MARINE RESERVE IMPLEMENTATION:
PILBARA

PLANNING AND PRE-DECLARATION PROCESSES FOR A MARINE PROTECTED AREA IN THE DAMPIER ARCHIPELAGO/CAPE PRESTON REGION

Final Report: MRI/PI/MBI-39/2000

A collaborative project between CALM Marine Conservation Branch
and the Pilbara Regional Office

A project partially funded through the Natural Heritage Trust's
Coast and Clean Seas Marine Protected Area Program
Project No: WA9701

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Biodiversity Group
GPO Box 787
CANBERRA ACT 2601
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EXECUTIVE SUMMARY

This report summarises the major activities and outcomes of a one-year project entitled "*Planning and pre-declaration processes for a marine protected area in the Dampier Archipelago/Cape Preston region*".

This project is the first stage of the process to establish a marine conservation reserve in the Dampier Archipelago/Cape Preston region. This specific project covers the start-up stage of information gathering, forming committees and initial consultation. The subsequent phase is covered under another MPAP project (stage 2).

The process of establishing a marine reserve is a complex and difficult one, which often is affected by external forces. These external forces make it difficult to predict timeframes and the amount of resources required to achieve certain outcomes. There were four key objectives of this project which were hoped to be achieved within the timeframes and budget allocated for this project.

The overall aims of the project were:

1. *to initiate planning and pre-declaration processes for the proposed Dampier Archipelago/Cape Preston marine conservation reserve;* This has been fully achieved with the process underway to consider the area as a potential marine conservation reserve.

2. *to compile the ecological and socioeconomic information;*

This has been fully achieved with the compilation of written and spatial information on the ecological and socioeconomic values of the area. CALM undertook field surveys of habitats and compiled human usage information on recreational and commercial use. These have been produced in a Regional Perspectives document for publication, as well as posters and hard copy maps of the commercial and recreational human usage, oceanography, climate, habitats and significant conservation features. This process was far more difficult than anticipated as there was very little suitable information available to document these values and as such CALM had to actively seek this data through field survey, interviews of experts and compiling anecdotal data from people with local knowledge. As such this component of the project took significantly longer and cost more than initial estimates.

3. *to provide advice to the WA Government, through the stakeholder/community advisory committee process, on the suitable reserve category, boundaries and management zoning options, and;*

The Committee has been established by the Minister for the Environment (June 2000). It was a complex task to form the committees and took significantly longer than anticipated. The committee information package has been prepared and the foundations set for the operation of the committee. However the process has not proceeded to the point of recommending suitable reserve categories, boundaries and management zoning. The operation of the committee is covered under stage 2 of this process, funded under *Community Participation in the Declaration Process- Proposed Dampier Archipelago/Cape Preston and Montebello/Barrow islands Marine Protected Areas* project. This will see the completion of the proposal in the form of an indicative management plan.

4. *to develop and implement a community consultation process.*

CALM has undertaken a number of consultative steps in relation to this proposal. This included early consultation in respect to ensuring there was a positive reaction to the call for nominations to form the advisory committee. This involved meetings with stakeholder representatives, media articles and briefings. The next stage related to ongoing interest in the proposal created through the information gathering stage, particularly in relation to obtaining information on usage from recreational and

commercial users of the area. This mainly consisted of meetings, briefings, written letters and media articles. CALM also undertook an issue analysis, involving interviews with 164 people. This involved canvassing a broad range of individuals with an interest in the proposal and assessing their level of knowledge and understanding of marine reserves, the process etc and noting issues of concern regarding the proposals and management of the area. This assessment will form the basis of the development of the next stage of the consultation program and is critical to ensuring the consultation program targets groups at an appropriate level.

In summary the majority of objectives were fully achieved and one objective was partially achieved. The lessons learned from this project are that;

- There is a dearth of information available in the right format to provide the necessary background and as such the lead agency will in most cases have to actively source this information.

- Timeframes are difficult to control given the large external influences on a proposal which has broad interest in the community and

As a result of the above two points the process will generally be more resource intensive and take longer than previously anticipated.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter One

Introduction

CHAPTER ONE INTRODUCTION

This report summarises the major activities and outcomes of a one-year project "*Planning and pre-declaration processes for a marine protected area in the Dampier Archipelago/Cape Preston region*". The outcomes of specific action items detailed in the project specifications are reported on.

1.1 BACKGROUND

In recognition of the importance of conserving the State's marine biodiversity, the Minister for the Environment established the Marine Parks and Reserves Selection Working Group (MPRSWG) in 1986. The main aim of the MPRSWG was to identify representative and unique areas of Western Australia's marine waters for consideration as part of a statewide system of marine conservation reserves under the *Conservation and Land Management (CALM) Act* 1984. The MPRSWG's report was released in June 1994 and identified over seventy such candidate areas throughout the coastal waters of Western Australia (CALM, 1994).

The State's vesting body for marine conservation reserves is the Marine Parks and Reserves Authority (MPRA) which was established in 1997. The MPRA has prioritised the candidate areas for implementation as marine conservation reserves and the proposed Dampier Archipelago/Cape Preston marine conservation reserve (Figure 1) was one of the MPRA's high priority candidate areas.

Under the State Government's marine and conservation strategy detailed in *New Horizons - The way ahead in marine conservation and management* released by the Western Australian Government in 1998 (WA Government, 1998), there is a requirement for:

"Extensive assessment, community consultation and management planning before a new marine conservation reserve is established."

In view of the high standing that the proposed Dampier Archipelago/Cape Preston marine conservation reserve has in the Governments priority list for new marine conservation reserves, CALM applied to Environment Australia for funding to perform a biological survey in the area. Partial funding of $64,000 for the project has been obtained through Environment Australia's Natural Heritage Trust, via the Coast and Clean Seas Marine Protected Area Program (Project No. WA9701). CALM contributed further resources to the project, valued at approximately $150 000.

The data acquired during this project will be important in the determination of the relative conservation values of the respective major habitats of the proposed Dampier Archipelago/Cape Preston marine conservation reserve. It will also contribute to the information base required for the marine reserve planning process, during which marine reserve boundaries and zones for multiple-use will be considered for the area.

This project was coordinated by CALM's Marine Conservation Branch (MCB) and conducted in collaboration with the Pilbara Regional Office.

1.2 OBJECTIVE

The aims of the project are:

1. to initiate planning and pre-declaration processes for the proposed Dampier Archipelago/Cape Preston marine conservation reserve;

2. to compile the ecological and socioeconomic information;

3. to provide advice to the WA Government, through the stakeholder/community advisory committee process, on the suitable reserve category, boundaries and management zoning options, and;

4. to develop and implement a community consultation process.

1.3 STUDY AREA

The area of interest for this project is the proposed Dampier Archipelago/Cape Preston marine conservation reserve (Figure 1). This area includes all the islands of the Dampier Archipelago to the islands around Cape Preston. The study area extends to the State Territorial Seas in the north to the high Water Mark landward, the Fortescue River mouth in the west to Dixon and Delambre in the east.

1.4 PROJECT TASKS

The project details are outlined in the Work Schedule (*see* Appendix A) and the Variation to Contract (*see* Appendix B) which include five specific action items:

Task 1 Review and collate existing information layers and acquisition of additional data (chapters 2, 3 &4)

Task 2 Preparation of a stakeholder advisory committee information package (chapter 6), comprised of:

a) A regional perspectives paper, comprising the conservation, cultural/historical, social and economic values of the candidate area (chapter 5);

b) A biological perspectives paper, summarising biological data for the candidate area, and discussing the implications for reserve design (chapter 5);

c) Relevant biological, economic and social information layers in GIS format, and;

d) Procedural guidelines for marine reserve implementation;

Task 3 Prepare and submit a Progress Report (chapter 11);

Task 4 Implementation of statutory community/stakeholder advisory committee process (chapter 6 & 7), and;

Task 5 Implementation of a community consultation program, including public meetings and the preparation of education/interpretive materials (chapter 8, 9 &10).

Chapter Two

RESOURCE ASSESSMENT ACTION: BENTHIC HABITAT MAPPING

In view of the high standing that the Dampier Archipelago/Cape Preston region has in the MPRA's priority list for new marine conservation reserves, CALM applied to Environment Australia for funding to develop an accurate habitat survey of the area. Partial funding of $64,000, grant number WA9701, for the Dampier Archipelago/Cape Preston region, was obtained through Environment Australia's Natural Heritage Trust, via the Coast and Clean Seas Marine Protected Area Program. CALM also contributed further resources to the projects, valued at approximately $150,000.

Although there is a large amount of information currently known on the biological resources of the proposed marine reserve area, the accuracy, and comprehensiveness of habitat maps and human usage data for the area is still inadequate. This survey serves to redress these outstanding information requirements.

2.2 OBJECTIVES

The objectives of this resource assessment field survey were:

- to undertake ground-truthing to develop a habitat map for currently unmapped areas in the proposed reserve regions;
- to assess the accuracy of existing benthic habitat maps;
- to obtain still photographs and video footage for the public participation and management planning processes, and for future management purposes;
- to investigate the status of the reefs through:
  - an investigation of the extent of known crown-of-thorns sea-star infestations;
  - an investigation of the extent of cyclone damage to the fringing coral reefs (both regions), and;
  - an investigation of the extent of recovery of known coral spawn death events.

- to raise the community awareness of planning process, in relation to the proposed Dampier Archipelago/Cape Preston marine conservation reserve, through the media;
- to familiarise CALM's planning staff with the major marine habitats and human activities in the region;
- to identify areas of high multiple use (outer reefs, trawl grounds and potential aquaculture);
- to opportunistically consult with mariculture managers (whose leases are likely to be examined during the planning process), charter operators and the recreating public;
- to document incidental sightings of marine fauna, and;
- to record the number of users observed at selected sites throughout the region.

2.3 METHODS

Study area

The study area for this resource assessment field survey encompasses the proposed marine conservation reserve area of the Dampier Archipelago/Cape Preston region, Western Australia (Figure 1).

Site selection

Potential sites were determined prior the field survey, for various reasons (Bancroft, 1999):

- the investigation of cyclone damage;
- the investigation of Crown of Thorns infestations;
- the investigation of the coral recovery from a coral spawn death;
- the habitat mapping information was deficient, and;
- to gather human usage information.

The actual habitat ground-truthing sites were selected with the consideration of weather and sea conditions, and access.

Field methods

Data was collected to biologically verify marine benthic habitat maps of the Dampier Archipelago/Cape Preston region, through video imagery of the major benthic community types (e.g. seagrass meadows, limestone reefs etc.) and the visually dominant flora and fauna.

Most ground-truthing sites were recorded using a manually deployed drop-down underwater camera system. The video camera was lowered over the side of the field survey vessel and 30 seconds of video imagery of the seabed was recorded at each site. At some sites the hand held video camera was used to obtain footage.

Site number, date, time, water depth, DGPS coordinates, and a description of the habitat was noted and recorded for each section of video imagery.

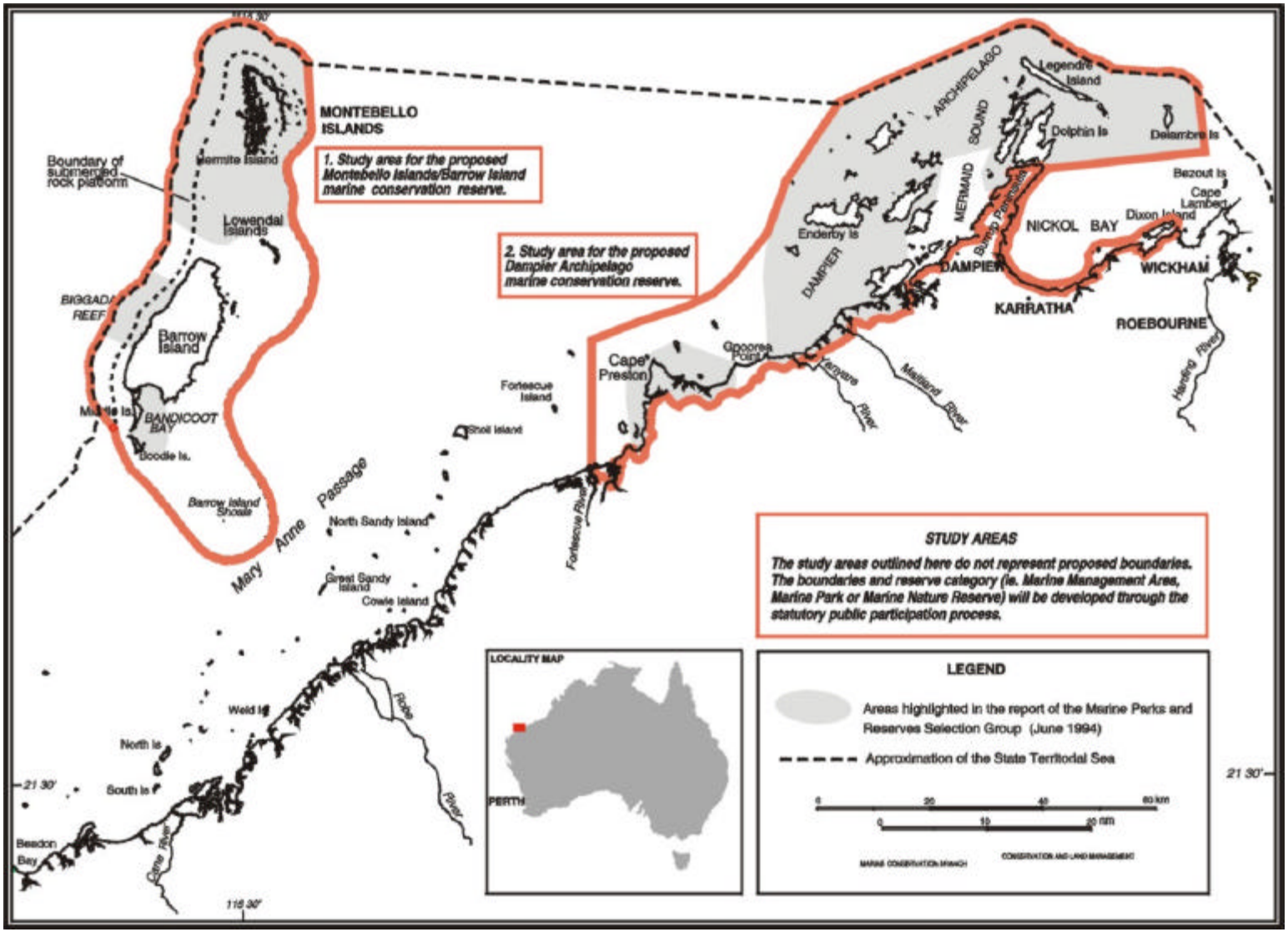


Figure 1 Study area for the proposed Dampier Archipelago/Cape Preston marine conservation reserve

Underwater and above water video imagery was recorded using a Canon MV1 digital video camera. Underwater still photography was taken using a Nikonos V camera with a Nikonos 15 mm wide-angle lens.

Above water still photography was taken using a Canon EOS camera.

Habitat classification

Habitats were classified as per the draft classification scheme presented in Table 1. The classification system is being refined on an on-going basis.

A combined category of "*coral rubble, reef platform, macroalgae (subtidal)*" was used to classify areas described as "scattered isolated corals, rubble, reef platform with some seasonally variable macroalgae cover.

Table 1. Draft habitat classification scheme

HABITAT CLASSIFICATION	TIDAL RANGE	SUBSTRATE TYPE	TROPICAL	TEMPERATE	RELIEF	MACROBIOLOGY	SUB -CATEGORIES	COMMENTS
1. Island	Supratidal	Sand igneous metamorphic sedimentary	✓	✓	high & low	Can be vegetated or bare		• Permanent land above HWM • May have seasonal vegetation • Seabirds, terrestrial mammals & reptiles • Important for marine mammals as haul out or breeding areas
2. Rocky shore	Intertidal Supratidal	igneous metamorphic sedimentary	✓	✓	high & low	bare		• continuous rocky shore • cliff, boulders, pavement • around HWM • "*uncomfortable to walk on*"
3. Beach	Intertidal Supratidal	sand	✓	✓	low	bare		• continuous intertidal sand • unvegetated • mobile sands • "*comfortable to walk on*"
4. Salt marsh	Intertidal Supratidal	mud silt	✓	✓	n/a	samphire saltmarsh blue-green algal mats can be bare		• continuous salt marsh cover (>1 ha) • on protected or low energy coastline • often landward of mangals and estuaries • includes unvegetated coastal saline flats
5. Mangal	Intertidal	Muds silts	✓	✓	n/a	mangroves		• continuous mangrove cover (>1 ha) • mud/sand/intertidal reef/shoreline reef may be present • intertidal gastropods and other invertebrates may be present
6. Mudflat	Intertidal	mud silts	✓	✓	low	bare blue-green algal mats		• continuous mudflat, intertidal or shallow Intertidal or very shallow, <1m lowest astronomical tide (LAT) • includes mudflats behind mangals • intertidal gastropods and other invertebrates may be present
7. Sand shoal	Intertidal	sand	✓	✓	low	bare little macroalgae		• Often in offshore macrotidal areas • medium to coarse sand • highly mobile sand

HABITAT CLASSIFICATION	TIDAL RANGE	SUBSTRATE TYPE	TROPICAL	TEMPERATE	RELIEF	MACROBIOLOGY	SUB -CATEGORIES	COMMENTS
								• Intertidal or very shallow, <1m lowest astronomical tide (LAT) •
8. Shoreline reef platform	Intertidal	igneous metamorphic sedimentary	✓	✓	low	bare, algal turf		• continuous reef platform along the shoreline • may be bare or have macroalgal turf or sand patches • intertidal gastropods and other invertebrates may be present
9. Offshore intertidal reef	Intertidal	igneous metamorphic sedimentary	✓	✓	low	coralline algae, macroalgal turf, macroalgae		• Offshore reef • Intertidal or very shallow, <1m lowest astronomical tide (LAT) • intertidal gastropods and other invertebrates may be present
10. Coral reef communities	Intertidal & subtidal	n/a	✓		high & low	hard & soft corals other sessile invertebrates	• **Coral reef communities (subtidal)** - subtidal, often high live coral cover , coral colonies with sand patches in lagoons ➢ *Seaward reef slope* ➢ *Deep lagoon* • **Coral reef communities** (i**ntertidal or shallow)** - intertidal or shallow, <1m lowest astronomical tide (LAT), often live coral cover is low, ➢ *Reef crest* ➢ *Back reef* ➢ *Reef flat* ➢ *Shallow lagoon*	• typical coral reef community-hard coral, soft coral, sponges, bryozoans, ascidians, etc. • seaward reef slope, reef crest, back reef, reef flat and individual bommies • some sand, pavement, macroalgae or seagrass interspersed
11. Rubble	Subtidal	dead coral	✓		low	sparse live coral sparse vegetation		• lagoonal areas • mainly unconsolidated coral rubble
12. Subtidal reef platform	Subtidal	igneous metamorphic sedimentary	✓	✓	low	diverse algae sessile invertebrates (including sponges, sea-whips, sea-pens)	• **Subtidal reef platform (high relief)** - >1 m high • **Subtidal reef platform (low relief)** - <1 m high	• includes limestone pavement or low relief reef • may be covered with macroalgae or seagrass, patchy mobile sands • may incorporate sand patches, rubble and scattered isolated corals

HABITAT CLASSIFICATION	TIDAL RANGE	SUBSTRATE TYPE	TROPICAL	TEMPERATE	RELIEF	MACROBIOLOGY	SUB -CATEGORIES	COMMENTS
13. Macroalgae dominated limestone reef	Subtidal	sedimentary	✓	✓	high & low	large fleshy macroalgae invertebrates	• **Macroalgae dominated limestone reef (high relief)** - >1 m high • **Macroalgae dominated limestone reef (low relief)** - <1 m high	• typically covered in macroalgae with diverse invertebrate life in overhangs & caves • may incorporate sand patches, rubble and scattered isolated corals
14. Macroalgae dominated granite reef	Subtidal	igneous metamorphic	✓	✓	high & low	Large fleshy macroalgae invertebrates	• **Macroalgae dominated granite reef (high relief)** - >1 m high • **Macroalgae dominated granite reef (low relief)** - <1 m high	• typically covered in macroalgae with diverse invertebrate life in overhangs & caves
15. Seagrass meadows	Subtidal	sand pavement	✓	✓	low	seagrasses	• **Perennial seagrass** - ➢ Perennial seagrass (dense) substrate cover < seagrass cover ➢ Perennial seagrass (medium) substrate cover = seagrass cover ➢ Perennial seagrass (sparse) substrate cover > seagrass cover • **Ephemeral seagrass** - ➢ Ephemeral seagrass (dense) ➢ Ephemeral seagrass (medium) ➢ Ephemeral seagrass (sparse)	• continuous seagrass coverage (>1 ha) • ephemeral seagrass species *Halophila* • perennial seagrass species *Amphibolis, Cymodocea, Enhalus, Halodule, Heterozostera, Posidonia, Syringodium, Thalassia Thalassodendron, Zostera*
16. Sand	Subtidal	Sand (generally white)	✓	✓	low	Bare may have seagrass or macroalgal patches		• little or no vegetation • may have patches of other habitat • may overlay reef platform • may have patches of seagrass or macroalgae • may have seasonal vegetation
17. Silt	Subtidal	muds silts	✓	✓	low	bare		• marine and/or terrigenous muds & silts • little or no vegetation • may have seasonal vegetation

Mapping methods

The habitat maps for the Dampier Archipelago/Cape Preston marine conservation reserve was developed using ArcView Version 3.2 (ESRI). The method used in the mapping of the marine benthic habitats was as follows:

(a) Acquired existing habitat GIS data layers,

(b) Performed a union of datasets in ArcView;

(c) The attributes to the datasets were cleaned for errors such as spelling and typing errors, and a restructure of categories was performed;

(d) Resolved multiple classifications in existing data;

(e) Standardised habitat attributes to the CALM draft broadscale habitat classification (Table 1);

(f) Prioritised datasets by their spatial accuracy, spatial extent and habitat attribution;

(g) Adjusted polygons by overlaying habitat data on Landsat and/or aerial and/or Digital Multi-Spectral Video (DMSV) imagery, and;

(h) Modelled unknown or not attributed areas based on field verification data, ecological knowledge and local knowledge.

The extent of silt and sand habitats were modelled in the development of the habitat layers. The transition boundaries were determined through understanding the oceanographic processes that occur within the Archipelago. The basic argument is that sand habitats occur where there is high current influence resulting in fine sediment particles being transported elsewhere. Alternately silt habitats occur where there is low current influence and low wave exposure resulting in finer sediments settling out of the water column.

