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Mermaid Reef Marine National Nature Reserve

PLAN OF MANAGEMENT 2000-2007

Mermaid Reef Marine National Nature Reserve Plan of Management
Environment Australia
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Cover images

LARGE BLACK AND WHITE IMAGE:
Coral reef habitat — reflections on a calm sea.
Photo courtesy Clay Bryce, Western Australian Museum.

FOUR SMALL IMAGES — LEFT TO RIGHT:
Yellowmask angelfish (*Pomacanthus xanthometapon*).
Photo courtesy Sue Morrison, Western Australian Museum.

Gorgonian coral (soft coral).
Photo courtesy Clay Bryce, Western Australian Museum.

AIMS diver, Mermaid Reef lagoon.
Photo courtesy Australian Institute of Marine Science.

Giant clam (*Tridacna gigas*).
Photo courtesy Clay Bryce, Western Australian Museum.

Foreword

Mermaid Reef was declared a Marine National Nature Reserve by the Commonwealth Government on 21 March 1991. This proclamation protects the most northerly reef of the Rowley Shoals which lie some 300 kilometres off Broome in north-western Australia. Mermaid Reef is totally submerged at high tide and falls under Commonwealth jurisdiction. Environment Australia is the Commonwealth's managing authority for the Reserve.

Clerke Reef and Imperieuse Reef, the two southerly reefs of the Rowley Shoals, include permanent sand cays above the high water mark. Together they were incorporated into the Rowley Shoals Marine Park, declared under Western Australian legislation as a Class A Marine Reserve on 25 May 1990.

The three reefs of the Rowley Shoals have been described as the most morphologically perfect examples of shelf-edge reefs occurring in Australian waters. Each reef includes spectacular and unusual underwater topography and life forms that have attracted recreational divers from all over the world.

Mermaid Reef Marine National Nature Reserve and Rowley Shoals Marine Park are part of the National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA is a national system of marine protected areas which aims to contain a comprehensive, adequate and representative sample of Australia's marine ecosystems. Marine protected areas within the NRSMPA have been established especially for the conservation of biodiversity and have a secure status.

In December 1998, the Commonwealth Government launched Australia's Oceans Policy with a commitment to integrated and ecosystem-based planning and management. The Oceans Policy has the delivery of the National Representative System of Marine Protected Areas as a major focus.

It is important that steps are taken to preserve the character and values of the Rowley Shoals reefs. To achieve a consistent management regime for the whole of the Rowley Shoals,

Environment Australia has entered into a cooperative management agreement with the Western Australian Department of Conservation and Land Management and Fisheries Western Australia. The terms of the agreement are established in a Memorandum of Understanding that reflects the special circumstances of the Rowley Shoals. Parties to the Memorandum of Understanding will cooperate in implementing a range of conservation measures designed to fully protect the diverse marine habitats of this area.

This Plan of Management sets out strategic objectives, management goals and management strategies to ensure that the natural resources of this remarkable area receive an appropriate level of protection. To the maximum extent possible, these will be consistent with the management regime developed by the Western Australian Government for the Rowley Shoals Marine Park.

This Plan of Management is prepared under the *National Parks and Wildlife Conservation Act 1975* (NPWC Act). The NPWC Act will be replaced by the *Environment Protection and Biodiversity Conservation Act 1999*. This Act will commence by 16 July 2000. When the *Environment Protection and Biodiversity Conservation Act 1999* has commenced, this Plan will continue to operate and references to the NPWC Act in this Plan of Management are to be read as references to the new Act.

The management planning for Mermaid Reef Marine National Nature Reserve is designed to conform to the Australian and New Zealand Environment and Conservation Council (1997) *Best Practice in Performance Reporting in Natural Resource Management* with an emphasis on goals, strategies, performance measures, targets and monitoring. A key aspect of this model is a feedback loop to management. The performance assessment framework will also generally follow that set out in the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments* (ANZECC, 1999). This Plan of Management is a legal document which will be in force for seven years. As detailed performance measures, targets and monitoring regimes will be developed in this period, they are not included in the Plan. A detailed work plan including performance assessment will be developed to allow for changes in management activities to occur, provided

those changes are consistent with this Plan. The Plan itself may only be altered following the same process, including public consultation, used in the preparation of this Plan.

The Plan has an extensive summary which is intended to be able to be used as a stand-alone document and is provided for those who may not wish to read the whole Plan. There is therefore some duplication of text.

This Plan of Management is intended to be in force for a period of seven years. As required under the Act, the date the Plan will cease to have effect will be published in a notice in the Government Gazette when the Plan has commenced operation.

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Acknowledgments

Environment Australia is grateful to those individuals and organisations that assisted in the drafting of this Plan, in particular the Western Australian Department of Conservation and Land Management, Fisheries Western Australia and LeProvost Dames and Moore Pty Ltd. LeProvost Dames and Moore prepared a literature review to provide background information for the preparation of the Plan (see Bibliography). Much of the descriptive section has been drawn from this report. The contribution of those individuals and groups that provided initial submissions, information and assistance in the period leading up to the proclamation of the Mermaid Reef Marine National Nature Reserve is acknowledged. In November 1995, a joint Australian Nature Conservation Agency/ Western Australian Department of Conservation and Land Management advertisement sought views on tourism at Rowley Shoals. The submissions from those individuals and organisations that responded were also of great value. In September 1999 the Plan was put out for public comment. The submissions received were incorporated into the Plan where appropriate, and Environment Australia also gratefully acknowledges the input from these submissions.

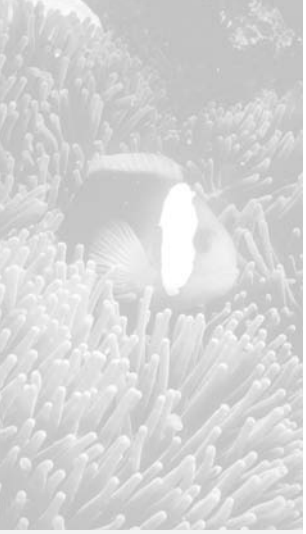
Table of contents

Figures

Tables

List of abbreviations used in this Plan

AFMA	Australian Fisheries Management Authority
AGSO	Australian Geological Survey Organisation
AIMS	Australian Institute of Marine Science
ANZECC	Australian and New Zealand Environment and Conservation Council
CALM	WA Department of Conservation and Land Management
Director	The Director of National Parks and Wildlife (Commonwealth)
EA	Environment Australia
Fisheries	Fisheries Western Australia
IMCRA	Interim Marine and Coastal Regionalisation for Australia
IUCN	World Conservation Union (previously: International Union for the Conservation of Nature and Natural Resources)
Marine Park	Rowley Shoals Marine Park
Marine National Nature Reserve	Mermaid Reef Marine National Nature Reserve
MOU	Memorandum of Understanding between Environment Australia, CALM and Fisheries WA
NPWC Act	*National Parks and Wildlife Conservation Act 1975*
NRSMPA	National Representative System of Marine Protected Areas
RAOU	Royal Australian Ornithologists Union
Regulations	Regulations to the *National Parks and Wildlife Conservation Act 1975*
UNEP	United Nations Environment Programme



Summary

1. Introduction

Mermaid Reef is one of a group of reef systems known as the Rowley Shoals, located off the coast of north-western Australia. The Mermaid Reef Marine National Nature Reserve was proclaimed as a reserve by the Commonwealth to protect its diverse marine life and virtually pristine coral formations.

The clear oceanic water, coral formations and abundant marine life of Mermaid Reef and the other reefs of the Rowley Shoals make them a spectacular destination for recreational diving and eco-tourism. The abundance of marine life in a relatively undisturbed condition also provides opportunities for research.

This Plan of Management is written to conform to the *Best Practice in Performance Reporting in Natural Resource Management* (ANZECC, 1997), with an emphasis on strategic objectives, goals and management strategies, performance measures, targets and monitoring. As a result of the performance assessment, the management goals and strategies will be reviewed prior to the next Plan of Management.

2. Management Framework

The Rowley Shoals, including Mermaid Reef, have national and international significance due to their pristine character, geomorphological interest and diverse fauna, including species which have not been recorded elsewhere in Western Australia. Mermaid Reef and the other two reefs of the Rowley Shoals have been listed on the Register of the National Estate, and the World Conservation Union (IUCN) has included Rowley Shoals in its list of coral reefs of international significance (UNEP/IUCN, 1988).

The Mermaid Reef Marine National Nature Reserve was proclaimed in 1991 under the *National Parks and Wildlife Conservation Act 1975*. The Marine National Nature Reserve is classified as an IUCN Category 1a — Strict Nature Reserve.

The Marine National Nature Reserve is managed on behalf of the Director by the Marine Group of Environment Australia (EA) under a cooperative arrangement with the Western Australian Department of Conservation and Land Management (CALM) and Fisheries Western Australia (Fisheries). These agencies carry out much of the local management of the Marine National Nature Reserve. CALM also manages the nearby Rowley Shoals Marine Park. This cooperative arrangement for management of both the Marine National Nature Reserve and the Marine Park is formalised under a Memorandum of Understanding (MOU) between these three agencies.

A number of other agencies assist in the management of the Rowley Shoals, including Coastwatch, a program run by Australian Customs, and the Royal Australian Navy. The Western Australian Department of Transport is responsible for regulations relating to boating and boating safety.

3. Strategic Objectives

The strategic objectives for Mermaid Reef Marine National Nature Reserve are as follows:

a. to manage the area as part of a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems;

b. to ensure the preservation of Mermaid Reef in its natural condition and the protection of its special features, including objects and sites of biological, historical, paleontological, archaeological, geological and geographical interest;

c. to protect, conserve and manage the wildlife in the Marine National Nature Reserve;

d. to protect the Marine National Nature Reserve against damage; and

e. to encourage and regulate the appropriate use, appreciation and enjoyment of the Marine National Nature Reserve.

4. Description of Mermaid Reef Marine National Nature Reserve

Mermaid Reef Marine National Nature Reserve is located about 300 kilometres north-west of Broome. Mermaid Reef has an outer reef rim which fully encloses an inner lagoon. The lagoon is only accessible through one navigable passage, through which tides of up to 4.5 metres ebb and flow. There are no areas above high water in the Marine National Nature Reserve, but a large sand cay at the northern edge of the lagoon and several smaller cays to the west are exposed at low water.

The early years of the Rowley Shoals' history saw visits by Indonesian fishermen from at least the mid-18th century onwards. The fishermen sought supplies of trepang (holothurians), turtle shell, trochus shell and shark fin. There is a current Memorandum of Understanding between Indonesia and Australia which allows access by traditional fishermen to parts of north-western Australia, but this does not include the Rowley Shoals. There are also records of some collection of trepang, fish and other resources by European traders.

There is one historic shipwreck, believed to be that of the English whaler, the *Lively*, located on the western edge of Mermaid Reef. This shipwreck was declared under section 5(1) of the *Historic Shipwrecks Act 1976*.

