelf, ranging in width from 30 km in the north to greater than 100 km in the south, is more steeply sloped than the narrower inner shelf which also widens to the south, ranging from 18.5 km at North West Cape to 40 km at the southern end of the Marine Park. Detailed survey transects undertaken across the continental shelf break (the area where the continental shelf meets the continental

slope) in the area to the north of the Marine Park have revealed the presence of occasional low limestone ridges protruding through Recent unconsolidated sediments.

The geological structures control the major landforms, with the ranges (Cape Range and Rough Range) coinciding with anticlines, and the depressions and bays coinciding with synclines. To the east of the peninsula, relief is subdued and grades from extensive intertidal and supratidal flats into sand plains and longitudinal dunes (Van De Graaff et al. 1982).

There has been limited study of the characteristics of the seafloor in the Commonwealth Waters of the Ningaloo Marine Park (Boldy 1986; WAM 1988). HMAS *Moresby* collected most of the available data in 1981. As would be expected, the bottom in shallow depths (<30 m) is dominated by sand, with broken shell fragments, coral and seaweeds also present. Sediment grain size decreases with increasing depth. Fine sand dominated in intermediate depths, but mud and ooze were the major sediment components in depths greater than 180 m. Some data were also collected by HMAS *Diamantina* in 1963 and 1964 and, despite some nomenclatural differences, there was broad agreement with the Morseby findings as to bottom types at given depths.

6. DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT

6.1 BIOGEOGRAPHY

Historically, the shallow water marine environment of Western Australia has been divided into three biogeographic regions (Wilson & Gillett 1971; Wells 1980; Wilson & Allen 1987; Morgan & Wells 1991; Wells 1997):

- Tropical. The zone of tropical biota extends north from North West Cape or Shark Bay across the entire northern coast of Western Australia to Queensland. It is continuous with the Indo-West Pacific biota which extends across the equatorial regions from the east coast of Hawaii;
- Temperate. The temperate zone comprising the southern coastline of Australia extends east from Cape Leeuwin to northern New South Wales and southern Queensland and supports a warm temperate biota which is largely distinct from that which occurs in New Zealand and South Africa;
- West coast overlap zone. The west coast overlap zone is located between Cape Leeuwin and Shark Bay or North West Cape, and is an area where the southern temperate biota overlaps with that of the tropical north. Tropical species dominate in the north and temperate species in the south.

The north coast of Australia has historically been divided into a Dampierian region west of Cape York and the Solanderian region to the east of Cape York. Some classifications have divided inshore Queensland from the Great Barrier Reef. The present approach is to regard the entire coastline as the Tropical Australian province (Wilson & Allen 1987). In this context, the west coast of North West Cape has been considered to be the northern extremity of the west coast overlap zone by Wells (1980), who found 3% of the shallow water gastropods of the area to be temperate species. Alternatively, Wilson & Allen (1987) considered Shark Bay to be the northern limit of the west coast overlap zone. Regardless of this detail, the shallow portions of the Commonwealth Waters off the west coast of North West Cape clearly have a predominantly tropical biota.

Superimposed on the tropical and temperate components of the fauna is a small element of shallow water species that are endemic to Western Australia. While these species occur widely throughout the State, the largest number have at least part of their ranges on the west coast. Many of the species endemic to Western Australia occur in the Ningaloo Marine Park. For example, Wilson (1972) described two new species of volutid gastropods from depths of approximately 130 m in the Commonwealth Waters of the Marine Park. The proportion of Western Australian endemics varies from about 5% in fish (Hutchins 1994) and 10% in molluscs (Wells 1980; 1997) to 20% in shallow water echinoderms (Marsh 1976).

More recently, as part of the process of developing a consistent, national, ecologically-based planning framework for sustainable development and biodiversity conservation, information on ecological patterns and processes has been synthesised to produce an ecological regionalisation of Australian waters which will have wide scientific recognition. This process is known as the Interim Marine and Coastal Regionalisation for Australia (IMCRA). The IMCRA regional units which are represented in the Ningaloo Marine Park are described below.

6.1.1 Interim Marine and Coastal Regionalisation Classification

6.1.1.1 Meso-scale regionalisation

The Ningaloo Marine Park falls primarily within the Ningaloo Region which extends northward from Gnaraloo Bay to North West Cape, and seaward from the shoreline to the outer edge of the continental shelf. This includes almost all of the Commonwealth Waters of the Marine Park. The Ningaloo Region is described as an area of great complexity with a species-rich coral reef community. The fringing reef is continuous in the north but interrupted in the south.

To the north and east of North West Cape the Park includes small portions of two other regions, the Pilbara (offshore) and Pilbara (nearshore) regions, the latter occurring only in the State Waters portion of the Marine Park (IMCRA 1998).

The Pilbara (offshore) region (defined as greater than 10 m in depth) is less turbid than nearshore waters and has a number of ecosystem differences. The region includes coral reef ecosystems with Indonesian and Pacific affinities. Only very small portions of both the Commonwealth and State Waters sections of the Marine Park are located within this region.

The Pilbara (nearshore) region (defined as less than 10 m in depth) is described as having a high diversity of infauna from intertidal mudflats and sandflats associated with fringing mangroves in bays and lagoons. Highly turbid water is frequently associated with areas having a large tidal range. Fringing coral reefs occur occasionally on shallow subtidal limestone pavements and around some of the nearshore islands. That portion which occurs within the Marine Park is at the western extreme of the region. In this area both tidal range and mangrove development are much reduced, but fringing coral reefs occur (e.g. Bundegi Reef) and turbidity, influenced by Exmouth Gulf, is frequently high. Within the Marine Park, representation of this region is confined to State Waters.

6.1.1.2 Demersal provinces and biotones

The Ningaloo Region coincides with the Central Western Demersal Biotone, an area of 27,370 km² which encompasses most of the Ningaloo Marine Park. It is described as a major zone of overlap between temperate and subtropical species, elements of the North Western Province, and a suite of tropical Indo-West Pacific species. Within the biotone, temperate elements are dominated by subtropical Central Western Province species and some South Western Province species. The biotone forms the north-western limit of a suite of widespread, eurythermal southern Australian species that extend east to the Central Eastern Province and Central Eastern Biotone.

To the west of North West Cape a small portion of the Marine Park occurs within the North Western Province, an area described as containing a large suite of widespread tropical species.

6.1.1.3 Pelagic provinces and biotones

The majority of the Marine Park falls within the Western Pelagic Biotone, an area of 1,390,000 km² extending south from North West Cape to Albany. It is described as being a

zone of faunal overlap representing the major termination zone for eastern tropical and temperate species.

To the west of North West Cape a small portion of the Marine Park falls within the Northern Pelagic Province, a region with similar origins to the demersal North Western Province (IMCRA 1998).

6.2 MARINE ECOSYSTEMS

The ecosystems represented within the Marine Park may be categorised into:

- open ocean, supporting planktonic and pelagic sea creatures including species of fish such as tunas and billfish, whales and Whale Sharks;
- the seabed of the continental slope and shelf, supporting demersal (bottom-living fish, mollusc and crustacean) species, epibenthic plants (algae) and animals (sponges, soft corals) and infauna (burrowing bivalves, crustaceans);
- coral reef, comprising the reef and lagoon; and
- intertidal systems formed at the point of contact between the land and the sea, including rocky shores, sandy beaches and mangroves.

However, these definitions are arbitrary, as there is difficulty in defining separate ecosystems within the marine environment due to the level of physical interaction between them and the movement of species across the artificially defined boundaries. Thus there is regular exchange between the pelagic and demersal systems for feeding and reproduction, and continuous movement of water and animals between the deep ocean and the reef and lagoon inshore.

6.2.1 Open Ocean Ecosystem

The open ocean ecosystem supports largely migratory populations of pelagic fish species such as tunas and billfish, and planktonic species which are carried on the currents. The density of the population it supports is dependent on factors such as water temperature, nutrient concentrations and salinity.

6.2.2 Seabed – Continental Slope and Shelf Ecosystems

The continental slope and shelf are, for the most part, ecosystems built on a soft sediment habitat with gradational variation in species composition due to depth, water temperature, light penetration and sediment composition/structure. It consists of generally sparse populations of sessile sponges, soft corals and algae (at shallower depths), with a mobile population of burrowing crustaceans, echinoderms and molluscs.

6.2.3 Coral Reef Ecosystem

The coral reef ecosystem comprises the reef and lagoon system. The main biotic elements are the reef forming corals and algae, and the plants and animals that depend on the reef for the shelter and food that the reef provides. It includes a diverse range of fish, molluscs, crustaceans, seagrasses and algae.

6.2.4 Intertidal Ecosystem

The intertidal area is the principal area of interaction between the land and the sea and is thus strongly influenced by both. The relative strength of influence tends to dictate the character of the habitats and the populations of plants and animals that occur within them.

Further discussion on the habitats and species occurring within each of these ecosystems is presented in the following sections.

6.3 MARINE HABITATS

The diverse array of marine habitats found within the Ningaloo Marine Park range from deep oceanic habitats to shallow subtidal and intertidal habitats supporting coral reefs, seagrasses, macroalgae and mangroves with a diverse range of associated flora and fauna (Figure 6).

The three major habitats represented within the Commonwealth Waters portion of the Ningaloo Marine Park are the open waters and the seabeds of the continental slope and continental shelf, part of the latter occurring in State Waters. Representation of the remaining shallow water habitats described below is confined to the State Waters portion.

6.3.1 Open Water

Off the Ningaloo coast the open water habitat is characterised by warm, relatively low salinity, low nutrient water. It supports populations of mainly migratory species of pelagic fish (e.g. mackerel, tuna marlin and sailfish) and other large creatures (whales, dolphins, turtles). These populations are supported by food chains based on phytoplankton which are the basis of primary production in this environment. The phytoplankton in turn support zooplankton, frequently including the juvenile stages of species found in other ecosystems, which directly or indirectly support the higher order predators.

6.3.2 Continental Slope

The continental slope occurs at depths of between 170 and 800 m. In the section of the Marine Park north of Point Edgar, where the continental shelf is quite narrow, the upper part of the continental slope, at depths of between 550 and 170 m, occurs within Commonwealth waters.

In this area the continental slope rises from the deep seafloor at an average gradient of 1:30 [i.e. a slope of 6° (Boldy 1986)]. The sediments are described as being comprised of mud, ooze and fine sand, becoming coarser in shallower water. The deep water sandy seafloor fauna are reported from occasional ROV studies to comprise a sparsely distributed, mainly burrowing fauna of worms and crustaceans.

During the late 1970s and early 1980s the CSIRO Division of Fisheries and Oceanography conducted exploratory cruises along the continental slope off north-western Australia searching for deepwater fisheries resources. A fauna newly recorded for Australia was found at a depth of 350-500 m which was closely related to fauna located at similar depths in the area of Japan and the Philippines. The existence of the fauna prompted a large number of papers on individual groups or species, particularly shelled molluscs, but there has never been a synthesis of the fauna. Rainer (1988) found a high diversity of benthic polychaetes. Many of the species recorded in north-western Australia were closely related to species from the area

further north. Some were conspecific, but many were described as new (Wells 1984, 1989; Kosuge 1985, 1986 and subsequent papers; Emerson 1985; Houart 1985; Poppe 1986). The gastropod species *Thatcheria mirabilis*, well known from Japan and the Philippines, was recorded for the first time outside that region. Some of the species were controversial. For example, Dr W.K. Emerson of the American Museum of Natural History in New York, described a new species of volute, *Teremachia dupreyae*, which reaches a length of 21 cm (Emerson 1985). Mr G.T. Poppe of Belgium described a subspecies of *T. dalli*, *T. dalli claydoni* (Poppe 1986). A subsequent revision considered *T. dupreyae* to actually be the species already named as *T. johnsoni* and that sub-specific status was not warranted for *T. dalli claydoni* (Wells 1989).

Most of the CSIRO survey was conducted off the North West Shelf in the area from Rowley Shoals to Ashmore Reef. However, isolated trawls conducted further south on the west coast of Western Australia, even south of Cape Leeuwin, collected specimens of the species found on the North West Slope. The limited information available suggests the bottom fauna at 350-500 m along the western coast is a continuation of the northern fauna (Wells 1989). The same fauna should thus occur in the deeper areas of Commonwealth Waters off Ningaloo.

6.3.3 Continental Shelf

Adjacent to the Marine Park, the continental shelf, which in this area is termed the Dirk Hartog Shelf (Carrigy & Fairbridge 1954), is of variable width, ranging from 5 to 6 km in the northern portion (north of Point Edgar) to 30+ km at the southern boundary of the Park. The substrate generally consists of a variable thickness veneer of sand overlying limestone. The predominant sessile flora and fauna are algae and sponges, and there is a diverse mobile crustacean and mollusc fauna. However, the bottom fauna of the Commonwealth Waters portion of the Ningaloo Marine Park remains largely unstudied. Wilson (1972) described two new species of volutid gastropods from the area. Marsh (in WAM 1988) provided a list of 30 species of echinoderms collected by the *Diamantina* cruises. The bottom fauna in waters deeper than about 40 m is dominated by sponges (WAM 1988), which is consistent with findings in other areas of the western coast of Western Australia, but the sponges at this depth have never been systematically examined. WAM (1988) also provides a list of 43 species of fishes recorded by CSIRO from depths of 40-80 m on the North West Shelf. Many of these would occur at the same depths west of the Ningaloo Reef Tract.

Limited surveys using remotely operated vehicles (ROV) in the area to the north of the Marine Park indicate the presence of occasional deep water sponge and soft coral communities on outcropping ridges on the continental shelf, however, there is no comprehensive record of their distribution. The offshore pavements and ridges support a more diverse and abundant sessile fauna including sponges, ascidians, soft corals, sea fans (Gorgonians) and sea whips.

The inshore portion of the continental shelf is flatter and continues inshore to the outer reef edge at a depth of about 10 m, the sediments becoming coarser as the water shallows. There are occasional ridges which lie parallel, and support similar species of coral to, the main reef inshore.

On the Rowley Shelf, a small part of which occurs in the north-eastern part of the Park, communities of sponges, soft corals, seawhips and sea fans occur on exposed limestone pavements, ridges and platforms at depths between 10 and 20 m.

6.3.4 Reef

6.3.4.1 Outer reef slope

The outer reef slope is relatively short and steep, extending from sea level to about 10 m depth. It may be undercut or extend seaward into a series of spurs and grooves, often supporting a rich coral growth.

6.3.4.2 Reef crest

The reef crest or outer reef rim is the highest part of the reef and thus most frequently exposed on low tides. It occurs as a narrow band only a few metres in width and distinguishable because of its height. There are occasional reef passes (deep channels), estimated at approximately 15% of the length of the reef, which allow the exchange of seawater and provide access to the lagoon for larger fauna on low tides.

6.3.4.3 Reef flat

The reef flat is the extensive shallow area located on the shoreward side of the crest. At Ningaloo it may be several hundred metres in width. Live corals occur throughout this area but do not frequently form a total cover due to frequent storm damage and other natural perturbations. The living coral overlies recently dead corals superimposed on Pleistocene aeolian and marine limestone/sandstone deposits.

6.3.5 Lagoon

Habitats within the lagoon may be further differentiated on the basis of substrate and water depth as follows:

6.3.5.1 Shallow sands

Shallow sand occur either in pockets within the reef platform and fringing limestone pavements or in more extensive areas within the lagoon. The flora and fauna supported by the sands tends to depend on their exposure to wave action. The more stable areas support meadows of seagrass and algae that are capable of anchoring in sand such as *Caulerpa*, *Penicillus* and *Udotea*, and have a more complex fauna of crustaceans, molluscs and small fish. On highly mobile sand there may be no attached plants and the fauna is reduced to burrowing bivalve molluscs.

6.3.5.2 Exposed Rock

The subtidal rock habitats within the lagoon include recently dead coral and exposures of the underlying Pleistocene sandstone/limestone. They provide habitat for a range of attached plant and animal species including macroalgae, hard and soft corals, sponges, anemones, clams and burrowing bivalves.

6.3.5.3 Coral bommies and pavements

Areas of rock within the lagoon on which there is significant coral cover support a different assemblage of plants and animals to those which occur on rock and dead coral substrates. These include a reduced diversity and abundance of algae and reef fishes.

6.3.5.4 Deep holes

The deep (10 - 14 m) channels and holes within the lagoon have substrates comprised of rock, with or without a thin veneer of sand. They support corals and large algae.

6.3.6 Intertidal Habitats

The intertidal habitats of the Marine Park comprise:

- rocky shores;
- sandy beaches; and
- mangrove lined embayments and creeks.

6.3.6.1 Rocky shores

Rocky shore habitats within the Park range from flat, relatively planar limestone/sandstone pavement to dissected low cliffs which provide a range of habitat niches. The diversity of fauna increases with the increasing complexity of the substrate and is dominated by sedentary fauna of rock oysters, barnacles and burrowing bivalves, and a mobile fauna comprised largely of crabs, chitons and gastropod molluscs.

6.3.6.2 Sandy beaches

Sandy beaches occur extensively within the Marine Park. However, they are a relatively depauperate habitat, supporting a sparse burrowing fauna of crabs, mainly ghost crabs, and burrowing bivalve molluscs.

The beaches are seasonally important for turtle nesting and migratory wading birds.

6.3.6.3 Mangrove-lined embayments and creeks

Small areas of mangrove habitat occur in sheltered waters within the lagoon and creek mouths. The sediments in these areas are fine grained with an accumulation of organic matter. Combined with the mangroves, this habitat supports a diverse range of dependent fauna including birds, molluscs and crustaceans. It also provides habitat for the juvenile stage of a range of marine fish and crustaceans.

6.4 MARINE FLORA AND FAUNA

6.4.1 Mangroves

Being intertidal, mangroves within the Marine Park are confined to the State Waters portion. The dominant mangrove species of the region is the White Mangrove, *Avicennia marina*. The

two other species recorded are the Spotted-leaved Red Mangrove, *Rhizophora stylosa*, and the Ribbed-fruit Orange Mangrove, *Bruguiera exaristata*. The southernmost occurrences of both *Rhizophora* and *Bruguiera* occur within the Marine Park.