2.4 RESULTS

Site and Habitat data

A total of 81 ground-truthing sites were surveyed in the field from the Dampier Archipelago/Cape Preston region (Figure 2 & 3). Site information, location, habitat classification and biological assemblage data was collected. This data was used in conjunction with satellite and aerial imagery to produce a revised broadscale map of the major marine habitat types for the study areas (Figure 4).
There were 17 habitat types identified:

1. Island;
2. Rocky shore;
3. Beach;
4. Saltmarsh;
5. Mangal;
6. Mudflat;
7. Sand shoal;
8. Shoreline reef platform;

9. Offshore intertidal reef;
10. Coral reef communities (subtidal);
11. Coral reef communities (intertidal or shallow <1m LAT);
12. Rubble;
13. Subtidal reef platform;
14. Macroalgae dominated limestone reef (low relief),
15. Sand;
16. Silt, and;
17. Pelagic communities.

These categories are defined in Table 1.

Subsequent Groundtruthing

An additional 78 sites were surveyed on 21 – 26 May 2000 in the Dampier Archipelago/Cape Preston region, to confirm habitat classifications in areas which were uncertain following the initial survey. This subsequent survey focused on deep channels and deep offshore areas, with the aim of refining the extent of filter feeder communities.

Still photography and digital video footage

Underwater video footage was recorded at all of the ground-truthing sites. This footage was coded by site and referred to in the habitat data and provides examples of all habitat types encountered.

Underwater and above water still photography and video footage was taken whenever possible to record icon marine fauna and flora, prominent local landmarks and features.

The information has been archived in CALM's Marine Conservation Branch's video and slide libraries.

2.5 DATA MANAGEMENT

Data report

Hard copies of the benthic habitat data report will be held at three locations:

1. Marine Conservation Branch, Department of Conservation and Land Management, 47 Henry St., Fremantle Western Australia, 6160. Ph. (08) 9432 5100 Fax. (08) 9430 5408.

2. Woodvale Library, Science and Information Division, Ocean Reef Rd., Woodvale, Western Australia, 6026. Ph. (08) 9405 5100 Fax. (08) 9306 1641.

3. Archives, Woodvale Library, Science and Information Division, Ocean Reef Rd., Woodvale, Western Australia, 6026. Ph. (08) 9405 5100 Fax. (08) 9306 1641.

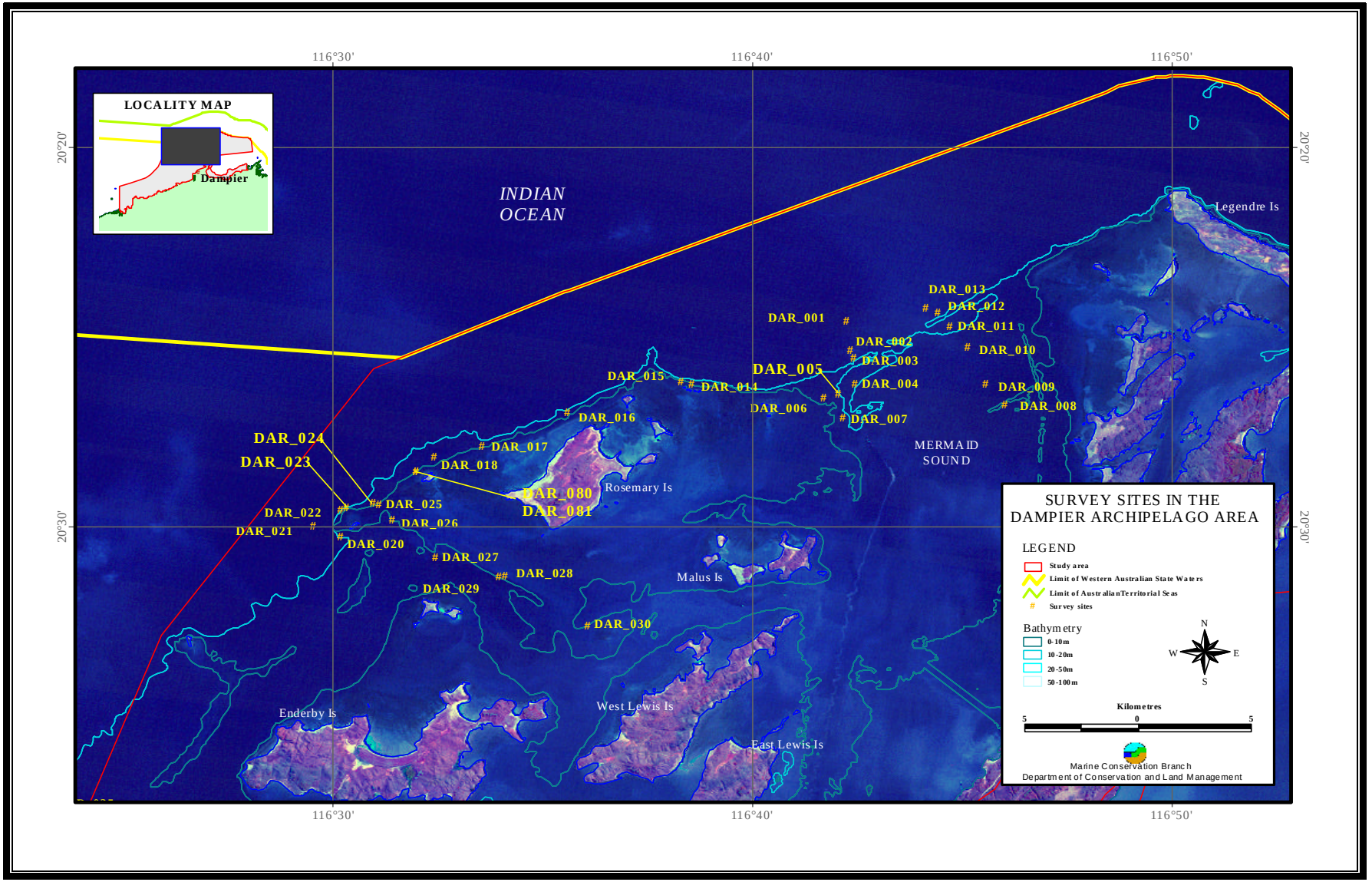


Figure 2 Benthic habitat ground-truthing sites for Dampier Archipelago

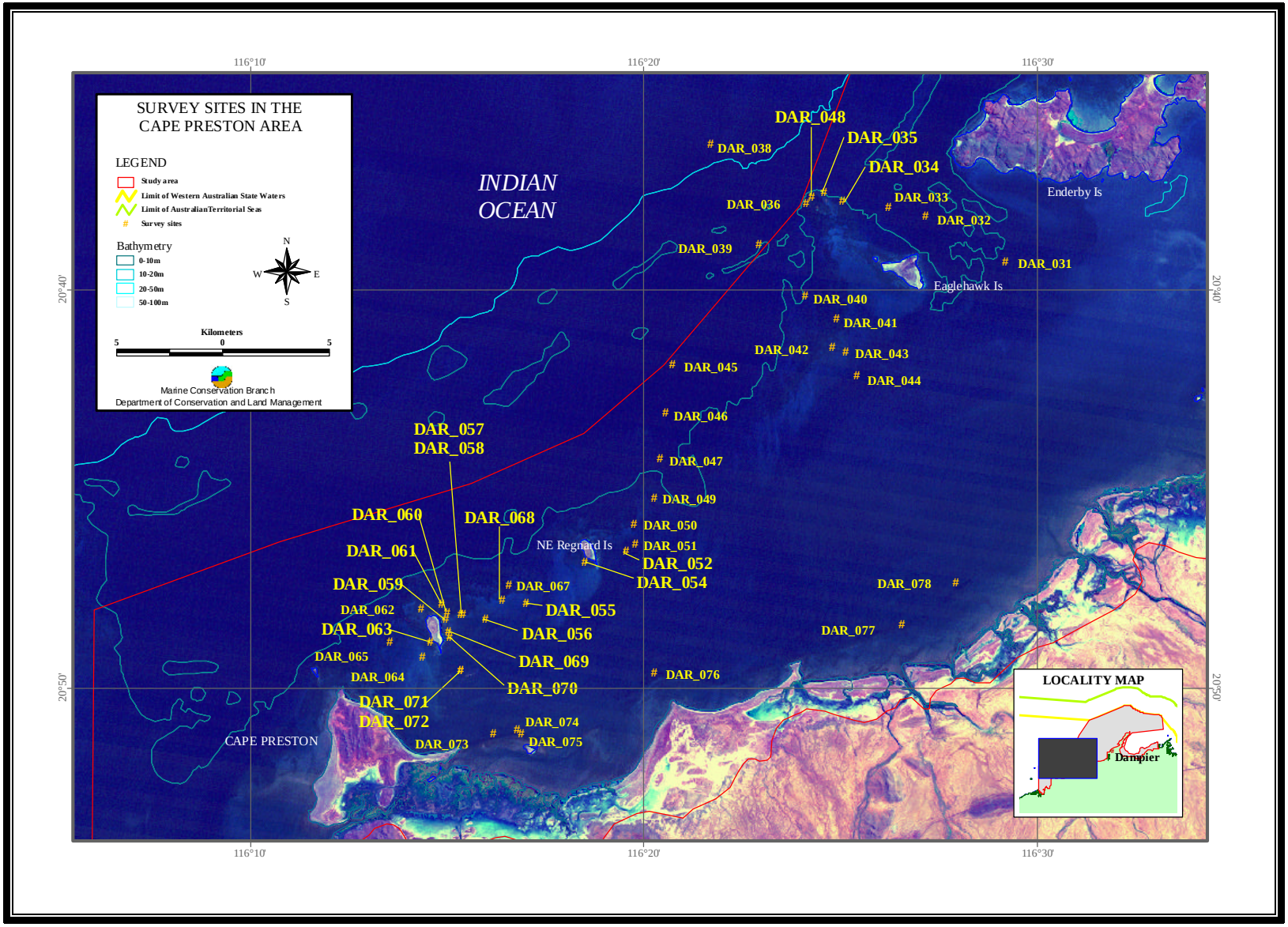


Figure 3 Benthic habitat ground-truthing sites for Cape Preston

The Marine Conservation Branch will hold digital copies of the benthic habitat data report at three locations:

1. The Marine Conservation Branch Server:
   mcb on StreetTalk\User Data@CALM.FREM@CALM [T:/Reports/MRI/mri_3400]

2. MCB Server full backup DAT tape [T:/Reports/MRI/mri_3400]

3. CD-ROM [mri_3400]

GIS data

Data presented in the form of GIS layers will be stored digitally at three locations:

1. The Marine Conservation Branch Server:
   GIS Data@FREM.SHARED@CALM on StreetTalk
   [L:\Marine_Information\Data\Production\Marine_Biology\Benthic_habitats\CALM/]

2. MCB Server full backup DAT tape:
   [L:\Marine_Information\Data\Production\Marine_Biology\Benthic_habitats\CALM/]

3. On GIS Information Coordinator's [L] drive backup DAT Tape:
   [L:\Marine_Information\Data\Production\Marine_Biology\Benthic_habitats\CALM/]

Video Records

Five mini digital video (MDV) tapes were used to record resource imagery and habitat data. Tape numbers are:

1. MRI/PI/DA/HH#2-06/1999

2. MRI/PI/DA/HH#3-06/1999

Three VHS tapes were used to record resource imagery and habitat data. Tape numbers are:

1. MRI/PI/DA/DD#1-06/1999

2. MRI/PI/DA/DD#2-06/1999

Video footage will be held at two locations:

1. MDV masters to be archived at the CALM Information Management Branch, Kensington.

2. MDV copies to be stored at CALM Marine Conservation Branch, Fremantle.

Still photography

All slide photographs are held at CALM's Marine Conservation Branch (MCB), Fremantle, Western Australia.

Digital images of selected slides are available on the MCB slide library.

Meta data

Table 2 Benthic habitat metadata

GIS shapefile	Spatial extent	Brief description
mangrov_p	Exmouth to Dampier	Polygon data with attributes: feat_code and md_code
sw_habit_p	North West Shelf	Polygon data with attributes: Habitat and md_code.
coast_mudflats_p	North West Shelf	Source: Auslig & 1994 Leprovost Dames & Moore Map
nw_shelf_marine_p	North West Shelf	Source: sw_habitat_p (BHP Dataset) & 1994 Leprovost Dames & Moore Map

All data courtesy of Apache Energy Pty Ltd

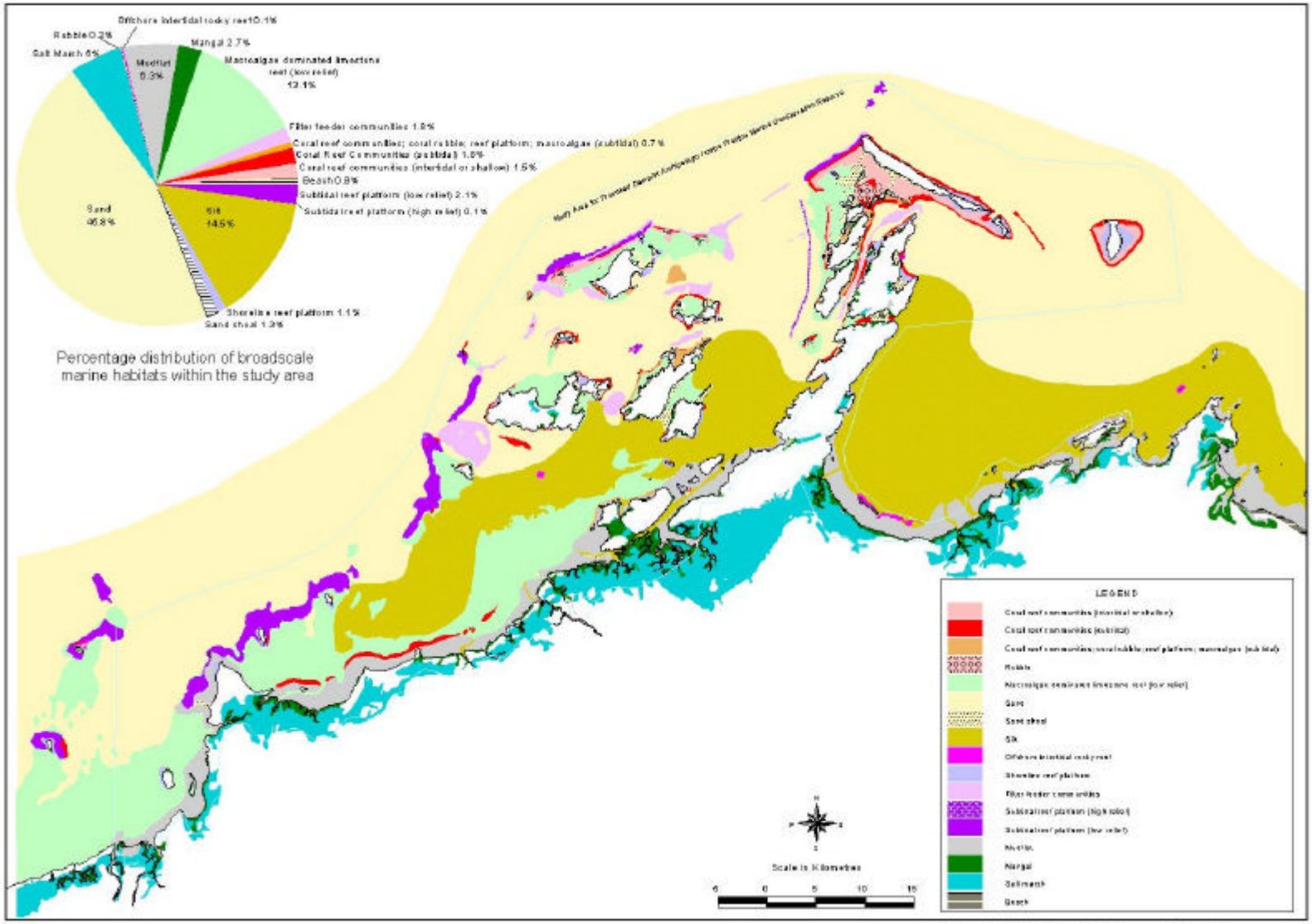


Figure 4 Broadscale benthic habitat map for Dampier Archipelago / Cape Preston

Chapter Three

RESOURCE ASSESSMENT: HUMAN USAGE

CHAPTER THREE RESOURCE ASSESSMENT: HUMAN USAGE

3.1 INTRODUCTION

The Dampier Archipelago region has been selected by the state government for consideration as a marine conservation reserve under the *CALM Act* (1984). The region was selected after being identified in the report, *A Representative Marine Reserve System for Western Australia* (CALM 1994) as an area worthy of reservation. To assist in the planning process, data have been gathered on the human activities currently undertaken in the study area (Figure 1). This report presents the spatial boundaries and intensities of various human activities, including recreation, commercial fishing, industrial development and marine infrastructure.

3.2 SOURCES & METHODS

Data was collected based on the general list in Table 2, which lists required socio-cultural datasets for management of marine parks. All data except the recreational data was taken from existing digital datasets from government departments.

The spatial recreational fishing data was gathered in a three-step process. In the first step, Andrew Hill of CALM consulted with Dennis Bryan-Smith (DAPA and Adventure Dive Charters).

In step two, Fran Stanley from the Karratha Office of CALM verified this preliminary information with people with extensive local knowledge. The contributors to the line fishing data were:
- Dennis Bryan-Smith
- Bob and Anna Vitenbergs
- Mike Moore of Deck 'em Charters
- Rick MacGregor of Point Samson Charter Company
- Alan Patzak of Tidal Zone Charters
- Tim Anderson of Tackle Time
- Warren Hoskin of Nor-West Game Fishing Club.

The contributors to the scuba diving data were:
- Rick MacGregor
- Paul and Bev Horton of Port Walcott Dive Club
- Mike Moore
- Pat Ellison
- Bob and Anna Vitenbergs
- Dennis Bryan-Smith
- Adam Ambroziak of Adventure Dive Charters
- Shane Peters of Dampier Island Tours

The contributors to the shore based activities data were:
- Bob and Anna Vitenbergs
- Trevor Solomon
- Fran Stanley of CALM

The contributors to the spearfishing data were:
- Adam Ambroziak
- Pat Ellison
- Mick Davis.

The final step involved the data being checked by Len Vertigan of the Pilbara Recreational Fishing Advisory Council.

The metadata for each data set used is provided in Table 3. For more detailed metadata refer to the custodians (source) listed in Table 3. As the data was collected, the relevant sections were added to a digital database in the form of ArcView shape files. To allow for a common viewing environment, all data was converted to Australian Map Grid 1984, with World Geodetic Spheroid Datum 1984. Any information relating to the data is labelled metadata.

3.3 DATA MANAGEMENT

Raw data

Raw data was collected only for recreation and recreational fishing uses. The hand drawn and edited maps are stored in hard copy, at Marine Conservation Branch Office and at the Karratha regional office.

Final Product

The spatial data is stored in three forms; a report, a CD/ROM and within the Marine Conservation Branch spatial database.

- The report contains hard copy maps of all the activities carried out within the study area.

- The CD/ROM contains the ArcView project and associated data and will be stored at the Marine Conservation Branch or the Regional Office.

- The Marine Conservation Branch spatial database contains a winzip file of the ArcView project file and the associated data.

Table 3 Required Socio-Cultural Datasets for Management of Marine Parks

Tenure
- Territorial Water Limits
- Existing management/Ownership
  Conservation Reserves (CALM)
  Other Reserves (Govt./vested)
  Private/Leasehold/VCL
- Proposed Conservation Reserve
- Marine Park Zoning
- Petroleum Leases
- Mining Leases
- Aboriginal Claim Boundaries
- Historical
  Australian Heritage Commission areas
  Aboriginal Sacred and Ceremonial Sites
  Heritage/ Historical Sites
  Shipwrecks

Urbane & Tourism Development
- Urban Development
  existing
  proposed
- Resort
  existing
  proposed
- Camping
  existing
  wild (free)
  proposed

Industrial Development
- shipping
- oil & gas exploration
- oil & gas production
- mining
- other industries

Maritime Infrastructure
- anchorages
- shipping lanes
- port facilities
- marina facilities
- moorings
- groynes
- boat ramps
- navigation markers
- fish attracting devices

Commercial Fishing
- trawling
- wetline fishing
- netting
- fish-trapping
- rock lobster
- abalone
- aquaculture
  non-feeding
  feeding
- collection
  invertebrates
  vertebrates

Recreation: Fishing
- rod & line fishing
  shore based
  boat based
- netting
  set
  haul
  throw
- drop netting
- spearfishing
- shell collection
- rock lobster
- crabbing
- abalone
- game fishing
- bait collection

Recreation: Non-extractive
- powerboats
- hovercraft
- water skiing
- jet skiing
- parasailing
- float planes
- sailing vessels
- paddle boats
- kayaks/canoes
- windsurfing
- scuba diving
- snorkelling
- wildlife viewing
- wildlife interaction
- surfing
- swimming
- reef walking
- beach walking
- beach launching

Scientific
- research and monitoring
- extractive

Table 4 Human Usage Metadata

Required Dataset	Theme	Filename	Source	Source Filename	Completeness
Tenure					
Territorial Water Limits	Territorial Water Limits	Dacoast_ll_wgs.shp	AMBIS	Ambis.shp	Complete
EXISTING LEASEHOLD/MANAGEMENT					
Conservation Reserves	Conservation Reserves	Dacalmreserves_ll_agd.shp	CALM	Clw498ll_m.shp	Complete
Other Reserves	Other Reserves	Daocres_ll_agd.shp	CALM	Ocres.shp	Complete
Private/Leasehold/VCL	Cadastre	Dacadastre_ll_agd.shp	DOLA	SCDB CD/ROM	Complete
Proposed Conservation Area	Proposed Conservation Area	Dastudyarea_ll_agd.shp	CALM (MCB)		
Marine Park Zoning	Not Applicable				
Petroleum Leases	Petroleum Leases	Daleases_ll_wgs.shp	DME	Wapmap_99_02_15_ll_wgs84.shp	Complete
Mining Leases					
Aboriginal Claim Boundaries	Aboriginal Claim Boundaries	Datitle_ll_wgs.shp	AAD	Native_title_290300.shp	Complete 3/2000
Historical					
Australian Heritage Commission Sites					
Aboriginal Sacred and Ceremonial Sites	Aboriginal Sacred and Ceremonial Sites	Daabsites_ll_wgs.shp	AAD	Sites_ll_wgs84.shp	
Heritage/Historical Sites					
Shipwrecks	Not Applicable				
Urban & Tourism Development					
Urban Development	Town Planning Scheme Borders	Datownsites_ll_wgs.shp	MfP		Complete
Resort Development					
Campsites	Areas of free camping & beach shacks.	Dacampshacks_ll_wgs.shp	Regional Office Information		Still being checked
Airstrips	Airstrip	Daairstrip_ll_wgs.shp	Apache		Complete
Roads	Road system	Daroads_ll_wgs.shp	Apache	Roads_apache.shp	unknown
Industrial Development					
Shipping	Navy Navigation Charts		Australian Hydrographic office	CD/ROM Seafarer A00742.tif A00057.tif	Complete
Oil/Gas Exploration	Not Applicable				
Oil/Gas Production	Not Applicable				
Mining	Not Applicable				
Maritime Infrastructure					
Anchorages	Navy Navigation Charts		Australian Hydrographic office	CD/ROM Seafarer A00742.tif A00057.tif	Complete
Shipping Lanes					
Port facilities					
Marina facilities					
Moorings					
Groynes					
Navigation Markers					
Boat ramps					
Fish Attracting Devices					

Required Dataset	Theme	Filename	Source	Source Filename	Completeness
Commercial Fishing					
Licence Areas	Nickol Bay Prawn LEF	Nickbaylicence_ll_wgs.shp	Fisheries WA	Fl_nbplef.shp	Complete 2/98
	Onslo Prawn LEF	Onslolicence_ll_wgs.shp		Fl_opmf.shp	Complete 1/98
	Principle fishing areas	daPrincfsh_ll_wgs.shp		Princfsh_wgs84.shp	Complete
	Mudcrab Fisheries Licence Area	damudcrabfla_ll_wgs.shp		Fl_mcf.shp	Complete 12/97
Trawling	Pilbara Fish Trawl Interim Mgmnt Area	datrawl_fla_ll_wgs.shp	Fisheries WA	Fl_pftimf.shp	Complete 7/97
Wetline fishing					
Netting					
Fish-trapping					
Rocklobster	Tropical Rock Lobster FLA	Darocklobsterfla_ll_wgs.shp	Fisheries WA	Fl_trlf.shp	Complete 1/98
Aquarium Collecting		Daaquariumcollecting_ll_wgs.shp	Regional Office Information		Still being checked
Abalone	Not Applicable				
Aquaculture licenses (non-feeding/feeding)	Aquaculture licenses	Daaquacult_ll_wgs	Fisheries WA	Aq090899_wgs84.shp	Complete
Recreation					
Fishing					
Netting					
Abalone					
Game fishing					
Bait collection					
Rod & line fishing	Linefishing	Dalinefish_ll_wgs.shp	Regional office information		Not Complete
Spearfishing	Spearfishing	Daspearfish_ll_wgs.shp	Regional office information		Not Complete
Crabbing	Blue manna crabs, and mudcrabbing	Dacrab_ll_wgs.shp	Regional office information		Not Complete
Shell collecting	Shorebased recreation	Shorebased_ll_wgs.shp	Regional office information		Not Complete
Rocklobster	Corresponds to scuba areas		Regional office information		Not Complete
Non-extractive					
Water skiing	DoT Waterski designated area	Dawaterski_ll_agd.shp	DOT	Navwatersz50_gda.shp	complete
Jetskiing					
Parasailing					
Sailing					
Powerboats					
Hovercraft					
Float planes					
Paddle boats					
Kayaks/canoes					
Windsurfing					
Beachwalking	Shore Based Recreation	dashorebased_ll_wgs.shp	J. Carey field notes, regional office information	-	Still being checked
Swimming					
Reef walking					
Beach launching					
Surfing areas					
Scuba Diving Snorkelling	Scuba Diving and Snorkelling Areas	dascuba_ll_wgs.shp	regional office information		Still being checked
Wildlife Interactions					

3.4 RESULTS

A summary of the currently available data is given in Table 4. Further details (metadata) are contained in the Table 3, the metadata.