The Rowley Shoals, including Mermaid Reef, has an abundance and variety of marine wildlife which is in a relatively undisturbed condition. While little is known of the marine flora, collections and surveys have been made of some of the major groups of marine fauna such as the corals, echinoderms (for example, starfish and sea urchins), molluscs (for example octopus, squid and shells), sponges and fish. For example, there are known to be more than 200 species of corals in the Rowley Shoals reefs, with the clear waters allowing coral communities to exist over a great depth range. The reefs have biogeographic value due to the presence of species which are at or close to the limit of their distribution.

Mermaid Reef offers spectacular diving conditions in a near pristine environment. However, due to the remote location and the monsoon season, there is limited visitation. The Rowley Shoals area is accessed by some private individuals and by charter vessels which provide diving and snorkelling, limited

shore-based activities and some recreational fishing. Neither recreational nor commercial fishing or collecting is permitted in Mermaid Reef Marine National Nature Reserve.

Since the mid-1990s, the Australian Institute of Marine Science has been running a long-term research and monitoring project at Mermaid Reef and the other reefs of the Rowley Shoals, generally concentrating on coral and fish.

5. Pressures on Mermaid Reef Marine National Nature Reserve

The existing or potential human activities that could affect the natural and social values of Mermaid Reef are:

- activities causing pollution, such as the discharge of sewage and other wastes, bilge water, fuel and oil;
- boating and other vessel-related activities such as anchoring, which may damage coral formations;
- damage to coral and other features by diving (for example, fin damage and damage by touching fragile formations) or other recreational activities;
- illegal fishing and collection of specimens;
- littering; and
- petroleum and mineral exploration and extraction activities.

There are also potential pressures from natural disasters such as tropical cyclones, predators such as crown-of-thorns starfish, and global phenomena such as increased sea water temperatures, which could impact on the Marine National Nature Reserve.

6. Managing Mermaid Reef Marine National Nature Reserve

In summary, the main management goals for the Marine National Nature Reserve are to:

- maintain the current high water quality;
- minimise damage to coral and other features from boating and recreational activities;
- ensure protection of the wildlife from illegal collecting and fishing;
- allow visitor access subject to continued minimal environmental impacts;
- educate visitors about the conservation values and significance of the Marine National Nature Reserve;
- encourage appropriate research and monitoring programs that will inform management; and
- minimise potential impacts from exploration and extractive operations such as those for petroleum (oil and gas).

The main management strategies for the Marine National Nature Reserve can be summarised as follows:

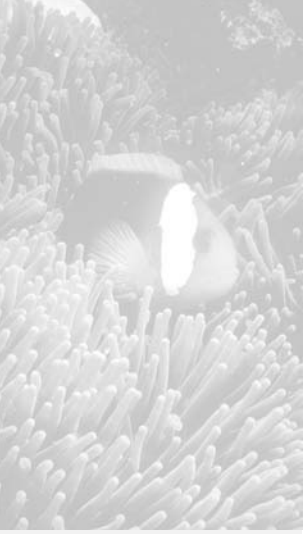
- Apply restrictions on certain activities, such as the release of wastes and sewage into the Marine National Nature Reserve through consultation with commercial operators and via commercial permit conditions.
- Provide Reserve users with educational and interpretative material aimed at reducing the impacts of visitation and enhancing the visitor experience.
- Develop and implement a mooring and anchoring strategy in consultation with CALM and the Western Australian Department of Transport.
- Work with CALM and Fisheries to enhance enforcement and compliance with prohibition of fishing and collection of specimens.
- Develop and implement monitoring programs in consultation with CALM and Fisheries.
- Undertake performance assessment and utilise this information to improve management.

7. Performance Assessment and Reviewing the Plan

A performance assessment framework has been developed in line with the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments* (ANZECC, 1999) and the ANZECC (1997) *Best Practice in Performance Reporting in Natural Resource Management*.

This Plan of Management presents elements of the performance assessment, including the legislative framework, strategic objectives, management goals and management strategies. The detailed performance measures, monitoring programs and targets will be developed in consultation with CALM and Fisheries. Some proposed performance measures and monitoring programs relate to water quality in Mermaid Reef lagoon; monitoring of benthic communities to assess physical damage and community health; operation of commercial tours; and research in the Marine National Nature Reserve.

Results from performance assessment will be used to undertake a review of the Plan of Management commencing about two years before the termination date of the Plan. The results of the review will be used in the development of the next Plan of Management for Mermaid Reef.



1. Introduction

Mermaid Reef is one of a group of three reef systems known as the Rowley Shoals located about 300 kilometres off Broome in north-west Australia. Mermaid Reef is under Commonwealth jurisdiction. The other two reefs are Clerke Reef and Imperieuse Reef which constitute the Western Australian Rowley Shoals Marine Park. The Mermaid Reef Marine National Nature Reserve was proclaimed as a reserve by the Commonwealth to protect its diverse marine life and virtually pristine coral formations. The location of Mermaid Reef Marine National Nature Reserve in the Rowley Shoals is indicated in Figure 1.

The boundaries of Mermaid Reef Marine National Nature Reserve and the Rowley Shoals Marine Park are shown in Figure 2. The total area of the Marine National Nature Reserve is 53,984 hectares and the declaration includes the seabed and sub-surface to a depth of 1000 metres. A copy of the proclamation of the Mermaid Reef Marine National Nature Reserve is presented in Attachment 1.

This Plan of Management is written to conform to the *Best Practice in Performance Reporting in Natural Resource Management* (ANZECC, 1997) with an emphasis on strategic objectives, goals and management strategies, performance measures, targets and monitoring. A key aspect of this model is a feedback loop to management. Because the Plan of Management is a statutory document intended to be in force for seven years, the detailed performance assessment will be developed separately from the Plan to allow for improvements to management during the duration of the Plan. The performance assessment framework will generally follow that set out in the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments* (ANZECC, 1999). As a result of the performance assessment, the management goals and strategies will be reviewed prior to the next Plan of Management.

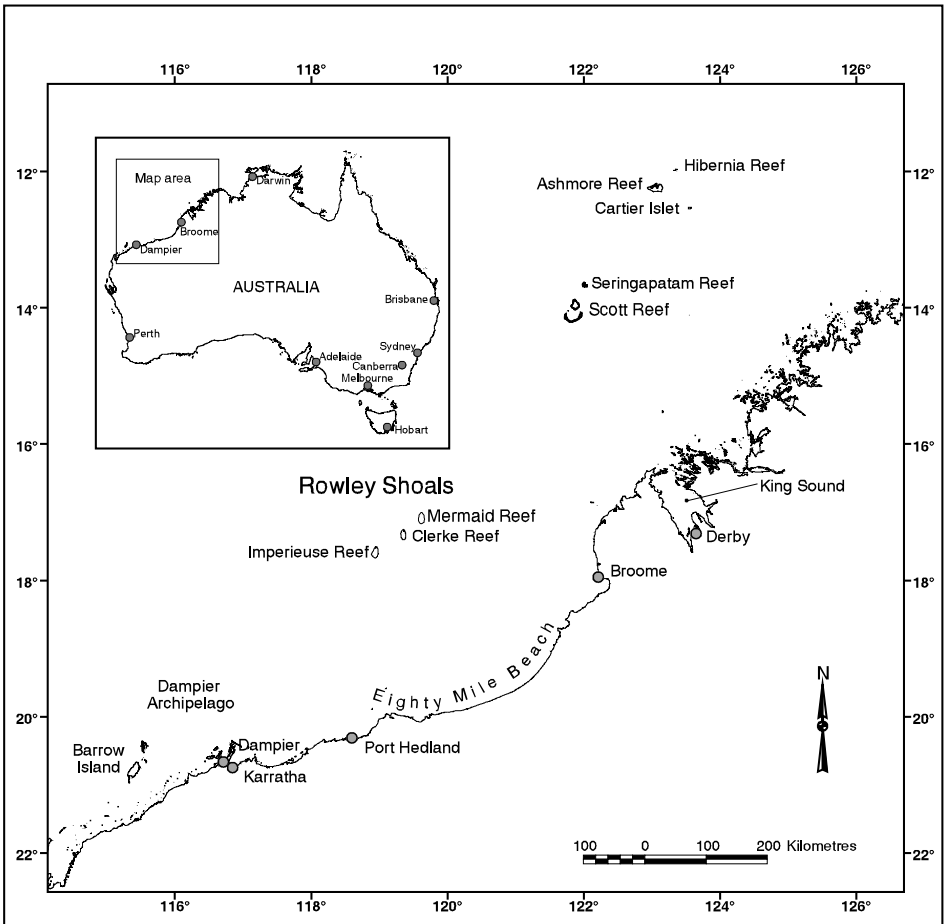


Figure 1: Location of Mermaid Reef in the Rowley Shoals

SOURCES:

AUSLIG (1990) "Australia, Coastlines and State Borders (1:100K)"
AUSLIG (1991) "Populated Places (1991) - Australia"

Produced by Environmental Resource Information Network (ERIN)
Environment Australia, Commonwealth of Australia, Canberra.

Projection: Geographic
Datum: WGS1984

Caveat: Data are assumed to be correct as received from the data suppliers.

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Department of the Environment and Heritage

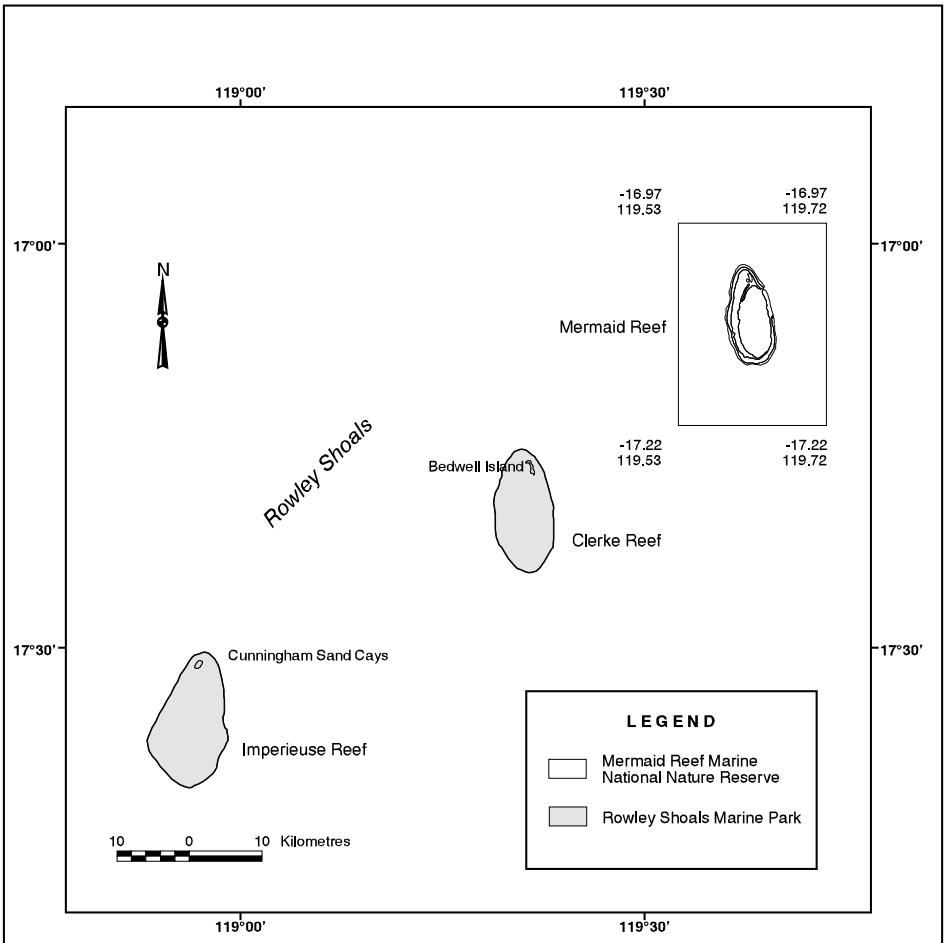

Figure 2: Boundary of Mermaid Reef Marine National Nature Reserve

SOURCES:

Environment Australia (1998) "Collaborative Australian Protected Areas Dataset (CAPAD), version 2.0"

Produced by Environmental Resource Information Network (ERIN) Environment Australia, Commonwealth of Australia, Canberra.