However, mangroves within the Ningaloo Marine Park are not extensive. On the east side of the Cape Range peninsula, a fringing mangal of *A. marina* occurs to the south of Cape Murat, between Bundegi Reef and Exmouth. On the west side of the Peninsula, mangals occur at Mangrove Bay (*A. marina*, *R. stylosa* and *B. exaristata*), Low Point (*Avicennia marina*) and Yardie Creek (*A. marina* and *R. stylosa*) (Johnstone 1990) (Figure 7).

There are no mangroves present on the islands offshore the west coast.

6.4.2 Marine Micro Flora and Fauna

Little is known of the planktonic flora and fauna of the Marine Park. These species are distributed by tides and currents and typically have wide distributions.

The planktonic larval stages of a range of invertebrates, particularly corals, sponges and polychaete worms, follow the mass spawning of corals in March and April each year. These in turn may be followed by an explosion of the population of krill, a macro-planktonic crustacean.

Occasionally, 'red tides', caused by tidal aggregations of blooms of Dinoflagellates (microscopic planktonic algae) can be seen floating on the surface of the water.

6.4.3 Macroalgae

No comprehensive mapping of the distribution of marine macroalgae has been undertaken in the region in which the Marine Park is located (McCook et al. 1995). Elsewhere on the Rowley Shelf macroalgae occur most extensively in the intertidal and shallow subtidal zones on hard substrates which may include limestone reefs, platforms and pavements, coral rubble and on dead or partially dead (mainly *Porites*) coral heads. Within the Park they may also be expected to occur wherever suitable hard substrates are present.

The dominant macroalgal genera of the region include *Sargassum*, *Padina*, *Dictyota* and *Hydroclathrus* (McCook et al. 1995). Species of a number of genera commonly found in the region, e.g. *Caulerpa*, *Udotea*, *Halimeda* and *Penicillus*, grow on soft substrates, usually pockets of sand in sheltered areas, such as sand-filled depressions in the reef flat, back reef lagoon and in fringing limestone pavements.

There are some sites within Commonwealth Waters that, on the basis of depth and water clarity, would be considered suitable for algal growth, however, there is no information of the occurrence and distribution of algae within these areas.

6.4.4 Seagrasses

Most of the known occurrences of seagrasses in the region are from shallow waters less than 5 m in depth, although one species, *Halophila spinulosa*, has been observed in deeper water (10-20 m). Available information suggests that seagrass meadows in the region are generally small, patchily distributed and sparse (McCook et al. 1995).

Observations by the present authors are that the seagrasses are able to take advantage of quiescent conditions created in the lee of islands and reefs where stable accumulations of sediment occur to develop small monospecific or mixed meadows. However, these occurrences tend to be ephemeral and the meadows may persist for only one or two seasons.

Species recorded by McCook et al. (1995) for Exmouth Gulf and which could be expected to occur within the Marine Park (State Waters) are:

Cymodocea angustata
Cymodocea serrulata
Halodule uninervis
Halophila ovalis
Halophila spinulosa
Syringodium isoetifolium
Thalassodendron ciliatum

Halophila ovalis and one additional species, *Posidonia coriacea*, are reported by the proponent for the Coral Coast Marina Development as occurring some 4 km north-east of Mauds Landing (EPA 1995).

No records have been located of seagrasses occurring in the Commonwealth Waters portion of the Marine Park. Given that only two small portions of this area have water depths of between 20 and 50 m (north of North West Cape and west of Warroora) with the remainder deeper, this would indicate that only one species, *Halophila spinulosa*, may occur in Commonwealth Waters.

6.4.5 Sponges

Sponges are reported to dominate the bottom fauna in waters deeper than about 40 m, i.e. in the deeper parts of State Waters and in Commonwealth Waters. This is consistent with findings in other areas of the west coast of Western Australia, but the sponges at this depth have never been systematically examined (WAM 1988).

6.4.6 Corals

Extensive coral development within the Marine Park is confined to the shallower State Waters. The majority occurs along the Ningaloo Reef Tract, where over 200 species have been recorded, and on the eastern side of the peninsula at Bundegi Reef (CALM 1989).

More recently, Storrie and Morrison (1998) have placed the number of coral species found within the Park at 250 and it is likely that additional species will be identified as the reef is more completely surveyed.

The corals are members of the Phylum Cnidaria which includes the hard and soft corals, anemones and jellyfish. The hard, or stoney, corals comprise two groups, the ahermatypic or non-reef building corals which include the gorgonians and black corals, and the hermatypic or reef-building corals, so called because of the carbonate skeletons which they secrete and which form the basic building blocks of coral reefs.

Representatives of all 15 families of hard (reef-building) corals occur within the Marine Park (Storrie and Morrison 1998).

The cemented carbonate skeletons of the hard corals form the bulk of the reef, the living corals comprising only a thin veneer over the surface. Ningaloo differs from coral reefs in many other parts of Australia and the world in that it is a relatively recent reef which has grown on a limestone platform rather than by continuous growth of pre-existing reef.

A comparison of reefs offshore Western Australia by the Western Australian Museum (1993) shows that the number of hermatypic (reef-building) genera and species of coral found on the Ningaloo reefs is comparable with reefs located in more northerly (tropical) waters (Table 2).

Locality	Genera	Species
Ashmore Reef	56	255
Scott/Rowley Reefs	56	255
Dampier Archipelago	57	216
Montebello Islands	54	150
Barrow Island	17	32
Ningaloo Reef	54	217
Abrolhos Islands	42	184

Source: WAM (1993).

The physical structure of the reef, including the sheltered lagoon inshore, creates habitats for many species of marine life. Corals also contribute directly to the food chain being a source of food for various species of fish, molluscs and echinoderms.

The types of coral most likely to be encountered in deeper water, including some parts of the Commonwealth Waters, are the soft corals, gorgonians (sea fans), sea whips, sea pens and the black and thorny corals. These are predominantly solitary species that do not contribute significantly to reef formation.

6.4.7 Crustaceans

The North West Shelf is reported to have a very high diversity of epibenthic (bottom living) decapod crustacea (crabs, shrimps, prawns, lobsters, etc.) with over 300 species recorded at depths between 40 and 80 m (Ward and Rainer 1988). A similar situation is expected to occur in the Ningaloo Marine Park, although factors at Ningaloo such as reduced habitat diversity, the narrower continental shelf and steeper continental slope, and cooler bottom water temperatures are likely to result in some species differences between the two areas.

6.4.7.1 Spiny lobsters (rock lobsters or crayfish)

Both temperate and tropical lobster species occur within the Park. The temperate Western rock lobster, *Panuliris cygnus*, occurs to North West Cape (and occasionally further north) in small numbers at depths to 200 m. Spawning of this species takes place in spring/early summer and larvae may be swept up to 1,500 km from the coast during their free swimming stages [Fisheries Department of Western Australia (undated)].

Tropical species occurring in the Marine Park include the Ornate (*Panulirus ornatus*) and Painted or Green (*P. versicolor*) lobsters. The habitat of both species is shallow water to depths of 10 to 16 m. They generally occur in association with coral reef, but may occur on soft or broken bottom where shelter is present.

6.4.7.2 Prawns

Prawns and shrimps occur commonly in both Commonwealth and State Waters portions of the Marine Park, with deep-water species occurring at depths of greater than 300 m.

The dominant prawn species of the region are the Penaeid species:

Western King Prawn	<i>Penaeus latisulcatus</i>
Tiger Prawn	<i>Penaeus esculentus</i>
Banana Prawn	<i>Penaeus merguensis</i>
Endeavour Prawn	<i>Metapenaeus endeavouri</i>

The above species occur in coastal waters to depths of approximately 200 m, with shallower inshore waters acting as nursery grounds for juveniles. All of the above species occur widely through subtropical and tropical waters from Western Australia to New South Wales (Jones and Morgan 1994). However, the absence of suitable shallow water nursery habitat on the western side of the Cape Range peninsula means that prawns do not occur in the large numbers found on the east coast.

Coral prawns (*Metapenaeopsis* spp.) also occur to depths of 200 m but are more common at shallower depths, often in the vicinity of coral reefs. They are also widely distributed around northern Australia (Jones & Morgan 1994).

6.4.7.3 Scampi and other deepwater crustaceans

Scampi (*Metanephrops australiensis*, *M. Andamanicus*, *M. boschmai* and *Nephropsis stewarti*) occur in deep (170 - 1,000 m depth) water on the continental slope, with each of the several species present having its own preferred depth range.

Those species occurring in the upper half of the depth range, i.e. less than about 550 m, can be expected to occur in Commonwealth Waters in the northern portion of the Park, with the remaining species occurring in deeper waters to the west.

6.4.8 Echinoderms

More than 90 species of echinoderm have been recorded in the Marine Park, predominantly in the shallower waters of the reef and lagoon. Marsh (in WAM 1988) provided a list of 30 deeper water species of echinoderms collected by the *Diamantina* cruises. With a higher intensity of sampling, a more extensive echinoderm fauna could be expected to be found within the Park.

6.4.9 Molluscs

The region contains a diverse molluscan fauna, with over 600 species recorded in the Ningaloo Marine Park (CALM 1989). The majority of species are widespread with only about

5% endemic to the region. The deeper offshore waters are reported to have a separate and distinct fauna (Fred Wells, WAM pers. comm.).

Wilson (1972) has described two new species of volutid gastropod from deeper waters offshore the reef, *Amoria diamantina* and *Volutocirnus capricorneus*, and recorded a third species, *Amoria grayi*.

The obligate coral feeding snail, *Drupella cornus*, a species of muricid whelk, underwent rapid population expansion resulting in marked reduction in hard coral cover on Ningaloo Reef during the 1980s. The infestation appeared as a slow moving wave travelling from north to south along the reef predated on selected coral species (Forde 1992). The population has subsequently declined and is not presently considered to pose a threat to the reef.

6.4.10 Fish

6.4.10.1 Scale fish

The region in which the Ningaloo Marine Park is located contains a diverse range (approximately 1,400 species) of fish of tropical Indo West Pacific affinity (Allen & Swainston 1988).

In offshore waters, pelagic species recorded include trevally (Family: Carangidae), tuna (Bigeye, *Thunnus obesus*, Yellowfin, *T. albacares*, Albacore, *T. alalunga*, and Bluefin, *T. maccoyii*) and mackerel (Family: Scombridae), marlin (Striped Marlin, *Tetrapturus audax*) and sailfish (Broadbill Swordfish, *Xiphius gladius*) (Family: Istiophoridae). Commonly encountered species include Spanish Mackerel (*Scomberus commerson*), Golden Trevally (*Gnathanodon speciosus*) and Yellowfin tuna (*Thunnus albacares*). Large demersal species, including snappers and seaperches (Family: Lutjanidae), emperors (Family: Lethrinidae), lizardfish (Family: Sinodontidae) and goatfish (Family: Mullidae), also occur. WAM (1988) contains a list of 43 smaller demersal fish species recorded by CSIRO from depths of 40-80 m on the North West Shelf, many of which could be expected to occur at the same depths west of the Ningaloo Reef Tract, including both State and Commonwealth Waters. The Commonwealth Waters are significant for tuna migration (WAM 1988) and potentially for juvenile Southern Bluefin Tuna (Caton et al. 1988).

The inshore (State) waters of the Ningaloo Marine Park are reported to support some 500 species of fish (CALM 1989) on the coral reefs and broken ground around islands and offshore rises. These include a wide range of small, often highly coloured fish associated with the reefs including damselfishes, butterflyfishes, angelfishes, scorpionfishes, wrasses and parrotfishes. Larger, commercial and recreational species include coral trout (*Plectropomus* spp.), Blue bone or Baldchin Groper (*Chocrodon rubescens*), North-west Snapper (*Lethrinus nebulosus*), Yellow-tailed Emperor (*Lethrinus mahsena*), Red Emperor (*Lutjanus sebae*) and species of cod (*Epinephelus* spp.).

6.4.10.2 Sharks and rays

Whale Sharks

The Whale Shark, *Rhincodon typus*, is the largest fish in the world, reaching a length of 12 m. They are filter feeders, feeding on plankton, small fish and squid and occur in both tropical

and temperate waters. Normally oceanic and cosmopolitan in their distribution, Whale Sharks aggregate in the waters of the Ningaloo Marine Park, frequently close to the Ningaloo Reef front, during late March to early May following the mass spawning of coral (CALM 1989).

The largest numbers are reported to occur in April, however, the season is somewhat variable, and whale sharks have been recorded between mid March and the beginning of June (J. Colman pers. comm.). This timing coincides approximately with the coral mass spawning period when there is an abundance of food in the form of planktonic larvae and schools of small fish in the waters adjacent to the reef (Thompson and Stevens 1994). The Whale Sharks feed on the small fish and zooplankton which occur in very large numbers in the weeks following coral spawning (Fisheries Western Australia 1998).

Taylor (1996, reported in Colman 1997a) has estimated the size of the local whale shark population to number between 200 and 300 individuals. The majority of animals observed are between 3 and 9 m in length and, at Ningaloo, are predominantly sexually immature males.

A plot of Whale Shark encounters in the northern area of the Ningaloo Marine Park in 1996 (Colman 1997b) shows a concentration of encounters between Jurabi Point and Ned's Camp with relatively fewer sightings to the north and south. Whale Sharks are also regularly observed in the area between Point Maud and Point Cloates, generally in May, most sightings occurring close to the reef front and within 3 nm of the shoreline. During the 1998 season the distribution was similar, being centred on Mangrove Bay and extending south to Turquoise Bay and north to Torpedo Bay.

Other Sharks and Rays

Large sharks, such as the Oceanic White-tip Shark (*Carcharhinus longimanus*), Tiger Shark (*Galeocerdo cuvier*), Blue Shark (*Prionace glauca*) and Grey Reef Shark (*Carcharhinus amblyrhynchos*), and the Manta Ray (*Manta birostris*) predominantly occur in deep water outside the reef and are thus likely to be found in Commonwealth Waters. Ningaloo Reef is regarded as an important area for Manta Rays in autumn and winter (Preen et al. 1997). Numerous other species of ray and small sharks, such as the Blacktip Reef Shark (*Carcharhinus melanopterus*), Wobbegongs (*Orectolobus ornatus*, *O. wardi* and *Euchrossorhinus dasypogon*) and Lemon Shark (*Negaprion acutidens*), and juveniles of the larger shark species occur inside the reef, i.e. in State Waters (Storrie and Morrison 1998).

6.4.11 Marine Reptiles

6.4.11.1 Sea snakes

Sea snakes are observed on the outer reef, with the Olive Sea Snake, *Aipysurus laevis*, most commonly reported.

There is no information on the frequency of occurrence of sea snakes in deeper offshore waters, although individuals are frequently observed at the surface.

6.4.11.2 Sea turtles

Four species of marine turtle are known to occur in the region. These are the:

Hawksbill	<i>Eretmochelys imbricata</i>
Flatback	<i>Natator depressus</i>
Green	<i>Chelonia mydas</i>
Loggerhead	<i>Caretta caretta</i> .

Individuals of all four species have been observed within the Marine Park, with the Green Turtle being the most common. The turtle density of Ningaloo Reef is reported to be exceptionally high (Preen et al. 1997).

Green Turtles are reported to nest on many beaches in the Ningaloo Marine Park during the summer nesting season (CALM 1989). Nesting has been recorded as early as August and to continue to late March (Tingay & Tingay 1984) with the core period for nesting and hatching between September and March. Loggerhead Turtles also breed in the Marine Park with up to 70 nesting turtles recorded in a year.

The main nesting period for each of the four turtle species is:

Hawksbill	July to March
Green	September to March
Flatback	September to March
Loggerhead	September to March.

Turtles are most vulnerable during the nesting period when they congregate in shallow water near the breeding beaches and come ashore to lay eggs, and subsequently when the hatchlings make their way across the beaches to the water.

6.4.12 Marine Mammals

6.4.12.1 Dugongs

Dugong, *Dugong dugon*, mostly inhabit the shallow (0-5 m) waters fringing the coast and offshore islands, occurring in close conjunction with the seagrass and algae beds on which they feed. Frequent sightings have been made at Norwegian Bay and the lagoon north of Bruboodjoo Point, which is a dugong sanctuary, within the Marine Park (State Waters). Ningaloo Reef supports an estimated 1,000 Dugong (Preen et al. 1997).

There is little data on the presence of dugongs in deeper offshore waters, although the absence of food would suggest this is unlikely. Observations made during whale watch surveys tend to confirm this assessment (Curt Jenner pers. comm.).

6.4.12.2 Cetaceans

Whales and dolphins are regularly observed in the waters of the Ningaloo Marine Park. Blue (*Balaenoptera musculus*) and Sperm (*Physeter macrocephalus*) whales occur well offshore and may occasionally be observed in the offshore parts of the Marine Park (Commonwealth Waters) (Curt Jenner pers. comm.).

Humpback whales (*Megaptera novaeangliae*) migrate annually through the Marine Park moving northward to Kimberley breeding grounds in winter (June-July) and southward toward summer Antarctic feeding grounds in August-October. Peaks in the numbers of

pregnant females migrating northward and cow-calf pairs migrating southward tend to be later, with peaks predicted in August and November, respectively (Jenner Marine Biology Consultants 1993). Through the Marine Park, both northward and southward migrations occur within 10 to 20 km of the shoreline, with the whales frequently passing close to the reef front (CALM 1989). The southward migration may occasionally be broken with some whales moving into Exmouth Gulf to rest and feed for one to two weeks before rounding North West Cape and continuing the southern migration. During the southern migration, cows with calves tend to travel closer to shore (Jenner Marine Biology Consultants 1993).

Minke Whale, *Balaenoptera acutorostrata*, and Bryde's Whale, *B. edeni*, have been observed along with Whale Sharks and other sharks feeding on large schools of anchovies (Thomson and Coughran 1996).