Onshore Infrastructure

The data supplied by the Ministry for Planning (Shown in Figure 5) gives the area covered by the Dampier and Karratha Town Planning Schemes. While this may not all be urban development at the moment, it is the effective boundary for all future urban development in the area.
Apache supplied the airstrip and road data.

Reserves

There are two CALM reserves within the study area (shown in Figure 6). These are the Dampier Archipelago Island Nature Reserves and the Great Sandy Island Nature Reserve. The other Crown Reserves within the study area are generally concerned with roads or town planning, although there are several for parkland and the protection of aboriginal cultural material.

Aboriginal Sacred Sites

The information provided by the Aboriginal Affairs Department consists of aboriginal sacred sites with buffers of either 1 or 10 kilometre squares. Further information is available about the nature of each site, with categories such as ceremonial, quarry, midden or artefacts. Most sites also have names and an indicator of reliability. The position of each of the buffers is presented in Figure 7

Native Title Claims

There are four separate overlapping claims within the Dampier study area. These are shown in Figure 8. The data includes the name of each claim and the claim number and status with the Aboriginal Affairs Department.

Petroleum Leases

The petroleum leases dataset is correct as at 15 February 1999. According to the data from Department of Minerals and Energy, there are currently no exploratory or producing wells within the study area. The petroleum leases are shown in Figure 9. The Apache pipeline data was digitized from the bathymetry, where it showed as a distinct feature.

Fisheries Licence Areas

The licensing areas set out by the Fisheries WA are drawn in Figure 10. Fisheries WA supplied the datasets, most of which were created in July 1997. The only exception was the Tropical Rock Lobster Fishery, created January 1998 to include the "Prohibition on commercial fishing for Rock Lobster (Dampier) order 1997".

Aquaculture Licenses

Fisheries Department supplied this data, which is accurate up to 9 August 1999. The license areas are shown in Figure 11.

Aquarium Collecting

This dataset was digitized from regional office information in April 2000. The aquarium collecting areas are shown in Figure 12.

Line Fishing

The line fishing areas are shown in Figure 13. The sites further from Dampier, in the outer archipelago and reefs, are more popular in fine weather. 'Bad' weather results in more inshore fishing, and fishing on the lee side of islands and the peninsula.

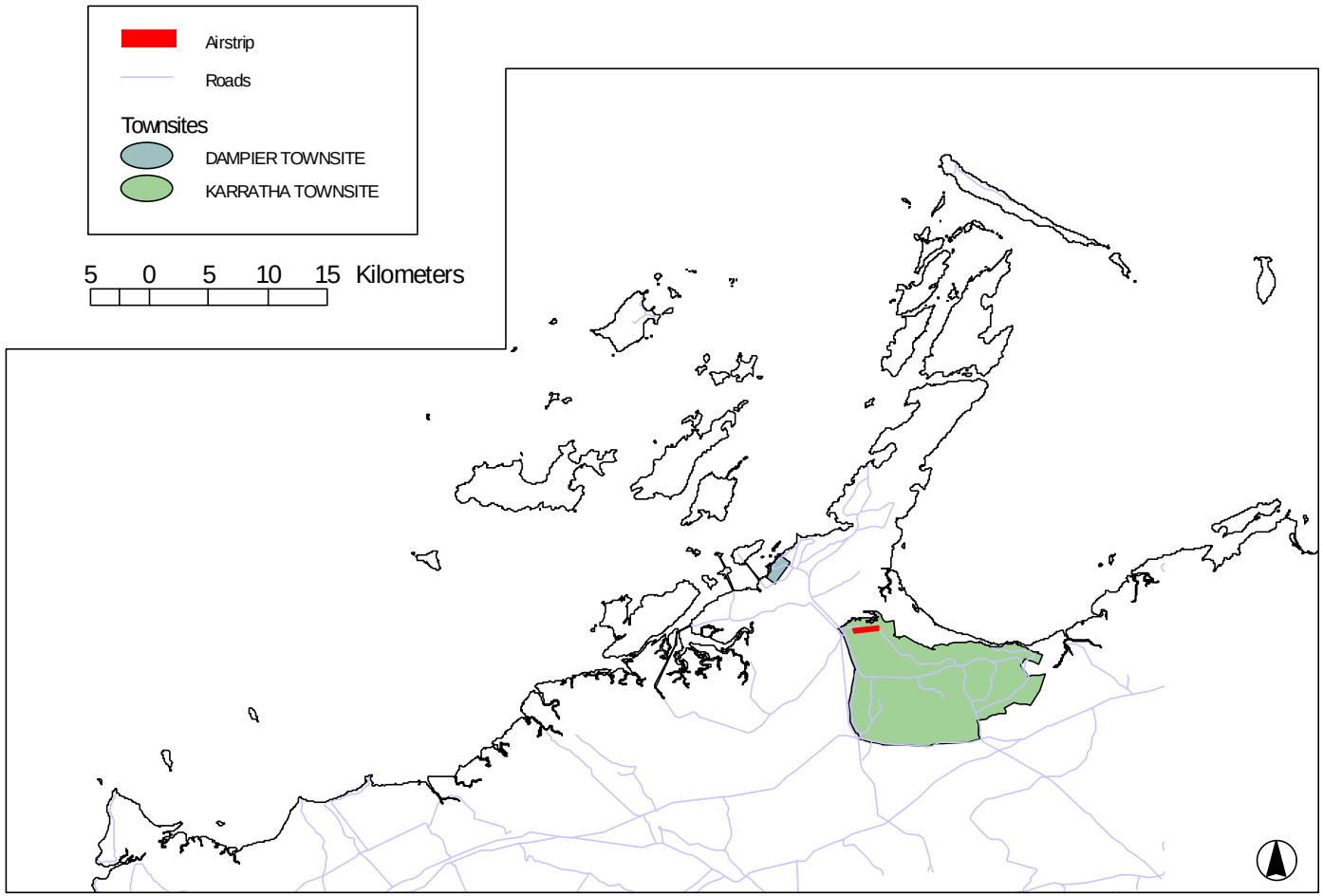


Figure 5 Onshore Infrastructure: Town planning scheme boundaries, roads and airstrips