Projection: Geographic
Datum: WGS1984

Caveat: Data are assumed to be correct as received from the data suppliers.

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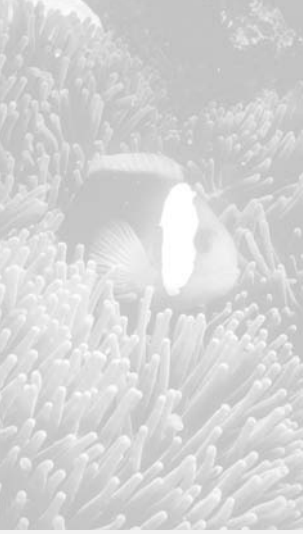


2. Management Framework

2.1 National and International Context

The Rowley Shoals, including Mermaid Reef, have significance due to their pristine character, geomorphological interest and diverse fauna, including species which have not been recorded elsewhere in Western Australian. For these reasons, Mermaid Reef and the other two reefs of the Rowley Shoals have been listed on the Register of the National Estate (Australian Heritage Commission, 1999).

The World Conservation Union (IUCN) has included Rowley Shoals in its list of coral reefs of international significance (UNEP/IUCN, 1988). Continued and perhaps unsustainable fishing and development pressures on the coral reefs in the Indonesian archipelago may lead to nearby reef systems, including the Rowley Shoals, having an increasing international conservation importance (UNEP/IUCN, 1988).

Fairbridge (1950) considered that these reef systems represented the most perfect example of shelf-edge oceanic reefs in Australian waters. The Rowley Shoals are situated in a remote oceanic environment and subject to a high tidal range which has caused unique geomorphic features to develop. These reefs occupy an unusual niche in coral reef geomorphology (UNEP/IUCN, 1988).

The reef systems of the Rowley Shoals support a rich range of coral assemblages and do not have a recorded history of disturbance, either by the crown-of-thorns starfish, *Acanthaster planci*, the predatory marine snail, *Drupella cornis*, or any other coral predator. Done *et al*. (1994) characterised the status of the coral communities at Rowley Shoals as excellent.

A major regional ecological significance of the Rowley Shoals is likely to be as one of a series of important 'stepping stones' for a range of reef biota originating from Indonesian waters. The fauna of the Rowley Shoals shows particular affinities with that of reefs of the Indonesian region (Berry and Marsh, 1986). The fauna of

the Rowley Shoals is also considered regionally important as it contains a large number of species not found in the more turbid coastal environments of northern tropical Australia. The strategic position off the north-west Australian coast in an area of few offshore reef systems provides an important upstream recruitment area for reefs further south. This may play a significant role in maintaining gene flow along the north-west Australian coastal reefs (LeProvost Dames and Moore, 1995).

The pristine state of the Rowley Shoals provides an ideal opportunity for studying reef development and dynamics (Berry and Marsh, 1986; UNEP/IUCN, 1988).

The clear oceanic water, coral formations and abundant marine life of Mermaid Reef and the other reefs of the Rowley Shoals make them a spectacular destination for recreational diving and eco-tourism. The abundance of marine life in a relatively undisturbed condition also provides opportunities for research.

Both Mermaid Reef Marine National Nature Reserve and the Rowley Shoals Marine Park are part of the National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA is a national system of marine protected areas which aims to contain a comprehensive, adequate and representative sample of Australia's marine ecosystems. Marine protected areas within the NRSMPA have been established especially for the conservation of biodiversity and have a secure status.

In December 1998, the Commonwealth Government launched Australia's Oceans Policy with a commitment to integrated and ecosystem-based planning and management. The delivery of the NRSMPA is a major focus of the Oceans Policy. Regional marine plans under the Oceans Policy will contribute to integrating marine protected areas into broader ecosystem management.

The Rowley Shoals are in the North-West Shelf region under the Interim Marine and Coastal Regionalisation for Australia (IMCRA) (IMCRA Technical Group, 1998).

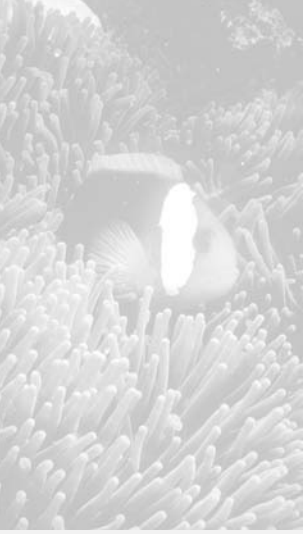
2.2 Management of Mermaid Reef Marine National Nature Reserve

The Mermaid Reef Marine National Nature Reserve was proclaimed in 1991 under the *National Parks and Wildlife Conservation Act 1975*. The Regulations of the Act apply to the Marine National Nature Reserve. Mermaid Reef Marine National Nature Reserve is classified as an IUCN Category 1a — Strict Nature Reserve.

The Director of National Parks and Wildlife is responsible under the NPWC Act for the administration, management and control of Mermaid Reef Marine National Nature Reserve. It is managed for the Director by the Marine Group of Environment Australia (EA) under a cooperative arrangement with the Department of Conservation and Land Management (CALM) and Fisheries Western Australia. These agencies generally carry out the local management of the Marine National Nature Reserve. CALM manages the nearby Rowley Shoals Marine Park under the *Conservation and Land Management Act 1984*. Fishing in the Marine Park and adjoining State waters is regulated by Fisheries under the *Fish Resources Management Act 1994*. The cooperative management of both the Marine National Nature Reserve and the Marine Park is formalised under a Memorandum of Understanding (MOU) between these three agencies; that is EA, CALM and Fisheries.

A number of other agencies assist in the management of the Rowley Shoals including Coastwatch, a program of Australian Customs, and the Royal Australian Navy. The Western Australian Department of Transport is responsible for regulations relating to boating and boating safety.

The main Commonwealth legislation relevant to the planning and management of the Marine National Nature Reserve is summarised in Attachment 4.



3. Strategic Objectives

The strategic objectives for Mermaid Reef Marine National Nature Reserve derive from the NPWC Act and the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments* (ANZECC, 1999). They form the basis for this Plan and are presented below:

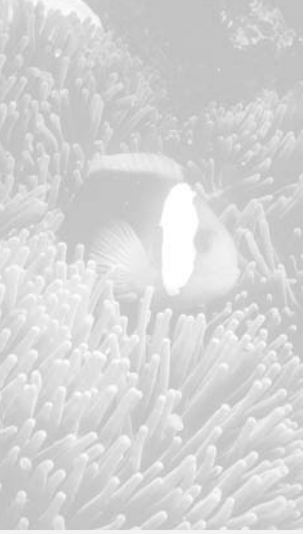
a. to manage the area as part of a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems;

b. to ensure the preservation of Mermaid Reef in its natural condition and the protection of its special features, including objects and sites of biological, historical, paleontological, archaeological, geological and geographical interest;

c. to protect, conserve and manage the wildlife in the Marine National Nature Reserve.

d. to protect the Marine National Nature Reserve against damage; and

e. to encourage and regulate the appropriate use, appreciation and enjoyment of the Marine National Nature Reserve.



4. Mermaid Reef Marine National Nature Reserve — A Description

4.1 The Rowley Shoals

The Rowley Shoals comprises three distinct reef systems arising from depths of between 500 metres and 700 metres along the edge of the continental shelf. These are emergent annular shelf reefs, all of a similar size and distance from one another, with each having a north-south orientation (see Figure 1). The three reefs are considered to be representative of the progressive stages in platform reef formation.

Mermaid Reef is the most north-easterly atoll of the Rowley Shoals. It lies some 29 kilometres to the north of Clerke Reef and is representative of the early stage of shelf reef development. It is 14.5 kilometres long and has a maximum width of 7.6 kilometres. It is situated at latitude 17 degrees 7 minutes South and 119 degrees 36 minutes East. The outer reef rim fully encloses an inner lagoon only accessible through one relatively narrow navigable passage, through which tides of around 4.5 metres ebb and flow. The depth of the lagoon averages 20 metres and is relatively unobstructed, although it does contain a few lagoonal patches of rubble mounds topped by live coral communities reaching almost to the surface. These are more common in the southern sector of the lagoon. There are no areas above high water in the Marine National Nature Reserve, but a large sand cay at the northern edge of the lagoon and several smaller cays to the west are exposed at low water.

4.2 History

The early years

It is believed that the Kimberley Coast and the Rowley Shoals reefs have been visited by Makassan and possibly Bajo fishermen from Indonesia, from at least the mid-18th century onward (Campbell and Wilson, 1993). Voyaging southwards in their sailing praus, these fishermen were seeking supplies of trepang (holothurians or sea cucumbers) from new areas to meet rising market demand in south-east Asia. Affluent Chinese had come to regard certain species of these holothurians as a delicacy, and accordingly they were, and still are, a greatly sought-after marine product (Cannon and Silver, 1987). Turtle shell, trochus shell and shark fin were other valuable commodities sought by these fishermen in waters south of the Indonesian archipelago (MacKnight, 1976).

These early visitors apparently knew the Rowley Shoals as *Pulau Pulo Dhaoh* (Campbell and Wilson, 1993). In later years, fishermen from Roti Island, south of Timor, also visited the Rowley Shoals, which they knew as *Pulau Bawa Angin*. The individual reefs were also given names, Mermaid being called *Pulau Manjariti*, Clerke Reef was *Pulau Tengah* and Imperieuse Reef was *Pulau Matsohor* (N. Stacey, Northern Territory University, pers. comm.).

These voyages by the Indonesian fishermen to the reefs off the north-west coast of Australia increased in number during the early part of the 20th century. However, although regularly visited, the Rowley Shoals were never as frequently visited as the more northerly reefs, possibly because of navigational difficulties. Later, in the European era, it was found that the Rowley Shoals lay across the direct sailing route between the early pearling settlement of Cossack and the then Dutch colonial outpost of Kupang. Pearling vessels returning divers and crew members to Kupang at the end of the season would often call in at these reefs to exploit their resources. So, as early as the 1870s, the Rowley Shoals reefs were found to be a rich source of marine products which were in popular demand in Dutch ports and which could be sold there to Chinese merchants (Bain, 1982).