The most common species of dolphin occurring in the Marine Park is the Bottlenose Dolphin, *Tursiops truncatus*. Other species reported inshore include the Indo-Pacific Humpbacked Dolphin, *Sousa chinensis*, Common Dolphin, *Delphinus delphis*, and Spinner Dolphin, *Stenella longirostris*.

The Common Dolphin, Risso's Dolphin, *Grampus griseus*, and Spotted Dolphin have also been observed well offshore (Storrie and Morrison 1998).

Apart from the seasonal migration of Humpback Whales, most of the whales and dolphins observed in the Park tend to move singly or in small pods and do not congregate in large numbers.

Species of whale and dolphins that, on the basis of their known distributions, may on occasion be observed in the Marine Park include:

Baleen Whales (Mysticeti)	Blue Whale	<i>Balaenoptera musculus</i>
	Humpback Whale	<i>Megaptera novaeangliae</i>
	Minke Whale	<i>Balaenoptera acutorostrata</i>
	Bryde's Whale	<i>Balaenoptera edeni</i>
	Sei Whale	<i>Balaenoptera borealis</i>
	Fin Whale	<i>Balaenoptera physalus</i>
	Southern Right Whale	<i>Eubalaena australis</i>
Toothed Whales (Odontoceti)	Sperm Whale	<i>Physeter macrocephalus</i>
	Pygmy Sperm Whale	<i>Kogia breviceps</i>
	Killer Whale	<i>Orcinus orca</i>
	Pygmy Killer Whale	<i>Feresa attenuata</i>
	False Killer Whale	<i>Pseudorca crassidens</i>
	Short Finned Pilot Whale	<i>Globicephala macrorhynchus</i>
	Melon Headed Whale	<i>Peponocephala electra</i>
	Bottlenose Dolphin	<i>Tursiops truncatus</i>
	Indo-Pacific Humpbacked Dolphin	<i>Sousa chinensis</i>
	Common Dolphin	<i>Delphinus delphis</i>
	Risso's Dolphin	<i>Grampus griseus</i>
Striped Dolphin	<i>Stenella coeruleoalba</i>	
Spinner Dolphin	<i>Stenella longirostris</i>	

Source: Tucker (1991)

6.4.12.3 Seals and Sea Lions

Australian Sea Lions, *Neophoca cinerea*, have on occasion been observed in the Park and a Southern Elephant Seal was recorded on the beach at Sandy Bay in August 1998 (CALM 1999).

Both species would be considered as visitors and north of their normal range.

6.4.13 Sea Birds

The information below relating to distribution, breeding localities and ecological requirements of seabirds in the North West Shelf area is largely based on general regional accounts for individual species (Burbidge et al. 1996; RAOU 1990, 1993, 1996; Storr 1984) and from CALM's Seabird Breeding Islands database which contains records of seabird breeding for individual islands. The CALM database is based on a wide definition of seabirds to include species that breed on islands and depend largely on the sea for their food (e.g. Beach Stone Curlew, White-bellied Sea Eagle and Eastern Reef Egret). A number of species have also been recorded by Keeling and Parker (1986) on the seaward side of the outer reef and could thus be expected to occur in the Commonwealth Waters portion of the Marine Park.

In 1995, a systematic survey of seabird distribution in oceanic waters was undertaken by biologists aboard the RV *Franklin* on a voyage visiting the Houtman Abrolhos, Dampier Archipelago and the waters off the North West Shelf. While data from that survey are not yet available, an account of the survey indicates that seabird distributions in tropical waters were generally very patchy except near islands "where shelter and anomalies in surface water concentrate food seasonally" (Wooller 1995).

Seabird species reported to occur on the coastal islands, mainland coastline and offshore waters in the region, as reported in the WA CALM Seabird Breeding Islands data base, CALM (1997), Keeling and Parker (1986), RAOU (1990, 1996) and Storr (1984), are listed below. The approximate breeding season is also given for those species observed to have nested within the study area.

Seabirds reported as occurring in the Ningaloo Marine Park and Adjacent Areas

	Species	Breeding Season
Cape Petrel	<i>Daption capense</i>	Do not breed in the region
Southern Giant Petrel	<i>Macronectes giganteus</i>	Do not breed in the region
¹ Great-winged Petrel	<i>Pterodroma macroptera</i>	Do not breed in the region
Soft-plumaged Petrel	<i>Pterodroma mollis</i>	Do not breed in the region
¹ Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	October to May
¹ Flesh-footed Shearwater	<i>Puffinus carneipes</i>	Do not breed in the region
¹ Hutton's Shearwater	<i>Puffinus huttoni</i>	Do not breed in the region
¹ Little Shearwater	<i>Puffinus assimilis</i>	Do not breed in the region
Yellow-nosed Albatross	<i>Diomedea chlororhynchus</i>	Do not breed in the region
¹ Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	Do not breed in the region
White-faced Storm-Petrel	<i>Pelagodroma marinus</i>	Do not breed in the region
¹ Brown Booby	<i>Sula leucogaster</i>	No record for this area
Australasian Gannet	<i>Morus serrator</i>	Do not breed in the region
¹ Lesser Frigatebird	<i>Fregata ariel</i>	No record for this area
Pied Cormorant	<i>Phalacrocorax varius</i>	Opportunistic

Seabirds reported as occurring in the Ningaloo Marine Park and Adjacent Areas (cont'd)

	Species	Breeding Season
Australian Pelican	<i>Pelecanus conspiciciatus</i>	Opportunistic
Eastern Reef Egret	<i>Egreta sacra</i>	September to February
Osprey	<i>Pandion haliaetus</i>	April to October
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	May to November
Beach Stone Curlew	<i>Esacus neglectus</i>	August to October
Pied Oystercatcher	<i>Haematopus longirostris</i>	July to September
Pacific Gull	<i>Larus pacificus</i>	Do not breed in the region
¹ Silver Gull	<i>Larus novaehollandiae</i>	September to December
¹ Caspian Tern	<i>Sterna caspia</i>	June to November
Gull-billed Tern	<i>Sterna nilotica</i>	No record for this area
¹ Lesser Crested Tern	<i>Sterna bengalensis</i>	No record for this area
¹ Crested Tern	<i>Sterna bergii</i>	March to August
¹ Roseate Tern	<i>Sterna dougallii</i>	August to December
¹ Common Tern	<i>Sterna hirundo</i>	Do not breed in the region
¹ Fairy Tern	<i>Sterna nereis</i>	July to September
¹ Bridled Tern	<i>Sterna anaethetus</i>	No record for this area
¹ Sooty Tern	<i>Sterna fuscata</i>	No record for this area
¹ White-winged Tern	<i>Chlidonias leucoptera</i>	No record for this area
¹ Cape Pigeon	<i>Daption capensis</i>	No record for this area

¹ Recorded by Keeling and Parker (1986) seaward of the outer reef.

Frazer Island, located 10 km NNW of Pt Cloates, is reported as supporting breeding congregations of Caspian Tern, Crested Tern, Roseate Tern and the Osprey (Storr 1984). However, Frazer Island is subsequently reported to have eroded such that it is now not exposed even on low tides and hence seabird breeding is no longer possible on the island (Carolyn Williams, CALM pers comm).

On the mainland, the Low Point - Mangrove Bay area is reported as an important roosting and breeding habitat for seabirds including the Fairy Tern and White-bellied Sea Eagle. Nesting sites typically favoured by the terns are located high in the intertidal zone as scrapes in sand spits, beaches and rocky flats. Such sites may be subject to inundation only during extreme tidal events and storm surges. The Osprey and Sea Eagle both construct large stick nests above the tidal zone, sometimes in large mangrove trees.

Mangrove habitats fringing the coastline may also provide suitable roosting and nesting for some seabirds. In addition, they support a suite of avifauna that are confined or largely confined to these habitats. A study of mangrove resident birds in Western Australia (Johnstone 1990) included sites on the Ningaloo coastline at Mangrove Bay, Low Point and Yardie Creek where the following seven species were recorded: Striated Heron (*Butorides striatus*), Bar-shouldered Dove (*Geopelia humeralis*), Dusky Gerygone (*Gerygone tenebrosa*), White-breasted Whistler (*Pachycephala lanioides*), Mangrove Grey Fantail (*Rhipidura phasiana*), White-breasted Woodswallow (*Artamus leucorynchus*) and Yellow White-eye (*Zosterops luteus*). These species nest in mangrove trees, usually well above tidal levels.

The following summarises the seabird breeding records for locations within and adjacent to the Marine Park (State Waters). There are no breeding sites within Commonwealth Waters.

Summary of Seabird Breeding Records from Island and Mainland Breeding Sites in the Ningaloo Marine Park

¹ Frazer Island	Caspian Tern Crested Tern Osprey Pied Cormorant Roseate Tern
² Low Point/Mangrove Bay	White Bellied Sea Eagle Beach Stone Curlew Fairy Tern

¹Data for Frazer Island taken from CALM Seabird Breeding Islands Database

²Data for Low Point/ Mangrove Bay from Johnstone 1990.

6.5 SENSITIVE MARINE RESOURCES

The Ningaloo Reef Tract is the longest fringing barrier reef in Australia and one of only a few extensive continental fringing reefs found in the Southern Hemisphere. The reef is also one of the few places in the world where Whale Sharks are known to congregate regularly and in significant numbers, and lies on the annual migration route of the Humpback Whale.

A number of the species which occur within the Marine Park area are considered to be rare or endangered or in need of protection under State and/or Commonwealth legislation or under international treaties or agreements.

The adjacent Cape Range and fringing coastal plains are known to support an extensive troglobite and stygofauna, of which many of the species are also rare and/or geographically restricted.

6.5.1 Endangered Species (Commonwealth Legislation)

Marine fauna of the Ningaloo Marine Park listed by the Commonwealth of Australia under the *Endangered Species Protection Act* 1992. The species on the Endangered Species Protection Act schedules of 21 July 1999 that may occur within the waters of the Marine Park are listed below.

Schedule 1: Species that are considered endangered or vulnerable or presumed extinct

Part 1: Species that are endangered

Blue Whale	<i>Balaenoptera musculus</i>
Southern Right Whale	<i>Eubalaena australis</i>
Loggerhead Turtle	<i>Caretta caretta</i>

Part 2: Species that are vulnerable

Fin Whale	<i>Balaenoptera physalis</i>
Humpback Whale	<i>Megaptera novaeangliae</i>
Sei Whale	<i>Balaenoptera borealis</i>
Flatback Turtle	<i>Natator depressus</i>
Green Turtle	<i>Chelonia mydas</i>
Hawksbill Turtle	<i>Eretmochelys imbricata</i>
Soft-plumaged Petrel	<i>Pterodroma mollis</i>

Part 3: Species that are presumed extinct

None listed

6.5.2 Rare or Endangered Species (State Legislation)

Under the Western Australian *Wildlife Conservation Act* 1950, fauna in need of special protection is listed in four schedules. The following list includes listed species that may be found in Commonwealth as well as State Waters of the Ningaloo Marine Park.

- Schedule 1: Fauna which is rare or likely to become extinct
- | | |
|----------------------|------------------------------|
| Blue Whale | <i>Balaenoptera musculus</i> |
| Fin Whale | <i>Balaenoptera physalus</i> |
| Sei Whale | <i>Balaenoptera borealis</i> |
| Southern Right Whale | <i>Eubalaena australis</i> |
| Humpback Whale | <i>Megaptera novangliae</i> |
| Loggerhead Turtle | <i>Caretta caretta</i> |
- Schedule 2: Fauna which is presumed to be extinct
None listed
- Schedule 3: Birds which are subject to an agreement between the Governments of Australia and Japan and birds in danger of extinction.
None listed
- Schedule 4: Fauna which is in need of special protection, other than species listed in Schedules 1, 2 and 3
- | | |
|----------------------|-------------------------------|
| Dugong | <i>Dugon dugon</i> |
| New Zealand Fur Seal | <i>Arctocephalus forsteri</i> |
| Australian Sea Lion | <i>Neophoca cinerea</i> |

6.5.3 Species Listed Under International Agreements

6.5.3.1 CITES

Australian species (including species which occur in Australian Waters) protected under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) are listed in the first three of the 10 schedules to the *Wildlife Protection (Regulation of Exports and Imports) Act* 1982.

The most recent (May 1999) official list of species provided by ANZECC for inclusion under CITES contains the following marine vertebrate species that are known or likely on the basis of their known distribution to occur within the Ningaloo Marine Park:

- Species that are Extinct
None Listed
- Species that are Extinct in the Wild
None listed
- Species that are Critically Endangered
None Listed
- Species that are Endangered
- | | |
|------------------------------|-------------------|
| <i>Balaenoptera musculus</i> | Blue Whale |
| <i>Caretta caretta</i> | Loggerhead Turtle |

Species that are Vulnerable

<i>Balaenoptera borealis</i>	Sei Whale
<i>Balaenoptera physalis</i>	Fin Whale
<i>Eubalaena australis</i>	Southern Right Whale
<i>Megaptera novaeangliae</i>	Humpback Whale
<i>Pterodroma mollis</i>	Soft-plumaged Petrel
<i>Chelonia mydas</i>	Green Turtle
<i>Eretmochelys imbricata</i>	Hawksbill Turtle
<i>Carcharodon carcharias</i>	Great White Shark
<i>Carcharias taurus</i>	Grey Nurse Shark

6.5.3.2 Bonn Convention

Migratory species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) as at 14 February 2000 that are known or likely to occur within the Ningaloo Marine Park are listed below.

Appendix 1: Endangered migratory species

<i>Balaenoptera musculus</i>	Blue Whale
<i>Megaptera novaeangliae</i>	Humpback Whale
<i>Caretta caretta</i>	Loggerhead Turtle
<i>Chelonia mydas</i>	Green Turtle
<i>Eretmochelys imbricata</i>	Hawksbill Turtle

Appendix 2: Migratory species to be subject of agreements

<i>Sousa chinensis</i>	Indo-Pacific Humpbacked Dolphin
<i>Stenella longirostris</i>	Spinner Dolphin
<i>Dugong dugon</i>	Dugong
<i>Diomedea chlororhynchos</i>	Yellow-nosed Albatross
<i>Macronectes giganteus</i>	Southern Giant Petrel
<i>Pandion haliaetus</i>	Osprey
<i>Rhincodon typus</i>	Whale Shark

A number of species that are recorded from the Park are identified as endangered or in need of protection elsewhere within their ranges. These include the Common Dolphin, *Delphinus delphis*, Bottlenose Dolphin, *Tursiops truncatus*, and Crested Tern, *Sterna bergii*.

6.5.3.3 International Convention for the Regulation of Whaling

Under the Convention, whaling is presently restricted to subsistence whaling by traditional Aboriginal hunters and to scientific whaling. There is currently in place an international moratorium on all commercial whaling.

Australia's commitments under the Convention are presently met through the *Whale Protection Act* 1980 and will, on its commencement, be met in the future through the *Environment Protection and Biodiversity Conservation Act* 1999. Australian trade in cetaceans and cetacean products is regulated under the *Wildlife Protection (Regulation of Exports and Imports) Act* 1982.

6.5.3.4 JAMBA and CAMBA Agreements

The following table lists species of bird which have been identified either within or adjacent to the Marine Park and are listed on either the Japan - Australia or China - Australia agreements for the protection of migratory birds.

Seabirds listed under the JAMBA and CAMBA Agreements and reported to occur in the Ningaloo Marine Park and adjacent areas

	Species	Agreement
¹ Wedge-tailed Shearwater	<i>Puffinus pacificus</i>	JAMBA
¹ Flesh-footed Shearwater	<i>Puffinus carneipes</i>	JAMBA
¹ Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	JAMBA
¹ Brown Booby	<i>Sula leucogaster</i>	JAMBA, CAMBA
¹ Lesser Frigatebird	<i>Fregata ariel</i>	JAMBA, CAMBA
Eastern Reef Egret	<i>Egreta sacra</i>	CAMBA
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	CAMBA
¹ Caspian Tern	<i>Sterna caspia</i>	CAMBA
¹ Lesser Crested Tern	<i>Sterna bengalensis</i>	CAMBA
¹ Crested Tern	<i>Sterna bergii</i>	JAMBA
¹ Common Tern	<i>Sterna hirundo</i>	JAMBA, CAMBA
¹ Bridled Tern	<i>Sterna anaethetus</i>	JAMBA, CAMBA
¹ White-winged Tern	<i>Chlidonias leucoptera</i>	JAMBA, CAMBA

¹ Recorded by Keeling and Parker (1986) seaward of the outer reef and hence expected to occur in Commonwealth Waters.

7. DESCRIPTION OF THE SOCIAL ENVIRONMENT – CULTURAL RESOURCES

7.1 PRE-HISTORY

Although a full survey of the western coastline has not been undertaken, numerous sites of Aboriginal occupancy have been recorded on the Cape Range peninsula. Most sites have been located in the coastal dunes and beneath rock overhangs and in caves in the foothills, rather than in the more inhospitable country inland.

Numerous shell middens of varying sizes and camp sites have been located among the coastal dunes, together with a number of burial sites. The age of shell material in the coastal dunes has indicated dates of between 6,000 and 7,000 years Before Present (BP) (CALM 1987).

A number of rock shelter sites have also been located in the western fringe of the ranges, overlooking the Marine Park. The most intensively studied of these rock shelter sites are the Mandu Mandu Creek rock shelter, Pilgonaman Creek rock shelter and Yardie Well rock shelter (Morse 1988, 1993a, 1993b). Radiocarbon dating suggests initial occupancy of the Cape Range peninsula occurred some 32,000 years ago with subsequent intermittent use or abandonment in response to climatic change (Morse 1993a). Materials collected from the sites indicate that both terrestrial and marine resources were exploited for food (Morse 1988) and decorative ornaments (Morse 1993b). These sites represent the oldest known exploitation of marine resources in Australia.