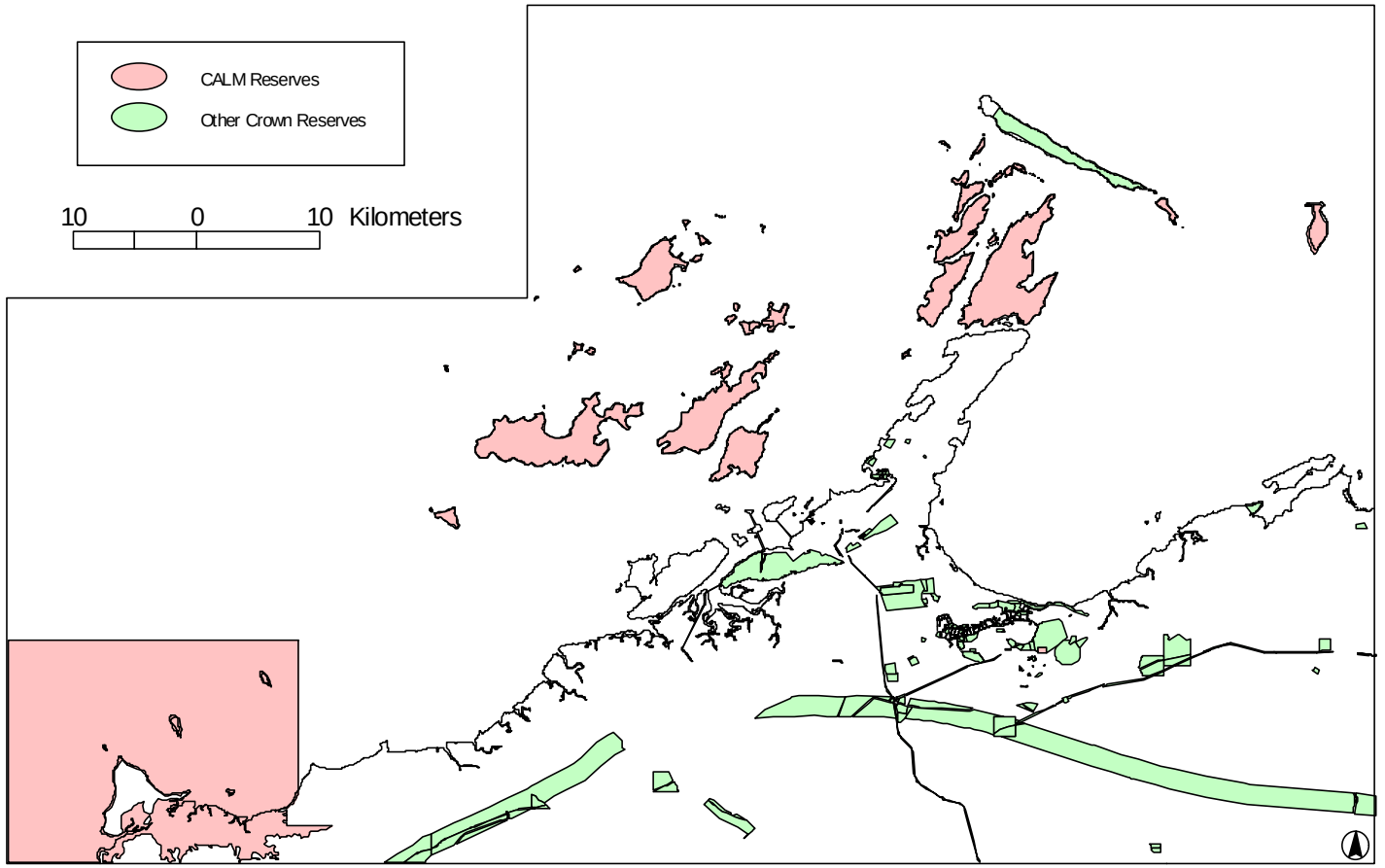


Figure 6 CALM and other reserves in the study area

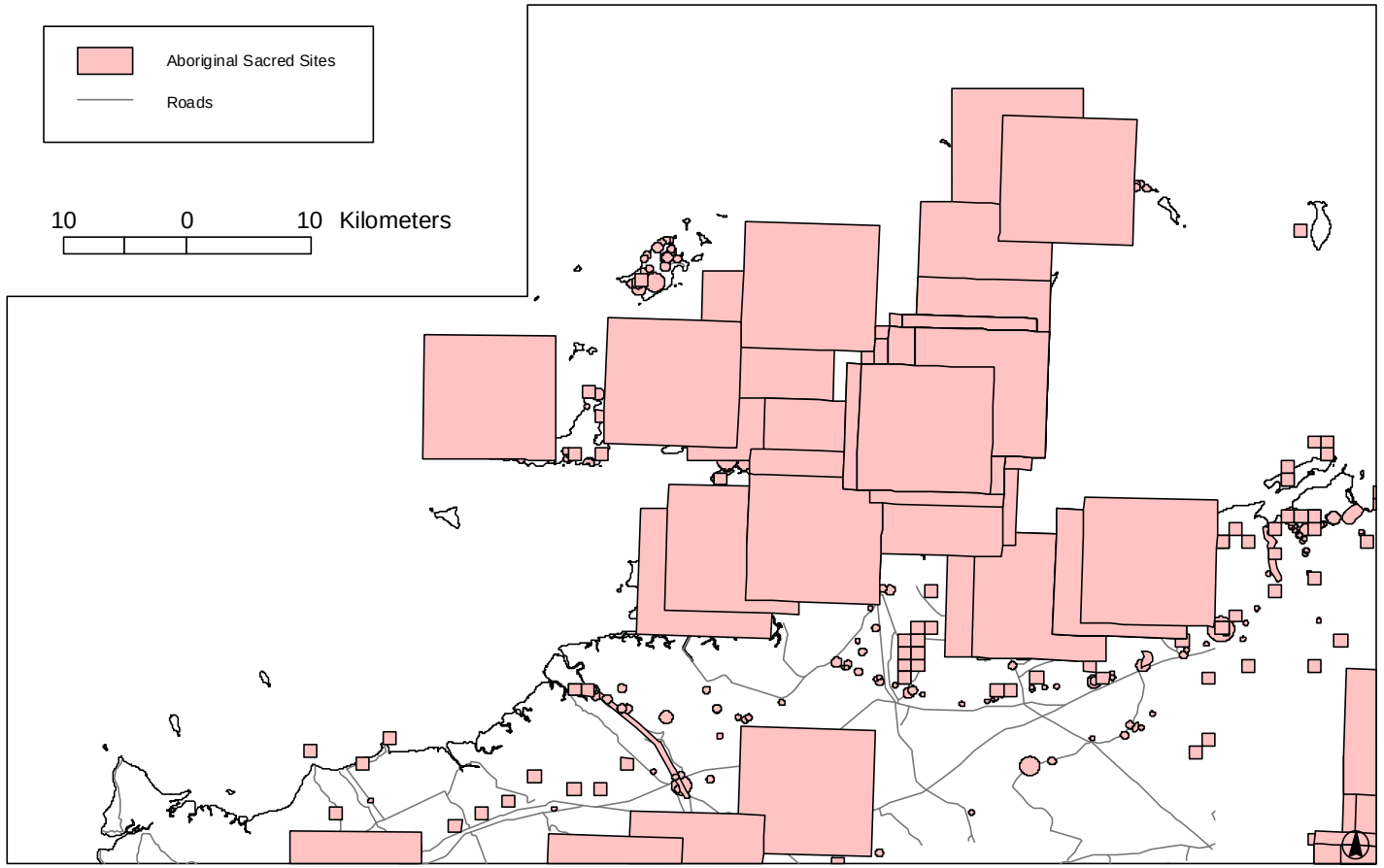


Figure 4: Aboriginal Sacred Sites - provided by Aboriginal Affairs Department

Figure 7 Aboriginal sacred sites in the study area

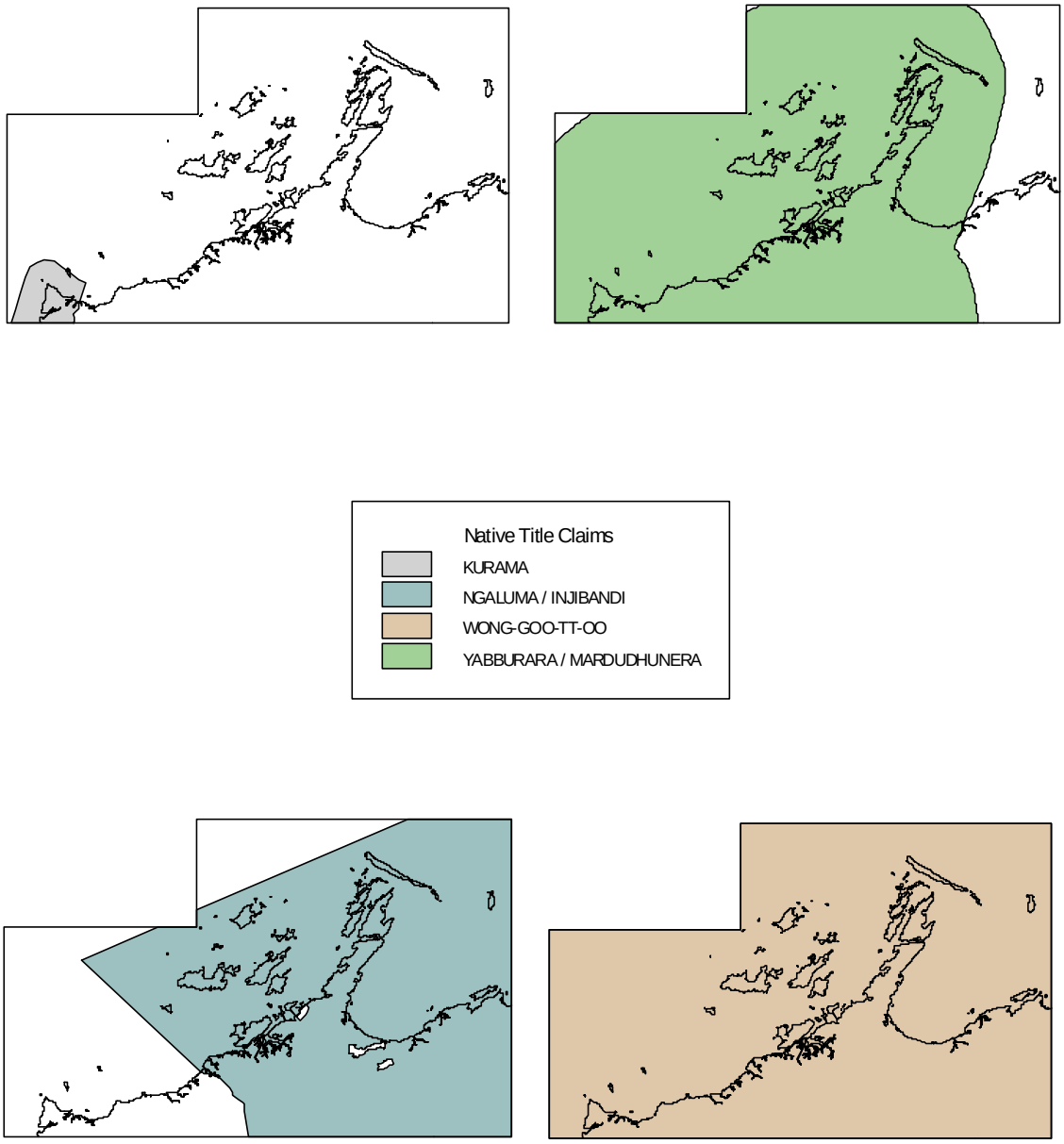


Figure 8 Native title claims in the study area

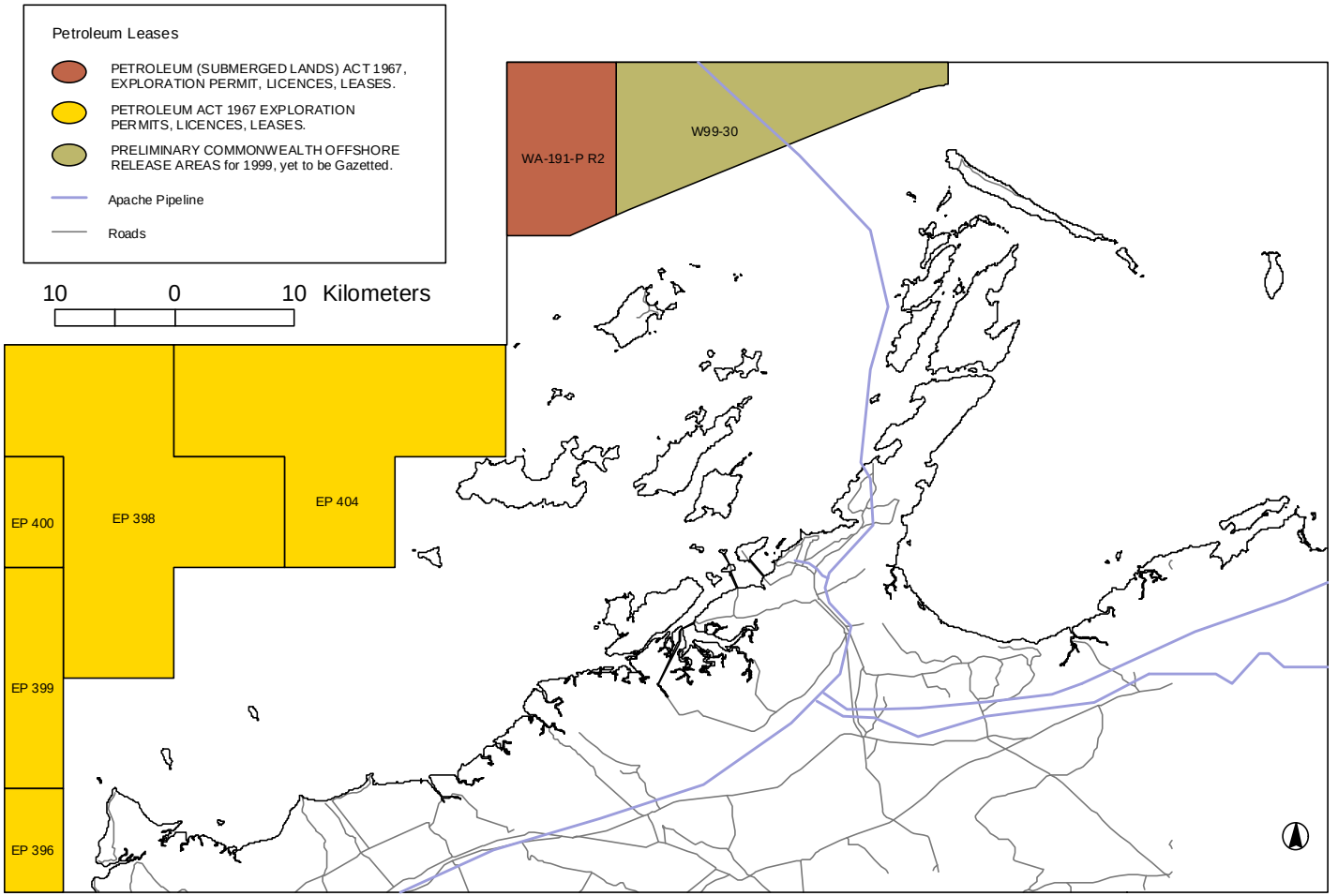


Figure 6: Petroleum Leases and the Apache Pipeline

Figure 9 Petroleum leases in the study area and the Apache pipeline

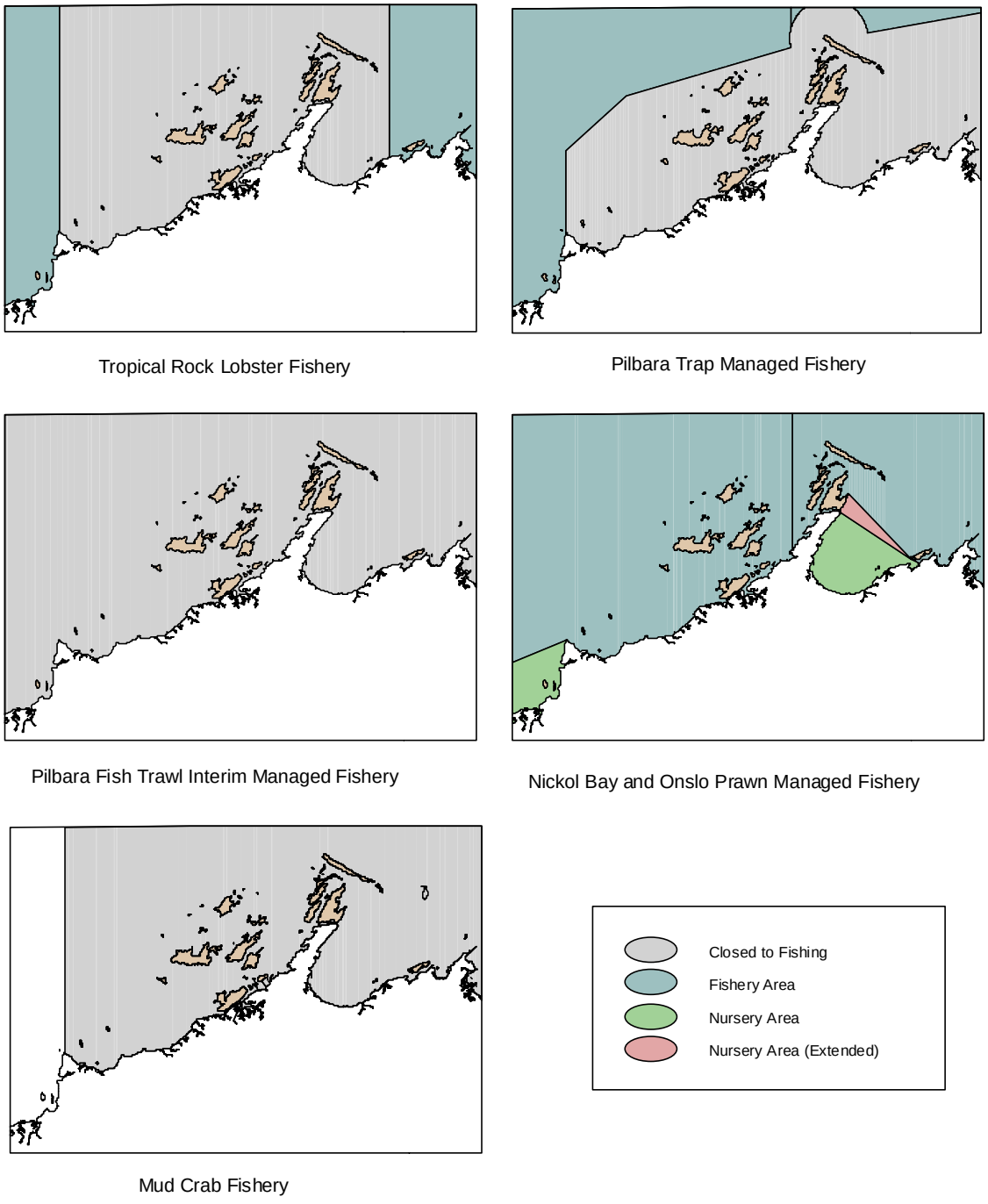


Figure 7: Fisheries Licence Areas

Figure 10 Fisheries licence areas in the study area

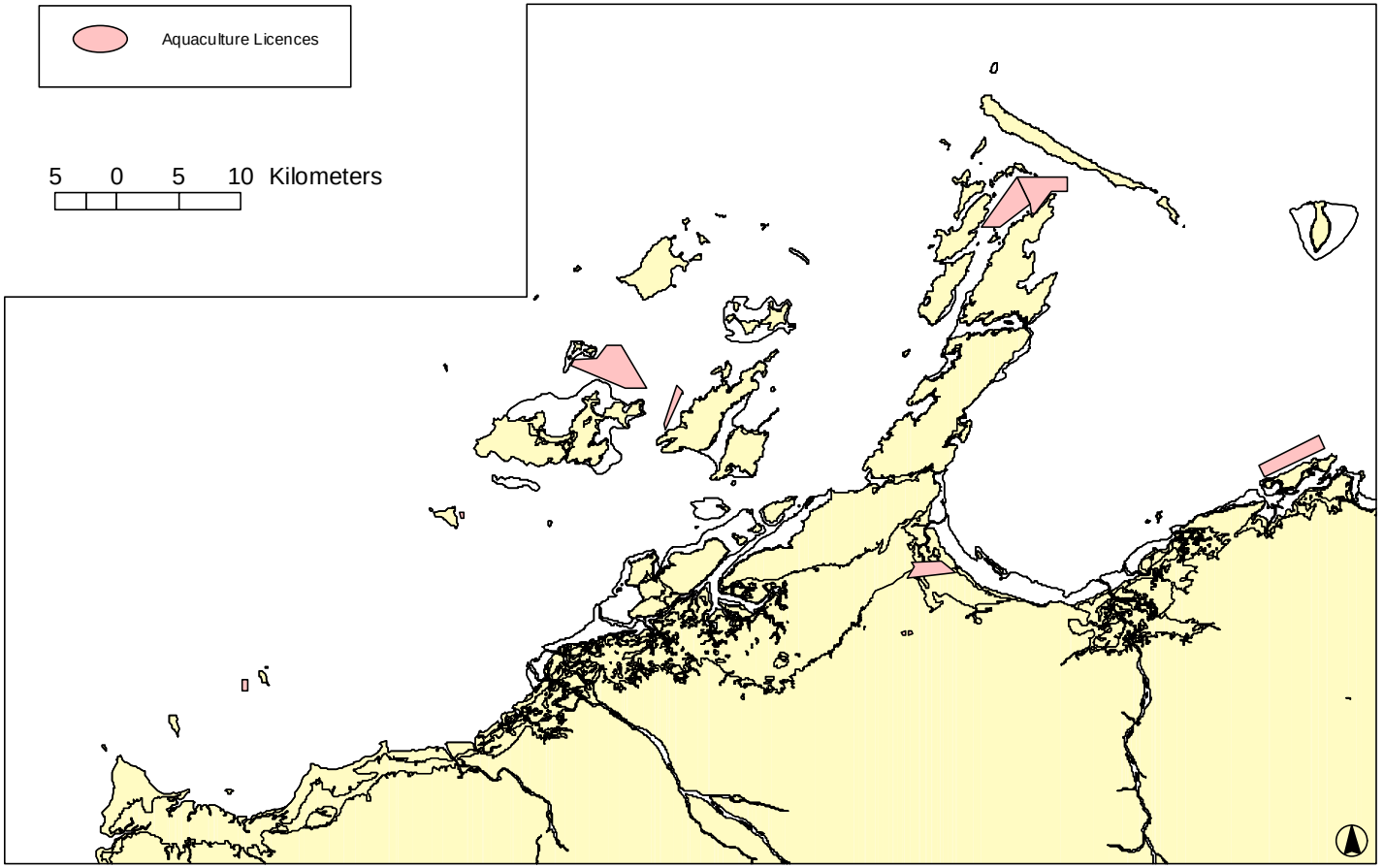


Figure 8: Aquaculture Licences

Figure 11 Aquaculture licences in the study area

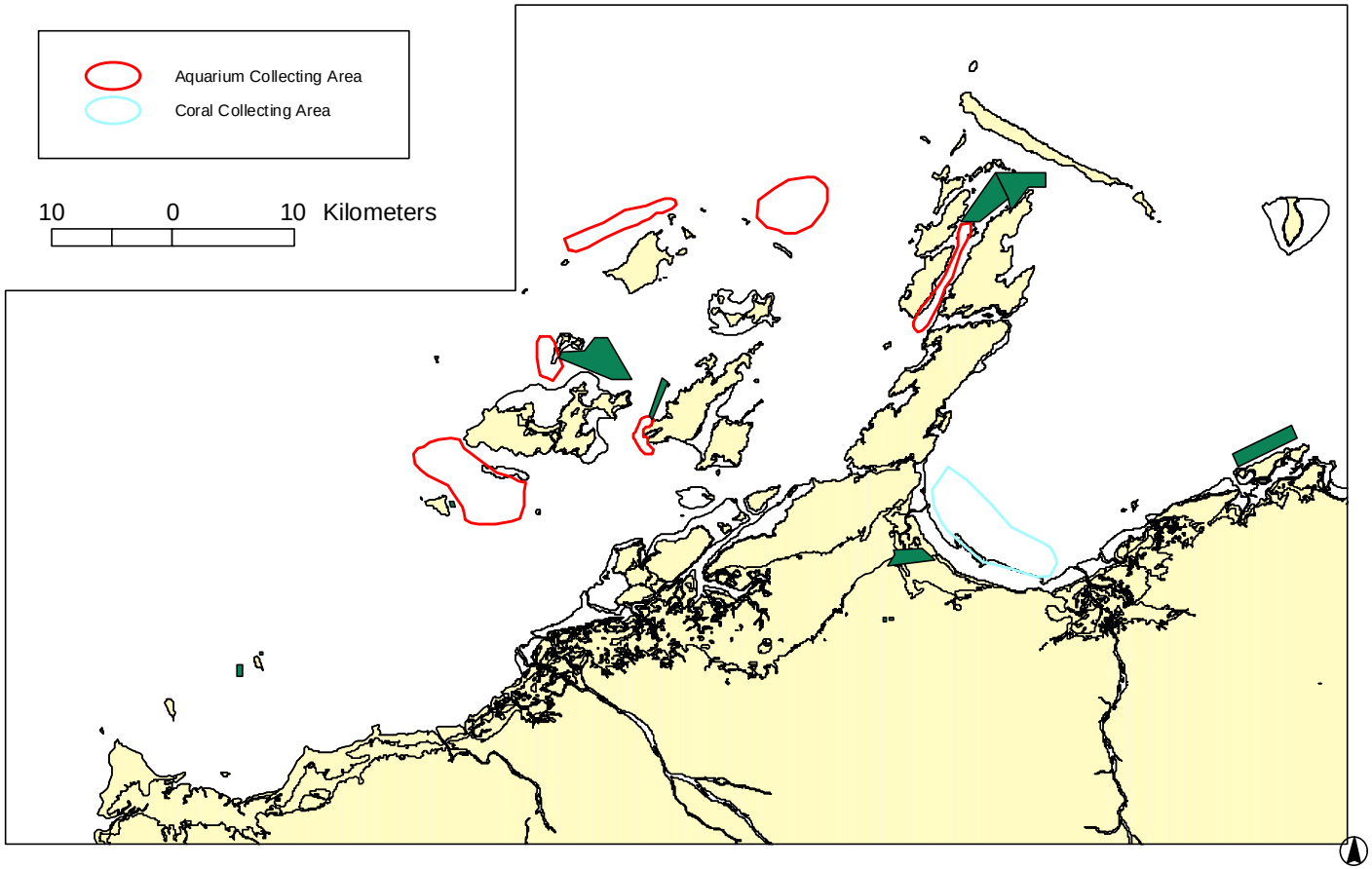


Figure 9: Aquarium Collecting

Figure12 Aquarium collecting in the study area

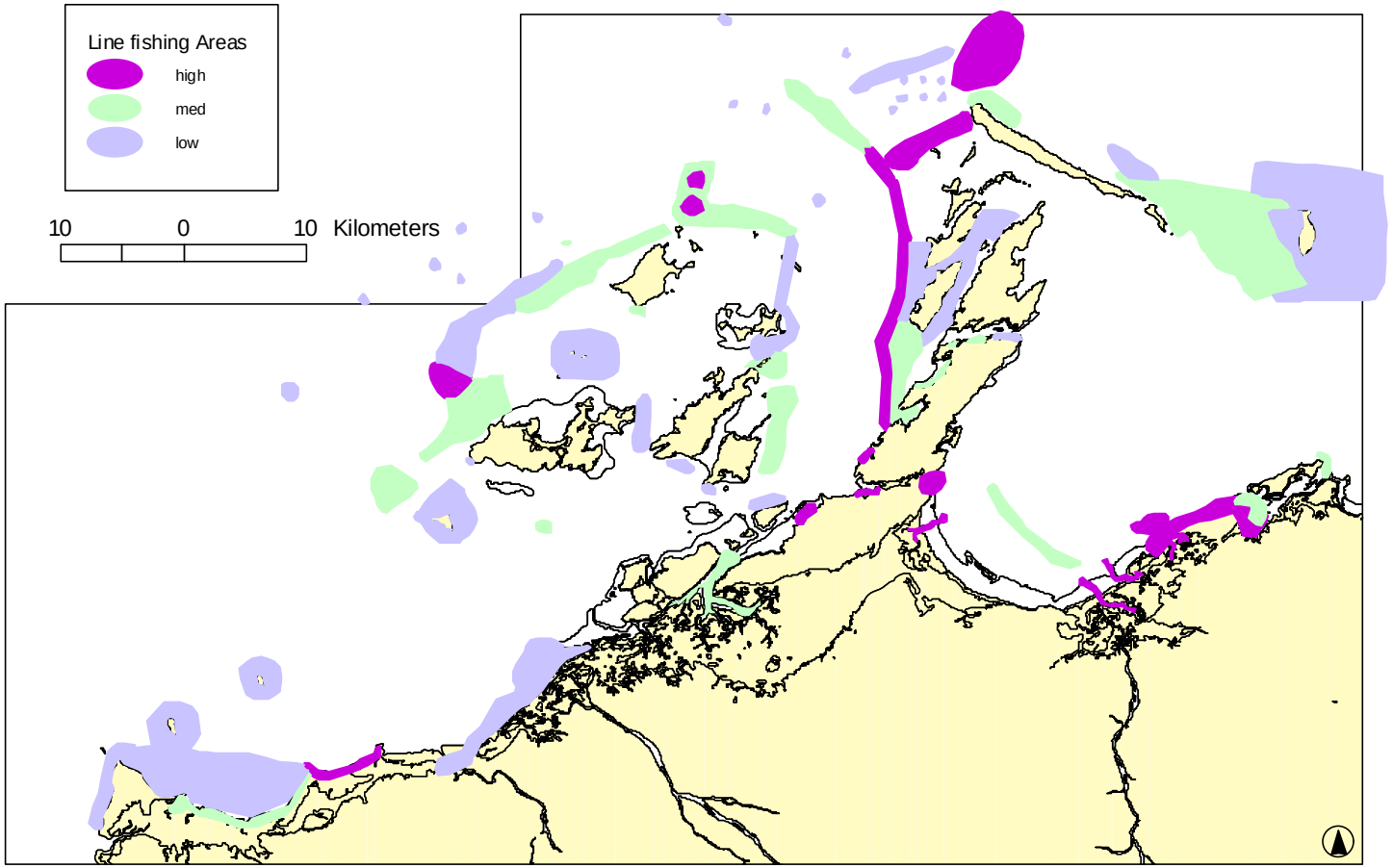


Figure 10: Line Fishing Areas - Compiled from local knwoledge by Regional Office of CALM.

Figure 13 Line fishing areas in the study area

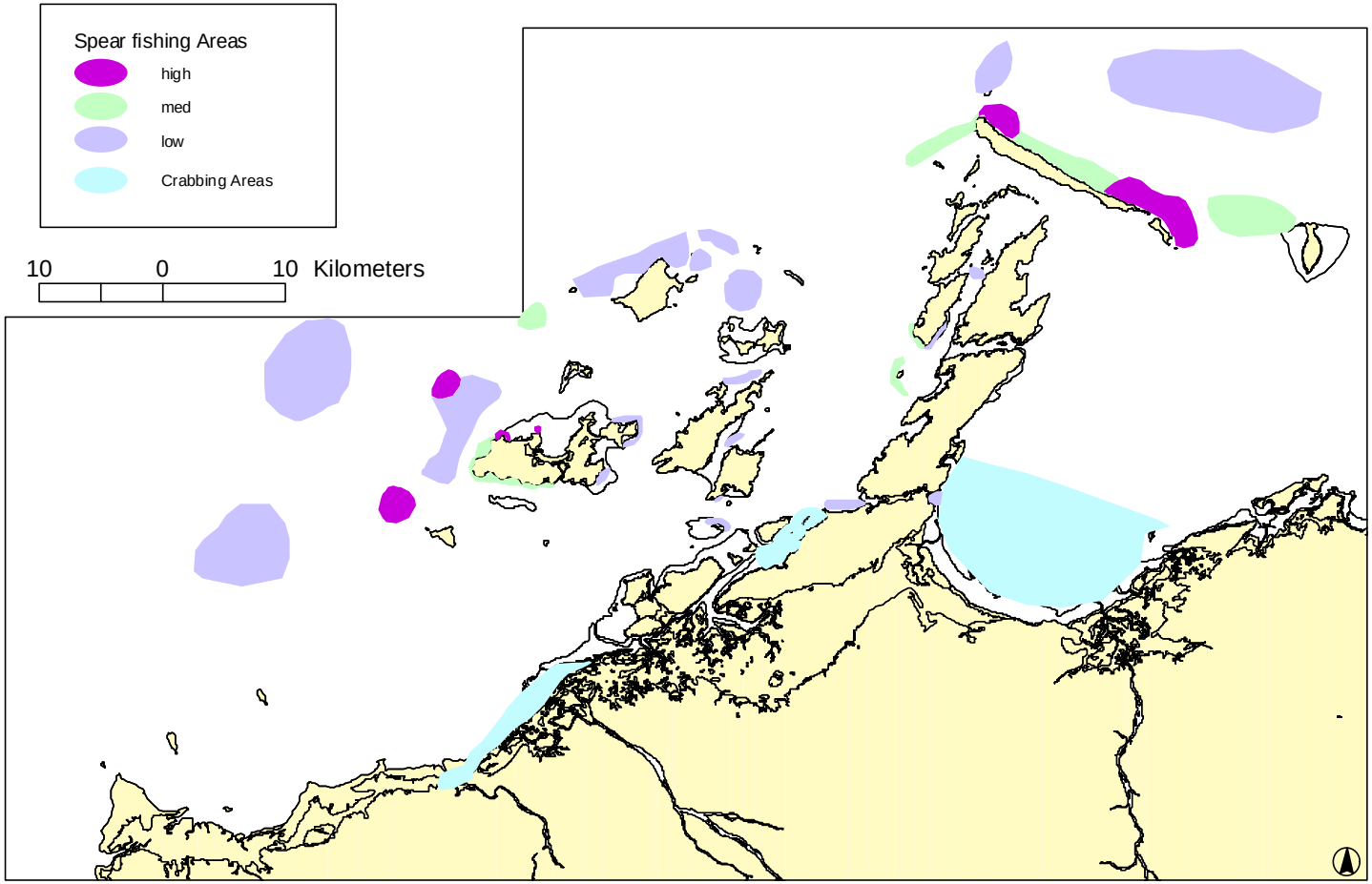


Figure 11: Spearfishing and Crabbing Areas - Compiled from local knowledge by Regional Office of CALM

Figure 14 Spearfishing and crabbing areas

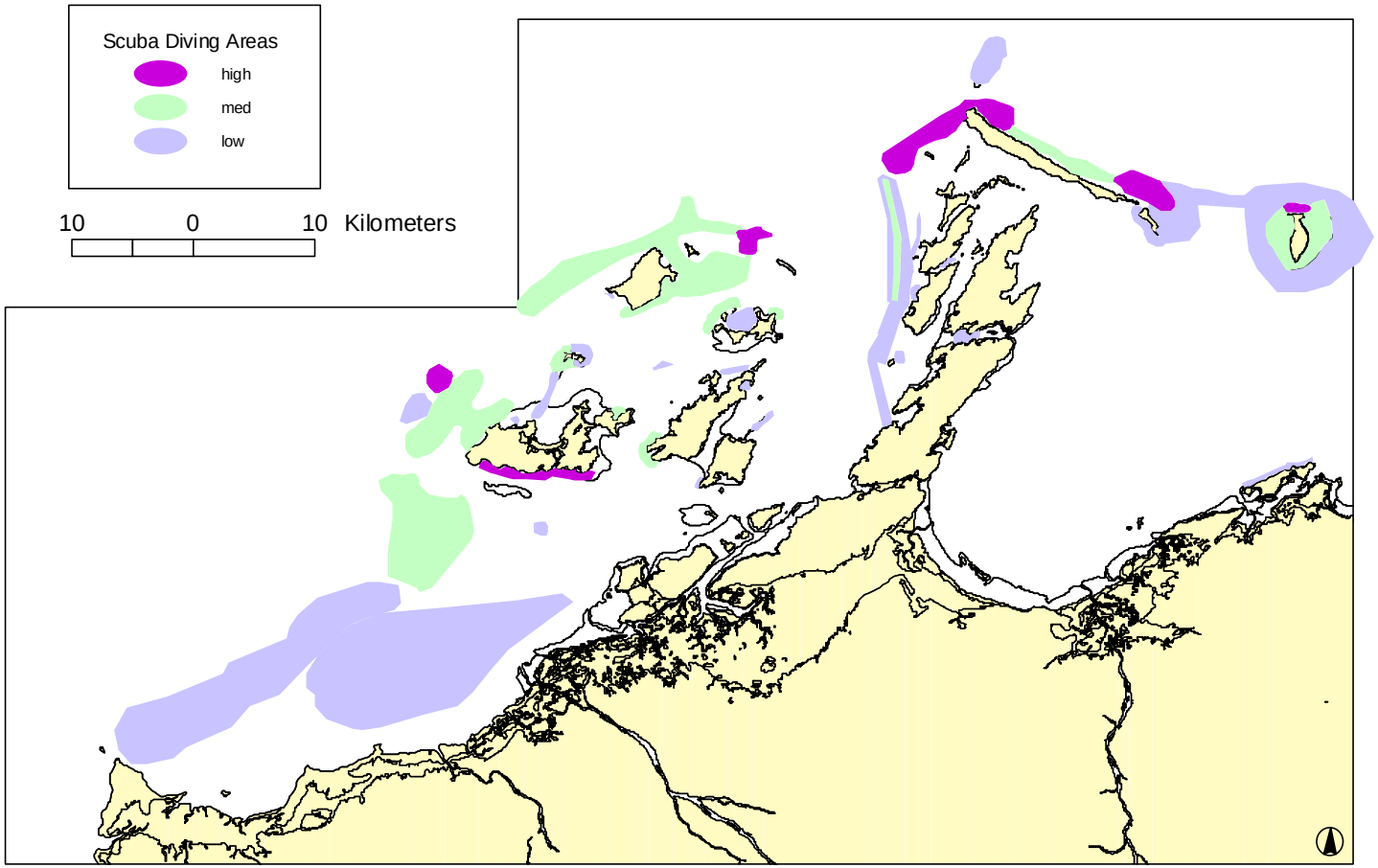


Figure 12: Scuba Diving Sites - Compiled from local knwoledge by Regional Office of CALM