A trochus and trepang fishery is reported to have been based at least partly on the Rowley Shoals between 1890 and 1930,

comprising several Kupang-based luggers which spent up to six weeks a year at these reefs (Berry and Marsh, 1986; Campbell and Wilson, 1993). From the end of the Second World War to 1975, Indonesian fishermen continued to visit the Rowley Shoals, although possibly less frequently than in the past. The expansion of Australian surveillance activities after 1975 led to an increase in apprehensions, following which the number of Indonesian visits significantly declined.

Today, Indonesian fishermen continue to visit their traditional areas in Australian waters. This recognition of traditional rights is incorporated into a Memorandum of Understanding signed by the Australian and Indonesian governments and permits fishing and the collection of marine species from the reefs of the Ashmore, Seringapatam, Scott and Browse areas, subject to certain regulatory requirements. The Rowley Shoals area is not included in the area open to Indonesian fishermen under the provisions of this Memorandum of Understanding.

The European era

Captain Phillip Parker King gave the three reefs their collective and individual names when he came upon them in 1818. They were named after Captain Rowley, the master of the *HMS Imperieuse*, who had reported the presence of the most southerly reef in 1800. The northernmost reef was named Mermaid, after Captain King's vessel, a teak cutter of 85 tons (McMinn, 1970), and the middle reef he named Clerke after the captain of a whaling vessel who had seen the reef while in the area between 1800 and 1809. The southernmost reef was named Imperieuse after Captain Rowley's vessel (Berry and Marsh, 1986).

Australian pearling luggers with Indonesian divers worked out of Cossack on the north-west Australian coast from the mid-1800s to about 1930. Some of these vessels made voyages of up to six weeks to the Rowley Shoals, usually at the end of the pearling season. Other luggers visited the Rowley Shoals en route to Timor to return employed divers to Kupang and, while there, trepang and fish were taken for sale in Kupang (Berry and Marsh, 1986).

After the Second World War, there was intermittent interest in commercial fishing in the Rowley Shoals area.

A Broome-based tourist industry developed in the late 1970s and early 1980s, exploiting the ideal diving conditions and spectacular coral formations found on the reefs of the Rowley Shoals.

Historic shipwrecks

Only one historic shipwreck is known at the Rowley Shoals. It is believed to be that of the English whaler *Lively*, a three-masted, ship-rigged vessel of approximately 250 tons. This vessel was lost when it struck the western edge of Mermaid Reef in the early years of the 19th century. As a result of this shipwreck, from about 1829 a number of early charts of the area showed a Lively Shoal, but this was marked about 40 nautical miles north of Mermaid Reef. The fact that the location of the wreck was so identified indicates that there were possibly some survivors of the disaster, who were able to report its actual location.

The two anchors and several iron knees from the wreck still lie on the reef flat on the western side. The trypots and cannon remain in an underwater gully off the edge of the reef near the anchors (Mermaid Reef Patrol Report No. 1, unpub.). None of the recovered material allows a positive identification of this wreck as being that of the *Lively*.

This shipwreck was declared under section 5(1) of the Commonwealth *Historic Shipwrecks Act 1976*.

4.3 Geology and Geomorphology

The Rowley Shoals comprises three large, oval reefs surrounded by waters between 500 metres and 700 metres deep. The reefs follow a south-west to north-east alignment along the edge of the continental shelf.

The Rowley Shoals have been considered 'the most perfect examples of shelf atolls' in Australian waters (Fairbridge, 1950). Imperieuse, Clerke and Mermaid Reefs are very similar in dimensions, shape, orientation and separation. Each has a central lagoon, or lagoons, broken by at least one passage on the eastern side. These channels are navigable at Mermaid and Clerke Reefs. In the case of Mermaid this channel is about 60 metres wide at its narrowest and lined with living coral. Much of the tidal exchange takes place through this passage (Berry and Marsh,

1986), although a considerable portion also occurs over the 5 kilometre section of submerged reef flat to the south of this channel (Done *et al*. 1994).

The semi-diurnal tide and exceptional spring tide range (4.5 metres to 5 metres) explains the lack of both a localised surf zone and well defined algal reef crest or boulder zone (UNEP/IUCN, 1988). The prevailing swells are from the south-west and are responsible for the wider reef flats on the western margins of each shoal.

There is no permanent land on Mermaid Reef, but a large sandbank near the northern end and a series of small banks along the western side of the lagoon become exposed during low water spring tides (Berry and Marsh, 1986).

The Rowley Shoals lie in the centre of the Roebuck Basin, which is a petroleum prospective province which continues to be explored by the offshore oil industry (LeProvost Dames and Moore, 1995). There has been no petroleum exploration at the Rowley Shoals to date, although there was a well located approximately 30 kilometres north-east of Mermaid Reef (Berry and Marsh, 1986).

4.4 Oceanography

The currents affecting the Rowley Shoals are important in determining water characteristics such as temperature and clarity, as well as influencing the dispersal and mixing of sediments, biota and pollutants to and within the reefs. Figure 3 shows the main circulation patterns.

As indicated, the Rowley Shoals experience a semi-diurnal tidal cycle with a spring range of about 4.5 metres. Tidal range in the lagoons is much less due to the restricted flow from the lagoons which results in the waters becoming impounded by the emergent rim.

Mean sea surface temperatures in the Rowley Shoals area vary from about 25°C in winter to a peak of 29 to 30°C in March and April (Holloway and Nye, 1985).

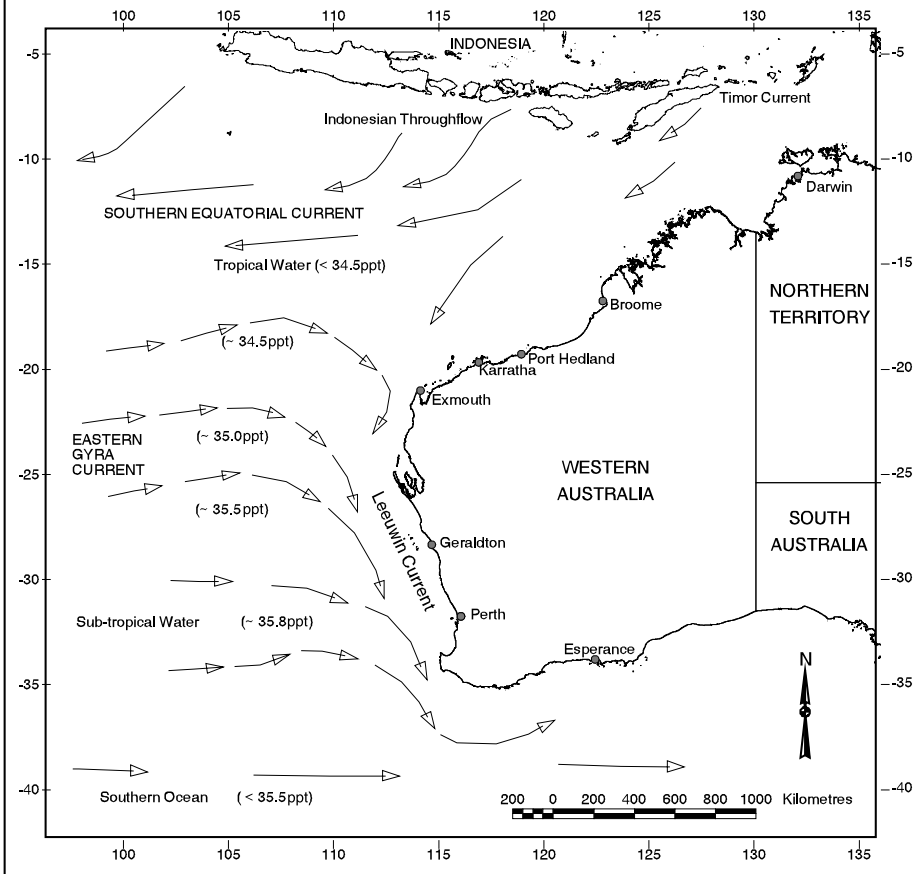


Figure 3: Gross circulation in the Eastern Indian Ocean

SOURCES:

AUSLIG (1990) "Australia, Coastlines and State Borders (1:100K)"
AUSLIG (1991) "Populated Places (1991) - Australia"
ESRI Australia (1993) "Digital Chart of the World (1:1 million)".

Produced by Environmental Resource Information Network (ERIN)
Environment Australia, Commonwealth of Australia, Canberra.

Projection: Geographic
Datum: WGS1984

Caveat: Data are assumed to be correct as received from the data suppliers.

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4.5 Climate

The Rowley Shoals lie in the monsoonal belt, within which westerly to north-westerly rain-bearing winds blow from about November to March, and dry south-easterly to easterly trade winds prevail from about May to September. The area experiences mild summers and winters. The climate is dry (arid tropical), with most annual rainfall being restricted to the relatively short summer monsoon period. Prolonged periods of rainfall are rare.

Based on the historical records available for Broome and Cape Leveque, Mermaid Reef can be expected to experience an approximate average of 25 rainy days per annum, with most of the precipitation occurring in the December to March monsoonal period, and from epitropical storms in late autumn to early winter (Gentilli, 1978).

Annual rainfall at Mermaid Reef is highly variable and probably ranges from less than 500 millimetres to more than 1000 millimetres.

Cyclones affecting Mermaid Reef typically form in the Timor or Arafura Seas between January and April. Sixty-two cyclones (with wind speeds of 63 kilometres to 225 kilometres per hour) and 15 tropical lows (wind speeds less than 63 kilometres per hour) are estimated to have passed within two degrees of the Rowley Shoals, between 1910 and 1995. Destructive winds and other cyclonic effects are unlikely to be experienced at Mermaid Reef from cyclones which remain more than 120 nautical miles distant (K. Smith, Bureau of Meteorology, pers. comm.).

4.6 Biological Values

Major marine habitats

The major marine habitats of Mermaid Reef have been mapped and classified as sand cay, lagoon, submerged sand, deep reef flat, and emergent areas (Done *et al*. 1994, in LeProvost Dames and Moore, 1995; see Figure 4).

Flora

There have been no specific studies of the marine algae of Mermaid Reef or of the other Rowley Shoals reefs. The seagrass *Thalassia hemprichii* occurs in the lagoon and in patches of the back reef slope at Mermaid Reef (Berry, 1986a) but no other species of seagrass have been recorded from the Rowley Shoals.

Fauna

There have been a number of fauna surveys at the Rowley Shoals including three by the Western Australian Museum (see Berry, 1986a) and one by the Australian Institute of Marine Science (AIMS) (Done *et al*. 1994).

The findings from the surveys show that Mermaid Reef and the other Rowley Shoals reefs have a rich and diverse fauna which is regionally important and which includes species not occurring elsewhere in Western Australia, as well as some endemics.

The coral communities are one of the special values of Mermaid Reef. Other benthic groups include sponges, bryozoans, ascidians (sea squirts), polychaetes, molluscs, echinoderms, crustaceans and cnidarians (jellyfish). The following provides more information on some of the most studied groups of fauna.