Occupancy of the peninsula is reported as sporadic in response to long-term climate-driven sea level change and also shorter-term sequences of adverse (dry) seasons. The unique topography of the area, particularly the central portion of the Park, results in the edge of the continental slope lying very close to shore. Even during the major glaciation some 20,000 years ago, the sea retreated no more than 10 – 12 km from its present position. Consequently the rock shelters remained accessible throughout this and subsequent periods and, combined with the carbonate composition of the rock, has resulted in the shell and bone fossils being preserved. In other parts of Australia, fringing lands exposed during the major glacial periods are now mostly inundated and records of human occupation have not been preserved.

7.2 ABORIGINAL HERITAGE

During the middle part of the twentieth century, anthropologist Norman Tindale undertook a project to describe the tribal territories of the Aboriginal peoples of Australia (Tindale 1974). Tindale mapped the northern part of the Cape Range peninsula comprising Cape Range and the eastern coast of Exmouth Gulf and coastal waters as the tribal territory of the 'Jinigidira (Figure 3). To the south of the present settlement of Coral Bay and extending south to Quobba Point is mapped as the territory of the 'Baijunju (spelling of tribal names after Tindale).

The 'Jinigidira were located on the North West Cape and its peninsula (the Cape Range peninsula) to a line between the bottom of Exmouth Gulf and Whaleback Hills. The people were described as coast frequenting who used rafts made of sticks. They also lived along the eastern shore of Exmouth Gulf (Figure 3). Most of their food is said to have come from fish traps set in the tidal estuaries. Their language was described as close to that of the 'Talandji, the neighbouring tribal group to the east (Tindale 1974).

Tindale describes the 'Baijunju as being located “on Lower Lyndon and Minilya rivers. Southwest of the saltmarshes to Quobba: east to Winning Pool; north to Giralia and Bullara

but not to the seacoast and Exmouth peninsula”. The coastal portions of the area described by Tindale comprise the present day Ningaloo (southern portion only), Cardabia and Warroora Stations.

7.3 RECENT OCCUPATION

The Jinigudira people are variously reported to have abandoned the peninsula either prior to European settlement or shortly thereafter, possibly due to the incidence of introduced diseases (by whalers or early settlers), or to a series of adverse seasons which resulted in insufficient food and water to support the population. Turner (1985, quoted in Morse and Wright 1989) reports that the Jinigudira people were wiped out in the later part of the nineteenth century by an epidemic which also affected the Baiyungu people to the south.

The Baiyungu people, however, continued to live in the region and were employed in the pastoral industry and wild pearl shell industries until these became uneconomic (pearl shell), or were affected by industry restructuring (pastoral industry) which lead to great reduction in the workforce on stations and the gradual drift of people toward the major town of Carnarvon.

People living in the Carnarvon area are reported to have regarded Point Maud as a favourite camping area of recent times (Morse and Wright 1989).

At the time of the 1996 census there were about 30 persons who identified themselves as being of Aboriginal descent living in the Shire of Exmouth which includes the northern part of the Cape Range peninsula.

7.4 EUROPEAN HISTORY

7.4.1 Pre-Settlement (Exploration and Whaling)

The first recorded European contact with North West Cape was a sighting by the crew of the Dutch ship *Zeewolf* in 1618. Later in the same year, the first known landing by a European was made by Captain Jacobz of the ship *Mauritius*.

Cape Murat was named after Napoleon’s brother-in-law by French explorers who visited the area at the beginning of the nineteenth century. Nicholas Baudin charted the northern entrance to Exmouth Gulf and obtained what was at the time the most accurate fix on the position of North West Cape, critical for safe navigation in an area which had already claimed a number of ships.

In 1818, Captain Phillip Parker King rounded the Cape in the cutter *Mermaid* on his exploratory voyage from Port Jackson in New South Wales. King named the Exmouth Gulf.

However, American whalers had operated in the area as early as the 1790s, some 30 years prior to King’s expedition and 90 years before the land was taken up by Europeans for grazing. Whaling at this time was a ship-based operation and, while it is likely landings were made to acquire fresh water and possibly game, no infrastructure was established on the land. The whalers are reported to have initially targeted Sperm Whales and subsequently, in response to a better understanding of whale migrations, the Humpback Whale.

7.4.2 Post-Settlement (European Occupancy)

The pastoral industry commenced in the 1880s with the development in 1876 of Minilya Station which originally extended northward from the present station bearing that name to encompass the whole of the Cape Range peninsula. This area was progressively subdivided into the present station areas, with Yardie Creek, Ningaloo, Cardabia and Warroora Stations occupying the western coastline. (Yardie Creek Station was subsequently acquired by the State Government to form part of the Cape Range National Park).

Pastoralist and ornithologist, Thomas Carter, one of the first Europeans to settle the area, took up residence at Point Cloates (Yardie Creek Station) in 1889. A townsite at Mauds Landing was set aside in 1896 and a 450 m long timber jetty constructed in 1896-97 for the shipment of wool. The Mauds Landing site was subsequently split into two areas comprising the present Mauds Landing townsite of approximately 65 ha and the smaller Coral Bay settlement.

A licence to construct and operate a shore-based whaling station was granted to a Norwegian company, the 'Western Australian Company' commencing on 1 January 1912. Construction of the shore station was delayed pending survey of the bay and establishment of automatic lights for navigation and it was not until August 1915 that building commenced. In the interim, whaling was undertaken using a factory ship and four chasers. The station, then the most advanced of its type in the world, was sold to the 'North West (Aust.) Whaling Company' headed by a group of local investors in 1922 but, due to inadequate capitalisation, was subsequently re-sold to another Norwegian company, the 'Norwegian Bay Whaling Corporation' in 1925. These operations were all short lived and the station closed in 1928. An attempt to re-open the station in the early 1930s was unsuccessful, but between 1936 and 1938 factory ships with chasers operated off the north west coast, taking a total of 7,240 humpback whales in three years (Chittleborough 1962).

It was not until 1949 that Robert Moore and Associates (later incorporated into the public company 'Nor'-West Whaling Co. Pty Ltd') made a further attempt to re-establish shore-based operations from Point Cloates. This was successful and the station operated until 1957 when it was closed and the men and equipment were transferred to Carnarvon to operate from the Company's Babbage Island station (Stanbury 1985).

Pearling (diving for wild pearl shell) was an activity primarily carried out in Exmouth Gulf and the Rowley Shelf to the east and north of the Marine Park. It is therefore likely that some pearling activity took place in the north-eastern part of the Marine Park. Many of the pearling vessels, or "luggers" undertook voyages between Exmouth Gulf and Fremantle, and it was on these voyages that a number were lost along the Ningaloo coast.

Defence facilities were established at Learmonth and adjacent areas on the eastern side of the peninsula during World War II. US Navy-operated facilities included a submarine base at Learmonth and a Catalina flying boat base in the Bay of Rest. The Australian defence forces operated radar and radio stations and anti-aircraft batteries, and provided fighter cover for the submarines. Exmouth Gulf was also a training and forward support base for operations undertaken by the Z Special Force in the Indian Ocean and in the Dutch East Indies (Indonesia) and Singapore.

West Australian Petroleum Pty Ltd (WAPET) commenced oil exploration in the region in 1953 and made a discovery at Rough Range in 1954. Although no subsequent discoveries were made, exploration activity was subsequently directed to Cape Range where further

seismic survey and exploration drilling was carried out. The Shothole Canyon Road and Charles Knife Road that were constructed as part of that program are still in use as tourist roads.

In 1962 agreement was reached between the Australian and United States Governments to construct a Very Low Frequency Communications Station on North West Cape. The nearby town of Exmouth was constructed to support the facility.

The Exmouth Gulf prawn trawling industry was established by MG Kailis fisheries in 1964.

As the area became increasingly well known, tourist facilities gradually developed, first at Exmouth and subsequently at Coral Bay.

7.4.3 Establishment of the Ningaloo Marine Park

A marine reserve was first declared over Bills Bay, between Point Maud and Coral Bay, under the WA Fisheries Act in 1968. The purpose of the 453 ha reserve was to protect all marine fauna and algae within the reserve boundaries.

Creation of a much larger reserve to protect the Ningaloo reef tract was proposed by the Western Australian division of the Australian Marine Sciences Association in 1972. In 1974, the Conservation Through Reserves Committee recommended the creation of a marine park to protect the Ningaloo Reef in its report to the Western Australian Environmental Protection Authority (CTRC 1974). The CTRC recommendations were subsequently largely endorsed by the EPA in its recommendations to State Cabinet (EPA 1975). Cabinet endorsed the EPA's recommendations in 1976.

At that time there was no legislation enabling the creation of aquatic National Parks, however, the Fisheries Act empowered the State Governor to set aside aquatic reserves in State territorial waters. A working group known as the Marine Park Working Group was convened by the National Parks Authority in 1978 to formulate management proposals for the proposed Ningaloo Marine Park which would be proclaimed under Section 30 of the Fisheries Act (May et al. 1983). The deliberations of the working group were suspended during the process of establishing coastal baselines by the Commonwealth Government, which were proclaimed in 1983. The working group released its report later in the same year (May et al. 1983).

Key recommendations of the working group report were the inclusion of Commonwealth Waters within an expanded marine park and the integration of all of the proposed areas of the Park under one management unit (CALM 1989).

The State Waters portion of the Ningaloo Marine Park was gazetted in April 1987 and the Commonwealth Waters portion in May of the same year. In July 1987, a strip of land extending 40 m inland from the High Water Mark between Winderabandi Point and Amherst Point was reserved under the *Land Act* 1933.

A draft management plan for the Ningaloo Marine Park (State Waters) was released in May 1988 (CALM 1988a) with the final Ningaloo Marine Park (State Waters) Management Plan 1989-1999 released in 1989 (CALM 1989).

The Plan of Management for Ningaloo Marine Park (Commonwealth Waters) came into operation in June 1996 and will expire on 31 December 2000. Once the Plan expires it ceases to have effect and therefore needs to be replaced on or before that date.

7.4.4 European Coastal Heritage Sites

7.4.4.1 Point Maud Jetty

To service the pastoral industry a 450 m long timber jetty was constructed at Point Maud in 1896-97. Piles from the old jetty are reported to be still visible.

7.4.4.2 Lighthouses

Constructed in 1912 as a direct result of the wreck of the *SS Mildura* in 1907, the lighthouse and keepers quarters at Vlamingh Head have largely been preserved. The lighthouse is constructed of cement-rendered local capstone surmounted by a prefabricated steel dome that encloses the lantern. A wooden tramway with horse drawn trams was used to transport building materials and supplies from the beach to the lighthouse.

Both the lighthouse and keeper's quarters are listed on the Register of the National Estate. It has been proposed that the lighthouse be transferred from the Commonwealth to the State and be incorporated into the Ningaloo Marine Park. The keeper's house is privately owned (CALM 1989). The light was transferred to the Naval Communications station in the 1960s.

At Point Cloates there is an original lighthouse and keeper's quarters constructed soon after the lighthouse at Vlamingh Head. It was subsequently found that these were constructed on an unstable dune and a second steel-framed lighthouse was constructed on nearby Frazer Island in 1936. Frazer Island, a sand cay, also proved to be unstable, and over time the migrating sand left the light marooned in open water. The remains of the lighthouses attract numerous visitors. An automatic light was constructed in the 1950s (CALM 1989).

7.4.4.3 Norwegian Bay Whaling Station

The remains of a whaling station constructed in 1915 are located at Norwegian Bay, south of Point Cloates. Established by Norwegian whalers, the station's equipment was the most up to date of its time (Stanbury 1985).

An attempt to re-open the station in the early 1930s was unsuccessful, but a latter attempt in 1949 was successful, despite the station having been damaged by time and cyclone damage (Chittleborough 1962).

Following the closure of the station in 1957, much of the equipment was removed to Carnarvon where it was used in the shore station at Babbage Island. The remainder has deteriorated through natural processes and pilfering (CALM 1989), however, it remains a popular tourist destination. The wreck of the whale chaser "Fin", wrecked during a cyclone in 1923, is located close to Frazer Island, north-west of Point Cloates (Figure 8).

7.4.5 Shipwrecks

A number of shipwrecks are known from the Marine Park (State Waters) and adjacent areas outside the Marine Park boundaries. These date from the earliest known wreck in 1811 to 1964, and are listed below by location and chronology. There are no known wrecks within the Commonwealth Waters.

7.4.5.1 Location

The Department of Maritime Archaeology, Western Australian Maritime Museum, Shipwreck Database lists historic shipwrecks by name of vessel, date wrecked and location of wreck (within a broad geographical region). Further information on those wrecks and the circumstances surrounding them, and on some vessels not recorded on the database, are provided in wreck survey reports of the Western Australian Maritime Museum.

Records of Shipwrecks in the Marine Park and Surrounding Region

Vessel	Type	Wrecked	Location
POINT CLOATES (NINGALOO REEF)			
<i>*Rapid</i>	Wooden ship, 366 ton	07/01/1811	22°44.0' S 113°41.0' E
<i>Ollices</i>	Galley	1811	N. of Point Cloates
<i>Caledonia</i>	Galley	1815	S. of Point Cloates
<i>Correo d'Azia</i>	Brigantine	1816	Point Cloates
<i>*Occator</i>	Brigantine, 145 ton	05/02/1856	Not Found (NW Cape)
<i>Brothers</i>	Schooner, 16 ton	1867	S. of Coral Bay
<i>*Emma</i>	Schooner, 116 ton	--/03/1867	S. of Point Anderson
<i>*Strathmore</i>	Barque, 450 ton	1870s	Not Found (Point Cloates)
<i>*Bertha</i>	Cutter	20/07/1874	Not Found (Point Cloates)
<i>*Fairy Queen</i>	Pearling schooner, 115 ton	08/10/1875	Point Murat (21°49.2' S 113°01.5' E)
<i>*Stefano</i>	Barque, 875 ton	27/10/1875	Point Cloates
<i>*Cock of the North</i>		--/05/1879	Not Found (Point Cloates)
<i>*G.G.S</i>	Lugger	--/--/1883	Not Found (Point Cloates)
<i>*Perth SS</i>	Steamship, 499 ton	17/09/1887	22°41.64' S 113°38.43' E
<i>Ada May</i>	Cutter, 3 ton	06/03/1888	Point Anderson
<i>*Benan</i>	Iron ship	23/12/1888	Point Cloates
<i>*Queen</i>	Cutter, wooden 6 ton	22/10/1891	Not Found (Point Cloates) Foundered approx. 800 m S of the wreck of the SS Perth
<i>Emerald</i>	Pearling lugger	25/02/1893	Not Found (North West Cape)
<i>*Gem</i>	Pearling lugger	25/02/1893	Not Found (North West Cape)
<i>*Nellie</i>	Pearling lugger	25/02/1893	Not Found (North West Cape)
<i>Courteous</i>	Steamship, iron	1897	Unknown
<i>*Beatrice</i>	Lugger, 12 ton	15/03/1899	Not Found (NM Cape)
<i>*Don Joseph</i>	Lugger, 13 ton	30/04/1899	Not Found (Point Cloates)
<i>*Zvir SS</i>	Steamship, iron	27/11/1902	Norwegian Bay (22°36.1' S 113°37.1' E)
<i>*Mildura SS</i>	Steamship, iron	12/03/1907	North West Cape
<i>*Hampton</i>		18/05/1908	Not Found (NW Cape)
<i>*Iona</i>		16/04/1923	Not Found (Point Cloates)
<i>Finn</i>	Whale catcher, iron	15/02/1923	Norwegian Bay (22°39.0' S 113°38.0' E)

7. Description of the Social Environment – Cultural Resources

Vessel	Type	Wrecked	Location
* <i>Patience</i>		13/07/1930	Not Found (Point Cloates)
* <i>Chofuku Maru SS</i>	Freighter	18/02/1931	Norwegian Bay
* <i>Shunsei Maru SS</i>		05/02/1931	Not Found (Norwegian Bay)
* <i>Lady Ann</i>		18/09/1982	NW Cape
* <i>Wyndham</i>			Not Found (Point Cloates)
EXMOUTH GULF			
* <i>Blossum</i>	-	24/12/1875	Not Found (Exmouth Gulf)
* <i>Lily of the Lake</i>	-	24/12/1875	Not Found (Exmouth Gulf)
* <i>Wild Wave</i>	-	24/12/1875	Not Found (Exmouth Gulf)
* <i>Agnes</i>	Pearling lugger	25/02/1893?	Not Found (Exmouth Gulf)
* <i>Bell</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Elizabeth</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Ellen</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
<i>Fleetwing</i>	Pearling lugger	25/02/1893	'Exmouth Gulf'
* <i>Florence</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
<i>Florence</i>	Cutter	25/02/1893	'Exmouth Gulf'
* <i>Lamareaux</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Leave</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Mabel</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Olive</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Rose</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Ruby</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Sea Queen</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Smuggler</i>	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
*Lugger (unidentified)	Pearling lugger	25/02/1893	Not Found (Exmouth Gulf)
* <i>Cutty Sark</i>		14/03/1907	Not Found (Exmouth Gulf)
* <i>Eclipse</i>		14/03/1907	Not Found (Exmouth Gulf)
* <i>Hawk</i>		14/03/1907	Not Found (Exmouth Gulf)
* <i>Kate Florence</i>		14/03/1907	Not Found (Exmouth Gulf)
* <i>Eclipse</i>		19/11/1910	Not Found (Exmouth Gulf)
* <i>Veronica</i>		--/07/1928	Not Found (Exmouth Gulf)
* <i>Kapala</i>		01/05/1964	Not Found (Exmouth Gulf)

Sources: * Department of Maritime Archaeology, Western Australian Maritime Museum Shipwreck Database Search Facility (as updated July 1999).

Additional information from CALM 1989; Henderson 1980; Henderson and Henderson 1988; Cairns and Henderson 1995.