Figure 15 SCUBA diving sites in the study area

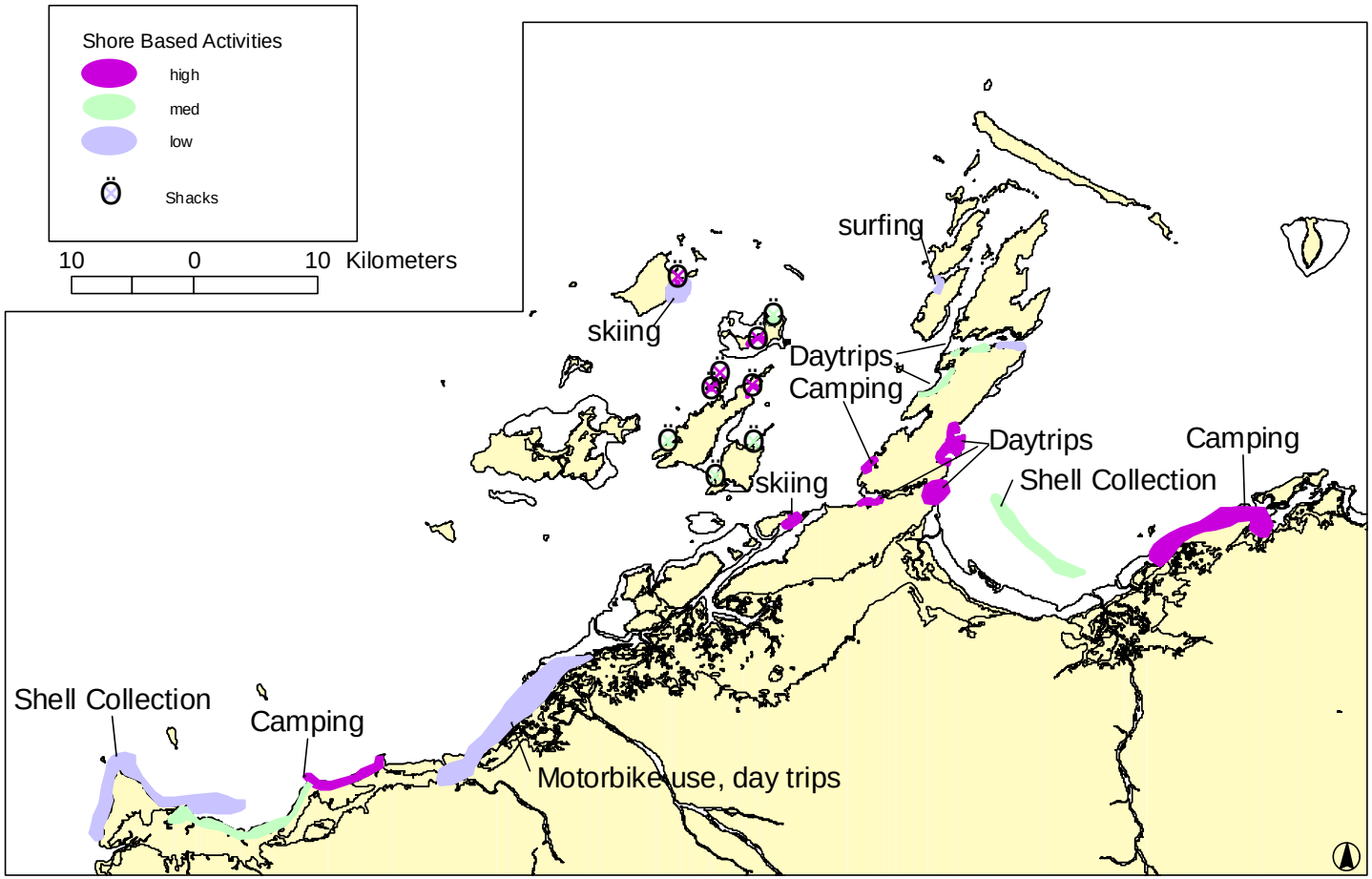


Figure 13: Shore Based Activites - Compiled from local knowledge by Regional Office of CALM.

Figure 16 Shore based activities in the study area

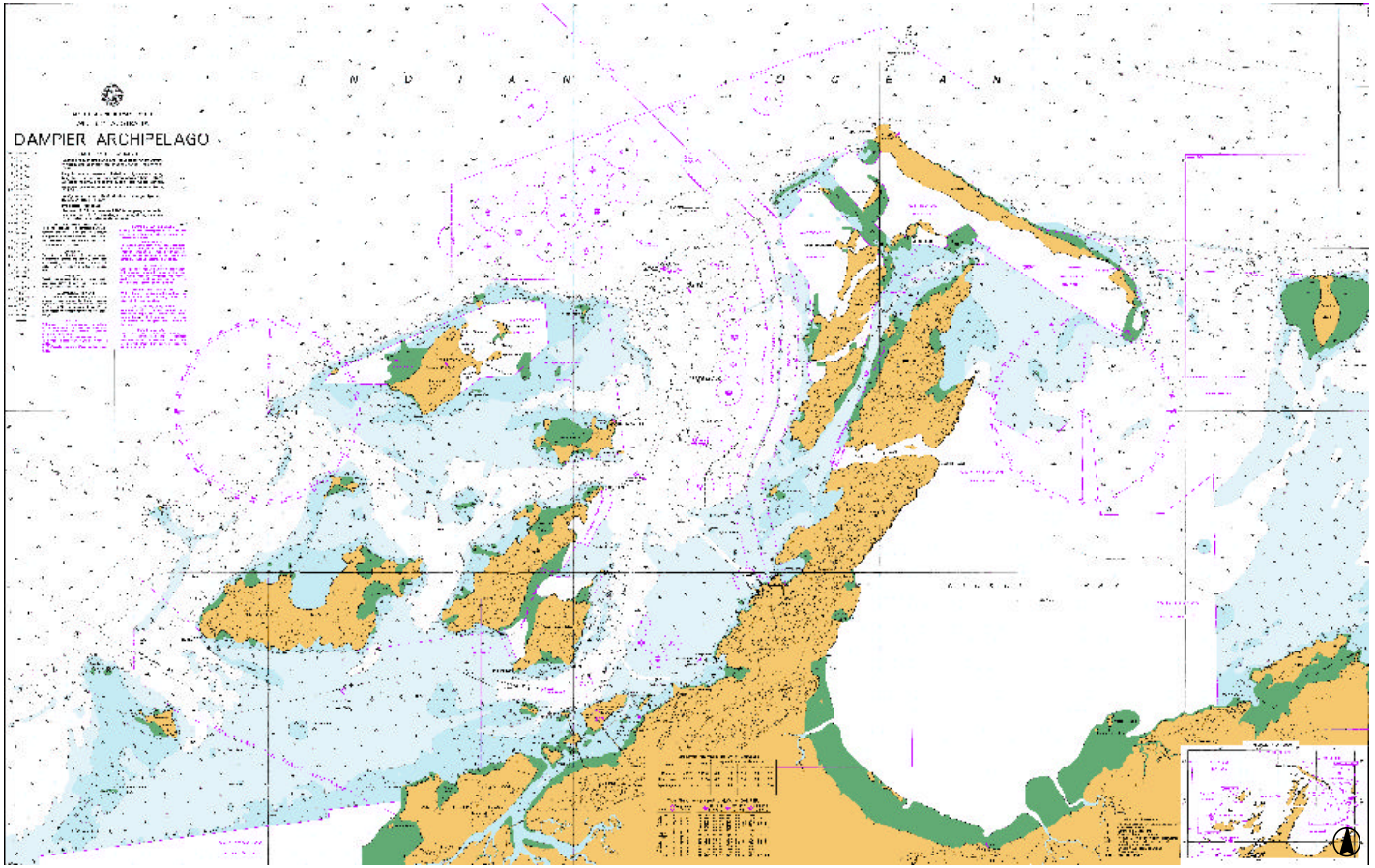
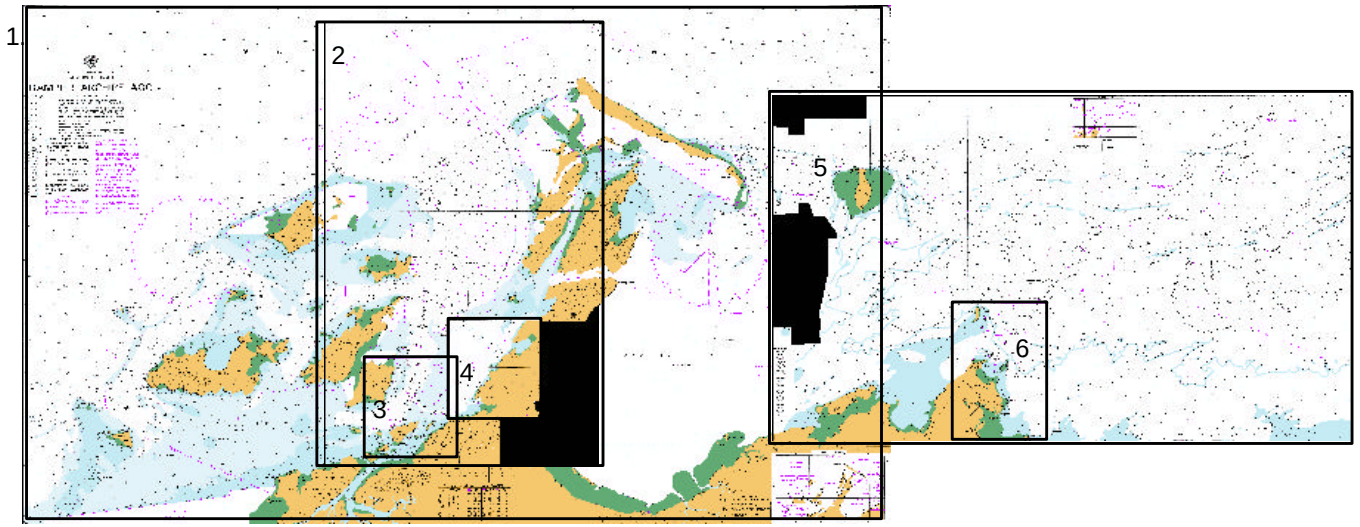


Figure 14: Navigation Chart - Supplied by RAN

Figure 17 Navigation charts of the study area



1. Dampier Archipelago
2. Port of Dampier
3. Withnell Bay to King Bay
4. Dampier Wharves
5. Approaches to Port Walcott
6. Port Walcott

Figure 15: Key to Navigation Charts

Figure 18 Key to navigation charts for the study area

Spearfishing

The spearfishing areas are shown in Figure 14. The people who provided the spearfishing information indicated that they tend to spearfish in many different places and don't always go to the same site. They take few fish and are selective for both species and individuals. There were differing opinions as to whether spearfishing should be allowed using SCUBA.

Scuba Diving

The SCUBA diving sites within the study area are mapped in Figure 15. Most divers appear to also spearfish or take crayfish if they see them. Few people go out specifically to get crayfish although some go specifically to spearfish. There is only one charter boat that does only diving (i.e. no fishing) - Dampier Island Tours run by Shane Peters.

The Port Walcott Dive Club dives the north end of Delambre Island approximately once a fortnight and the east and west sides once a month. They snorkel in the shallow areas and also dive off Dixon Island. The Dive Club also identified two sites outside the study that they feel deserve protection. The first is Bezout Island, where they dive more often than Delambre Island. The second is a wreck east of Delambre Island and they are currently lobbying to get protected within a Fish Habitat Protection Area (FHPA). Generally sites further from Dampier are less popular due to travelling distance and rougher sea conditions.

Shore Based Activities

The shore based activities are mapped in Figure 16. The activities include shell collecting, camping, motorbike use, surfing and water skiing. The high intensity camping sites are particularly busy in winter, with some people staying for more than a month. There are no official campsites and most of the camping takes place on vacant crown land. There was a plan to give control of those areas to the local shire, so that camping facilities could be built, and the impact controlled. However, as this area is under native title claims, no change of tenure is possible.

Navigation Charts

The navigation chart is a digital copy of the Royal Australian Navy Chart. It provides bathymetry, anchorages and shipping channel information at high resolution. There are several charts covering areas within the study area. The chart which covers most of the study area, the 'Dampier Archipelago' chart is shown in Figure 17. The spatial extents of the other overlapping charts are shown in Figure 18.

Table 5 Human Usage Data Availability

Human Usage Dataset	Available Data
Tenure	
Territorial Water Limits	Yes
Existing Leasehold/Management	
- Conservation Reserves	Yes
- Other Reserves	Yes
- Private/Leasehold/VCL	Yes
Proposed Conservation Area	Current Study Area
Marine Park Zoning	Not Applicable
Petroleum Leases	Yes
Mining Leases	No
Aboriginal Claim Boundaries	Yes
Historical	
- Australian Heritage Commission Sites	No
- Aboriginal Sacred and Ceremonial Sites	Yes
- Heritage/Historical Sites	No
- Shipwrecks	Not Applicable
Urban & Tourism Development	
Urban Development	
Existing	Yes
Proposed	Yes (Town Planning Scheme Boundaries)
Roads	Yes
Airstrips	Yes
Helipads	No
Resort Development	No
Existing	
Proposed	
Campsites	Yes and shacks
Maritime Infrastructure	
Anchorages	Yes (on Navigation Chart)
Shipping Lanes	Yes (on Navigation Chart)
Port facilities	RAN Navigation Charts (georeferenced picture not GIS)
Marina facilities	Not Applicable
Moorings	Yes (on Navigation Chart)
Groynes	Yes (on Navigation Chart)
Boat ramps	Yes (on Navigation Chart)
Navigation Markers	Yes (on Navigation Chart)
Fish Attracting Devices	No

Industrial Development	
Shipping	Yes (on Navigation Chart)
Oil/Gas Exploration	Not Applicable
Oil/Gas Production	Not Applicable
Mining	No
Commercial Fishing	
Trawling	Fisheries Licence Areas
Wetline fishing	No
Netting	No
Fish-trapping	No
Rocklobster	Fisheries Licence Area
Abalone	Not Applicable
Aquaculture (non-feeding/feeding)	Aquaculture licenses / leases
Aquarium Collecting	Yes
Recreation	
Fishing	
Rod & line	Yes
Netting	No
Spearfishing	Yes
Shell collecting	Yes (in shore based activities)
Rocklobster	No (see spearfishing)
Crabbing	Yes
Game fishing	No
Bait collection	No
Non-extractive	
Water skiing	Yes
Jetskiing	No
Parasailing	No
Sailing	No
Powerboats	No
Hovercraft	No
Float planes	No
Paddle boats	No
Kayaks/canoes	No
Windsurfing	No
Beach walking	Yes
Swimming	No
Reef walking	No
Beach launching	No
Surfing areas	Yes
Scuba Diving	Yes
Snorkelling	No
Wildlife Interactions	No
Wildlife Viewing	No

Chapter Four

SIGNIFICANT WILDLIFE VALUES

CHAPTER FOUR SIGNIFICANT WILDLIFE VALUES

The region in which the proposed Dampier Archipelago/Cape Preston marine conservation reserve lies is significant for variety of wildlife which has which has protection at a state, commonwealth or international level and which is also susceptible to detrimental impacts from human activity. Data on the significant wildlife conservation values of the region was gathered from a variety of sources, listed below:

- Whale migration and resting area data was provided by Kurt Jenner of the Whale Research Institute,
- Turtle aggregating and nesting area data was provided by Bob Prince and Keith Morris of CALM
- Seabird breeding areas were sourced from CALM's Seabird Breeding Database
- Data on dugongs was supplied from all the above respondents.

Seabirds breed on the majority of the islands in the study area, with a significant population of wedgetail shearwaters breeding in the region. Many of the seabirds are resident in the region throughout the year however their distribution becomes more concentrated around the rookery sites during breeding. Breeding seabirds are susceptible to human disturbance, especially if it results in adult birds leaving the nests and leaving the chicks vulnerable to predators and temperature extremes.

Five of the six species of marine turtle found in Western Australia have been recorded from the study area, these being the green (*Chelonia mydas*), loggerhead (*Caretta caretta*), flatback (*Chelonia depressa*), leatherback (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). As well as being a site in which turtles aggregate, presumably for feeding, the study area is also used for nesting. Green, loggerhead, flatback and hawksbill turtles breed in the study area and current research indicates that Rosemary Island is the main focus for hawksbill breeding in the State, and is thus of international significance.

Loggerhead and leatherback turtles are threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. Green and hawksbill turtles have no special status under the Wildlife Conservation Act, but are protected under Commonwealth legislation. The flatback turtle is not listed under either Commonwealth or State legislation.

Humpback whales are often sighted in the study area, either on their annual north and south migration or when females with calves are resting. Female humpbacks sometimes give birth in the study area, though this is not common. Humpback whales are threatened species declared to be specially protected under the *Wildlife Conservation Act* and declared to be endangered under the Commonwealth *Endangered Species Protection Act* 1992.

Current knowledge on the size, distribution and migratory habitats of dugongs in the study area is limited, however dugongs have been observed grazing in many of the shallow bays and in areas between the islands. Dugongs are specially protected under the *Wildlife Conservation Act*, but not listed under Commonwealth legislation.

Significant wildlife values for the proposed Dampier Archipelago/Cape Preston marine conservation reserve are shown in Figure 19.

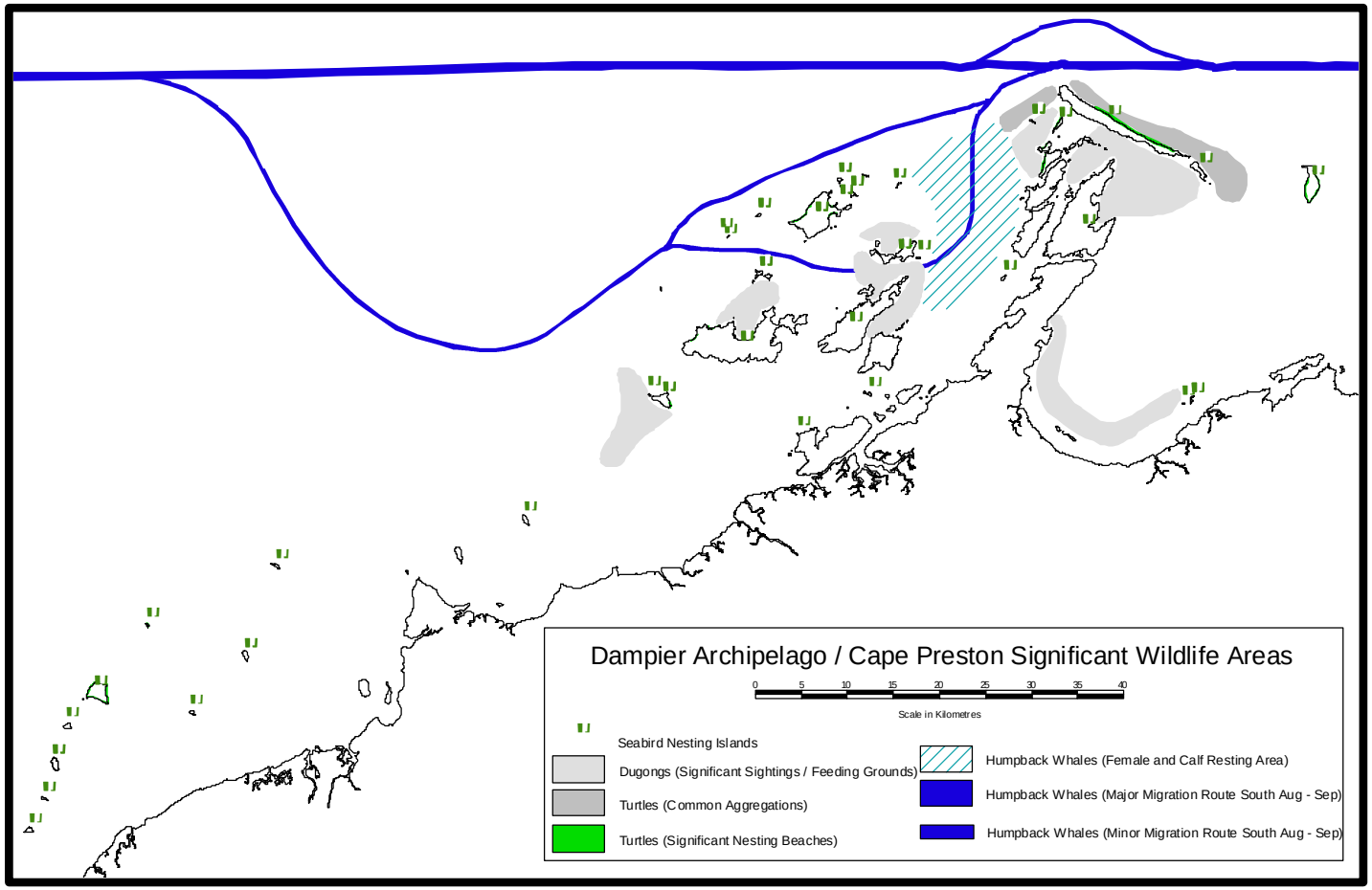


Figure 19 Significant Wildlife values

Chapter Five

A REGIONAL PERSPECTIVE

CHAPTER FIVE A REGIONAL PERSPECTIVE

1. INTRODUCTION

The mainland coastline of Western Australia is approximately 21,500 km long and there are 3,424 offshore islands. The adjacent coastal waters support a diverse range of tropical, subtropical and temperate ecosystems such as coral reefs, mangroves, seagrass meadows, algal covered rocky reefs, soft sediment communities and deep open oceans. Recreational use of our marine environment is an integral part of the Australian way of life and 'the beach' is a national icon. Our living and non-living marine resources also support major marine-based industries including tourism, oil and gas, mining, fishing, aquaculture and pearling. These industries represent a significant component of the State's economy providing employment, both directly and indirectly, for many thousands of Western Australians.