CORALS

One of the most spectacular forms of fauna at Mermaid Reef is the corals. From a 1993 survey, Done *et al*. (1994) recorded 214 species of scleractinian corals and 12 genera of soft corals. Done *et al*. (1994) identified five assemblages of corals at Mermaid Reef. They found that the coral assemblages of the Rowley Shoals are broadly comparable to those found on the reefs of the outer Great Barrier Reef and in the Coral Sea. While the coral fauna is

similar to the relatively nearby Scott Reef (see Figure 1), it differs considerably from that of north-western Australia (Veron, 1986). Veron (1986) notes that the clear water allows coral communities to exist over a great range of depths, while the strong wave action on the outer coral slopes and the wide tidal range cause them to be strongly zoned.

ECHINODERMS

Echinoderms include starfish, seastars, sea urchins and holothurians (called trepang or sea cucumber). The echinoderm fauna of Mermaid Reef is considered to be typical for isolated reef systems surrounded by clear, deep oceanic water (Marsh, 1986b). A total of 90 species have been recorded from the Rowley Shoals area, a substantial number of these being new records for Western Australia.

Most echinoderm species found at Rowley Shoals also occur at Scott Reef, which has a richer echinoderm fauna. This has been attributed to its closer proximity to the Indonesian archipelago (Marsh, 1986b). The fauna consists almost entirely of Indo-West Pacific species together with a few which have a more restricted distribution in the waters north of Australia.

Of particular note are the 28 species of holothurians, including several edible species. *Holothuria nobilis*, known as black or white teatfish, is one of the most highly regarded of the trepang species and was relatively common at collecting sites in the Rowley Shoals. This contrasts with Scott Reef, where it is rare, probably due to intensive collection by Indonesian fishermen visiting that area, as allowed by the Memorandum of Understanding between Australia and Indonesia (Marsh, 1986b).

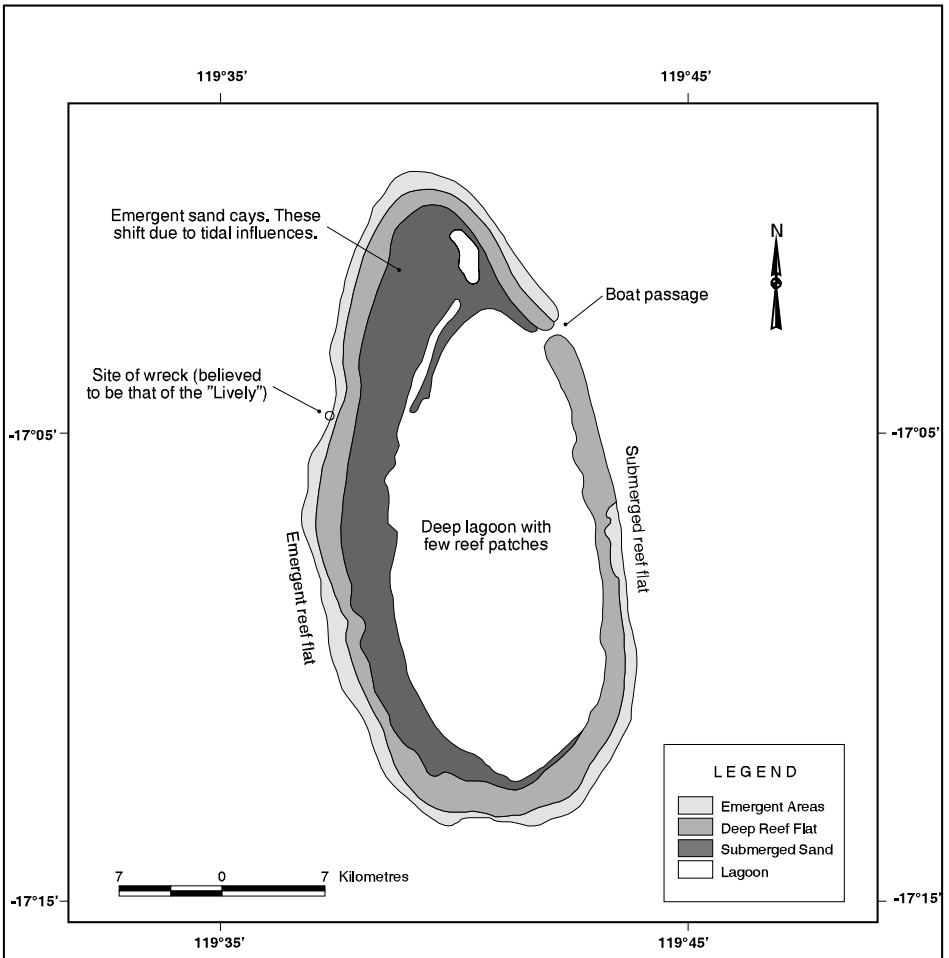

Figure 4: Mermaid Reef Marine National Nature Reserve - Marine Habitat Types

SOURCES:

Done,T.J., Williams,D.McB., Speare,P., Turak,E., Davidson,J., DeVantier, L.M., Newman,S.J., & Hutchins,J.B. (1994) "Surveys of Coral Fish and Communities at Scott Reef and Rowley Shoals." Australian Institue of Marine Science, Townsville, Australia.

Produced by Environmental Resource Information Network (ERIN) Environment Australia, Commonwealth of Australia, Canberra.

Projection: Geographic
Datum: WGS1984

Caveat: Data are assumed to be correct as received from the data suppliers.

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MOLLUSCS

Molluscs include octopus, cuttlefish, squid and baler shells, as well as many species which live on the reef flats, such as cones, cowries, thaids, mitres and giant clams. A total of 260 macro-mollusc species, all of which are widespread Indo-West Pacific forms, were recorded at the Rowley Shoals by the 1982 Western Australian Museum expedition (Wells and Slack-Smith, 1986). While the molluscan fauna of the Rowley Shoals and Scott and Seringapatam Reefs show considerable overlap, they are considered to be distinct from that of the adjacent continental mainland, as evidenced by the 70 new records for Western Australia, which were among specimens collected from these reefs.

Notable differences between Scott Reef and Rowley Shoals include a greater abundance of giant clams (both *Tridacna* and *Hippopus spp*.) at the Rowley Shoals. These have been severely depleted at Scott Reef by Indonesian fishing, especially prior to 1989.

CRUSTACEANS

Crustaceans include crabs, lobsters, prawns and crayfish. While no specific collections of crustaceans have been made from the Rowley Shoals there are records of 34 specimens of decapod crustaceans from the Rowley Shoals reefs since 1983. Information from the nearby Scott and Seringapatam Reefs (Berry and Morgan, 1986) suggests that in the order of 50 different species could be present.

FISHES

Three expeditions to the Rowley Shoals and Scott Reef by Western Australian Museum staff between 1982 and 1984 produced a collection containing 688 species, representing 258 genera and 77 families, of which 262 species were common to both reef systems (Allen and Russell, 1986). As a result of these collections, it was concluded that the composition of the overall fish assemblage on the shelf-edge reefs is similar to that of other reef areas in the tropical Indo-West Pacific. Allen and Russell (1986) also commented that, since the oceanic reef habitat of the Rowley Shoals and Scott Reef is unique in Western Australian waters, it is not surprising that species were found there which do not occur elsewhere in the State. A total of about 380 species

not previously recorded from the coastal reefs of Western Australia were identified.

The 1993 AIMS survey (Done *et al*. 1994) recorded a further 37 new fish species from the Rowley Shoals. A later survey by AIMS (1995) noted a clear distinction between the fish assemblages of the lagoon and outer reef slope.

REPTILES

Reptiles are not represented in great numbers at the Rowley Shoals. Small numbers of green turtle (*Chelonia mydas*), including sub-adults, have been sighted at the Rowley Shoals (Berry, 1986a; Mermaid Reef Patrol Report No. 1, unpub.). The nearest significant turtle rookery, which is also the largest green turtle rookery in the region, is approximately 300 kilometres to the east, on the Lacepede Islands (Prince, 1990). Green turtles are listed as vulnerable by ANZECC and as endangered by IUCN.

Berry (1986a) comments on the apparent absence of sea snakes on the Rowley Shoals reefs, while these are abundant at Scott and Seringapatam Reefs.

SEABIRDS AND MIGRATORY BIRDS

A number of seabirds have been sighted at the Rowley Shoals, with three species recorded as breeding in the Rowley Shoals Marine Park on Clerke and Imperieuse Reefs.

The sand cays at Clerke and Imperieuse Reefs and the sand areas exposed at low tides at Mermaid Reef are possibly important resting and feeding sites for migrating transcontinental waders.

The birds recorded from the Rowley Shoals since 1986 are presented in Attachment 2.

MARINE MAMMALS

Records from regions similar to the Rowley Shoals would indicate that the waters around Mermaid Reef may be visited by a number of cetacean species (dolphins and whales). These are presented in Attachment 2.

Humpback whales are more likely to pass close to the Rowley Shoals on their northward migration in late autumn to early winter towards the calving grounds, which are in an area offshore extending from Dampier to the Kimberley coast, than in their southern migration (Jenner and Jenner, 1995).

4.7 Social And Economic Values

Due to their remote location, tourist access to Mermaid Reef and the Rowley Shoals is generally only by private vessels, charter boats or commercial guided tours. There is no commercial passenger transport providing non-tourist access to the area. Current uses include recreational diving and snorkelling, recreational fishing (prohibited in some areas, including all of Mermaid Reef), and limited shore-based recreation. A number of yachts on long tours stop off at the Rowley Shoals for safe anchorage.

Recreational diving

The Rowley Shoals offers spectacular diving conditions in a near pristine environment. The combination of clear oceanic water, an unusual abundance of large reef fish such as the potato cod, massive, dramatic coral formations and near vertical drop-offs out from the reef rim, has ensured that Mermaid Reef has become internationally recognised as one of the world's great dive sites. The Rowley Shoals is attracting an increasing number of visitors both from the Australian mainland and overseas, and is the basis for a developing tourism industry based in Broome.

Recreational fishing

Interest in the Rowley Shoals area as a recreational fishing destination commenced in the mid-1970s. Although this was based largely on the use of chartered vessels, a few privately owned recreational fishing craft have ventured out to the Rowley Shoals. A State fishing ban has been placed on a range of nominated fish species in some parts of the Rowley Shoals Marine Park.

All non-commercial fishing is prohibited in Mermaid Reef Marine National Nature Reserve. This action was taken as a conservation measure aimed at protecting the populations of fish species occurring in the lagoon and in the waters around the reef, thereby contributing to the retention of the unspoiled nature of the reef.

A copy of the Determination by the Director prohibiting non-commercial fishing in the Marine National Nature Reserve is included in this Plan at Attachment 3.

The distance from the mainland limits the number of Australian recreational fishers at the Rowley Shoals, with the high cost of chartering an appropriate vessel being a further constraint on such visits.

Commercial charter tours

There are a number of operators carrying out commercial charter tours to the Rowley Shoals, including Mermaid Reef. Activities carried out by the clients include diving and snorkelling, recreational fishing (in permitted areas and excluding Mermaid Reef) and limited shore-based activities.