7.4.5.2 Circumstances surrounding historic shipwrecks

The oldest known wreck in the Marine Park is that of the American China trader *Rapid*, an armed, 3-masted wooden ship which was wrecked in 1811. Eight cannon, 20,000 Spanish silver dollars, US dollars and one cent pieces were recovered from the wreck (Henderson and Henderson 1988).

The Singapore-built brigantine (also listed as a schooner), *Fairy Queen*, was wrecked at Point Murat in 1875 while on a pearling cruise. The visible remains include a small cannon, several anchors and some ballast brick and stone (description extracted from the Register of the National Estate database). The location of the *Fairy Queen* shipwreck is given in the Register of the National Estate as being located 10 m from shore at Point Murat, just south of the naval jetty. Also in 1875, the Austrian barque *Stefano* enroute from Cardiff to Hong Kong carrying 17 crew and a cargo of 1,300 tons of coal ran aground on reef approximately six miles south of Point Cloates. Although most of the crew were able to make shore, only two were

subsequently rescued. The remainder perishing due to unfamiliarity with the environment and lack of water.

The iron screwed steamship *SS Perth* foundered on Ningaloo Reef in the vicinity of Point Cloates on 13 September 1887. The passengers and crew were saved and most of the mail recovered but most of the cargo was lost. The wreck is still visible on the reef at low tide (Cairns and Henderson 1995).

The *Ada May*, a wooden pearling cutter of about three tons, foundered at sea off Point Anderson on 6 March 1888 with the loss of two of the crew of five. In the same year the iron, ship-rigged vessel *Benan* struck the reef off Point Cloates on 23 December. The cause of the wreck was put down as “a strong current setting from the north-west, and wrongly laid down in the Admiralty sailing charts.” Wreckage of a ship, tentatively identified as the *Benan*, was located at Point Cloates in 1992 (Cairns and Henderson 1995).

On 22 October 1891, the wooden cutter *Queen* ran aground on the Ningaloo Reef, approximately 800 m south of the wreck of the *SS Perth*. One of the three crewman on board was unable to make his way to shore from the wreck and is presumed to have drowned. The vessel was too badly damaged to be recovered (Cairns and Henderson 1995).

In February of 1893, a cyclone devastated the pearling fleets of Shark Bay and Exmouth with many vessels and numerous crewmen lost. A number of these vessels were subsequently recovered and incomplete records from the time mean that a complete accounting of losses is not possible. Three of the luggers are reported to have gone aground on North West Cape, possibly within the Marine Park. The fate of many others is unknown and it is possible some may have sunk within the Marine Park. The vessels were generally small, between 8 and 12 m in length, and almost all appear to have been sailing vessels of wooden construction and there is little chance of substantial wreckage being found.

A number of other pearling luggers and small cutters were lost along the Ningaloo Reef tract at the end of the nineteenth and in the early years of the twentieth century. Most were in transit from Fremantle to the northern pearling grounds.

The cattle ship *SS Mildura* was wrecked on the reef at North West Cape during a cyclone in 1907. No lives were lost and timbers and iron from the wreck, which lies just offshore, were subsequently salvaged and used in the renovation of the Yardie Creek homestead. The hull remained on the reef until World War II when it was used for bombing practice.

In 1923, the *Fin*, one of two whale chasers moored in Point Cloates harbour at the time, was totally wrecked when the boats were blown ashore.

8. EXISTING INFRASTRUCTURE

The Shire of Exmouth, which takes in the northern part of the study area, had an estimated resident population in 1999 of 2,149 persons (ABS Estimated Resident Population, 1999 [preliminary]). Infrastructure in the study area is centred on Exmouth, which is also the largest population centre in the region (Figure 8). There are two closely spaced townsites, Coral Bay and Mauds Landing, located on the west coast to the south of the peninsula and within the Shire of Carnarvon. Coral Bay is an existing tourism-based settlement located at the northern end of Coral Bay, while Mauds Landing is the site of a proposed tourism and residential development.

8.1 TOURIST INFORMATION/FACILITIES

There is a tourist information centre at Exmouth operated by the Exmouth Tourist Bureau and a smaller facility at Coral Bay. CALM also operates a visitor information centre at Milyering, within the Cape Range National Park. Located some 52 km from Exmouth, the centre features graphic displays, models, videos and a library with information relevant to both Cape Range National Park and Ningaloo Marine Park. The centre is jointly funded by Environment Australia. Displays of tourism and recreational attractions are also featured at the Learmonth airport terminal.

8.2 ROADS

By road, the distance to Coral Bay and Exmouth is 1,132 km and 1,263 km, respectively (RACWA 2000). The main road through Exmouth is linked to Perth and Dampier via a sealed, bitumen road which joins the North West Coastal Highway at Minilya Station. The bitumen road extends north of Exmouth to Point Murat and Vlamingh Head from where it continues south along the west side of the Cape as a minor sealed road to Tulki Beach, as an unsealed road to Yardie Creek, and subsequently as a track to Coral Bay. Road access to Coral Bay and Ningaloo Station from the Learmonth-Minilya Road is by sealed and unsealed roads, respectively (RACWA 1997).

Burkett Road, which links the Learmonth-Minilya Road to North West Coastal Highway, has also been sealed, reducing the sealed road distance from Dampier to Learmonth and Exmouth by approximately 160 km.

8.3 BOATING FACILITIES

Marine facilities, including boat launching ramps, jetties, marinas, etc., within the Marine Park are limited, with most located along the Exmouth Gulf side of the peninsula, including:

- Point Murat - naval supply jetty (restricted access);
- Bundegi - facilities include a concrete launching ramp, unserviced jetty, unsealed car park and public toilets. There are a number of private swing moorings located within the shelter of the reef, principally used by recreational and charter vessels;
- Exmouth Marina - provides launching, mooring, fuelling and supply facilities for commercial fishing, charter fishing, tourist and private vessels; and
- Learmonth jetty - providing fuel for commercial and recreational vessels.

Boat ramps on the Ningaloo side are located at:

- Tantabiddi Creek - facilities include a concrete launching ramp, unsealed car park and public toilets; and
- Coral Bay - which also has a concrete launching ramp.

In addition to the formalised launching ramps, small boats are also launched across the beaches in a number of areas including Ned's Camp and Bills Bay (CALM 1989). The beaches are generally suitable for launching boats up to 5 m in length but low tides may restrict the times that launching is possible. The reef lagoon provides sheltered waters for mooring however accessing the lagoon is reported to be difficult in bad weather.

Conditions outside the reef can change very quickly making access to the calmer waters inside the lagoon dangerous. Swell waves and rips often develop in the area of access channels making the passages difficult for the inexperienced to navigate.

8.4 AIRPORTS AND AIRSTRIPS

The major air support facility in the region is Learmonth Airport, which is a combined defence/civilian facility with capacity to handle commercial passenger jet aircraft, heavy lift planes and general air cargo transport.

Landing strips suitable for light aircraft and helicopters are located at Exmouth and Coral Bay, while there are numerous private landing strips supporting the pastoral stations of the region.

8.5 ACCOMMODATION

Exmouth is the main tourist accommodation area for the region and includes hotel, chalet and self-contained apartments, caravan parks and backpacker accommodation.

Limited resort, chalet, caravan and camping and backpacker facilities are also available at Coral Bay.

Camping also occurs in the coastal dunes of the stations and in the RAAF bombing range. However, facilities in these areas are described as basic or non-existent.

8.6 MEDICAL FACILITIES

The Exmouth District Hospital is a small, 15 bed facility providing local community health services. The hospital is able to provide limited first aid and limited emergency services comprising injury stabilisation, limb and chest x-ray and pain relief, but is not equipped (or staffed) for surgery.

The area is serviced by the Royal Flying Doctor Service which operates from Meekatharra.

8.7 POWER GENERATION

Electrical power generation in the region, including the main population centres of Exmouth and Coral Bay, is by local diesel generating plants.

8.8 WASTE DISPOSAL SITES

Sanitary landfill sites for the disposal of domestic wastes are operated in Exmouth and Coral Bay. At Coral Bay, the disposal of both solid and liquid wastes are currently issues of environmental concern.

At Exmouth there is a small site for the disposal of oily wastes located within the waste disposal area, south of town. This site is able to accept small quantities of waste only (e.g. service station waste) and the Shire is currently looking at alternative disposal options.

In the event of an oil spill or clean-up operation requiring the disposal of significant amounts of oil or oil-contaminated sands or absorbents, the material would have to be transported to Karratha or Perth for treatment and/or disposal, due to the environmental sensitivity of the area (G. Savage pers. comm.).

9. CURRENT USES OF THE NINGALOO MARINE PARK

9.1 TOURISM AND RECREATION

The Gascoyne Region, in which the Marine Park is located, received a total of 257,000 visitors in 1998, of which 50,000 were from overseas and 207,000 from within Australia (source: Western Australian Tourism Commission). Expenditure by domestic visitors (i.e. persons from elsewhere within Australia) for the year is estimated at \$85 million, indicating total visitor expenditure of over \$100 million per annum and making tourism one of the largest industries in the region.

9.1.1 Nature-based Tourism

The main marine nature-based tourist activities are snorkelling and scuba diving (including underwater photography) which take place relatively close to shore on the Ningaloo and Bundegi Reefs. Recreational diving is facilitated by the ease of access to the reef which, in many areas, can be accessed from shore by dinghy. Glass-bottomed boat tours are also available for non-divers.

Whale Shark encounters and whale watching are the other major nature-based activities undertaken within the Park. Whale watching and Whale Shark encounters take place during the seasonal migration of the Humpback Whale and Whale Shark aggregation periods, respectively. These activities also occur relatively close to shore, outside the reef edge and range across both Commonwealth and State Waters of the Ningaloo Marine Park. At present there are some 15 commercial licences for Whale Shark interaction, 13 for the northern part of the reef and two for the southern area. Turtle watching tours also take place during the turtle-breeding season.

Other marine creatures, e.g. dolphins, dugongs, manta rays and large fish such as cod or groper, are of interest when encountered by divers or tourist vessels but as yet no industry has grown up around any specific location.

Scenic flights over the reef and adjacent Cape Range may also be undertaken.

9.1.2 Other Recreational Activities

9.1.2.1 Recreational boating

Most recreational boating is associated with fishing and diving, and includes privately owned and commercial charter vessels. Most are day sailors and consequently limited to coastal waters and the offshore islands, although charter boats may venture further afield. Surfing, sailboarding and small sailing catamarans are also popular recreational activities.

Cruising yachts may pass through the area at any time of year, although many sailors tend to avoid the cyclone season. Yachts participating in the Fremantle to Bali (Lombok) race pass through the area in May.

9.1.2.2 Recreational fishing for food

Permitted fishing activities within the Marine Park include line fishing from both boat and shore, spearfishing and net fishing. Surveys conducted in 1992 and 1993 (Nowara, in prep.) indicate that line fishing from boat and shore were the most popular methods of fishing and North-West Snapper the most frequently sought after and caught species.

Recreational line fishing includes beach fishing from most accessible locations and dinghy fishing within the Ningaloo Reef lagoon and close to shore in northern Exmouth Gulf. Most offshore fishing is conducted from larger privately owned power boats and charter vessels, and comprises bottom fishing for reef fish such as Red Emperor and North-West Snapper, and trolling close to the reef edge for Spanish Mackerel, trevally and tuna (F. Prokop, pers. comm.).

Recreational net fishing, using throw nets, haul nets and set nets, for species such as mullet is permitted in specified areas of the Park subject to licence and quota requirements.

Spearfishing and diving for rock lobsters occur around the reefs and offshore islands, mainly in water depths of less than 20 m. There are restrictions on the methods of fishing permitted, the areas that may be fished and the species that may be caught.

There is only one species of bivalve mollusc within the Park that is regularly consumed by humans, the rock oyster, *Saccostrea cucullata*. This is a recreational fishery only, but over zealous collecting has led to denudation of rock surfaces in easily accessible areas (CALM 1989). Squid, octopus and cuttlefish are also permitted to be caught.

Permitted equipment, bag limits and minimum sizes have been set for most popular species caught within the Marine Park. In addition, fishing and collecting is totally banned within the eight Sanctuary Zones, while additional restrictions apply to spearfishing and netting (Fisheries Western Australia 1999).

A 1996 recreational fishing survey undertaken as part of a study on the future of recreational fishing in the Gascoyne, which includes the Ningaloo Marine Park and Shark Bay World Heritage Area, found widespread support for the introduction of additional measures to protect fish stocks where these have been shown to be necessary (Gascoyne Recreational Fishing Working Group 1999).

9.1.2.3 Game fishing

In the area west of the Ningaloo Reef tract there has been an increase in recent years in recreational fishing for billfish, especially sailfish. While most of this fishery occurs inshore close to the reef, it is estimated that about 25% of this activity takes place in Commonwealth Waters of the Park. The number of charter vessels in the area varies seasonally, but approximately six boats are consistently based in either Exmouth or Coral Bay (R. Owens, pers. comm.). The area is regarded as one of the most successful in the world for small individuals of billfish species. The catch is dominated by sailfish, primarily in the 30-40 kg range. These animals, which are part of migratory populations, are normally released when caught.

There are also catches of tuna, dominated by Yellowfin, with some Bluefin and occasional Black Tuna also being caught (F. Prokop, pers. comm.).

9.1.2.4 Shell collecting

Amateur shell collecting typically occurs in the shallow waters of the reef and lagoon areas (live shell) and on the beaches (dead shell). As such, it is an activity almost entirely confined to inshore (State) waters rather than deeper waters offshore (i.e. Commonwealth Waters).

Due to the importance of molluscs to the functioning of the marine ecosystem and the fact that collecting can quickly result in populations being depleted, live shells and corals may not be collected within the Park, other than edible shellfish (oysters, squid, cuttlefish, octopus and rock lobsters) (Fisheries Western Australia 1999).

9.2 COMMERCIAL FISHING

The Ningaloo Reef Tract has never been a major area for commercial fisheries.

There are a number of different fisheries either presently operating or with the potential to operate within and/or adjacent to the Marine Park. These include fisheries operating under the management responsibility of the Australian Fisheries Management Authority (Commonwealth) and Fisheries WA (State). The Commonwealth generally has responsibility for management of all marine species taken by trawl in waters deeper than 200 m and for pelagic species (primarily tunas), while the State has responsibility for species taken by non-trawl methods in deep waters (from 200 m to the outer edge of the AFZ) and for all trawling in inshore waters. Under the agreement between the Commonwealth and the State, Fisheries Western Australia is responsible for the management of fisheries within the Marine Park. However, under the regulations to the National Parks and Wildlife Act 1975, all commercial fishing in the Commonwealth Waters of Ningaloo Marine Park require a permit from the Director of National Parks and Wildlife. There are no current permits for commercial fishing in the Commonwealth Waters.

For the last 30 years, there has been a condition on all Western Australian State fishing licences prohibiting fishing in the area between Tantabiddi Well in the north and Point Maud in the south, and out to the limit of the Australian Exclusive Economic Zone.

9.2.1 Crustaceans

9.2.1.1 Prawns and scampi

During the late 1970s and early 1980s the CSIRO Division of Fisheries and Oceanography conducted exploratory cruises along the continental slope off north-western Australia searching for deepwater fisheries resources. A commercial fishery was discovered for stocks of crustaceans, with a wide variety of deepwater benthic species being fished. Initially there was considerable enthusiasm for the potential of a crustacean fishery on the slope (Sainsbury 1979; Carter et al. 1983; Davis & Ward 1984). An exploratory fishery commenced in 1985, based on three species of the scampi, genus *Metanephrops* (*M. velutinus*, *M. australiensis*, and *M. boschmai*). Scampi catches reached a maximum of 162 tonnes in 1988-89.

Interest in deepwater prawns increased as the animals dominated the catches. Four species of penaeids (*Aristaeomorpha foliacea*, *Aristeus virilis*, *Plesiopenaeus edwardsianus*, and *Haliporoides sibogae*) and two species of carids (*Heterocarpus sibogae* and *H. woodmasoni*) provided most of the animals caught. Catches peaked at about 850 tonnes in the 1987-88

fishing season, then declined sharply. Most of the prawns were caught at depths of 300-550 m by demersal trawling during the day. The prawns actually live on the bottom during the day and migrate into the water column at night and feed there. At its peak, the North West Slope Trawl Fishery was utilised by up to 21 vessels in any one year. Squid are also reported to have formed an important part of the bycatch on occasion (Caton et al. 1998). However, the viability of the fishery is uncertain due to the low egg production by the adult prawns and consequent susceptibility to overfishing (Jones and Morgan 1994). Catches declined sharply after the 1987-88 peak, and the fishery has largely ceased (Ward and Rainer 1988; Phillips and Jernakoff 1991; Rainer 1992, 1994). There is presently no trawling within the Park area (Andrew Bartlett pers. comm.).

The Exmouth Gulf Prawn Fishery that operates in Exmouth Gulf and in the shallow water to the north of the Gulf is the most important of the region's fisheries. The major species caught are the Western King Prawn, *Penaeus latisulcatus*, Tiger Prawn, *Penaeus esculentus*, Endeavour Prawn, *Metapenaeus endeavouri*, and Banana Prawn, *Penaeus merguensis*. Coral Prawns are also caught and sold, but are considered a by-product of the fishery. Trawling for prawns occurs in that part of the Marine Park which lies to the east of the line between North West Cape and South Muiron Island. This includes a small area of the State Waters portion of the Marine Park.

9.2.1.2 Rock lobsters

One fisherman operating under a non-transferable licence previously captured Western Rock-lobster (*Panulirus cygnus*) by hand in the southern portion of the Marine Park. The activity was confined to the reef and thus was confined to the State Waters of the Park. The licence was purchased by the State some years ago and this activity has now ceased (Andrew Bartlett pers. comm.).

9.2.2 Molluscs

Commercial shell collecting was previously undertaken on the Ningaloo Reef but is not considered an appropriate activity within the Marine Park and is no longer permitted (CALM 1989).