The Dampier Archipelago and Cape Preston region were identified in the MPRSWG report for their significant terrestrial and marine flora and fauna, and because they are subject to increasing human impact. The Dampier Archipelago includes inshore, relatively calm, turbid environments and offshore areas where the conditions are influenced by clearer waters and rougher seas. Because of the variety of environmental conditions, the area supports a wide range of habitat types including mangroves, rocky shores, sand and mud shores, macroalgal or seaweed communities and coral reefs. Within these habitats there is a high diversity of organisms including species of special significance like humpback whales, dugong, migratory birds and marine turtles.

Aboriginal people have lived in the area for many thousands of years. In recent times, human use of the area has escalated with the development of town sites, port facilities and a liquefied natural gas processing facility. Fishing, pearling and tourism industries also operate in the region and the area provides important recreational opportunities for residents who enjoy fishing, boating and diving.

With the mixture of high natural, cultural, commercial and recreational values within the region, there is the potential for degradation of the environment and conflict among users. In addition, proposed developments in the area indicate that the trend is towards further human use of the area, which is likely to increase the potential for both degradation and conflict. The area is therefore to be considered for reservation both to preserve the marine environment and to put a formal management framework in place to ensure the various uses are managed in an equitable, integrated and sustainable manner.

The term 'marine conservation reserve' often raises concern that these areas will exclude many recreational and commercial activities. Although conservation is the primary objective of marine conservation reserves, recreational and commercial uses are catered for, as long as these activities do not cause unacceptable changes to the environment and can be managed without undue conflict.

The Western Australian Government is committed to full and open consultation before areas are dedicated as marine conservation reserves. The focus of consultation during the first stage of the planning process for the Dampier Archipelago and Cape Preston reserve proposal is a community-based advisory committee. Committee membership is community based and includes experts from a wide range of interest and user groups. Members contribute technical expertise and exchange ideas among themselves and with the broader community in a collaborative process to develop advice to Government on the most appropriate reserve category, boundaries and management strategies to ensure sustainability. There is a statutory requirement for the second phase of public participation in the planning process. During this phase, the draft management plan is published for public comment and a minimum three-month submission period is made available.

This chapter aims to provide an overview of the environmental, cultural, commercial and recreational values within the area and complements a series of booklets and brochures that address other topics associated with marine conservation reserve planning and management.

2. STUDY AREA

A study area has been defined to guide the community-based advisory committee in its consideration of a marine conservation reserve proposal in the Dampier Archipelago/Cape Preston region. Before the planning process for new marine conservation reserves can begin, Ministerial agreement is needed on the maximum geographical area the advisory committee can consider. In this instance, the Ministers for the Environment, Fisheries, Minerals and Energy and Resources Development have agreed on the extent of the study area. The study area will not necessarily correspond with reserve boundaries once the community consultation process is complete. However, reserve boundaries are unlikely to encompass areas outside the study area.

The study area lies about 1650 kilometres north of Perth, Western Australia, between 20º 20' to 20º 45'South and 116º 25' to 117º East. The archipelago consists of about 12 major islands and a number of smaller islands, rocks and shoals.

The area is broadly defined as the offshore waters between the Fortescue River mouth to the west, and the Burrup Peninsula to the east. It includes State Territorial waters east to Delambre Island and nearshore waters in Nickol Bay east to Dixon Island (Figure 1).

The largest islands in the Dampier Archipelago include Dolphin Island (3203 ha), Enderby Island (3290ha), West Lewis Island (2144 ha), Legendre Island (1325ha), Rosemary Island (1145 ha) and East Lewis Island (1050 ha).

Major population centres bordering the study area are Karratha (population approximately 11325) and Dampier (population 1810). Other nearby towns are Wickham/Port Samson (population 1973), Roebourne (population 1213) and Onslow (population 881).

3. PHYSICAL ENVIRONMENT

3.1 Geology and geomorphology

The surface layers of rock within the study area are some of the oldest in the world, formed in Precambrian times when life on Earth was just beginning. The Precambrian rocks were laid down in three stages. Around 3300 million years ago, volcanoes in the area produced layers of lava. Two hundred million years later, large masses of molten rock were intruded into the lava layers and these cooled slowly forming the large crystals characteristic of granite. Erosion wore down the layers of lava and exposed the granite before the third stage of Precambrian rock formation 2700 million years ago. During this stage volcanic lava was deposited on top of the earlier rocks and molten rock intruded into cracks in the older rocks, forming dykes. The lava that filled the dykes cooled quickly, forming small crystals characteristic of dolorite and granophyre rocks. It is the granophyre rock of this period that forms the Burrup Peninsula. In addition, carbonate rocks formed from sediments in shallow seas. These deposits contain fossil stromatolites similar to the living stromatolites, which occur in Shark Bay today.

The north-western boundary of the study area extends into the Carnarvon Basin. Here, thick layers of sediments accumulated between 300-70 million years ago. In some locations, these sediments contain petroleum products and there are exploration leases that extend within the study area. The petroleum products within the Carnarvon Basin were formed mainly from the organic remains of plants and animals that lived between 300-140 million years ago during the Permian, Triassic and Jurassic periods. At that time, Australia was joined to India, South America, southern Africa and Antarctica and the study area was at higher latitudes, and much colder than it is today. The organic remains that

formed the petroleum deposits were most likely of mixed marine and terrestrial origins. The organic marine deposits consisted primarily of single celled plants and animals which lived in the plankton while the terrestrial deposits were most likely derived from *Glossopteris* fern and other plant assemblages that were widespread during those periods.

The organically rich deposits were transformed into petroleum products by being subjected to specific heat and pressure conditions referred to as the hydrocarbon generating window. At this stage, the deposits were buried deeply, up to a thousand metres below more recent rocks. Once formed, the fluid and gaseous petroleum products seeped upwards through cracks and pores in the younger rocks. This migration continued until it reached the surface and escaped, or became trapped by impermeable layers formed by domes or faults in the rock. To date, no petroleum products have been found within leases that extend into the study area to the west of Cape Preston and north of Enderby Island.

While the western and north-western edges of the study area are characterised by Carnarvon Basin deposits, it is the Precambrian rocks that form the backbone of most of the study area. These ancient rocks are either exposed at the surface, or are covered by layers of young sediments deposited during the last 65 million years. A major component of this young rock is limestone, made of the compressed skeletons of millions of plants and animals that fell to the bottom of the sea. Varying thicknesses of sand, gravel or mud cover the limestone and Precambrian rocks associated with localised deposition on beaches, coastal deltas, mangrove communities and other features.

The study area has experienced significant changes in sea level through recurring ice ages. The most recent of these occurred about 260,000, 150,000 and just 18,000 years ago. During the most recent ice age, sea level was 150 metres lower than it is today. The rise of sea level since the last ice age was rapid and 7000 years ago sea level was up to one and a half metres higher than it is today. At that time, many of the islands, which are exposed today, would have been much smaller. Sea level then dropped to its present level just 4500-4000 years ago exposing the islands as we know them today.

Today, the 12 major islands and 30 smaller islands, rocks and shoals within the Dampier Archipelago represent the peaks of a drowned land mass, which is essentially similar to the present hinterland. The islands range in size from 3203 hectares (Dolphin Island) to small rocky islets of less than one hectare. The highest island, Dolphin Island rises to 120 metres above mean sea level. Many of the islands are composed of Precambrian rocks. Granite occurs at the surface on Dolphin, Tozer and Enderby Islands and granophyre makes up the Burrup Peninsula. In addition volcanic Precambrian rocks underlie the major reefs and shoals in the archipelago. Many of the islands are similar to the present mainland and Burrup Peninsula with steep and rugged coastal cliffs, large rock piles and rocky shores. Valleys, beaches and coastal sandplains separate the rock piles. However, Legendre Island and the other flatter islands and islets to the north of the archipelago look quite different. They consist primarily of limestone and are low set and lack the rock piles.

The islands and shoals rise above submarine plains that are gently sloping from 5m deep near the mainland coast to 15-20m deep at the northern margin. The sea floor has extensive limestone pavements and large sheets of shell gravel, sand and muddy sand/gravel.

In addition to the islands, submerged and tidally-submerged hills and ridges rise from the submarine plain. These are rocky reefs, comprised of rock formations and boulder deposits, some of which are colonised by corals and form coral reefs. Shoals often form connections between the islands and coral reefs of the archipelago, they also form on the leeward sides of many islands.

At the northern margin of the submarine plains, the sea floor descends steeply to more than 30m. These deep open oceanic waters form the inner part of the north-west shelf. In places, the junction between the submarine plains and the deep open waters is delineated by a line of submerged rocky reefs, coral reefs or shoals that locally protrude above the water surface, such as Hamersley Shoal, Legendre Island and Sailfish Reef.

The Burrup Peninsula and Dolphin Island separate Nickol Bay from the Dampier Archipelago. Nickol Bay is a large shallow embayment measuring 35 km by 20 km. The seabed slopes gently from 20m at the northern margin and becomes intertidal at the south. The shoreline includes mudflats, rocky shores, limestone pavements, sand beaches and mangrove flats.

The mainland coast between Cape Preston and Cape Lambert is characterised by rocky headlands interspersed with low-lying mudflats and adjoining mangroves. The mangrove communities are generally fringed inshore by saltmarshes. Some of the mud flats at Dampier are now used commercially as evaporation ponds for the production of salt. Remnant mangroves are a reminder that these areas used to support extensive mangrove forests. Behind the low-lying coast is a granitic plain that gently rises inland.

Many rivers drain the Pilbara region but most flow only for short periods. Two major rivers drain into the study area; the Maitland River and the Fortescue River. They contribute alluvial deposits at their mouths, which are colonised by mangrove communities. The seabed adjacent to the mainland coast between Cape Preston and the Dampier Archipelago is shallow and gently shelving.

3.2 Drainage and groundwater

Groundwater results from rain that has percolated down through soil and cracks in rocks. Geological formations such as sand, sandstone and limestone, which contain useable amounts of water, are called aquifers. Deep aquifers that have been under pressure between relatively impervious layers of rock are called artesian basins. The availability of groundwater depends on how easily water can move through the substrate.

Groundwater in the general Karratha region is of good quality for agricultural stock and is readily available throughout most of the mainland coast. The most significant and exploited groundwater resources are contained within the alluvial aquifers of the coastal plain and valley-fill aquifer of the Fortescue Valley. No significant water resources in the Karratha area have been identified for domestic and industrial uses. As a result of limitations on the supply and quality of water, fresh water is obtained externally from Millstream and the Harding Dam.

Rainfall in the Dampier Archipelago region is unreliable and comes mainly from thunderstorms and cyclones. Rainwater either drains into one of the major rivers or is captured by a number of ephemeral streams and creeks which drain elevated areas. Stream-flow in these creeks is sporadic and brief after heavy rains. Surface runoff is relatively efficient due to the hard terrain, and fast-running streams form along the valleys after rainfall. Rocky depressions in the streams can retain water for up to three months after the rains, creating attractive pools. The streams transport high particulate loads, maintaining colluvium fans at the bases of hills where the streams dissipate across coastal plains.

The main rivers within and adjacent to the study area are the Harding, Maitland and Fortescue Rivers. The Fortescue River has a catchment area of about 50,000 km^2 and the Maitland River catchment area, above Miaree Pool, is 2010 km^2. The Harding River has a catchment above the Harding Dam of 1068 km^2. These large catchment areas and heavy rains associated with cyclones result in periodic flooding when large quantities of sediment laden freshwater are introduced into the coastal marine environment.

Little is known about the hydrology of the Burrup Peninsula area, other than it is part of the Indian Ocean drainage area. There are currently no stock-watering wells or stratigraphic test wells available to assist in determining water-table levels. However, permanent water does occur in several pools in hilly areas and these appear to be fed from ground sources which gain entry along fault lines.

3.3 Climate

The climate within the study area is both arid and tropical. It is controlled largely by the seasonal movement of high pressure anti-cyclonic weather systems that migrate from approximately 25º-30º South in winter, to 35º-40º South in summer. As a result, there are two broadly defined climatic seasons over north-western Australia; a warm dry 'winter' season from May to September and a hotter and wetter 'summer' season from October to April. However, the region has a low yearly rainfall and is quite arid.

During the winter season, the northern position of the high pressure cells results in a prevailing east-south-easterly offshore flow of relatively cool air (south-east trades) over the north-west coast. These offshore winds are often modified by local breezes. They are enhanced by late night/early morning south-easterly land breezes as the land cools, and are moderated by afternoon north-westerly sea breezes as the land heats. In winter, offshore winds reach speeds of 20-30 kn inshore and can occasionally peak at 60 kn offshore.

During summer, the high-pressure cells are further to the south, resulting in warmer winds from the north-west and south-west. There is a pattern of daytime seabreezes and night time land breezes, with wind speeds typically less than 20 kn.

Winds are at their weakest and most variable during the seasonal changeovers between summer and winter, around April and August, and it is during these periods that the weather is most favourable for recreational activities within the study area.

Cyclones generally form during December to March over the Timor Sea or off the north-west coast and can result in winds up to 300 km/hr. On average, two cyclones cross the coast each year, typically between Onslow and Broome. Cyclones bring destructive winds, heavy rains, storm surges, large waves and cause substantial movement of coastal sediments. Cyclonic waves can damage or dislodge corals and other benthic, or seabed-attached, communities. Sediments that are mobilised by cyclonic waves and currents can also smother marine organisms. In addition, infrastructure associated with the port and industries has to be designed to withstand the severe conditions associated with cyclones.

Mean annual rainfall at Karratha (Dampier Salt) is 249 mm, with over half occurring during the January to March period, but this varies from year to year as a result of cyclones, and extreme downpours are sometimes recorded. The highest recorded rainfall in a 24 hour period in the vicinity of the study area was about 1000mm at Whim Creek.

The air temperature at Karratha (Dampier Salt) peaks in January and is at its lowest in July. The mean monthly maximum and minimum temperatures are 35.9º C and 13.4º C, respectively and the highest and lowest recorded temperatures are 47.1º C and 4.6º C, respectively. The relative humidity is highest during the summer months, with average daily humidity for the Dampier/Karratha area ranging from 45 to 64 per cent. Early morning dews can occur during both summer and winter, and these provide an important source of water for fauna. Annual evaporation in the Dampier Archipelago region is about 3500 mm, far exceeding mean annual rainfall.

The proximity of the study area to the north west coast results in the unusual exposure of the sea surface to both the relatively cold offshore breezes of the south-east trades in winter and the contrasting warm onshore breezes in summer. As a result, water temperatures in the Dampier Archipelago display a relatively large annual range compared with other tropical ecosystems, thereby subjecting the local coral reef communities to seasonal temperature fluctuations close to their natural limits of tolerance.

3.3 Oceanography

Oceanography is a comprehensive discipline that incorporates chemical, physical, biological and geographical principles in studying the world’s oceans. The biological values of the Dampier

Archipelago/Cape Preston region are described in the Natural Heritage section of this chapter, so we will focus here on the chemical and physical attributes of the waters of the study area by considering the general components of water movement and water quality.

Water level

Tides are caused by the gravitational pulls of the sun and moon on the planet Earth. Because of the orbital motions of the Earth and the moon, the relative locations of the sun, moon and Earth, and therefore the directions of gravitational pull, change with time. When the gravitational pull of the sun and moon complement each other, the tides are referred to as spring tides, which are characterised by large tidal changes. When the gravitational pulls work against one another, the tidal range is much lower and these are referred to as neap tides.

The tides of the Dampier Archipelago region are macrotidal and semi-diurnal; that is, they go through two peaks and two troughs – or highs and lows – per day. They propagate shoreward, or move towards the mainland coast, and amplify across the continental shelf with predicted tides at the coast having a maximum range of 6.3 m, a mean spring range of 5.6 m and mean neap range of 1.0 m.

Combined meteorological effects such as storm surges, barometric pressure and coastally trapped long period waves can change the water level by up to 3 m. Meteorologically forced changes in water level are important as they can influence sustained drying of normally submerged benthic communities, which are also subject to the effects of wind and wave turbulence during periods of low water levels.

Waves

There are many sources of energy that create waves in the ocean including tides and seismic activity, but wind is the primary energy source of ocean waves. In the region of a high wind or storm, the ocean surface is a jumble of waves of various sizes. To produce large waves, high-speed winds must move in the same direction over an extensive area for a considerable period of time. When the wind abates or when waves move out of a storm system, the waves sort themselves out. Smaller waves interfere with one another, break on the crests of larger waves and dissipate rapidly. What are left are the larger waves, which are known as swell.

Waves on the North West Shelf come from Southern Ocean swell, summer monsoonal (wet season) swell (from the west-north-west), winter easterly swell, tropical cyclone swell and local wind-driven swell. The most persistent swell arrives from the south-south-west before refracting (bending) over the shelf to become more westerly to north-westerly as it approaches the coastline.

Normal ocean swell heights are about 2 m in winter and 1 m in summer with periods of about 12-16 seconds between waves. Monsoonal swells can reach heights of 6-10 m offshore and generally approach the coast from the west-north-west. Winter easterlies generate 1-2 m swells at 6-8 second intervals in the open waters offshore from the archipelago. Swell waves generated in deeper water during storms and cyclones can reach heights well over 5 m, with the theoretical maximum wave height for a strong cyclone estimated to be 18 m.

Oceanic swells can be reduced to less than half of their original size and energy en route to the inner archipelago region through bottom friction over the shallowing sea bed, breaking over reefs and blocking by islands and promontories. Wave patterns can influence marine communities by causing spatially variable sedimentation rates and by sorting sediment fractions. Persistent wave action over the offshore reefs of the archipelago transports fine sediment away from these areas, resulting in a relatively clear water column. In contrast, within the inner archipelago, wind and tidal stirring, combined with relatively low throughflow rates, result in local re-suspension of fine sediments, which reduces light penetration through the water column, and may in turn limit the growth of marine plants.

The intermediate zone between offshore and nearshore reefs fluctuates in water clarity depending on seasonal variations in wind and wave action.

Currents

Unlike waves, which bring about virtually no net water transport, currents result in mass movement and mixing of ocean waters. It is important to understand currents because of their role in transporting and dispersing both natural substances, such as deep-ocean nutrients, eggs and larvae, and pollutants such as oil, toxicants and introduced substances such as nutrients from outfalls and aquaculture. Currents are also important in the suspension and sorting of sediments and other particulate matter.

Ocean-scale pictures of sea-surface temperatures taken by heat-sensing satellites regularly show the long, narrow Leeuwin Current bringing tropical, warm water south along the west coast of Western Australia, around the South West Capes and then onwards to south Australia. The Dampier Archipelago/Cape Preston region however resides in the inshore zone of a relatively expansive shelf region. This, along with the presence of islands and reefs, reduces the ability of the Leeuwin Current and other broad scale regional currents to make any significant sustained incursions into the nearshore zone.

Currents in the Dampier Archipelago region are spatially and temporally variable due to the area's complex bathymetry, or seabed terrain, and changing tide and wind patterns. Currents are driven principally by tides and wind stress. Records collected from 1981 to 1984 at many sites throughout the archipelago indicate that circulation in the region can be characterised as follows;

- close to the coast, flows are mainly parallel to the shore with speeds ranging from about 5 cm/s (neap tides) to 25 cm/s (spring tides);

- within the archipelago, flows are strongly steered by the bathymetry in and around the islands with speeds ranging typically from 10 to 40 cm/s (neaps and springs, respectively), but with flow concentrations along channels between islands generating currents of up to 80 cm/s ;

- currents over the exposed mid-shelf region (20-50 m depth) generally run perpendicular to the depth contours with speeds ranging from about 10 to 50 cm/s (neaps and springs, respectively).

An important feature of the water movement is that during a typical ebb/flow cycle, water oscillates back and forth throughout the archipelago. During spring tides the oscillations typically span five kilometres but result in only a small net movement away from any one particular location because water is repeatedly brought back to near its original location on every cycle. During neap tides however, it appears that a relaxation in the influence of strong tidal stirring allows the wind to play a more effective role in moving water and net movement away from any one location is greater.

Prevailing summer winds from the south and west drive water eastward through Mermaid Straight and between Rosemary and Enderby islands, while water in Mermaid Sound is forced northwards towards the seaward entrance. Easterly and northerly winds induce southward flow into and through Mermaid Sound and drive water westward in between the islands. These winds may occur occasionally as a result of cyclones in summer or during winter wind fields. Net residual transport through the archipelago is thus generally directed towards the north during summer and offshore during winter, in response to the prevailing seasonal wind directions.

Salinity

Salinity measurements taken in and around the archipelago during 1982 and 1983 indicated that the range of salinities was between 35.1 and 37.1 parts per thousand (ppt). The smallest range and lowest salinities (35.1 to 36.1 ppt) occur offshore at the 20 m contour, and the largest range and highest salinities (35.45 to 37.1 ppt) occur inshore within 2 km of the Burrup Peninsula. These salinities are well within the range of salinities typical for reefs where corals flourish. These data are also useful because elevated salinities in a semi-enclosed region of water may reflect a relatively slow flushing time and, when compared to oceanic salinities, can enable salt-budget calculations to be used to estimate the rates at which water is flushed through the area during various times of the year.

Temperature

Water temperatures within the Dampier Archipelago range from about 18 to 31.5º C throughout the year, with minima in July to August and maxima in February to March. The nearshore waters have a greater seasonal temperature range than the offshore waters. Water temperatures can impact coral communities, which may show signs of stress, such as bleaching, during prolonged exposures to either low (<18º C) or high (>32º C) temperatures. The recorded temperature range indicates that corals in the archipelago survive within a temperature regime that is close to their natural tolerance levels.

Turbidity

Turbidity is a measure of water clarity. Turbid water contains high levels of fine suspended material that can smother marine organisms and reduce light penetration to marine plants. Turbidity is influenced by water movement and sediment type.

Most corals can tolerate deposition rates of less than about 50 g/m^2/day and these rates are rarely exceeded throughout the Dampier Archipelago during normal winter and summer conditions. However, a Department of Environmental Protection study indicates that elevated levels (>250 g/m^2/day), caused by turbidity plumes from an active dredge spoil dumpsite, coincided with significant localised coral deaths, probably due to smothering.