The number of charter tour operators is restricted and each must have a current permit from EA and current licence from CALM to carry out commercial activities in the Marine National Nature Reserve and Marine Park.

Other recreational activities

There are a small number of private visitors to the Rowley Shoals, including touring yachts. The activities carried out by these visitors are generally the same as those who visit with the tour operators. There is currently little conflict between tour and private visitors.

There is currently no visitor infrastructure at Mermaid Reef, although it is anticipated that a limited number of permanent moorings may be established. This will be subject to the development of an anchoring and mooring strategy (see section 6.1.3).

Research

Despite its distance from the mainland, Mermaid Reef has a significant research potential. It is currently the site of a long-term research project, monitoring fish and corals, by AIMS.

In consultation with CALM, Fisheries and other relevant organisations, long-term monitoring projects will be developed at Mermaid Reef and the other reefs to assist with managing the Marine National Nature Reserve and the Marine Park.

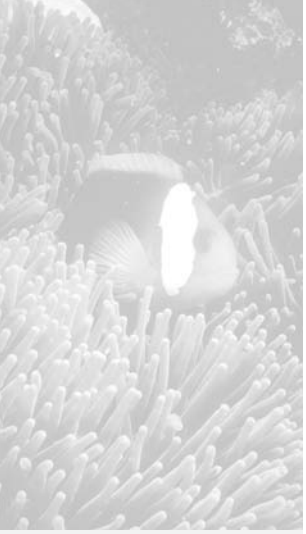
Commercial fishing

Limited commercial fishing occurs in the waters surrounding the Rowley Shoals. The Shoals are within the waters of the Western Tuna and Billfish Fishery and the North West Slope Trawl Fishery. Until October 1997, Japanese tuna vessels fished in waters around the Rowley Shoals under a bilateral agreement with Australia but were excluded from a zone surrounding Mermaid Reef. There has been little domestic tuna fishing in the offshore waters around the Rowley Shoals to date. Trawlers fishing for scampi (deepwater clawed lobsters belonging to the family Nephropidae) and deepwater prawns operate around the Rowley Shoals. These vessels operate in waters mostly deeper than 300 metres depth, outside the boundaries of Mermaid Reef Marine National Nature Reserve.

While there is some trap fishing closer inshore, there are no State-licensed fishers who fish near the Rowley Shoals. No commercial fishing is permitted in the Marine National Nature Reserve.

Petroleum (gas and oil) exploration and production

Highly productive source rocks for petroleum are found in the Carnarvon Basin, about 500 kilometres south-west of Mermaid Reef. Potential petroleum source rocks may also occur in the Rowley Sub-basin; however, the only exploration well drilled in the area to date was unsuccessful.

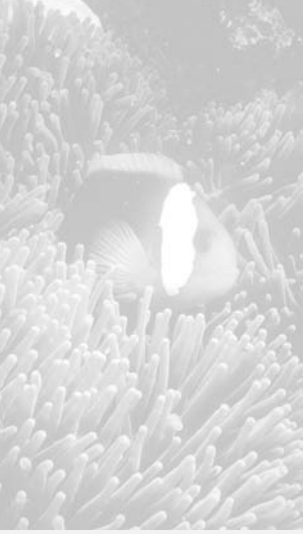


5. Pressures on Mermaid Reef Marine National Nature Reserve

Any natural area subject to human visitation is subject to real or potential pressures from human usage or impacts. Table 1 (page 30) presents an analysis of the main factors with potential to affect the key values of Mermaid Reef. There are also potential pressures from natural disasters, such as tropical cyclones, predators, such as crown-of-thorns starfish, and global phenomena, such as increased sea water temperatures, which could impact on each of the values listed. The proposed management strategies focus on those existing and potential pressures caused by human activities that can be influenced by management.

TABLE 1
Factors with potential to affect the major values of Mermaid Reef Marine National Nature Reserve

VALUES	POTENTIAL PRESSURES ON VALUE
i PHYSICAL	
1. Best geological example of shelf atolls.	– None identified.
2. Water quality.	– Pollution: contaminants; litter; sewage; pollution arising from mining or petroleum exploration or production. – Global warming.
3. Coral formations in pristine condition.	– Direct threats: anchoring; establishing moorings; diving; collecting. – Reduction in water quality (see above). – Infestation by crown-of-thorns or *Drupella cornis* (predators). – Global warming affecting sea water temperatures.
ii BIOLOGICAL	
1. Rich and diverse marine communities/habitats.	– Collection of fauna eg shells, clams, trepang (*holothurians*). – Fishing.
2. Pristine, undisturbed marine communities and habitats, eg. corals.	– Anchoring; establishing moorings. – Diving (eg damage caused by contact from fins); collecting. – Pollution from boats or other activities (see Water quality above). – Infestation by crown-of-thorns or *Drupella cornis* (predators). – Mining or petroleum exploration or production.
3. High abundance of marine fauna, eg. fishes.	– Fishing and collecting, including illegally by Indonesian fishers. – Pollution (see Water quality above).
iii SOCIAL	
1. Major destination for tourism operators (charter tours).	– No significant threat identified given current numbers.
2. Uniqueness as diving area.	– Physical degradation of physical features (eg damage to coral from anchors). – Pollution from boats and other activities (see Water quality above). – Mining or petroleum exploration or production.
3. Wilderness character.	– Too many boats and/or visitors; noise; visual impacts of facilities. – Litter and shore pollution.
4. Abundance and tame behaviour of large fish.	– Fishing. – Feeding the wildlife.
iv CULTURAL	
Shipwreck — believed to be the *Lively*.	– Deterioration due to natural elements. – Collection of artefacts from the wreck.



6. Managing Mermaid Reef Marine National Nature Reserve

This section of the Plan deals with each of the main values and major uses of the Marine National Nature Reserve. Consistent with the ANZECC best practice model in performance reporting (ANZECC,1997), for each value or use the following is presented: potential pressures; management goals; and management strategies. Performance measures, targets and monitoring programs will be further developed from these. Some proposed performance measures and monitoring programs are presented in section 7 below.

6.1 Biodiversity Values

One of the main reasons for the reservation of Mermaid Reef was the protection of the diverse and abundant marine wildlife. For management purposes, the wildlife can be classified as: the seaweeds and seagrasses; benthic communities, including the corals and other invertebrates; the fish; and other vertebrates such as reptiles, mammals and birds. Due to the small numbers of reptiles, mammals and birds at Mermaid Reef and the few potential pressures, most management effort is concentrated on the benthic communities and the fish and their habitat.

6.1.1 Potential pressures — biodiversity values

REDUCTION IN WATER QUALITY

The current high water quality is vital for the continued health of the coral and other fauna and flora as well as the value of the recreational diving and snorkelling experience. Increased turbidity can cause mortality, especially of corals. Excess nutrients can encourage growth of exotic flora and fauna. Increases in water temperature can cause the death and bleaching of corals.

Pollution can result from boating and recreation within the Marine National Nature Reserve, from petroleum (gas and oil) exploration and production activities, or from passing ships. Potential hazards include fuel and oil spills, the discharge of

drilling fluids and drill cuttings, release of sewage, grey water and litter, especially plastics and fishing line. Due to its more limited water circulation, the lagoon is most at risk from pollutants. Petroleum and mineral exploration and extraction in the vicinity of the Marine National Nature Reserve could have impacts including increased turbidity and toxicity, depending on the distance from the Reserve and water circulation patterns.

Regulations 11(1) and 11(4) of the NPWC Act restrict or prohibit, among other things, the depositing of rubbish or commercial waste and the release of liquid or gas where it is likely to pollute an area of water.

PHYSICAL DAMAGE FROM BOATING AND RECREATIONAL ACTIVITIES

Anchoring can cause significant damage to fragile features such as coral. Divers can also inadvertently damage coral through touch and fin damage. Reef walking will also damage coral features.

ILLEGAL COLLECTING AND FISHING

Removal of specimens of shells, coral and other invertebrates affects both community structure of the plants and animals and the recreational experience of other users. Generally the most spectacular and valuable specimens are most vulnerable. Similarly, fishing can reduce the size and abundance of fish as well as make the fish less tame and therefore less easily observed.

The removal of any wildlife from the Marine National Nature Reserve without a permit is prohibited under the Regulations. (Note that for the purposes of the NPWC Act, 'wildlife' includes all indigenous plants and animals.) In addition, there is a Determination issued by the Director which specifically prohibits recreational (non-commercial) fishing (This Determination is reproduced in Attachment 3).

6.1.2 Management goals — biodiversity values

1. To maintain high water quality especially in the lagoon.
2. To minimise damage to corals and other benthic organisms.
3. To protect the diversity, distribution, abundance and community structure of fish and other vertebrate fauna.

6.1.3 Management strategies — biodiversity values

WATER QUALITY

1. Provide information to Reserve users about the guidelines and regulations on marine pollution, including the disposal of bilge water, sewage, grey water, rubbish and other wastes. Provide information on the implications of such pollution for the marine environment.
2. Require sullage tanks or environmentally acceptable sewage systems on all new or replacement commercial tourism concession vessels and encourage existing operators to fulfil this requirement. Prohibit the release of sewage in the Marine National Nature Reserve by July 2000.
3. The disposal of all other waste and bilge water within the Marine National Nature Reserve is prohibited.
4. Develop a cooperative approach between Reserve users and management agencies for the surveillance of pollution events.
5. Implement a water quality monitoring program in association with CALM.
6. Prohibit petroleum and mining exploration and extraction.

PHYSICAL DAMAGE FROM BOATING AND RECREATIONAL ACTIVITIES

1. Develop and implement an anchoring and mooring strategy with CALM and the Western Australian Department of Transport. Anchoring will only be permitted in a restricted area. Moorings may be established.
2. Liaise with CALM concerning the preparation and distribution of educational and interpretative material to charter operators and other distribution avenues.
3. Consult with CALM and AIMS with the aim of implementing a monitoring program to include benthic communities. For the purposes of invertebrate communities, the monitoring should investigate abundance, diversity and community health at popular dive sites, anchoring and mooring areas and control areas.

ILLEGAL COLLECTING AND FISHING

1. Maintain the prohibition on fishing within the Marine National Nature Reserve.
2. Implement and encourage monitoring and research programs for fish.
3. Provide educational information on the requirement not to collect specimens in the Marine National Nature Reserve.
4. Investigate compliance of 'no take' in the Marine National Nature Reserve.

See also section 6.7 Commercial Fishing.

6.2 Cultural Values

A shipwreck believed to be that of the *Lively* is located on the western side of Mermaid Reef. The wreck is protected under section 5(1) of the Commonwealth *Historic Shipwrecks Act 1976* being listed in the *Commonwealth of Australia Gazette* of 12 March 1982 as being of historic significance. Under section 13 of this Act it is an offence for any person to damage, interfere with, dispose of or remove any part of the historic shipwreck without a permit under section 15 of the Act. The wreck now consists of two large anchors, several iron knees with two trypots and a cannon nearby. Some recovered material is now housed in the Western Australian Maritime Museum in Fremantle (Henderson, 1982).