9.2.3 Finfish

The fisheries operating under Commonwealth jurisdiction are the Western Deepwater Trawl Fishery and the Western Tuna and Billfish Fishery. Both are regarded as minor fisheries. The Western Deepwater Trawl Fishery is a demersal fish trawl fishery operating from the 200 m isobath to the edge of the AFZ, extending from North West Cape to Cape Leeuwin (south-west Western Australia). Within its area it includes part of the Ningaloo Marine Park (Commonwealth Waters). A small number of vessels (11 permits in April 1999) operate within the overall fishery and a wide range of species is caught. However, the total catch for the fishery is low with an estimated catch of 109 tonnes in 1997-98.

The Western Tuna and Billfish Fishery operates between Cape Leeuwin and Cape York (Queensland). The principal species targeted are Yellowfin, Bigeye, Albacore, Skipjack and Longtail tuna and Broadbill Swordfish. There are 123 permits of which 89 have a pelagic longline entitlement, 103 have minor line (hand line, rod and reel, and troll), 13 have purse seine and 38 have pole entitlements. The estimated catch for 1998-99 was 2,071 tonnes. The

fishery for the broadbill swordfish is centred in Geraldton, but there is some fishing off North West Cape. Fishermen use satellite images of the Leeuwin Current to locate warm water gyres which have spun off from the current or are on its margins, and fish these areas for swordfish. The Australian fishery for swordfish was reviewed by Caton et al. (1998). The area is also fished for Dogtooth and Albacore Tuna (R. Owens, pers. comm.). Most of the fishing occurs to the south and west of the Ningaloo Marine Park.

Trawling trials were conducted between 1994 and 1996 on the outer continental shelf south-west of Norwegian Bay to assess the potential for a demersal fishery north of the Shark Bay Snapper Fishery. A limited, but exploitable, fishery was found to occur at depths between 100 and 200 m.

There are no current permits for commercial fishing within the Commonwealth portion of the Marine Park. Some commercial fishing is undertaken within State waters of the Park, but closure of the area between Tantabiddy Well and Point Maud to commercial fishing means that between 50 and 60% of the State Waters portion of the Park are also closed to commercial fishing. In 1993, the waters of the west coast from Shark Bay to a line running north from North West Cape (which includes the Commonwealth Waters portion of the Marine Park) were closed to shark fishing to protect breeding stocks of large whaler sharks (e.g. *Carcharhinus obscurus* and *C. plumbeus*) (Simpfendorfer and Donohue 1998).

The present level of fishing activity in Commonwealth Waters is low, comprising mainly charter sportfishing for tuna and swordfish plus a low level of drop lining for reef fish species such as Red Emperor, undertaken in conjunction with, or as a supplement to, charter fishing operations (Andrew Bartlett pers. comm.).

9.2.4 Aquarium Fish

There are no current permits for the capture of aquarium fish from the Ningaloo Reef area (Andrew Bartlett pers. comm.).

9.3 PETROLEUM EXPLORATION AND PRODUCTION

9.3.1 Seismic Survey

There is no present seismic survey activity being undertaken in the Marine Park. However, recent surveys have been conducted in permits adjacent to the Park and it is reported that the survey vessel turned within Park waters at the end of the seismic lines.

9.3.2 Exploration Drilling

As present Commonwealth legislation does not allow for the coexistence of oil exploration permits and marine parks, there is no possibility of drilling taking place in the Commonwealth Waters of the Marine Park. Further, under Western Australian government policy, as set out in the New Horizons in Marine Management statement, exploration drilling is not permitted within State Waters of the Marine Park.

However, the region is considered prospective for oil and gas, and offshore exploration drilling on adjacent permits has taken place as recently as 1999.

9.3.3 Petroleum Production

There is no current production within or close to the Marine Park Boundaries. The closest production facilities are located at the Griffin oil and gas field some 75 km to the north-east of North West Cape. Griffin operates through a Floating Production, Storage and Offloading facility (FPSO) and also has a sub-sea pipeline from the field to the mainland at Tubridgi, east of Exmouth Gulf, for the transportation of gas.

9.3.4 Petroleum Processing, Storage, Transport and Infrastructure

No petroleum processing, storage or infrastructure facilities are located within the Marine Park boundaries.

However, processed petroleum products (bulk diesel fuel) are landed at Point Murat, involving transport by tanker through the waters of the Park and a pipeline from the Point Murat jetty to storage tanks on-land.

9.4 ACTIVITIES ACTUALLY OR POTENTIALLY AFFECTING THE MANAGEMENT OF THE MARINE PARK

Due to the remoteness of the Marine Park, the low level of development of the adjacent hinterland and low level of discharges from the land to the marine environment, the main activities that actually or potentially threaten the inshore values of the Park are recreation and tourism and the servicing of those activities.

Offshore the impacts of tourism and recreation decrease with increasing distance offshore, and the impact of commercial fishing, particularly trawling, would presently be considered more significant. However, the passage of commercial shipping and oil exploration and production in areas adjacent to the Park are also activities actually or potentially impacting on the Marine Park.

9.4.1 Tourism and Recreation

Existing or potential impacts from tourism and recreational activities include:

- incidental damage to the reef through impacts of dive fins, propellers, snagging of anchors and fishing gear, oil spills from boats, disposal of waste overboard from boats;
- reduction in fish populations due to recreational fishing (particularly higher-order, predatory reef species which are naturally present in relatively small numbers but are targeted by anglers both for eating and sport);
- disturbance and disruption to natural behaviour patterns of turtles, dugong, Whale Sharks and whales (particularly females with calves on their southward migration) by boats and divers or aircraft (including scenic flights and spotter planes searching for whales and whale sharks);
- damage to historic sites through vandalism and removal of artefacts;

- aesthetic impact of developments providing tourist accommodation and services within or adjacent to the Marine Park; and
- disposal of waste and pollutants from areas providing accommodation and services either within or adjacent to the Marine Park, e.g. sewage treatment and effluent disposal, disposal of non-degradable solid wastes, pollution of the air from burning fossil fuels for power generation and transport.

The majority of the above impacts are most likely to impact on inshore, i.e. State, than offshore (Commonwealth) waters.

Impacts on the Marine Park (Commonwealth Waters) from the above activities are likely to be confined to disturbance to whales and Whale Sharks caused by boats, divers and aircraft, and reductions in populations of demersal fish species from recreational food-fishing and a lower, but as yet undefined, level of impact on pelagic fish populations, including tuna, marlin, swordfish and sailfish, from gamefishing.

A further impact that is yet to be fully assessed is the potential for the introduction of exotic organisms, such as the Black-Striped Mussel, *Congeria salleri*, from cruising yachts as occurred recently in Darwin harbour. Cruising yachts seldom carry water ballast but introductions of exotic species can occur as a result of organisms carried on the hull either becoming detached from the hull or spawning while the vessel is anchored in the lagoon. The temptation for yachtsmen to take advantage of sheltered waters in the lagoons to clean the hull of fouling organisms increases the risk.

9.4.2 Commercial Fishing

The main types of commercial fishing that may potentially occur within the Park are demersal trawling, longlining and droplining. Activities associated with those activities that might potentially affect the management of the Marine Park (Commonwealth Waters) are as follows:

- over exploitation of the targeted fish species;
- over exploitation of non-target (generally non-commercial or low value) fish species;
- bycatch of non-target species including endangered species such as albatross and turtles, and dugong and dolphins;
- death of long-lived sessile epibenthic species, such as sponges and gorgonians; and
- adverse impact on benthic habitats and ecosystems.

9.4.2.1 Exploitation of the resource

The fisheries which are potentially able to take place within the Park generally comprise a small part of much larger fisheries and thus the comments made in this section generally relate to the overall fishery rather than specifically to that part which may take place within the Ningaloo Marine Park. The present level of commercial fishing activity in the Commonwealth Waters portion of the Park is considered low, comprising mainly charter fishing for tuna and swordfish plus a low level of droplining for reef fish species undertaken in conjunction with, or as a supplement to, charter fishing operations (Andrew Bartlett pers. comm.).

The information on the stock of the Western Deepwater Trawl Fishery is limited. However, effort levels are considered to be well below those considered to be sustainable for the Fishery (Caton et al. 1998). In general, demersal fishes tend to be more susceptible to over-exploitation than pelagic species due to their slow growth rates and low mobility.

There has been very little research and no formal assessment of tuna (excluding Southern Bluefin Tuna) and billfish stocks in the western AFZ. The status of the Western Tuna and Billfish Fishery is therefore uncertain (AFMA 1999). The Southern Bluefin Tuna is considered to be over-exploited and has been nominated for consideration as a vulnerable species under the Endangered Species Protection Act (Caton et al. 1998).

9.4.2.2 Bycatch

Impacts associated with trawl fishing include incidental catch of turtles and dugongs, overfishing of target species and damage to populations of non-target species (for which little data is available). In addition, bottom trawling may result in physical modification of sea floor habitats and the death of sessile marine organisms including sponges, gorgonian corals and sea whips.

The incidental catch associated with longlining includes seabirds (particularly species of albatross and shearwaters), non-target fish species, dolphins and turtles. For example, the non-fish bycatch associated with the swordfish longline fishery in the south west Atlantic Ocean (off the coast of Uruguay) included four bird species, the albatrosses *Diomedea exultans*, *D. melanophrys*, *D. chlororhynchos*, and *Procellaria aequinoctialis*, two mammals, the Common dolphin, *Delphinus delphis*, and *Arctocephalus tropicalis*, and two turtle species, the Loggerhead turtle, *Caretta caretta*, and *Dermochelys coriacea* (Marin et al. 1998). One species from each of these groups is known to occur within the Park, while a number of other species with similar habits are also present. In 1996, pelagic longlining was listed as a key threatening process under the *Endangered Species Protection Act 1992* due to its impact on seabirds (Caton et al. 1998).

Impacts associated with dropline fishing include bycatch of non-target species and potential over-exploitation of the target fish population.

Bycatch species listed under the Endangered Species Protection Act include albatrosses (four species listed as endangered, 13 species listed as vulnerable), five species of sea turtle, and the Great White Shark. Impacts are being assessed and measures put in place to reduce bycatch including the development of the National Policy on Fisheries Bycatch (Ministerial Council on Forestry, Fisheries and Agriculture 1999). The National Policy was adopted as the Western Australian Policy on Fisheries Bycatch in June 1999.

A Threat Abatement Plan has also been developed to reduce the bycatch of seabirds during longline fishing operations (Environment Australia 1998). The present worldwide bycatch of albatross is 0.4 birds observed caught per thousand hooks set (Environment Australia 1998). The aim of the Threat Abatement Plan is to reduce to below 0.05 seabirds per thousand hooks set, a reduction of up to 90% (Environment Australia 1998).

Other actions being implemented are the use of turtle exclusion devices on prawn trawl nets and modifications to line setting procedures to reduce the impact on seabirds.

Bycatch disposal can also result in short-term nutrient loading through decay of the bycatch species.

9.4.2.3 Loss of benthic species

Long-lived sessile bottom dwelling organisms, such as macroalgae, sponges, gorgonians and sea whips, are dislodged by trawling and cannot re-establish in areas which are regularly fished. There may also be significant catch of non-target species which, even if returned to the ocean, do not survive.

9.4.2.4 Damage to habitats and ecosystems

Trawling modifies the seabed habitats by the scraping action of the otterboards and chains. In addition to the loss of sessile species previously described, disturbance of the sediments may result in release of trapped nutrients and increased turbidity resulting in a reduction in light reaching the seafloor. In deep water sediments may take many weeks to settle once disturbed.

The changes in species composition and relative abundances of both large and non-target species result in long-term, if not permanent, changes to benthic ecosystems.

9.4.2.5 Other impacts

Other impacts associated with commercial fishing include:

- disposal of solid waste - bait straps, lost gear, etc.;
- disposal of liquid waste, e.g. from bilge cleaning, at sea; and
- anchor damage to the reefs around which demersal fish congregate.

Accidental impacts include the possibility of an oil spill in the event of a fishing boat being damaged or sinking as a result of a storm or collision at sea.

9.4.3 Shipping

Commercial shipping passes through the region, generally to the west of the Marine Park, on route to and from Asia and northern Australia to the southern ports of Western Australia (Geraldton, Fremantle, Bunbury and Esperance), South Australia and Victoria.

Impacts on the Park from passing vessels are only likely to occur as a result of a collision between vessels or between a ship and an oil rig or platform, or storm damage leading to a spill of fuel oil or loss of cargo. Such an incident could result in a spill of materials such as crude oil, refined petroleum products, fertilisers and chemicals.

The frequency of such incidents is relatively low.

The transport of oil through the Park to the offloading facility at Point Murat gives rise to the potential for the introduction of exotic species imported on ships' hulls or in ballast water, and the possibility of oil spills during off-loading.

9.4.4 Oil Exploration and Production

Two offshore (Commonwealth Waters) exploration permits and one retention lease currently share common boundaries with the Marine Park. These are WA-271-P and WA-24-P R4 (in two portions) and WA-12-R (Figure 9).

There are presently five exploration permits in areas under State control that include portion of the Marine Park (State Waters) within their area. These are EP 324 R2, EP 342 R1, TP/9 and EP 359 R1, all located east of North West Cape, and TP/3 R2, located on the west side of Cape Range peninsula, between Winderabandi Point and Osprey Bay (Figure 9).

At present, no oil or gas production occurs either within or adjacent to the Marine Park. The nearest producing field is the Griffin oil and gas field located some 75 km to the north-east of North West Cape. The area is, however, considered prospective and the likelihood of further exploration activity is high.

9.4.5 Defence Establishment

There are two defence establishments located in the region, the Harold E Holt Communications Base and the Learmonth Airbase, and a weapons range. Activities associated with each of these facilities have the potential to impact on the Marine Park.

9.4.5.1 Harold E Holt Communications Base, North West Cape

Although the majority of activity associated with this facility occurs on land, a service jetty is located at Cape Murat, within the Marine Park (State Waters) boundaries (Figure 8). The jetty is used for the transfer of bulk diesel fuel from tankers to onshore storage facilities where it is used for power generation. A spill resulting from a mooring accident or during offloading would directly impact on the Marine Park (State Waters) and have the potential as a result of subsequent dispersion to impact on the Marine Park (Commonwealth Waters).

Other issues associated with the use of the jetty are the introduction of exotic species, either on hulls or in ballast water.

9.4.5.2 Learmonth Airbase

A second defence establishment, the Learmonth Airbase, is located at Learmonth on the eastern side of the Cape Range peninsula (Figure 8). Operations at the airbase are remote from all parts of the Marine Park and would have no direct impact on it. Impacts may arise from low level flight over the Marine Park by aircraft operating from the airbase. A plane crash at sea could result in spills of aviation fuel, hydraulic fluid and munitions.

9.4.5.3 RAAF Weapons Testing Range (Lyndon Location 97)

Lyndon Location 97 is located between Ningaloo Station and the Cape Range National Park. Use of the weapons range, which is located inland from the Marine Park, could impact on the Park through low flying aircraft, as described above. In addition, use of the range necessitates restrictions on access to the coastal portion of Location 97.

9.4.6 Grazing

There are three operating grazing leases, Ningaloo, Cardabia and Warroora Stations, located adjacent to the Marine Park (State Waters). The operation of the stations has the potential to impact on water quality, particularly of nearshore waters through erosion and pollution. However, the aridity of the climate means that there is little run-off from the land, other than occasional discharge through the normally dry gullies following heavy rainfall. Combined with low stocking rates (approximately one animal to eight hectares) and low use of chemical fertilisers means there is a low potential for discharge of nutrients into the waters of the Park from this source.

Roads and tracks through the pastoral stations are also used to gain access to the Park and to camping areas. The use of parts of the stations for tourism/recreational purposes gives rise to the considerations is discussed in Section 10.2.1.

10. THREATS TO THE MARINE PARK

10.1 EXTENT OF HUMAN-INDUCED CHANGE

Human-induced physical change within the Marine Park is presently concentrated on the narrow coastal strip between Amherst Point and Winderabandi Point, extending into the adjoining pastoral leases, the defence establishment land and Cape Range National Park (Carolyn Williams, CALM, pers. comm.). Causes of change include the creation of access tracks (particularly 4WD drive tracks where these duplicate existing tracks), and the development of camp sites and settlements. Physical change to the marine environment is also concentrated in the nearshore environment and includes damage caused by moorings, anchor damage, construction of boat ramps and jetties (e.g. Bundegi).

Biological changes in the marine environment due to human presence are more subtle and may be brought about by:

- the disposal of waste from settlements and camp sites and from boats on the water, resulting in increased nutrient and contaminant loads;
- physical damage to living corals and other sedentary organisms from anchors and dive fins; and
- reductions in the populations of fish (particularly sedentary species) and other marine organisms due to excess fishing or collecting pressure.

Reduction in whale, dugong and turtle populations through capture of these species within and adjacent to the Marine Park ceased some time ago, but populations may not yet have fully recovered and may still be at threat elsewhere within their ranges.

10.2 THREATS FROM HUMAN ACTIVITY

10.2.1 Tourism/Recreation

The tourism industry with its intensity of human usage poses a number of threats to the Marine Park. These tend to be concentrated on the dune, beach, shallow nearshore and reef zones, and to decrease with increasing distance from the shoreline.

Tourism-related impacts in the terrestrial portion of the Marine Park extend into the adjacent pastoral leases (Ningaloo, Cardabia and Warroora Stations), the RAAF weapons range, Cape Range National Park and the coastal reserves to the north.

The terrestrial impacts include:

- erosion of coastal dunes and accompanied by loss of coastal flora and fauna;
- disturbance to nesting, breeding and feeding activities of sea turtles and shorebirds;
- damage to archaeological and historic sites;
- pollution of the terrestrial and subsequently marine environment with all forms of human waste from uncontrolled disposal and poorly located and/or inadequately designed treatment facilities, such as at Coral Bay; and
- aesthetic impacts on the 'wilderness experience' arising from the construction of tourist facilities within and on the margins of the Park.