Suspended sediment concentrations in the water column are characteristically higher in the relatively shallow nearshore regions of the archipelago compared with deeper sites further offshore. Wind waves are the main reason for sediment re-suspension within the nearshore waters, while offshore sediment re-suspension is mainly caused by ocean swells. Relatively high rates of sediment re-suspension throughout the archipelago have been recorded, with considerable damage to benthic communities and accumulations of calcareous rubble and sands in Mermaid Sound as a result of cyclone-induced wave action.

Salinity-temperature differences and density currents

Because of heating, cooling and evaporative effects, there are significant salinity and temperature differences between the nearshore and mid-shelf regions throughout the year. The nearshore waters are warmer and saltier than the adjacent mid-shelf waters during summer, while in winter, the nearshore zone is significantly cooler than the offshore zone, even though the direction of the salinity differential remains the same. The lower inshore water temperatures throughout winter are caused by relatively cold offshore winds.

As a result of these seasonal salinity-temperature changes, the nearshore waters of the Dampier Archipelago are less dense than the offshore zone in summer but more dense than the offshore zone during winter. Consequently, nearshore and offshore waters show a tendency for two-layer exchange, driven by either the density difference or wind-stress acting at the water surface. Two-layer exchange can be visualised as a buoyant surface flow in one direction under-ridden by a dense bottom flow in the opposite direction. In summer, the nearshore zone of the archipelago is much warmer and

therefore less dense than offshore waters, suggesting that it should propagate out as a surface flow. However, in winter the nearshore zone is much colder and therefore more dense than offshore waters, suggesting that it should propagate out as a bottom flow.

Density-driven cross-shelf exchange is important because upwelling and wind mixing can raise nutrients from deep water in the offshore zone into density-driven flows, which can transport them into the nearshore zone. Density gradients within the archipelago could drive gentle cross-shelf circulation at strengths of up to 5-10 cm/s, which is equivalent to about 4-8 km per day. These speeds are comparable with tidally driven currents during neap calm conditions and wind-driven currents during weak wind periods.

4. NATURAL HERITAGE VALUES

4.1 Regional Context

The marine flora and fauna of Western Australia belongs to two biogeographical provinces; a tropical province in the north and a temperate province in the south. The diversity of southern Australian species is relatively low, but the majority are endemic, that is, found nowhere else in the world. Conversely, the diversity of marine flora and fauna in the north is high and generally species are widespread throughout much of the Indo-West Pacific Region that stretches from the east coast of Africa to French Polynesia in the central Pacific and from Japan to the northern coasts of Australia.

The Interim Marine and Coastal Regionalisation for Australia (IMCRA) is an ecosystem-based classification for marine and coastal environments. It divides the marine environment of Australia into 60 different biogeographical regions, 18 of which occur in Western Australia. The marine and coastal environments of the Dampier Archipelago/Cape Preston study area lie within the “Pilbara IMCRA bioregion, which stretches from the North West Cape in the west to Cape Keraudren in the east.

The Pilbara Nearshore bioregion contains a wide range of habitats, which support a high diversity and abundance of marine organisms. Of particular note is the high diversity of animals associated with intertidal mud and sand flats, which have fringing mangroves in bays and lagoons. These animals provide an extremely important food source for migratory birds. The mangrove communities are extensive and structurally complex but they are made up of only six species. There are few places in the world where mangrove communities occur in arid conditions and for this reason they are of great scientific importance. The Pilbara Nearshore bioregion also encompasses significant fringing coral reefs, which have developed mainly around the more distant offshore islands. In addition, a significant number of the beaches are important turtle nesting sites and some of the islands support large seabird colonies.

The Western Australian Government is committed to establishing a system of reserves, which represent all bioregions. In 1994 the Marine Parks and Reserves Selection Working Group recommended that six areas within the Pilbara Nearshore bioregion be considered for reservation. From east to west, these areas are: Cowrie Beach and the intertidal waters of Cowrie Creek; the area extending from Delambre Island to Regnard Bay, which encompasses many of the islands in the Dampier Archipelago region; the Cape Preston area; the strip of hinterland from slightly south of James Point to Yammadery Island; an area within Exmouth Gulf which extends from Locker Point to Learmonth; and a small area south of Exmouth. Of these six proposed areas, none are currently marine conservation reserves. The Dampier Archipelago and Cape Preston study area is the first to be given consideration within the Pilbara Nearshore bioregion.

The study area is centrally located within the bioregion and includes representative samples of the wide range of both onshore and more exposed habitats that occur throughout the bioregion. The

establishment of a marine conservation reserve within the study area would therefore make a significant contribution to the state-wide system of representative reserves.

A comprehensive university study of the region during the 1980's highlighted its complicated physical characteristics and rich range of habitats. The ecological complexities were summarised by defining eight coastal geomorphologic units within the Dampier Archipelago and table 6 serves to illustrate the complex relationships between these units and the habitat types and animal assemblages which occur there. However, while providing a useful description of coastal ecology, these categories provide a greater level of detail than is required for marine reserve planning.

Table 6 The benthic biotic assemblages and habitats of the Dampier Archipelago/Cape Preston region

Assemblage	Geomorphic unit	Habitat	Tidal range	Biota
Oyster-barnacle	intertidal rocky shore intertidal limestone pavement	cliffed shore fissured pavement or slope bouldery shore limestone cliff limestone pavement	intertidal	Encrusting assemblage on hard substrate. Marked zonation of organisms at different heights with an algal slick covers the rocks at the top of intertidal zone, followed by bands of the milky oyster (*Saccostrea* sp.), coral rocky oyster (*S. cucculata*), barnacles (*Tetraclita porosa* & *Chthamalu* sp.), and at the lowest intertidal level are worm-like veritids and an algal turf. A wide range of bivalves, snails, chitons, crabs, polychaete worms, small crustaceans and some small fish are associated with the oysters and barnacles. On the outer islands, the ocean oyster (*Saccostrea commercialis*?) replaces the milk and coral rock oysters that occur in Mermaid Sound.
Coral	subtidal rocky shore subtidal limestone pavement	fissured pavement or slope bouldery shore limestone pavement	subtidal to depths of 10 m	Encrusting assemblage on hard substrate. Coral are conspicuous and dominant, with other fauna such as seawhips, anemones, seastars, sea urchins, sea cucumbers, other echinoderms, crustacean, reef fish, bivalves and gastropods. Sponges occur more abundant when assemblage is on limestone. Coral reef is associated with almost all the islands in the region, however size, diversity and condition of the reef varies. *Acropora, Favia, Goniopora, Goniastrea, Lobophyllia, Millepora, Pocillopora, Porites, Tubastrea* and *Turbinaria* are some of the corals found in the region.
Mangal	intertidal flat intertidal rocky shore	muddy sand flat banks of tidal creeks edges of spits bouldery shore	mid to high tidal	Mangals compose mangroves, shrubs and benthic fauna. Mangal is mainly found on the intertidal flats of embayments. They vary from wide tidal formations (Searipple passage, King Bay) to a narrow fringing formation. There is an obvious zonation that is the product of various tidal regimes. *Avicennia marina* parkland/shrubland are formed at about mean sea level. Closed forests *Rhizophora stylosa* or mixed *Rhizophora, Avicennia* and rarer *Bruguiera exaristata,* are usually in the interior sections. Shrublands of *Avicennia* and *Ceriops tagal* occur on the landward edge of the mangal (about high water spring level). In areas where the mangal is located on spits, *Bruguiera* occurs with *Ceriops* and *Avicennia*). Associated fauna include crustaceans (*Uca* spp., *Sesarma* spp., *Macrophthalmus*, shrimps, *Thalassina anomala, Epixanthus, Scylla serrata*); burrowing worms, gastropods (*Terebralia, Cerithidea, Telescopium, Littorina* and *Nerita*); encrusting organisms (barnacles, bivalves and limpets); gobioid fish and chitons.
Notocallista-echinoderm	intertidal flat	sand flat muddy sand flat	low tidal	This benthic assemblage comprises almost entirely of infauna, which includes bivalves (*Notocallista, Anomalocardium, Circe, Fragum, Pinctata, Pinna, Placamen* and *Modiolus*), crustaceans, worms, branchiopods, burrowing anemones, and echinoderms. On the surface of the flats, gastropods (*Natica, Cerithium, Epitonium, Rhinoclavus, Cominella* and *Strombus*) occur. Algae and, Morula and Trochus shells may occur on scattered rocks or larger shells. The sediment is usually highly bioturbated and during high tide inundation demersal fish feed on the benthos.
Demersal fish-echinoderm-crustacean	subtidal plain	muddy sand/gravel sheet	subtidal	This biotic assemblage inhabits substrates in 5-20 m depth in subtidal embayment plains such as Withnell Bay, King Bay and Mermaid Sound. It comprises of demersal fish (eg. flounder, flathead, rays, catfish and eels), echinoderms, polychaete worms, crustacean, bivalves and gastropods.
Donax-crustacean	intertidal beach	beach	mid to low tidal	The *Donax*-crustacean assemblage inhabits exposed beaches in small embayments and tombolo. It supports an infaunal assemblage of mainly *Donax* bivalves and surface gastropods. Zonation occurs and is a function of tidal level. *Scopimera* and *Mictyris* crabs, polychaete worms, surface gastropod *Nassarius dorsata* and *Donax* are found in the mid to low tidal zone. The crab *Matuta* is found in the low tidal zone and *Callapa* crabs are found in the subtidal zone.
Uca-cerithid	intertidal flat	salt flat	high tidal	This assemblage includes the burrowing crabs *Uca* sp., *Mictyris* and *Sesarma*, and *Cerithium* gastropod. The saltflats may have a covering of blue-green algae and saltbush may occur on the higher parts of the flat. .

Assemblage	Geomorphic unit	Habitat	Tidal range	Biota
	intertidal flat	shoal sand flat	low tidal	*Mictyris* soldier crab dominated low tidal sandflats and shoals. Bivalves, echinoderms, branchiopods and the sand bubbler crab Scopimera also occur, however to a lesser degree.
Uca-Macrophthalmus	intertidal flat	muddy sand flat	low tidal	The crabs *Uca* spp. and *Macrophthalmus* dominate and to a lesser extent bivalves, echinoderms and worms occur.
Xanthid-sponge	intertidal limestone pavement	limestone pavement	low tidal	This assemblage consists of several species of Xanthids (*Pilumnus*, *Atergatis*), sponges (encrusting to erect), tubeworms gobioid fish, bivalves (such as *Tridacna* and *Barbantia*), scattered coral and algae.
Ocypode	intertidal beach	beach beach ridge	high tidal	This assemblage is found in the high tidal to supratidal zones of sandy beaches and spits. The ghost crab *Ocypode*, hermit crabs *Coenobita* and amphipods are included in the faunal composition of this assemblage.
Seagrass	subtidal plain intertidal flat	sand/gravel sheet sand flat	subtidal low tidal	Seagrass occurs in the larger bays and sheltered flats of the region. *Halophila ovalis*, *H. decipiens* and *H. spinulosa* seagrasses occur in sparse density throughout this assemblage with green algae occurring in some shallow areas during winter. Sea urchins, sea cucumbers, molluscs, crabs and demersal fish are locally abundant. Seagrass assemblages are susceptible to changes in density due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature).
Algae	Subtidal shoal subtidal plain subtidal rocky shore subtidal limestone pavement	sand flat sand/gravel sheet bouldery shore fissured pavement limestone pavement	subtidal	Macroalgae occur on various substrates in the shallow waters of the region and coverage varies with seasonal physiochemical changes and cyclones. Where brown algae occurs, *Dictyopteris* is the most dominant. Articulate corallines are the dominant green algae. Molluscs, echinoderms, corals, crabs and fish also are found in the algae assemblage. Some of the bare limestone pavements are covered with crustose corallines and *Jania* sp turf. In sheltered embayments such as Conzinc Bay, *Sargasssum*, *Dictyopteris* and *Pandina* dominate with *Zonaria*, *Dictyota* and *Turbinaria* in less abundance.

The spatial variability in the physical and environmental characteristics within the study area is responsible for its high species diversity and abundance. Species numbers include six species of seagrass, 193 species of seabirds, 37 species of algae, 229 species of hard coral, 600 fish species, 184 species of shells, 126 species of crustaceans and 193 echinoderms (sea urchins, sea stars and their relatives), which is the highest number from any single area in Western Australia. It is likely that the numbers of recorded species will increase in all groups as more research is conducted.

While the exact numbers of species within the diverse marine communities have not been determined, there have been several studies to investigate the range and geographical locations of the habitats and assemblages in which they occur. These studies have used a combination of satellite imagery, aerial photography and in-the-field techniques. An amalgamation of data gathered using these techniques has facilitated the development of broad scale habitat maps of the study area (Figures 4). These maps provide a useful planning tool, but it should be remembered that the separation between habitat types is not always as distinct as the lines on a map would indicate. Also, the distribution of habitat types may vary from time to time as the sand sheets over limestone pavements are mobile and there are seasonal variations in the cover of macroalgae and seagrass.

For the purpose of marine reserve planning five marine habitats have been defined according to physical environmental influences, substrate type and dominant marine biota. These are:
rocky shores and intertidal limestone platforms;
intertidal sand/mud beaches;
mangrove communities;
coral communities; and
subtidal sand/rubble and limestone pavement with macroalgae & seagrass;

4.2 Marine Habitats

Rocky shores and intertidal limestone platforms

Rocky shores are a dominant feature within the study area but they vary according to rock type and aspect. The ancient igneous rocks form rubble, boulder or cliff shores. Igneous rubble and bouldery shores occur predominantly on the inshore islands. They are either steep or moderately inclined.

The sedimentary limestone rocky shores consist of cliffs, which often have intertidal platforms. The cliffs are formed by a combination of wave attack, biological erosion, undercutting and rock falls. Marine erosion is also a major contributor in the development of widespread limestone pavements where the limestone is degraded to an irregular or hummocky, and internally honey-combed pavement that is covered by a sand/gravel veneer.

Rocky shores are characterised by vertical zonation, with many of the plants and animals that live there restricted to a narrow horizontal band. The large tidal ranges within the study area result in pronounced horizontal banding. At the top of the intertidal zone, an algal film covers the rocks. Below that is a narrow band of the milky oyster, *Saccostrea sp*. The coral rocky oyster, *Saccostrea cucculata*, forms a broader band below the milky oyster. Barnacles, *Tetraclita porosa* and *Chthamalus sp*. become more abundant below the oyster level. The worm-like vermitids form a zone at the lower level of the intertidal zone where algal turf forms a border. Associated with the oysters and barnacles are a wide range of molluscs such as bivalves, gastropods and chitons as well as crabs and other crustaceans, worms and small fish. Most of these species occur in crevices in the rock and oyster clumps. This zonated intertidal assemblage of marine organisms extends throughout the study area. However, on the outer islands of the archipelago the milk and coral rock oysters are replaced by the ocean oyster *Saccostrea commercialis*.

The limestone platforms are inundated for most of the time and during low tide, many of the organisms are protected from desiccation in shallow pools. A wide range of bivalve shells, snails, crabs, worms, and some small fish are associated with intertidal limestone pavements and at high tide, larger fish from deeper water come in and feed on these organisms. In areas of moderate to high wave action, the platforms are covered with an algal turf and are rich with invertebrate life. On some of the more exposed platforms, corals are present on the outer edges. In areas of low wave action, the platforms have less algal turf and are often covered by sand and mud. The distribution of particular plant and animal species is largely dependent on the amount of sand and mud.

The abundance of invertebrate life on rocky shores and intertidal limestone platforms provides a valuable food source for shore birds. This habitat is under pressure from collectors, particularly during peak holiday periods on easily accessible shores. Rocky shores are also vulnerable to pollution from floating debris and contaminants, and strandline litter poses a threat to wildlife, which can become entangled.

Intertidal sand/mud beaches

The sediment size and organic content of beaches varies throughout the study area. It is the sediment size, organic content and the amount of tidal inundation, which determines the distribution of organisms, which live both on the sediment surface and buried within the sediment.

Most of the more exposed beaches are characterised by sand with a relatively low organic content. The upper reaches of some of these beaches and the adjoining sand dunes provide nesting sites for sea turtles and wedge tailed shearwaters. In the upper intertidal zone burrowing ghost crabs *Ocypode sp*. are the most conspicuous invertebrates as they scurry over the beach surface and disappear down their burrows. While some invertebrate species live buried within the clean sands of exposed beaches, their diversity is low in comparison with more sheltered conditions.

Sheltered beaches are characterised by fine grained sands with a high organic content. These areas are covered by a surface film of micro-organisms which provides a rich food source for marine snails, crabs and other organisms. These in turn are predated by larger fish, which swim over the area at high tide. Many of the species that live in this habitat are buried in the substrate itself. These include bivalve shells, lampshells or brachiopods, worms, crabs and sea urchins. Because of the burrowing activities and abundance of organisms within the soft intertidal sediments, the sediment is regularly turned over. Many of the estimated 330 mollusc species recorded in the study area can be found in intertidal and shallow subtidal regions.

Extensive sand and mud flats also occur over intertidal limestone platforms in sheltered conditions. Again, a high diversity of organisms is associated with these habitats and species include both those that live on the surface and those that burrow into the substrate. As with the rocky shore habitat the abundance of invertebrate life in intertidal sand and mud substrates provides a valuable food source for shore birds.

Currently, the level of human usage of sand and mud beaches pose little threat to these habitats. However, uncontrolled shell collecting of volutes, cowries and food species such as oysters and clams, could decimate local populations if these activities are not properly managed. The volutes are considered to be particularly vulnerable because their larvae hatch direct from attached egg masses and do not have a pelagic dispersal stage. Turtle and bird nesting are also relatively undisturbed though once again this activity is vulnerable to any increase in unmanaged human visitation. Soft substrate shores, like rocky shores remain vulnerable to pollution from floating debris and contaminants, and strandline litter poses a threat to wildlife, which can become entangled.

Mangrove communities

Mangroves are a diverse group of largely tropical trees, adapted for life between the tides on sheltered shores, estuaries and tidal creeks. They possess specially adapted roots for survival in mud, which is inundated by saltwater and depleted of oxygen. To cope with low oxygen levels in the mud, the roots of most mangrove species extend above the mud surface. Mangroves need soft substratum in which to anchor their roots.

Six species of mangrove are found in the Dampier Archipelago/Cape Preston region with the two most prevalent being the white mangrove (*Avicennia marina)* and the red mangrove *(Rhizophora stylosa).* The other species present are the club mangrove *(Aegialitis annulata),* the ribbed-fruit orange mangrove (*Bruguiera exaristrata),* the yellow-leaf spurred mangrove (*Ceriops tagal),* and the river mangrove *(Aegiceras cornculatum).* The only Pilbara mangrove species that does not occur in the study area is *Osbornia octodonta*.

Mangroves mostly inhabit intertidal flats in embayments between mean sea level and high water, though in some locations they occur on steep rocky shores in embayments. In areas exposed to waves, mangrove communities become progressively narrower (1 or 2 trees wide) and finally absent. The most luxuriant mangrove communities occur where a combination of low-energy conditions and sedimentation provide a gently sloping tidal flat. There are extensive mangrove communities within the study area on the tidal flats at Regnard Bay, the Maitland River mouth, West Intercourse Island, King Bay and Nickol Bay. Well developed communities also occur in some of the sheltered bays on the islands for example in Searipple Passage and the southern shores of Legendre, West Lewis and East Lewis islands. A tidal creek on the southern side of Enderby Island has both well developed mangroves and clear water. This unusual combination of attributes makes this a valuable and attractive site.

Well developed mangrove communities display an obvious zonation in response to tide levels salinity and substrate types. In areas where there are spits, *Bruguiera exaristata* occurs with *Ceriops tagal* and *Avicennia marina*. Along shorelines *Avicennia marina* forms open shrublands at about mean sea level. Interior parts of the mangroves are closed forests of *Rhizophora stylosa* or mixed *Rhizophora*, *Avicennia* and rarer *Bruguiera exaristata*. Landward parts of the mangal, at about high-water spring

tide level are shrublands of *Avecinnia* with *Ceriops tagal*. Landward of the mangrove communities, saltmarshes occur which are intertidal plant communities dominated by herbs and low shrubs.

The main source of food that fuels mangrove ecosystems are leaves from the mangrove trees themselves. When these leaves fall onto the mud below, they become available as a food source for microscopic organisms. These in turn provide a rich source of food for a variety of animals which either feed directly on the decomposing leaves, the microbes or on each other. These animals include snails, worms, crabs, shrimps, fish and birds. A substantial proportion of the fauna are burrowing species and their activities help to oxygenate the muddy substrate. However, the most prominent species occur on the surface and include the large conical snails *Telescopium telescopium*, gobioid fish or mud skippers and attached to the tree trunks and exposed roots, oysters of the genus *Saccostrea* and a variety of barnacles.

Mangrove communities provide important nursery areas for juvenile fish and they are also vitally important as prawn nursery areas. In addition, the mangals within the study area are of biogeographic significance as a centre of fiddler crab diversity.

The blue-green algal species, *Microcoleus* sp. and *Phormidium* sp. occasionally form mats over salt flats on the landward side of mangroves. In addition, the planktonic blue-green algae *Trichodesmium erythraeum* is often observed to bloom throughout the archipelago region during summer and autumn. This is a natural event and is not due to human influence.

Mangrove communities are affected by natural events such as cyclones and coastal erosion. Of greater concern from a management point of view however, is their vulnerability to human induced change. Some of the mangrove communities within the study area are easily accessible and favoured locations for fishing and collecting. With the prospect of a significant increase in the residential population in adjacent towns during the next few years, collection and fishing quotas will need to be monitored carefully.

Mangroves are also vulnerable to pollutants, in particular oil, which kills the trees by smothering the aerial roots. Debris, such as plastic bags and ropes may also become entangled among the complex root systems and branches and cause a hazard to wildlife.

Mangroves can be alienated from large areas of suitable substrate if tidal flow rates and directions are altered. This sometimes occurs naturally, but large-scale alienation can also occur as a result of industrial and public works development programs. Smelly, mosquito ridden mangrove communities have often been undervalued in the past and clearing and reclamation of mangroves is still occurring at an alarming rate overseas. Fortunately in Australia there is now a better understanding of the benefits associated with the protection of mangrove communities. These include the availability of nursery areas and habitats for commercial fish, increased inshore productivity, sediment trapping and protection from coastal erosion. Their benefits need to be considered carefully when planning any development that could have a negative impact on mangrove communities.

Coral communities

Corals grow as a result of a mutually beneficial (symbiotic) partnership between plant and animal. Single celled plant organisms called zooxanthellae occur within the coral animal tissues. These microscopic plants utilise energy from sunlight like other plants. They also take up much of the coral animal's waste products, supply up to 98 per cent of its carbohydrate requirements and assist in the deposition of the coral skeleton. Because the plant cells need sunlight, coral reefs grow best in clear shallow waters. They are also limited by temperature, optimum growth occurring between 25º to 29° C and at normal ocean salinity.