6.2.1 Potential pressures — cultural values

Potential pressures to the cultural values of the wreck include deterioration due to natural elements, and collection of artefacts from the wreck.

6.2.2 Management Goals — cultural values

1. To preserve the remains of the wreck in situ.
2. To allow access to the wreck site subject to the dictates of public safety and the *Historic Shipwrecks Act 1976*.

6.2.3 Management Strategies — cultural values

1. Incorporate information about the wreck into public education and interpretive material to be prepared for the Rowley Shoals.
2. The Marine Group of EA will liaise with the Australian and World Heritage Group of EA concerning any applications for permits to recover any relics, under section 15 of the *Historic Shipwrecks Act 1976*.

6.3 Recreational Values

The recreational values of the Marine National Nature Reserve depend largely on the physical attributes of the area and on the abundance, diversity and beauty of the marine wildlife in waters with high visibility. The recreational experience is enhanced by the wilderness setting and warm climate. Specific recreational activities include boating, and observation of corals, other invertebrates and fish by diving and snorkelling. Most users come to the area with a commercial charter tour but there are a few private vessels. Certain potential recreational uses are not permitted in the Marine National Nature Reserve. These include fishing, fish feeding and collection of specimens. For example, under a Determination made by the Director, all non-commercial fishing is prohibited at Mermaid Reef. Under the Regulations, feeding of fish and other wildlife is not permitted in the Marine National Nature Reserve.

6.3.1 Potential pressures — recreational values

The recreational experience at Mermaid Reef would or could be negatively impacted by significant damage to or removal of habitat and fauna; recreational activities which would conflict with other users and impact on the wilderness type experience; and over crowding due to too many commercial operators/tourists that may affect the wilderness type experience.

6.3.2 Management goals — recreational values

1. To ensure that all users of the Marine National Nature Reserve have a minimal environmental impact.
2. To ensure that appropriate anchoring and mooring areas are available.

6.3.3 Management strategies — recreational values

1. Educational and interpretive material will be distributed with an aim to reach private users of the Marine National Nature Reserve as well as the commercial tour users.
2. An anchoring and moorings strategy will be developed and implemented.
3. Numbers of private visitors will be monitored when practicable.
4. The feeding of fish and other wildlife in the Marine National Nature Reserve will continue to be prohibited under the Regulations.
5. The prohibition of all non-commercial fishing in the Marine National Nature Reserve will be continued.

6.4 Commercial Tours

A number of commercial operators currently run charter tours to the Rowley Shoals. The main activities carried out are diving and snorkelling, and recreational fishing (in parts of the Rowley Shoals Marine Park). Recreational fishing is prohibited at Mermaid Reef. There are a limited number of operators, each of whom must hold a licence from CALM for the Rowley Shoals Marine Park and a permit from EA for the Marine National Nature Reserve. The licence fees are used for the management of the Marine Park and Marine National Nature Reserve.

6.4.1 Potential pressures — commercial tours

Significant damage to habitat, and to corals and other wildlife would detract from recreational experiences as would pollution within the lagoon.

Overcrowding would also detract from the recreational experience.

6.4.2 Management goals — commercial tours

1. To allow access to Mermaid Reef by visitors who do not have private means of accessing the area.
2. To ensure that the commercial operators carry out their activities in a manner which is safe and has minimal impact upon the natural values of the Marine National Nature Reserve.
3. To both enhance the experience and reduce the environmental impact of visitors to the Rowley Shoals by providing educational and interpretative material.

6.4.3 Management strategies — commercial tours

1. Management of the commercial operations will be carried out with CALM: through consultation with operators; by the use of licence and permit conditions; and through the education of visitors.
2. There will be a restricted number of commercial operators granted permits to operate in the Marine National Nature Reserve.
3. In liaison with CALM, permit conditions will be reviewed prior to expiry of current permits.
4. The numbers of visitors using commercial tours will be monitored.
5. EA will liaise with CALM concerning the preparation and distribution of educational and interpretative material to charter operators and through other distribution avenues.
6. EA will continue to liaise with CALM over the use of some of the commercial operations' licence fees for the management of Mermaid Reef Marine National Nature Reserve.

6.5 Research

Research is both a use of the Marine National Nature Reserve and a potential management tool. Mermaid Reef provides a potential site for pure research, surveys and monitoring to increase knowledge of tropical ecosystems. Specific monitoring is proposed to provide information for management of the Marine National Nature Reserve and the Marine Park.

All research in the Marine National Nature Reserve requires a permit under the Regulations.

6.5.1 Potential pressures — research

Research has the potential for negative environmental impacts resulting from, for example, collection or damage.

There is the potential for negative interactions between research users and other users.

6.5.2 Management goals — research

1. To encourage appropriate research that will increase the knowledge of the natural and/or physical environments of the Rowley Shoals.
2. To develop research and monitoring programs that will provide information for management.
3. To ensure that research activities will have a minimal environmental impact on the Marine National Nature Reserve.
4. To monitor and manage conflicts with other users.

6.5.3 Management strategies — research

1. EA will administer any research permits for the Marine National Nature Reserve in consultation with CALM and Fisheries if appropriate.
2. EA will liaise with research organisations to ensure the information resulting from the research is available to managers.
3. EA will liaise with CALM and Fisheries and other relevant organisations to develop and establish monitoring programs to provide information on important management issues.

6.6 Petroleum and Mineral Exploration and Extraction

Highly productive source rocks for petroleum are found in the Carnarvon Basin, about 500 kilometres south-west of Mermaid Reef. Potential petroleum source rocks may also occur in the Rowley Sub-basin, however, the only exploration well drilled in the area to date was unsuccessful.

6.6.1 Potential pressures — petroleum and mineral exploration and extraction

There is potential for damage to the sensitive marine communities from exploration and extraction activities.

For example, negative effects which may result from petroleum exploration include:

- accidental discharge of substances (for example, oil or gas) caused by leakage, spillage, rupture or blowout;
- emission of high-energy, low-frequency noise during seismic surveys;
- rig and supply vessel anchors which may disturb bottom sediment or reef structures.

The majority of these effects would be localised and short term; however, if petroleum or mineral reserves were discovered in commercial quantities, extraction could result in significantly wider ranging and longer lasting impacts.

6.6.2 Management goals — petroleum and mineral exploration and extraction

1. To ensure that there is no damage to the natural physical and biological features of Mermaid Reef Marine National Nature Reserve from exploration and extraction activities within the Reserve.
2. To minimise damage to the natural physical and biological features of Mermaid Reef Marine National Nature Reserve from exploration and extraction activities in the vicinity of the Rowley Shoals.

6.6.3 Management strategies — petroleum and mineral exploration and extraction

1. No mining operations or other operations for the recovery of minerals, including petroleum, or mineral seismic and drilling exploration activities or extraction activities will be permitted in the Marine National Nature Reserve.
2. EA will continue to liaise with the Commonwealth Department of Industry, Science and Resources and the Western Australian Department of Minerals and Energy prior to the grant of exploration permits in the vicinity of the Rowley Shoals.
3. EA will seek to provide comment on any exploration and extraction activities proposed in the vicinity of Mermaid Reef with a view to minimising any potential effects on Mermaid Reef. It is expected that such activities will be reviewed under the *Environmental Protection and Biodiversity Conservation Act 1999*.

6.7 Commercial Fishing

The Western Tuna and Billfish Fishery and the North West Slope Trawl Fishery are the Commonwealth fisheries managed by the Australian Fisheries Management Authority (AFMA) in the area of the Rowley Shoals. The State fisheries in the area are managed by Fisheries Western Australia.

There is no commercial fishing permitted in the Marine National Nature Reserve.

6.7.1 Potential pressures — commercial fishing

Commercial fishing would be likely to reduce the size, abundance and community structure of fish in the Reserve. It would also change fish behaviour so that the remaining fish would be less tame and less easy to observe.

6.7.2 Management goals — commercial fishing

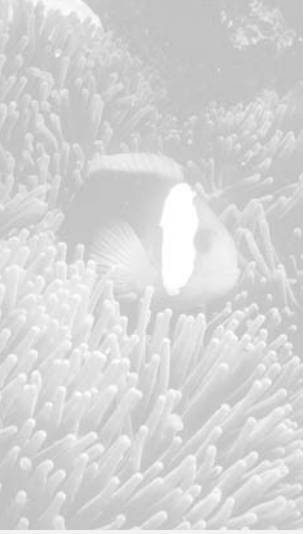
1. To ensure that there is no damage to the fish or other wildlife in the Marine National Nature Reserve resulting from commercial fishing operations.

6.7.3 Management strategies — commercial fishing

1. Commercial fishing will continue to be excluded from the Marine National Nature Reserve.
2. EA will liaise with AFMA to provide information to commercial fishers concerning the status and location of the Marine National Nature Reserve.
3. Aquaculture and pearling will not be permitted in the Marine National Nature Reserve.
4. EA will liaise with Fisheries and CALM to ensure adequate enforcement and compliance.

6.8 Other Commercial Activities

The use of Mermaid Reef for any other commercial activities, such as filming, requires a permit and will be considered on a case by case basis.



7. Reviewing this Plan

7.1 Performance Assessment

A performance assessment framework has been developed in line with the *Strategic Plan of Action for the National Representative System of Marine Protected Areas: A Guide for Action by Australian Governments* (ANZECC, 1999) and the *Best Practice in Performance Reporting in Natural Resource Management* (ANZECC, 1997). The performance assessment model for the management of Mermaid Reef Marine National Nature Reserve includes: the legislative framework; strategic objectives; analysis of potential pressures on the major values of the Marine National Nature Reserve; management goals; management strategies; performance measures, targets and monitoring programs. The first elements are dealt with in detail in this Plan, particularly in sections 5 and 6. The performance measures, targets and monitoring programs will be further developed from these elements. The performance assessment framework and workplan will be produced in consultation with CALM and Fisheries and reviewed annually by the Rowley Shoals Management Liaison Committee in accordance with the MOU.

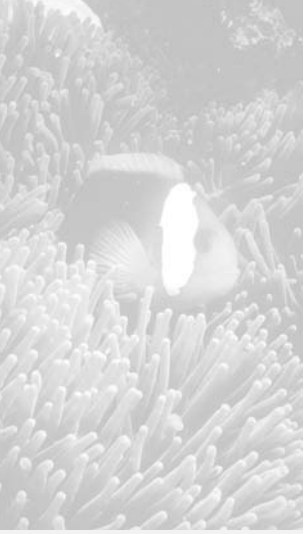
Management strategies and performance assessment will be important for a number of values requiring management in the Marine National Nature Reserve. For example, the maintenance of high water quality is vital for maintaining biodiversity, recreational and commercial tourist values. The provision of educational and interpretative material is a key strategy for the protection of biodiversity while at the same time it will enhance the recreation experience.

An outline of some of the proposed performance measures and monitoring programs is presented below.

- Performance measures, targets and a monitoring program will be developed to assist with maintaining high water quality in Mermaid Reef lagoon. Performance measures will include key water quality indicators such as levels of chlorophyll and faecal coliforms.
- EA will liaise with CALM and relevant research organisations with the aim of gaining long-term monitoring information on the benthic communities, including the corals. Performance measures relating to physical damage to corals from recreation-related activities and for benthic community health will be developed.
- Performance measures and targets will be developed for the operation of the commercial tours, for example, compliance with permit conditions and numbers of visits and visitors per season.
- Performance measures will be developed for research. Possible performance measures will relate to the relevance of the research to management issues and the provision of the results of research to management.