Threats from human activities in the marine environment include:

- physical damage to corals - from specimen collection and accidental damage by anchors and fins;
- over-fishing, both inside and outside the reef. A preliminary assessment of fish density within the Marine Park, from the lagoon to the outer reef slope, made by Ayling and Ayling in 1987, found no evidence of fishing pressure impacting on the two most popular recreational species, North-west Snapper and Yellow-tailed Emperor. Subsequently visitor numbers and recreational fishing pressures have increased, resulting in a tightening of restrictions designed to protect fish stocks;
- disturbance to the natural behaviour patterns of whales, dugongs and Whale Sharks by divers, boats and spotter aircraft;
- injuries to marine creatures caused through collisions with boats;
- direct discharge of untreated sewage and other wastes from boats, particularly in semi-confined embayments such as Bills Bay; and
- litter from boats, particularly non-degradable materials such as plastic bags, bottles and cans.

Activities within the Park are presently regulated by CALM (general activities) and Fisheries WA (fishing). There is a need for regular re-assessment of the levels at which all activities conducted within the Park can be sustained and for the implementation of management measures to ensure these are not exceeded.

10.2.2 Commercial Fishing

Threats posed to the Marine Park from commercial fishing activities include:

- damage to benthic habitats and communities;
- effect on populations of bycatch species;
- overfishing of target species; and
- disposal of bycatch and shipboard waste.

Commercial fishing continues to pose an unquantified threat to the Park through unresolved issues including bycatch, sustainability of the fisheries, impacts on populations of non-target species, and damage to benthic habitats, flora and fauna. On an industry wide basis, the commercial fisheries potentially operating within the Park are mostly of low value, with inconsistent fishing effort and frequent changes in target species, resulting in poor data on status of fish stocks in the region (Caton et al. 1998). In particular, the target species of the trawl fisheries are considered vulnerable to over-exploitation. However, the low value of the fisheries has resulted in there being limited expenditure on research (Caton et al. 1998).

The recent/proposed introductions of Turtle Exclusion and Bycatch Reduction Devices and seabird protectors and the implementation of bycatch policies will reduce some of the above impacts on a region-wide basis. Whether the reduction in impacts achieved will be sufficient to allow some or all types of commercial fishing to continue while still meeting the management objectives for a marine park has not been assessed.

10.2.3 Oil Exploration/Production

There are no oil exploration or production permits covering the Commonwealth Waters portion of the Marine Park and, although exploration permits cover some parts of the State

Waters portion, Western Australian Government policy is not to allow oil exploration drilling and production within the Park. Any future threat to the Park from oil exploration/production would only come from the conduct of these activities in adjacent waters. The region in which the Marine Park is located is, however, considered prospective for oil and gas and it is likely that further activity will be undertaken in the area surrounding the Park.

As previously noted, because of the distances involved, the threat posed by existing oil production facilities in the region is considered to be low. Only a large volume extended duration spill, such as could occur in the event of a well blow-out from the oil fields located to the north-east (Griffin or Barrow) or to the east (Thevenard, Airlie), could potentially pose any threat to the Park. Any such threat would be reduced not only by the dispersal that would occur, but by the evaporation and degradation of the oil that would take place before the slick could reach the Park.

The potential threats arising from future exploration and potential production closer to the Park are listed in the following sections. In all cases it has been assumed that the activities described will occur outside of the boundaries of the Marine Park in accordance with Western Australian government policy which prohibits oil drilling and production within the Park.

10.2.3.1 Seismic survey

Marine seismic survey is principally carried out using compressed air-guns as the sound source with a towed hydrophone array to record the return signal.

In open waters the main potential impacts associated with such operations are:

- the impact of the air gun operation on sensitive marine organisms in close proximity to the site of operations; and
- loss of buoyancy fluid (generally a light oil) from the hydrophone cable due to cable damage.

Although the impact of air guns on marine creatures has generally been assessed as low and localised, it is further mitigated by conducting surveys outside of the period when potentially affected creatures are present, in the case of migratory species such as cetaceans, or breeding, as in the case of dugong or turtles.

The use of foam as a buoyancy medium in place of oil is increasingly being used to avoid the possibility of cable oil leaks.

10.2.3.2 Exploration drilling

Disposal of drill cuttings and spent drilling fluid and disposal of other wastes from the drilling unit produce localised impacts that are unlikely to affect the Marine Park.

Potential oil spills may possibly occur during drilling as a result of accidental releases during:

- refuelling, typically as a result of a transfer hose rupture or coupling failure;
- flow testing, as a result of incomplete combustion;
- drilling unit re-supply, as a result of a collision between a supply vessel and the drilling unit resulting in a loss of fuel oil; and
- during drilling, as a result of a well blowout.

To date there has been no loss of oil as a result of a well blowout in Australian waters, and the risk of significant spillage is considered to be extremely low (Swan et al. 1994).

10.2.3.3 Oil and gas production

The main threats to the environment during oil production are oil spills resulting from:

- flow line rupture; and
- collision at sea between a tanker and a production platform or floating storage vessel.

Due to the depth of the water and its generally sparsely distributed fauna, an oil spill impinging on the Commonwealth Waters portion of the Marine Park would have only a short-term impact on water quality, with the likelihood of direct impacts on a small number of fauna caught within the plume. The threat to shallow water communities including the coral reef, mangroves and beaches within the State Waters portion of the Park is much more significant. However, the potential threat posed by any future exploration or development to the west or north of the Marine Park would need to be assessed on a case by case basis.

10.2.4 Shipping

The majority of shipping operations occurring in or adjacent to the waters of the Park involve the transit of vessels to and from ports located outside the Park boundaries and pose little threat to the Park under normal operations. Vessels passing through the region include bulk carriers of refined and unrefined petroleum products, minerals and grain. Collisions between vessels or grounding on reefs or shorelines are relatively rare events, although groundings or sinkings off the Western Australian coast through errors in navigation or storm damage have been recorded in recent times. Notable incidents involve the sinking of the phosphate carrier *Sanko Harvest* off Esperance, the petroleum tanker *Kirki* off Jurien and the bulk carrier *Korean Star* off Cape Couvier.

The operation of vessels through Point Murat poses a greater threat to the Marine Park as the vessels have to pass through Park waters in order to access the facility.

10.2.5 Pastoral Activity

The threat posed by to the Marine Park by pastoral activity has previously been assessed as low, largely due to the low intensity of development and usage and the arid climate. Any minor erosion associated with pastoral activities is likely to affect only inshore areas, causing low level increases in turbidity.

Changes to lease conditions to permit other activities could result in modified impacts. The most likely activities are those associated with tourism, with the impacts as described above.

10.2.6 Mining

The existence of leases for limestone mining on the west side of the Cape Range peninsula gives rise to concerns about impacts arising from its possible export including:

- an increase in shipping activity posing a higher risk of accident, including oil spills;
- introduction of exotic marine species in ballast water or on hulls; and
- contamination of the water and sediments with the active constituents of antifouling coatings, including tributyltin and copper, and hydrocarbons from incomplete combustion of fuel, and fuel and oil leaks/spills.

The level of threat posed to the Park would depend on:

- the location of shipping facilities with respect to the Park; and
- the origin and destination of the vessels engaged in the transport of the mineral.

Quantification and assessment of these threats is anticipated to be a requirement of any proposal to develop any export facility in the region.

10.3 THREATS FROM NATURAL PERTURBATIONS

10.3.1 Cyclones

Cyclones are a relatively frequent event off the north west coast of Australia, with an average of two cyclones each year crossing the coast. The Ningaloo coast is less frequently exposed to cyclone action than the Pilbara coast to the east. For example, in the period between 1986-87 and 1995-99 seven severe cyclones crossed the coast between Karratha and Exmouth but none tracked to the west of North West Cape.

However, over the period that cyclones have been recorded, the Ningaloo coast has experienced a number of severe cyclones. These have been responsible for many of the shipwrecks that have occurred over the years and in particular the large number of pearling boats that were lost in the late nineteenth and early twentieth centuries. In recent times the cyclones and the storm surges that accompany them have been identified as responsible for physical damage to the reef, erosion of beaches and damage to park infrastructure, notably tracks, camping areas and signage.

10.3.2 Deoxygenation Events Following Coral Spawning

During coral mass spawning events a large numbers of coral spawn are released into shallow waters generating a high demand for oxygen as the cells rapidly divide. When wind, tide and wave conditions are such that the spawn is not dispersed, the resultant oxygen demand may not be met, resulting in de-oxygenation of the water and death of fish, corals and other reef species as a result of anoxia (oxygen deprivation).

In March 1989 such an event was observed at Bills Bay. This resulted in the death of over one million fish representing at least 80 species and extensive mortality of corals and other reef species over an area of about 3 km². Coral deaths included large coral colonies up to 10 m in diameter and live coral cover within the affected area decreased from 42.9% to 9.4% (Simpson et al. 1993).

The phenomenon is believed to be relatively common, with such events having been recorded at a number of other locations off the north west-coast of Western Australia, and may play a significant part in influencing the community structure on some coral reefs (Simpson et al. 1993).

Harriott and Simpson (1997) have reported that subsequent coral recruitment was poor in the area of Coral Bay where extensive mortalities occurred following coral spawning in 1989. The authors speculate that poor water exchange at this site prevents corals from actively recruiting.

10.3.3 Predation

Although there are a number of species which feed directly on corals only two species that pose a recognised threat to corals through predation are known to occur in the Park. These are the coral eating snail, *Drupella cornus*, and the Crown of Thorns starfish, *Acanthaster planci*.

10.3.3.1 *Drupella cornus*

A population explosion of *Drupella* occurred in the early 1980s and there was heavy predating on the corals of the Ningaloo Reef as the infestation progressed from the northern end of the reef in a southerly direction (Osborne 1992). Snail numbers were estimated to have risen from 100-200 snails per kilometre of reef to 1-2 million per kilometre in 1989 with accompanying reduction in coral cover of up to 75% (Stoddart 1989).

In addition to the direct impact on corals, it has been hypothesised that the decline in Whale Shark numbers during the latter half of the 1980s may have been brought about by the reduction in coral cover, and hence coral spawn production, caused by *Drupella* (Taylor 1996).

Drupella populations are presently monitored at a number of sites within the Park but are not currently considered to pose a threat to the reef (Carolyn Williams and Chris Simpson, CALM pers. comms).

10.3.3.2 *Acanthaster planci*

The Crown of Thorns starfish is known to occur within the Marine Park at Coral Bay and on the outer reef (Storrie 1998). However, the individuals observed have all been mature adults considered to represent a senile population, i.e. there is no juvenile recruitment (Simpson pers. comm.) and the species has never been observed in numbers considered large enough to pose a threat to the corals of the reef.

Conditions which could lead to a rapid increase in the population of either species are not fully understood and further infestations, particularly of *Drupella*, must be considered a possibility.

10.3.4 Climate Change

Climate change is addressed in this review as a natural perturbation although human influences, e.g. Greenhouse effect and Ozone depletion, cannot be discounted. The outcomes (increased sea temperatures, sea level rise and changes in rainfall patterns) are, however, natural expressions of climatic change and for that reason are discussed here.

10.3.4.1 Higher sea temperatures

The effect of a rise in sea temperature combined with the southerly flow of the Leeuwin Current could be expected to enable more tropical species to live and breed in the Marine Park and to extend their range to the south. This effect may be detectable in nearshore (reef) areas but is unlikely to be detectable offshore. At the same time, the ranges of some temperate species which presently occur in the Park may contract southwards, increasing the dominance of tropical flora and fauna.

As sea temperatures at Ningaloo are several degrees lower than those of the main Indo-Pacific region to the north, corals on Ningaloo Reef are more able to tolerate a rise in sea temperature without adverse impact. For example, the widespread and extensive bleaching event that occurred in the Indo-Pacific region in 1999 had almost no impact on Ningaloo (Chris Simpson, CALM pers. comm.).

10.3.4.2 Changes in ocean currents

The Leeuwin Current has been hypothesised as a major influence in the maintenance of environmental conditions (elevated sea temperatures) and the dispersal and southward transport of coral propagules to sub-tropical and temperate waters extending as far south as Rottneest and Geographe Bay. Ningaloo would be both a recipient of coral propagules from reefs to the north (Barrow and Montebello Islands) and a donor of propagules to reefs to southerly areas such as the Abrolhos.

Harriott and Simpson (1997) have demonstrated higher levels of recruitment of corals on settlement panels at Ningaloo than in the subtropical waters of the Houtman Abrolhos to the south. The relative abundance of coral species was similar in the two areas.

Changes to ocean scale currents brought about by changes in global weather patterns could affect both the environmental conditions and persistence of the more southerly, non-tropical coral reefs.

10.3.4.3 Sea level rise

Sea level rise in offshore waters of the Marine Park is unlikely to be significant as a function of depth. Impacts that do occur are likely to be more evident in nearshore waters. The effects are likely to depend on the rate and magnitude of the rise.

The main change is likely to be a shoreward shift in the boundaries of some benthic species due to a reduction in light reaching the seafloor with increased depth. It is quite likely that this effect may not be detected in the field.

The growth of coral on the fringing reef is unlikely to be affected directly by sea level rise, as coral growth would be expected to keep pace with rising sea levels, however, accompanying changes in sea state, i.e. possible increases in tide and wave height, may have a greater impact on the reef.

10.3.4.4 Rainfall

As with the other elements of climatic change, a change in the rainfall regime is unlikely to have any significant effect in offshore waters.

Nearshore flora and fauna could, however, be affected by an increase in rainfall should this lead to significantly increased runoff from the land and results in increased nutrient loading and turbidity. A decrease in rainfall would not be expected to have a major impact on marine flora and fauna, as the present input of fresh water (groundwater and surface runoff) from the land is already at a very low level.

11. INDIGENOUS INTERESTS

As described in Section 4.8 the area in which the Ningaloo Marine Park is located is subject to a Native Title Claim, the Gnulli claim.

The Cardabia pastoral lease, which shares a common boundary with the Marine Park, was purchased by the Indigenous Land Corporation in 1997 and is in the process of being transferred to an Aboriginal corporation comprising members of the Baiyungu Aboriginal community, the traditional owners.

The local Aboriginal community, through the Gnulli claim, has also expressed interest in exercising rights over traditional fishing areas in the region.

12. CONSERVATION STATUS

12.1 COMPARISON TO MARINE PARKS/MARINE PROTECTED AREAS ELSEWHERE IN AUSTRALIA

Australia's marine parks can be divided into two groups, island marine parks and reserves and continental marine parks and reserves. The island marine parks and nature reserves include the Macquarie Island Marine Park, Mermaid Reef Marine National Nature Reserve, Ashmore Reef National Nature Reserve, Coringa-Herald National Nature Reserve, Lihou Reef National Nature Reserve, Elizabeth and Middleton Reefs Marine National Nature Reserve and the Tasmanian Seamounts Marine Reserve. In addition, marine park or nature reserve status is proposed for the waters surrounding Lord Howe Island (marine park) and Cartier Island (marine reserve). A common feature of the island reserves is that they are generally remote, isolated from major population centres and with very limited accessibility. The main exception is the proposed Lord Howe Island Marine Park which surrounds an island with a resident population and is relatively accessible.

The continental marine parks and reserves, i.e. those directly associated with the Australian mainland, include, in addition to Ningaloo Marine Park, the Great Barrier Reef Marine Park, Solitary Island Marine Reserve, Great Australian Bight Marine Park and Shark Bay Marine Park. In addition, there are numerous smaller marine parks and reserves occurring within States' waters and set aside for the protection of significant features within coastal waters. In Western Australia these include the Shoalwater Islands Marine Park and Marmion Marine Park. The continental marine parks and reserves share a number of common features in that they are: frequently located in relatively close proximity to population centres; readily accessible by conventional means (motor vehicles or scheduled commercial airline services); and frequently have been, or continue to be, impacted by adjacent terrestrial development (agriculture, industry and commercial development).

Located only a relatively short distance from Ningaloo, the Shark Bay Marine Park shares a number of features with Ningaloo. Both parks fringe a sparsely populated and developed arid hinterland and there are common elements in their marine faunas. These include the presence of large dugong populations, seasonal visits by Humpback Whales during their annual migration, as well as numerous other shared species including sea turtles, seabirds, fish and marine invertebrates. Shark Bay differs in that it comprises a series of shallow embayments with a complex salinity regime that supports fringing mangroves and internationally significant seagrass beds and stromatolite fields as opposed to the coral reefs of Ningaloo. The parks thus complement rather than duplicate the features of the other.

Ningaloo Marine Park also shares a number of other features with the Great Barrier Reef, having in common many of the species of corals and reef animals, including reef megafauna such as dugong and sea turtles. The Great Barrier Reef Park also lies on the migratory route of the (eastern) Humpback Whale. However, Ningaloo differs from the Great Barrier Reef Marine Park in that it is predominantly a fringing rather than a barrier reef, and the reef sits on a limestone basement rather than recent fossil reef deposits. The Great Barrier Reef is also located in a higher rainfall region than Ningaloo Reef and thus is subject to greater runoff from the land than at Ningaloo.

The Great Australian Bight Marine Park is significantly different to the other major marine parks, including Ningaloo, in that it is representative of temperate rather than tropical or sub-tropical waters and supports a different suite of flora and fauna in which there is significant endemism.

12.2 COMPARISON TO INTERNATIONAL MARINE PROTECTED AREAS

Ningaloo Marine Park is unique in that it contains the only example of a fringing coral reef located on the western side of a continental landmass. It also differs from many other tropical/sub-tropical marine parks in being located adjacent to an arid hinterland. The Park supports a high diversity and abundance of marine species including fish, corals, and other marine creatures of both tropical and temperate origin.

The location of the Park is also significant in that the lower sea temperatures that prevail in the more southerly latitudes in which it occurs means that the reef is not experiencing the extremes of coral bleaching which have affected parks in lower latitudes in recent years.

Ningaloo is also the only marine park and only place in the world that is known to be visited on a regular basis and in significant numbers by the Whale Shark (*Rhincodon typus*). The Marine Park also lies across the annual migration path of the Humpback Whale and is also home to turtles and dugongs, and regularly plays host to a number of species of migratory birds listed on the JAMBA and CAMBA agreements.

13. CONSERVATION SIGNIFICANCE

13.1 STATEMENT OF REGIONAL SIGNIFICANCE (TO INDIGENOUS AND NON-INDIGENOUS PEOPLE)

13.1.1 Non-Indigenous People

The Ningaloo Marine Park is significant within the region for its conservation and recreation values and for its contribution to the economy of the region generated through tourist activity. It also has high value as an area for scientific and educational studies that are facilitated by ease of access to the reef.

The accessibility of the reef, in some places separated from the shore by a distance of only a few hundred metres across a sheltered lagoon, is one of its major attractions. In many places the reef can be accessed quickly by small boat or dinghy, making the reef experience available at relatively low cost.

The Marine Park also offers opportunities to see and interact with large marine animals such as Whale Sharks, whales, turtles and dugongs, all within a few kilometres from shore, and to see corals and tropical marine fishes which either do not occur in more southerly areas or occur in locations which are not readily accessible.

Combined with the Cape Range National Park, the region offers the opportunity to experience a diversity of landscapes ranging from rugged arid ranges to clear water lagoon and reef and extending out to the deep water beyond. The area contains features of historical significance to early exploration and development, including the whaling and pastoral industries.

It is also an important regional holiday location, which provides opportunities for recreational fishing, including game fishing. A further attraction to residents of more southerly areas is the equitable climate that prevails during the winter months.

13.1.2 Significance to Indigenous People

The Cape Range peninsula has a long history of Aboriginal occupancy and is the earliest recorded area of marine resource exploitation by Aboriginal people. As previously noted, the area adjacent to the Cape Range peninsula was the traditional land of the 'Jinigudira people, while the adjoining land to the south is the traditional land of the 'Baijunju people (Tindale 1974).

The Jinigudira were reported to have died out as a result of disease at about the time of European settlement (Turner, 1985 quoted in Morse and Wright 1989). The Baiyungu, although presumably affected to some degree by the epidemic(s), remained in the area and took up work on the stations and in the pearling industry. Subsequent to the demise of the wild pearl shell industry and the restructuring of the pastoral industry, the region's Aboriginal people gravitated toward the main towns, and in particular Carnarvon.

A number of Aboriginal burial sites are known to occur along the coastal strip and there are geographic features of significance to present day members of the Aboriginal community.

Recently the Cardabia pastoral lease, which falls within the traditional area of the Baiyungu, was acquired by the Cardabia Pastoral Company Pty Ltd and will, over time, be transferred to

an Aboriginal corporation comprising members of the Baiyungu Aboriginal community. The local Aboriginal people, through their land claim, have also expressed interest in exercising their rights to traditional fishing areas, including the Marine Park.

In addition to the special interests of the Aboriginal people of the region, Aboriginal people generally share similar interests in the marine environment to the non-indigenous community.

13.2 STATEMENT OF NATIONAL SIGNIFICANCE

Ningaloo Reef is the longest fringing barrier reef in Australia and is Australia's only arid zone coral reef. The reef system extends for 260 km along the west coast of the Cape Range peninsula, from about 21°50'S to 23°35'S. The Ningaloo Marine Park encompasses the majority of the Ningaloo Reef system.

It is one of the most accessible coral reef systems in Australia, as only a shallow, narrow lagoon, averaging 2-4 m in depth and ranging in width from 200 m to in excess of 6 km, separates the reef from the mainland. Seaward of the reef crest, the reef drops gently to a depth of about 8-10 m and has a well-developed spur and groove structure. The bottom then falls more gently to the 100 m isobath some 5-6 km outside the reef edge, becoming progressively more sandy.

The reef features a great diversity of corals (more than 200 species), reef fish (more than 460 species), molluscs, crustaceans and other reef plants and animals. Sea turtles, dugongs and dolphins are common within the lagoon, while the waters immediately beyond the reef play host each year to migrating Humpback Whales and Whale Sharks.

The Park lies along a transition zone between tropical northern and southern temperate flora and fauna, and supports a high diversity and abundance of marine species including fish, corals, and other marine creatures. A number of tropical species which occur in the northern part of the reef reach their southern limits within the Park and do not occur in the southern part. Similarly some southern temperate species do not occur to the north of the Park.

The close proximity of the continental shelf break to land in the northern part of the Park, combined with the funnelling effect of the Leeuwin Current, leads to many typically deepwater pelagic species, such as marlin, sailfish and swordfish, being found much closer to shore than is the case in other parts of Australia and the world.

The annual migration of the western population of Humpback Whales through the Park, the seasonal aggregation of Whale Sharks following the annual coral mass spawning, and turtle breeding on mainland beaches within the Park are also natural features of national significance.

The Statement of Significance for the adjoining Cape Range National Park describes that area as being of outstanding National Estate significance for its geological, palaeontological, biological and cultural attributes and values. It also contains the site of the earliest known area of Aboriginal occupation based on a marine economy.

Together, the two parks provide a unique combination of vistas from the rugged ranges of the arid hinterland to the white sandy beaches and blue waters and reefs of the Marine Park.

13.3 STATEMENT OF INTERNATIONAL SIGNIFICANCE

In addition to the features previously listed, Ningaloo Reef is unique as the only example of a fringing coral reef located on the western side of a continental landmass. The location of the reef is also significant in that the lower sea temperatures which prevail in the more southerly latitudes in which the Park is located means that it does not experience the extremes of coral bleaching currently affecting the more northerly, tropical reefs around the world.

Ningaloo is also the only place in the world known to be visited on a regular basis and in significant numbers by the Whale Shark (*Rhincodon typus*). The Marine Park also lies across the annual migration path of the Humpback Whale and is also visited or home to dolphins, turtles and dugongs many of which are protected under international treaties and conventions. The Park also regularly plays host to a number of species of migratory birds listed on the JAMBA and CAMBA agreements.

13.4 LISTING ON REGISTERS

13.4.1 Register of the National Estate

The Ningaloo Reef and Marine Park and a number of adjacent areas have been listed on the Register of the National Estate Database (Australian Heritage Commission 1999) are as follows:

Location	Class	Status
Ningaloo Marine Park and Proposed Additions	Natural	Registered
Ningaloo Reef Tract	Natural	Registered
Fairy Queen Shipwreck	Historic	Registered
Cape Range National Park and Surrounds	Natural	Registered
Cape Range and Adjacent Coastal Plain	Natural	Interim List
Cape Range Geological Site	Natural	Registered
Islands, Exmouth Gulf and Rowley Shelf	Natural	Registered
Vlamingh Head Lighthouse	Historic	Registered
Vlamingh Head Lighthouse Keepers Quarters	Historic	-
Yardie Creek Station Homestead	Historic	Indicative Place

13.4.2 IUCN

Ningaloo Reef is listed on the IUCN list of Reefs of International Significance (Hatcher 1988).

The entire park is protected as an IUCN Category VI Managed Resource Protected Area, defined as an “area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs”.

14. RESEARCH

Research which has been undertaken in the Ningaloo Marine Park leading to published papers or reports is quoted where appropriate in the body of the report.

Historically, the main areas of research undertaken within the Ningaloo Marine Park have been:

- biological and habitat surveys, particularly within the shallow waters of the reef and lagoon;
- oceanographic studies, in particular the Leeuwin Current and more recently the Ningaloo Current, and their implications for species distributions and population dynamics within the Park;
- Whale Shark population and migration studies;
- Humpback Whale migration patterns in the Marine Park as part of broader-scale migration studies; and
- coral biology, including studies on coral predation, mass spawning and associated de-oxygenation events.

Studies presently being undertaken are mostly concerned with expanding the biological database for the Marine Park and further extending knowledge on the above topics.

14.1 RECENT AND ONGOING RESEARCH

The following is a list of research recently or currently being undertaken at least partly within the Ningaloo Marine Park and for which published papers are not quoted. Sources include the CALM licensing database and AIMS. CALM also conducts a number of ongoing monitoring programmes within the Marine Park, including:

- records of whales based on tourism operators' log books;
- records of Whale Shark interactions based on tourism operators' log books;
- a marine animal stranding database;
- visitor use patterns;
- vehicle and visitor counts;
- and visitor statistics for the Milyering Visitor Centre.

(Carolyn Williams, CALM pers. comm.)

CALM's Marine Branch is also undertaking a four-year reef-scale baseline monitoring programme based on 50 permanent monitoring sites. A photographic record of both hard and soft corals from replicate transects at each site is maintained. The information collected is designed to provide a benchmark for the assessment, management and potential remediation of human-induced changes to the reef system.

In October 1999, a survey of the major seabed habitats of the proposed extension (State Waters) of the Ningaloo Marine Park from Amherst Point to Gnaraloo Bay was carried out by CALM's Marine Conservation Branch in collaboration with regional staff from CALM's Midwest and Pilbara Region offices. The aim of the survey, partly funded by Environment Australia through the Natural Heritage Trust's Coast and Clean Seas Marine and Protected Areas Program, was to develop an accurate map of the distribution and composition of the various marine plant and animal habitats on the seabed within the area of the proposed marine park extension (CALM 1999).

Studies within the Marine Park, listed under major topic headings, are as follows:

Tourism

Ms Debra Slater, Murdoch University is studying marine tourism.

Mr Brad Norman, Murdoch University (Masters student), is studying aspects of the biology and ecotourism industry on the Whale Shark in north-western Australia.

Marine ecology

M Fuller, University of Western Australia, is conducting an assessment of the use of aerial photographs and GIS for marine habitat mapping in Ningaloo Marine Park.

Mark Westera, Edith Cowan University (PhD student) is studying marine ecology in the Park.

Whales

CALM has an ongoing program of recording whales within the Marine Park based on the whale watch logs kept by tourism operators.

Mrs M Jenner, Centre for Whale Research, is undertaking a project to photograph Humpback Whales for the purpose of identifying individuals in the field.

Turtles

CALM has an ongoing program of monitoring turtle nesting within the Marine Park with the assistance of volunteers.

Whale Sharks

CALM has an ongoing program of recording Whale Shark interactions within the Marine Park based on the logbooks maintained by tourism operators.

Researchers from CSIRO Marine Research and Murdoch University have been undertaking a Whale Shark tracking program using satellite tags. The program commenced in 1998 but problems were initially encountered in finding enough sharks to tag and in getting the tags to stay on the sharks. A further shark was tagged in 1999.

Mr Steve Wilson, Department of Zoology, University of Western Australia (PhD student), is currently undertaking studies on the physical, chemical and biological interactions controlling the aggregation of Whale Sharks off Ningaloo Reef.

Dennyse Newbound, University of Western Australia (PhD student), is currently undertaking a project on the biological tagging of Whale Sharks.

Mr Joris Wittenburg, University of Western Australia (associate), is studying ramoras on Whale Sharks.

Fish

As part of their studies of ecological processes, the Western Australian laboratory of the Australian Institute of Marine Science (AIMS) is currently undertaking a two year sampling program across the North West Shelf. The primary study transect originates in the lower portion of Exmouth Gulf, and goes north through the Gulf and across the shelf to the 300 m

isobath. Stations have also been made off the western side of Ningaloo Reef and a supplementary transect is undertaken off Onslow. Five cruises were made at monthly intervals during each of the last two summer seasons.

An extensive light trapping program which catches larval fish and larvae of planktonic invertebrates is conducted at night.

During the day, studies are made of the productivity of phytoplankton and zooplankton. At each site a CTD (conductivity, temperature and depth) cast is made to record physical features of the water. McIlwain (1997) recently reported on a portion of this work, centred on the reef crest at Ningaloo. In this study nets were used on the reef crest to examine small-scale distribution patterns. Larval fish were collected at hourly intervals from dusk to midnight during five nights after the new moon in December 1995 and January 1996. Twice as many fish were caught in December (dominated by gobies) as in January. In all, 45 families of fish were represented. The timing of arrival differed among families, suggesting that at least some of the fish are able to control the time at which they enter the lagoon prior to settlement.

In addition, AIMS is currently studying the comparative demography of adult reef fish at sites at Ningaloo, Dampier and the offshore reefs of Rowley Shoals and Scott Reef.

Mr Joris Wittenburg, University of Western Australia (associate), is studying the biology of Blue and Chevron Butterfly fish.

Dr Mark Meekan, AIMS, is conducting an otolith analysis of reef fishes in Ningaloo Marine Park.

Ms Kathryn Hall, University of Queensland (PhD student) is undertaking a study of the parasitology of fishes.

Corals

Dr Andrew Heyward, AIMS is investigating coral recovery and recruitment after the 1989 anoxia event in Bills Bay.

Dr Andrew Negri, AIMS, is conducting a study on the identification of chemical inducers for coral larval settlement of Australian reef building species.

Ms Bette Willis, James Cook University, is undertaking genetic analysis of several coral species (Reticulate evolution and geographic extent of hybrid zones in the coral genus *Acropora*).

Mr Affendi Yang-Amri, University of Sydney, is studying the effect of water temperature on coral reef structure.

Other invertebrates

Dr Barry Wilson, Murex Consultants, is undertaking a taxonomic survey of Cowrie Shells.

Dr Mark Norman, James Cook University, is conducting a survey of cephalopods.

Dr Michael Johnson, University of Western Australia, is studying the genetic structure, demography and recruitment of several species of marine invertebrates.

Ms Jenny McIlwain, University of Western Australia, is studying the larval biology of invertebrates in Ningaloo Marine Park.

Mangroves

Dr D Alongi, AIMS. Mangrove studies - Bay of Rest and Mangrove Bay.

Oceanography

Dr Stan Massel, AIMS, is conducting a study of wave-induced flushing and circulation. A buoy is operated off the Ningaloo Reef that can be accessed on the internet to provide real time observations on conditions in the area.

Sedimentology

Dr Yvonne Bone, CSIRO RV Franklin FR 4/99, University of Adelaide, is studying the extension of cool water carbonate facies into deeper waters in Australia's tropical North West Shelf area. The study incorporates elements of the oceanographic, sedimentological, palaeontological and geochemical history of the region.

Archaeology

The Western Australian Museum has undertaken a number of studies on Aboriginal occupation of the coastal zone, generally within the adjacent Cape Range National Park. The use of the marine environment for food and other resources and patterns of occupancy during periods of changing sea-levels are of direct relevance to Ningaloo Marine Park.

14.2 KNOWLEDGE GAPS

The presence of deep (50 to >500 m) water over most of the Commonwealth Waters portion of the Marine Park imposes restrictions on research due to technical limitations and high costs. Research in deep open waters requires the use of larger vessels, heavy sampling equipment and sophisticated technical equipment such as side-scan sonar and remotely operated vehicles. Even aerial surveys of migratory animals such as whales and whale sharks are more expensive due to restrictions on the use of single engine aircraft that necessitate the use of twin engine aircraft at significantly higher cost. Coupled with the fact that most of the recognised pressure on the resources of the Park occurs in shallow waters, it is a natural outcome that most research and most of the available funding is being expended in those areas. However, in order to obtain the level of information necessary to effectively manage the Commonwealth Waters portion of the Park, there are a number of areas in which further information is required. These are outlined below.

14.2.1 Oceanographic Studies

Recent studies on the currents operating within the Park, including the Ningaloo counter current (Taylor and Pearce 1999), would suggest that a significant proportion of the planktonic stages of various organisms, such as corals, and the nutrients that they contain may be recirculated within the waters of the Park.

While the mechanism itself needs to be further investigated, there is a need for further evaluation of physical and chemical oceanographic processes in order to evaluate the potential effects of development within or adjacent to the Park. This will assist in assessing the potential for 'trapping' or recirculation of nutrients and other contaminants which may be discharged into the waters from the land, and for modelling the trajectory of potential oil spills that may enter the Park as a result of a shipping or oil production accident.

14.2.2 Habitat Characterisation and Distribution

The available information on the deepwater habitats of the Marine Park is drawn mainly from a small number of oceanographic and fisheries resource surveys. These have produced regional scale information on the physical and chemical characteristics of the water and an indication of the composition of the benthic flora, fauna and sediments of the region from trawl and grab samples.

There is a need for a more detailed investigation of the deeper waters, including mapping and characterisation of offshore benthic habitats and identification of any significant geomorphological features which may be present. Studies undertaken elsewhere along the north-west coast shelf break have previously shown the presence of outcropping low limestone ridges which support a high diversity of benthic species. Such studies should include an inventory of the species and their distribution.

14.2.3 Impacts of Commercial Fishing

The overall (i.e. regional) impacts of the commercial fisheries operating or potentially able to operate in the waters of the Marine Park have been assessed as low (AFMA 1999). However, the fisheries have not been assessed in the specific context of their impact on the values of the Ningaloo Marine Park.

The potential impact of demersal fishing, particularly trawling, on the seabed means that there is a need for additional information on benthic habitats and the sessile flora and fauna which they support and which are susceptible to trawling impacts. There is also a need for a better understanding of the population dynamics and reproductive biology of the target and bycatch species.

Pelagic fisheries have a low impact on the physical habitat in which they operate (i.e. open water). They also tend to target species that are migratory, such as tuna and billfish, and consequently their impacts on target populations need to be assessed at the regional scale. However, there are issues of bycatch and the need to protect juvenile stocks that need to be evaluated in the context of the impact on the values of the Park.

14.2.4 Migratory Marine Animals

A number of the identified values of the Ningaloo Marine Park are associated with the migration of various species of animal for which the Park comprises only a small part of their range. These include the Humpback Whale, the various species of marine turtle, the Whale Shark and fish such as tuna and billfish, and seabirds. While the seasonal pattern of migration of the Humpback Whale is now relatively well known, further information is required on other species, for example on the post-aggregation dispersal of the Whale Sharks and the movement of turtles following breeding, in order to ascertain what use they make of the Commonwealth Waters portion of the Park and what strategies may be required for their management. It is, however, noted that due to their migratory habit, such management strategies may be effective only if implemented at an international level.

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