7.2 Reviewing the Plan

Results from ongoing performance assessment will be used to undertake a review of the Plan of Management commencing about two years before the termination date of the Plan.
The results of the review will be used in the development of the next Plan of Management for Mermaid Reef Marine National Nature Reserve.



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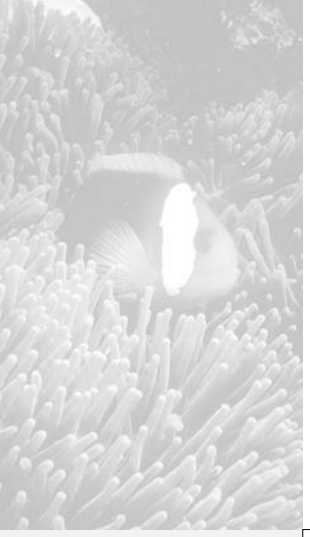

9. Attachments

Attachment 1: Proclamation of Mermaid Reef Marine National Nature Reserve

PROCLAMATION

Commonwealth of Australia
W G HAYDEN
Governor-General

By His Excellency the Governor-General of the Commonwealth of Australia

I, WILLIAM GEORGE HAYDEN, Governor-General of the Commonwealth of Australia, acting with the advice of the Federal Executive Council and after consideration by the Executive Council of the annexed report by the Director of National Parks and Wildlife, under subsection 7(2) of the *National Parks and Wildlife Conservation Act 1975*:

(a) declare the area constituted by the area specified in the Schedule to be a reserve; and

(b) assign to the reserve the name "Mermaid Reef Marine National Nature Reserve"; and

(c) specify the depth of 1,000 metres below the surface of any land within the area so declared as the depth to which the subsoil beneath that land is to be taken to be within the reserve; and

(d) specify the depth of 1,000 metres below the sea-bed beneath any sea within the area so declared as the depth to which the subsoil beneath that sea-bed is to be taken to be within the reserve.

SCHEDULE

Description of area of Mermaid Reef Marine National Nature Reserve

The area bounded by an imaginary line:

(a) commencing at a point of Longitude 119°32' East, Latitude 16°58' South;

(b) running thence east along the parallel of Latitude 16°58' South to its intersection by the meridian of Longitude 119°43' East;

(c) running thence south along the meridian of Longitude 119°43' East to its intersection by the parallel of Latitude 17°13' South;

(d) running thence west along the parallel of Latitude 17°13' South to its intersection by the meridian of Longitude 119°32' East;

(e) running thence north along the meridian of Longitude 119°32' East to the point of commencement.

GIVEN under my Hand and the Great Seal of Australia on 21 March 1991.

By His Excellency's Command,

ROS KELLY

Minister of State for the Arts, Sport,
the Environment, Tourism and Territories

GOD SAVE THE QUEEN!

Attachment 2:
Selected Species Lists

1. Birds at the Rowley Shoals

The following seabird species have been identified at the Rowley Shoals by visitors to the area since 1986:

Wedge-tailed Shearwater	*Puffinus pacificus*
Red-tailed Tropic Bird (B)	*Phaethon rubricauda*
White-tailed Tropic Bird	*Phaethon lepturus*
Brown Booby	*Sula leucogaster*
Least Frigate Bird	*Fregata ariel*
Eastern Reef Egret	*Egretta sacra*
White-bellied Sea Eagle	*Haliaeetus leucogaster*
Eastern Curlew	*Numenius madagascariensis*
Grey-tailed Tattler	*Tringa brevipes*
Ruddy Turnstone	*Arenaria interpres*
Red-necked Stint	*Calidris ruficollis*
Pacific Golden Plover	*Pluvialis fulva*[1]
Large Sand Plover	*Charadrius leschenaultii*
Sanderling	*Calidris alba*
Crested Tern	*Sterna bergii*
Little Tern (B)	*Sterna albifrons*
Sooty Tern (B)	*Sterna fuscata*
Sacred Kingfisher	*Todiramphus sanctus*
White-throated Needletail	*Hirundapus caudacutus*

Species marked (B) are recorded as having nested on Bedwell Island, Clerke Reef.

[1] This indentification is based on the lisitng in the RAOU's *The Taxonomy and Species of Birds of Australia and its Territories*, 1994. Among the changes imposed by this publication is the replacement of the name Eastern Golden Plover (*Pluvialis dominica*) with Pacific Golden Plover (*P. fulva*).

2. Marine mammals expected to occur in the vicinity of the Rowley Shoals

TOOTHED WHALES AND DOLPHINS	
Bottlenosed dolphin	*Tursiops truncatus*
Common dolphin	*Delphinus delphis*
Risso's dolphin	*Grampus griseus*
Striped dolphin	*Stenella coeruleoalba*
Spinner dolphin	*Stenella longirostris*
Melon-headed whale	*Peponocephala electra*
Short-finned Pilot whale	*Globicephala macrorhynchus*
False Killer whale	*Pseudorca crassidens*
Killer whale	*Orcinus orca* (probably uncommon)
Sperm whale	*Physeter macrocephalus* (probably uncommon)
BALEEN WHALES	
Bryde's whale	*Balaenoptera edeni*
Southern Minke whale	*Balaenoptera acutorostrata*
Humpback whale	*Megaptera novangliae*

Attachment 3:
Determination prohibiting fishing in the Mermaid Reef Marine National Nature Reserve

COMMONWEALTH OF AUSTRALIA

National Parks and Wildlife Conservation Act 1975

National Parks and Wildlife Regulations

Subregulation 36(1)

DETERMINATION RELATING TO MERMAID REEF NATIONAL NATURE RESERVE

I, PETER BRIDGEWATER, Director of National Parks and Wildlife hereby determine that the waters in Mermaid Reef National Nature Reserve, being the area described in the Schedule to this Determination, is an area where fishing is prohibited at any time.

THE SCHEDULE

The area bounded by an imaginary line:

(a) commencing at a point of Longitude 119 degrees 32 minutes East, Latitude 16 degrees 58 minutes South;

(b) running thence east along the parallel of Latitude 16 degrees 58 minutes South to its intersection by the meridian of Longitude 119 degrees 43 minutes East;

(c) running thence south along the meridian of Longitude 119 degrees 43 minutes East to its intersection by the parallel of Latitude 17 degrees 13 minutes South;

(d) running thence west along the parallel of Latitude 17 degrees 13 minutes South to its intersection by the meridian of Longitude 119 degrees 32 minutes East;

(e) running thence north along the meridian of Longitude 119 degrees 32 minutes East to the point of commencement.

Dated the 14 day of February 1995

The Seal of the Director of National Parks and Wildlife was hereto affixed in my presence:

DIRECTOR OF NATIONAL PARKS
PETER BRIDGEWATER
AND WILDLIFE

Attachment 4:
Commonwealth Legislation relevant to this Plan

Legislation relevant to the Commonwealth waters is described below.

- The *National Parks and Wildlife Conservation Act 1975* applies to all External Territories and Commonwealth waters. 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 *Environment Protection and Biodiversity Conservation Act 1999* was passed by the Commonwealth Parliament on 29 June 1999 and received royal assent on 16 July 1999. It will commence no later than 16 July 2000.

  The Act, and associated *Environmental Reform (Consequential Provisions) Act 1999*, will replace the *National Parks and Wildlife Conservation Act 1975* as well as the *Environment Protection (Impact of Proposals) Act 1974*, *Endangered Species Protection Act 1992*, *Whale Protection Act 1980* and *World Heritage Properties Conservation Act 1983*. When the *Environment Protection and Biodiversity Conservation Act 1999* has commenced, references to these Acts in this Plan of Management are to be read as references to the new Act.

  When it comes into effect, the *Environmental Reform (Consequential Provisions) Act 1999* will continue the operation of this Plan of Management as if it had been prepared under the *Environment Protection and Biodiversity Conservation Act 1999*, but the plan will need to be read subject to the provisions of the new Act.

- The *Whale Protection Act 1980* regulates the taking, killing, injuring or interfering with all species of cetaceans in the Australian Fishing Zone.

- The *Coastal Waters (States Powers) Act 1980* and the *Coastal Water (States Titles) Act 1980*. The States Powers Act gave the States powers over 'coastal waters' — the territorial sea to a distance of 3 nautical miles 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 *Wildlife Protection (Regulation of Exports and Imports) Act 1982* regulates the export and import of wildlife in Australia and its External Territories and gives effect to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITIES) to which Australia is signatory. Under this Act, export of species listed in Schedule 1, such as all marine turtles, is strictly regulated to prevent them becoming further endangered. Export of species listed in Schedule 2, such as clams, may only be taken under an approved management program.

- The *Historic Shipwrecks Act 1976* provides protection for all shipwrecks and relics over seventy-five years of age in waters under Commonwealth responsibility and for specific wrecks declared under sections 5 or 6 of the Act. Protected zones may be declared (section 7) around historic shipwrecks to prevent unauthorised access.

- The *Australian Heritage Commission Act 1975* requires any Commonwealth department or agency proposing an action significantly affecting a place listed on the Register of the National Estate to refer the proposal to the Australian Heritage Commission for consideration. If there are no feasible or prudent alternatives, all reasonable measures must be taken by the department or agency to minimise any damaging effects.

- The *Petroleum (Submerged Lands) Act 1967* and directions issued under the Act control the petroleum and mineral exploration and extraction activities on the continental shelf beyond the Territorial Sea.

- The *Offshore Minerals Act 1994* controls exploration for and the extraction of minerals other than petroleum on the continental shelf beyond the Territorial Sea.

- The *Fisheries Management Act 1991* regulates the commercial operations of all persons and boats and non-commercial activities of persons on foreign boats in respect of the taking of swimming fish in the Australian Fishing Zone. Under agreements made under the Offshore Constitutional Settlement, the *Fisheries Act 1905* (Western Australia), provides for management by the State of fisheries on the continental shelf, from the shoreline to the 200 metre isobath and, in some instances, to the 200 nautical mile limit of the Australian Fishing Zone.

- The *Environment Protection (Impact of Proposals) Act 1974* is triggered where a Commonwealth action (including a decision) is likely to have a significant environmental impact. It is under this Act that Environmental Impact Assessments are conducted for any proposal likely to have a significant effect on the environment.

- The *Environment Protection (Sea Dumping) Act 1981* controls, regulates and monitors sea dumping operations and gives effect to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matters.

- The *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* and the *Navigation (Protection of the Sea) Amendment Act 1983* give effect to the International Convention for the Prevention of Pollution from Ships (MARPOL) which came into effect internationally in October 1983. Discharges of oil and noxious chemicals from merchant ships and discharges of garbage, including plastic material, from all Australian ships are regulated under this legislation.

- The *Endangered Species Act 1992* provides protection for endangered and vulnerable species and ecological communities in Commonwealth areas, including marine areas.