Reef-building species are found along the whole coast of Western Australia, but species diversity decreases progressively from north to south. They are conspicuous and dominant in coral communities where they also provide food, substrate and shelter for prolific and varied marine life including

seastars, sea urchins, crustaceans, bivalve and snail shells, worms and of course fish. Many of the 420 recorded sponge specimens within the study area are found to be most abundant on coral reef and rocky reef habitats.

There have been 229 hard coral species recorded in the Dampier Archipelago/Cape Preston region. This high diversity of coral species is a reflection of the variety of substrates and oceanographic conditions. Variations in wave exposure, sediment deposition, water clarity, aspect, topography, slope and current all influences the distribution of individual species and the structure of coral communities. Within the study area there is a complete range of conditions from the exposed reefs with high wave action, clear water and low sediment deposition rates, on the seaward coasts of the outer islands, to the sheltered areas with high sediment deposition rates and turbid waters further inshore for example at Withnell Bay. Some coral species for example *Pavona minuta* and *Pocillopora eydouxi* occur only on seaward reefs, *Montipora eurythraea* occur only in lagoons, some Fungiidae species occur only on sand substrates and some *Caulastrea*, *Ducanopsammia*, *Euphyllia*, *Moseleya* and *Trachyphyllia* species occur only in turbid inshore habitats. The richest coral areas are found on the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and northwest Enderby Island. Live coral cover can also vary greatly from reef to reef, as indicated by contrasting covers of 60 and 10 per cent on Hamersley Shoal and Sailfish Reef, respectively.

Corals of the Dampier Archipelago/Cape Preston region survive within natural temperature regimes that are close to their tolerance levels with respect to maximal temperatures. Any further elevation in water temperatures related either to natural fluctuations or greenhouse emissions could cause coral bleaching and death. Any large scale discharges of industrial cooling water may also have localised affects on coral health.

Coral communities have evolved to compensate and recover from natural disturbances over time. As a result, coral communities may show temporal variation in structure and species composition. Fast growing *Acropora* species can recover from severe damage in a few years while slow growing massive species may take up to 30 years to recover from major damage.

Storms and other natural events, periodically affect the coral communities within the study area. Severe storms and cyclones sometimes cause significant coral breakage and damage resulting from suspended sediments. Other causes of mass coral mortality include bleaching and oxygen depletion of the sea water.

Bleaching occurs when corals become stressed by extreme conditions such as high temperatures. When this occurs, they expel the zooxanthellae from their tissues leaving only the colourless animal tissue and the white skeleton beneath. Corals do not always recover from bleaching events and there is some concern that the frequency and magnitude of bleaching events will increase in association with global warming.

Seawater can become depleted of oxygen when the corals undergo mass spawning in March and April. Large quantities of spawn released into the water column have a high oxygen requirement so if water currents do not disperse the spawn, or calm weather prevents mixing of the surface layers, the spawn can reduce levels of dissolved oxygen below that required to sustain marine life. When this occurs, it is not only the corals that perish, but also the multitude of snails, worms, starfish, fish and all the other organisms that live on the reef.

It remains uncertain as to whether outbreaks of the crown of thorns starfish *Acanthaster planci*, and the coral eating snail *Drupella cornus* are part of a natural cycle or are induced by human activity. The study area is within the natural ranges of both of these species. The living tissue of hard corals is located on the surface of the hard skeletal material and the coral eating starfish and snail remove this surface layer, leaving the white skeleton undamaged. The skeletons then become colonised by algae and in severe outbreaks, the whole coral reef community can become significantly altered. An

apparent increase in the number of *A. planci* was noticed by researchers on the western side of the Dampier Archipelago in 1983.

At present, the coral communities within the study area are mainly in good condition, with only limited human disturbance. The coral reefs of the region provide food and protection for an abundance of fish, which are enjoyed by recreational line and spear fishers as well as by divers wishing to observe and appreciate the sea scape. However, the potential increase in the size of coastal towns in the area could result in increasing pressure on reef habitats, for example from over fishing and anchor damage, and there is a need both to monitor coral reef health and to educate users to minimize their impact. Within the central Indo-Pacific region, 70 per cent of all coral reefs have experienced some degradation, so there is a great responsibility on Australia to ensure the conservation and good management of its coral reefs.

Subtidal macroalgae & seagrass on coarse sand/rubble and limestone pavement

The islands and shoals of the Dampier Archipelago and Cape Preston region rise above submarine plains. These plains are gently sloping from 5 m deep near the mainland coast to 15-20 m deep at the northern margin. The sea floor is characterised by extensive limestone pavements and large sheets of shell gravel, sand and muddy sand/gravel. The sediments that cover the submerged plains are generally of coarser grained sand and grit in offshore areas while the inshore substrates are characterised by fine-grained silts and mud. The locations and thicknesses of sand sheets and banks vary with time because these mobile sediments are shifted during strong storm events. The habitats are also subject to seasonal changes associated with algal cycles of growth and senescence.

At first glance some of the subtidal areas of sand and fine rubble look bare. However, a closer look reveals a multitude of burrows built by species that live within the sediment. Some of these burrows, for example those belonging to worms, are quite small, while others, such as the fearsome mantis shrimp make significant burrows with adjacent mounds up to 15 cm high. In addition, fish such as flathead, rays and flounder, together with echinoderms, crustaceans, bivalve molluscs and gastropods or sea snails occur on or above the substrate surface.

Large species of algae, or macroalgae dominate the study area and they are an important primary producer (capture the energy from sunlight so it is available for other organisms in the natural community). Macroalgae, grow on areas of limestone pavement and on stable rubble surfaces though some of these areas may have a thin veneer of sand. Algae are simple plants that require light to grow and occur at a variety of densities from sparse mainly bare substrate, to dense algal beds.

Brown algae are the most abundant of the major algal groups in the Dampier Archipelago/Cape Preston region, with *Sargassum* sp., *Dictyopteris* sp. and *Padina* sp. being the dominant species. Less prominent brown algal species include *Dictyota* sp., *Zonaria* sp. and *Turbinaria* sp.. Green algae are also present in the region, dominated by the articulate coralline, *Halimeda* sp.. The prominent red algal species, include crustose corallines, non-corallines and algal turf (*Jania* sp.).

At some sites, strong tidal currents provide good conditions for filter feeding animals including coral colonies, sea whips and sea squirts or ascidians. Colonies of filter feeding animals occur interspersed with marine plants but in places the algae are so sparse that the animal filter feeders form the dominant component of the biota. Both the plant and sedentary animal components of the subtidal communities provide an important habitat for bivalve shells, snails, sea urchins, sea stars, crabs and fish. Algal beds also provide important nursery grounds for juvenile fish.

Seagrasses are present on the subtidal soft sediment habitats. Seagrasses are far more advanced plants than algae with a vascular system, flowers and seeds. They do not form extensive meadows within the study area, but occur interspersed among the macroalgae. Six species of seagrass have been recorded in the study area; *Cymodocea angustata*, *Halophila ovalis*, *Halophila spinulosa*, *Halodule uninervis*, *Thalasssia hemprichii* and *Syringodium isoetifolium*. Seagrasses provide an important food source for

turtles and dugong. There are significant seagrass patches between Keast and Legendre islands and between West Intercourse Island and Cape Preston.

The balance between algal and seagrass species has been affected by elevated nutrient levels elsewhere in Australia. Nutrient rich discharges from agriculture and industry can result in excessive algal growth, which then smothers and kills the seagrass leaves. While this is not currently an issue within the study area, aquaculture developments that would require the application of additional nutrients would need to be carefully considered to prevent seagrass degradation. Seagrass and algal beds are also vulnerable to damage from inappropriate mooring designs and careless anchoring. Management of these activities would need to be considered if visitation levels increased significantly.

4.3 Marine Wildlife

While there are many hundreds of animal species within the study area, public attention often focuses on the larger, charismatic vertebrates (animals with a backbone), many of which migrate vast distances and some of which suffer an insecure population status. In some cases, fisheries and tourism are dependant on the maintenance of the larger marine wildlife populations, and these in turn are dependant on the integrity of the whole marine ecosystem.

Marine mammals

Whales and dolphins, or cetaceans, are some of the most charismatic of all marine wildlife. Like all mammals, they are warm-blooded, breath air and suckle their young. They live permanently at sea, and their streamlined shape, thick layer of insulating fat, efficient swimming and prolonged diving capabilities make them effective ocean-going animals. Cetaceans are also highly social animals that interact with one another and at times with humans.

There are two main types of cetaceans. Toothed whales have teeth and feed on squid, fish and in some cases, other marine mammals. Baleen whales feed by filtering large volumes of water for planktonic organisms through modified hairs that form sieve plates around the mouth.

There are about 76 species of whales and dolphins in the world's oceans, and 36 are known to visit Western Australian tropical and sub-tropical waters. Of these, three species of toothed whale and four species of baleen whale have been recorded within the Dampier Archipelago (Table 7). In addition, it is likely that most of the 36 Indian Ocean species occasionally visit the study area.

Table 7 Cetaceans known to visit the study area

Whales	
southern bottle-nosed whale	*Hyperoodon planifrons*
false killer whale	*Pseudorca crassidens*
killer whale	*Orcinus orca*
humpback whale	*Megaptera novaengliae*
tropical bryde's whale	*Balaenoptera edeni*
southern minke whale	*Balaenoptera acutorostrata*
blue whale	*Balaenoptera musculus*
Dolphins	
bottle-nosed dolphin	*Tursiops truncatus*
common dolphin	*Delphinus delphis*
Risso's dolphin	*Grampus griseus*
Indo-Pacific hump-backed dolphin	*Sousa chinensis*
striped dolphin	*Stenella longirostris*

Populations of large whales generally migrate south in summer and north, towards the tropics in winter. This behaviour is driven by the availability of abundant food in the polar seas during the summer months and the warm, calm tropical waters in winter. The Bryde's whale however, is limited to temperate and subtropical oceans where animals hunt coastal fish. Similarly, although minke whales are more prevalent at high latitudes in summer, some animals are found across their range throughout the year. Humpback whales follow a distinct migratory pathway. During the summer months, they feed in the nutrient-rich waters of Antarctica. They then migrate north to the warm tropical waters off the Pilbara and Kimberley coasts in June and July to give birth and suckle their young. In September, they move south again and mate before returning to their feeding grounds in Antarctica for the summer months. Female humpbacks sometimes give birth within the study area, though the main calving area is further north-east off the Kimberley coast. Adult humpback whales and their young frequent the archipelago on their migration back to their southern feeding grounds in early spring.

Humpback whales were once the mainstay of the Western Australian whaling industry. Whalers were active in the Dampier Archipelago between 1870 and 1872, with an associated oil processing facility on Malus Island. Continued whaling in the Antarctic feeding grounds has pushed humpback populations to the brink of extinction, and a moratorium on hunting humpback whales currently exists. Humpback whales are threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. They are listed as "*endangered"* under the Commonwealth *Endangered Species Protection Act 1992*.

Humpback whales are popular among whale watchers for their spectacular behavioural displays such as pectoral fin slaps, tail slaps and 'breaching', when they leap out of the water. Cetaceans are sometimes disturbed by boating and swimming. In order to protect them from unwanted human company, there are regulations under the *Wildlife Conservation Act*, which specify appropriate interactions.

Stories of dolphins befriending people have usually been about bottlenose dolphins. This species grows up to 3.9 m and eats a variety of fish and invertebrates. Bottlenose dolphins are capable and willing bow riders and are frequently seen body surfing at beaches. Many people feel an affinity with dolphins and resident populations of bottlenose dolphins support tourism at Shark Bay and other locations along the Western Australian coast, where animals regularly come to the shore or visit boats to interact with humans.

The other group of marine mammals found in the study area is the Sirenia, represented by one species, the dugong (*Dugong dugon*). Dugong are herbivores and depend primarily on seagrass. They may live for 70 years or more but females do not calve until at least their tenth year. They then produce young every three to seven years after a gestation period of about 13 months. A fully-grown adult dugong weighs around 400 kilograms and reaches a length of 2-3m.

Dugong occur throughout the tropical and subtropical Indo-West Pacific but they have been reduced to relict populations separated by large areas in which they are extinct, or close to extinction. Within the study area, dugong occur in the shallow, warm waters around the islands, although not in the comparatively large concentrations seen further south in Exmouth Gulf or Shark Bay.

Current knowledge on the size, distribution and migratory habits of dugong populations within the study area is limited. However, dugong have been observed grazing in many of the shallow bays and in areas between the islands. Recreational fishers report regular sightings of dugong at East Lewis Island, Cape Preston, Regnard Bay and Nickol Bay. The shallows west of Keast Island are also known to provide important dugong habitat.

Dugong are vulnerable to injuries from boat propellers and there are large numbers of boats which operate within the study area. Aboriginal and Torres Strait Islander people are allowed to take dugong under the *Wildlife Conservation Act 1950*. The number of dugong taken by indigenous people is not known.

Dugong are specially protected under the *Wildlife Conservation Act* 1950 and although not currently listed under Commonwealth legislation, it is listed internationally by the World Conservation Union (IUCN) as being "*vulnerable*". A dugong management plan for Western Australia is currently being prepared by the Department of Conservation and Land Management.

Birds

Marine birds are often subdivided into seabirds, and waders or shore birds. Ninety-three species of seabirds occur along the Western Australian coast and of these 41 species breed on offshore islands, thereby avoiding introduced ground predators common on the mainland. Many of the islands and rocks in the study area are known breeding grounds for a variety of seabirds and particularly the small islands and islets such as Goodwyn and Keast Islands, and Nelson Rocks provide important undisturbed nesting and refuge sites (table 8).

Table 8 The distribution of nesting seabirds in the Dampier Archipelago/Cape Preston region

ISLAND	Australian Pelican (*Pelecanus conspicillatus*)	Beach Stone-Curlew (*Esacus neglectus*)	Brahminy Kite (*Haliastur indus*)	Bridled Tern (*Sterna anaethetus*)	Caspian Tern (*Sterna caspia*)	Crested Tern (*Sterna bergii*)	Eastern Reef Egret (*Egretta sacra*)	Fairy Tern (*Sterna nereis*)	Osprey (*Pandion haliaetus*)	Pied Oystercatcher (*Haematopus longirostris*)	Roseate Tern (*Sterna dougallii*)	Silver Gull (*Larus novaehollandiae*)	Sooty Oystercatcher (*Haemotopus fuliginosus*)	Striated Heron (*Butorides striatus*)	Wedge-Tailed Shearwater (*Puffinus pacificus*)	White-belled Sea-Eagle (*Haliaetus leucogaster*)
Angel Is									●							
Brigadier Is				●											●	●
Cohen Is	●				●		●	●				●	●		●	
Conzinc Is					●		●		●						●	
Delambrie Is									●							
Dolphin Is			●						●							●
Eaglehawk Is					●				●						●	●
East Goodwyn Is									●						●	
Egret Is						●		●								
Elphick Nob				●			●					●			●	●
Enderby Is		●			●		●		●	●						
Fortescue Is									●						●	
Goodwyn (Islet to SW)															●	
Goodwyn Is				●							●	●			●	
Hauy Is									●						●	
Haycock Is				●												
Keast Is	●				●				●			●				●
Kendrew Is				●								●			●	●
Lady Nora (Islet to W)									●							
Lady Nora Is				●	●				●			●			●	
Legendre Is									●							
Malus Is		●	●						●					●	●	●
Mawby Is					●							●				
Nelson Rocks				●		●					●					
North East Regnard Is															●	
Roly Rocks						●										
Rosemary Is				●	●		●		●			●				
Steamboat Is						●			●		●				●	
Walcott Is					●	●			●	●		●	●			
West Lewis Is		●	●						●							

While many of the seabirds are resident in the area throughout the year, their distribution becomes more concentrated around the rookery sites during breeding. For many of the tern species, egg laying starts in mid December, fledging occurs in March and after breeding the terns disperse. A significant population of wedge-tailed shearwaters breed in the region. In late August, shearwaters return to their burrows and laying occurs for two to three weeks in late October. In late December, the chicks start to hatch and by mid April they are fledging. Adult wedge-tailed shearwaters are often observed swimming together in dense flocks called rafts.

Western Australia has 57 species of shorebirds of which 15 are resident and the remaining 42 are regular migrants. The vast expanses of arctic tundra are the breeding grounds of dozens of bird species collectively called migratory waders. During June and July the breeding birds and their young thrive on a protein-rich diet of midge and mosquito larvae, but as the short northern summer draws to an end and the tundra freezes over, the birds are forced to fly south in search of food. Every year from August to October, several million birds wing their way more than 10,000 km from the Siberian icelands to the northern shores of Australia; thousands more journey on to the shallow lakes and estuaries of southern Australia. Many stay until the shortening days of autumn send them back to their breeding grounds in Russia.

Although bird surveys have not been conducted during the migration season, the extensive mudflats, mangroves and rocky intertidal habitats in the study area almost certainly provide important feeding and nesting grounds for waders after their journey from south east Asia.

Many other bird species, while technically neither seabirds nor waders, inhabit marine and coastal environments within the study area. The Australian pelican nests on Keast Island and small birds such as the mangrove robin, the mangrove golden whistler, the white-breasted whistler, the mangrove fantail, the dusky warbler and the mangrove kingfisher all rely on mangrove habitats for food and shelter.

Birds of prey also feed on marine resources and nest on the islands. Sea eagles make large stick nests on the ground and eat both terrestrial and marine prey. Animal remains at their nests within the study area indicate that they eat small mammals, birds, in particular shearwaters and some fish. Ospreys also build their nests on the ground out of sticks and some are particularly large, up to 2 m high. Their diet is almost entirely of marine origin with a preference for fish. Brahminy kites build much smaller stick nests in mangrove trees within the study area.

Seabirds and other ground nesting marine and coastal birds are vulnerable to human disturbance at their rookery and roosting sites. Once the parent birds have been frightened away, the eggs and small chicks fall prey to predators or can be adversely affected by temperature extremes. Some chicks are left alone when they become larger so that both parent birds can forage to satisfy the voracious appetites of their young. These larger chicks are vulnerable to ground predators and the presence of feral ground predators can tip the balance and completely decimate bird rookeries. Both direct human access and potential feral introductions by visitors therefore require careful management if the valuable nesting sites within the study area are to remain sustainable.

Many seabirds feed by flying over and then diving into the water to catch fish. They have learnt that fish congregate under rafts of seaweed and other marine debris. However, oily residues look like rafts on the sea surface and feeding birds tend to dive into them. Oil also coats the surfaces of beaches and mangroves where shore birds feed and these species therefore are also impacted by oil spills. Oil spill contingency planning and the availability of spill combat equipment is essential to minimise the impacts of any spill within the study area.

Many of the migratory marine and coastal bird species which occur within the study area are protected under joint agreements between Australia and the Japanese and Chinese governments.

Marine reptiles

Marine reptiles are well represented in Western Australian waters with 22 species of sea snake, six species of marine turtle and the saltwater crocodile.

Of the six species of marine turtle occurring in Western Australia, five are recorded in the study region: the green (*Chelonia mydas*), loggerhead (*Caretta caretta*), flatback (*Chelonia depressa*), leatherback (*Dermochelys coriacea*) and hawksbill turtles (*Eretmochelys imbricata*). The study area provides important habitat for marine turtles as Australia is one of the few countries in the world still to have relatively large turtle populations.

From August to March, female turtles lumber ashore to deposit up to 150 eggs in a hole in the sand that they dig with their flippers. The young hatch about seven to nine weeks later, depending on the temperature, and usually leave their sandy nests at night to avoid predation by birds, lizards and crabs. Once in the ocean, the young turtles are under threat from sharks, birds and other predators, and it is estimated that only five out of 100 reach the open ocean and less than one per clutch survives to breed.

Green turtles are found throughout tropical and subtropical waters but they are heavily exploited in many places for meat and other products. Large numbers nest within the study area, some migrating from as far away as the Northern Territory, Indonesia and the Gulf of Carpentaria. Green turtle adults are herbivores, feeding on seagrasses and algae while juveniles feed on jellyfish, shellfish, crabs and sponges. The green turtle has major nesting sites on the north-eastern shore of Legendre Island and the north-western beaches of Rosemary Island.

Loggerhead turtles are found in tropical and temperate waters worldwide and while their meat is not prized, they have suffered from significant disturbance to nesting beaches elsewhere. There is concern that their populations are declining in Australia possibly because animals are drowning in trawl nets. The number of nesting loggerheads within the study area is lower than that of green turtles. Loggerhead turtles migrate from their feeding grounds in the Northern Territory, Shark Bay, the Gulf of Carpentaria and Indonesia to breed within the study area. The Dampier Archipelago contains the northern-most known nesting beaches for loggerhead turtles in Western Australia.

Hawksbill turtles are found worldwide in tropical and warm temperate waters. The hawksbill has a beautiful carapace that is prized in some areas and globally this species has experienced significant population declines. The Western Australian population is the only large population of hawksbill turtles remaining in the entire Indian Ocean and research to date indicates that Rosemary Island is the main focus for nesting in this State. The hawksbill nesting beaches on Rosemary Island are therefore of great value not only at a State level but also internationally. None of the hawksbill turtles that have been tagged within the study area have been recaptured so there is little information about their migratory behaviours but it is believed that they migrate large distances from their rookeries within the study area, like the greens and loggerheads. The hawksbill turtle uses its beak to feed on sponges, seagrasses, algae, soft corals, shellfish and sea squirts.

The flatback turtle is not widely distributed and occurs mainly in the tropical waters of northern Australia with low numbers recorded in Indonesia and Papua New Guinea. The flatback breeds only in Australia and flatbacks which were tagged within the study area, have been recovered from the Northern Territory, the Kimberley coast and Exmouth. They inhabit the soft bottom seabeds of sand and mud and feed on soft corals, jellyfish, sea cucumbers and sea pens. Rosemary, Delambre and Malus Islands are significant flatback turtle nesting sites.

Leatherback turtles are the largest species of marine turtle. They grow to a length of 1.6m and weigh up to 500kg. Only a small proportion of the world's leatherback population is observed in Australia, and there have been few sightings recorded within the study area. The study area is not used as a rookery by this species, which migrates mainly to the east coast of Malaysia and Indonesia to breed. Leatherback turtles are heavily exploited mainly by taking eggs from rookery beaches.

Nesting turtles can be disturbed by people wishing to observe their nesting behaviours. While visitation levels are currently low, any significant increase in tourism within the study area would need careful management. A code of practice has been adopted to minimise disturbance at some of Western Australia's other busy rookeries and a State marine turtle management plan is currently being prepared by the department of CALM.

Hatchlings are attracted to lights, particularly in the blue range of the spectrum. This can cause them to perish because they fail to reach the open ocean. The impacts of any development with lighting therefore need to be given careful consideration. Aboriginal people have traditionally hunted turtles.

The threatened conservation status of sea turtles has been recognised in wildlife legislation. All four species which nest within the study area are included in a National Action Plan prepared by the Commonwealth and State Governments. Green, leatherback and hawksbill turtles are listed as "*vulnerable*" under the Commonwealth *Endangered Species Protection Act 1992* and the loggerhead is listed as "*endangered"* also under the *Endangered Species Protection Act 1992*. Under Western Australian legislation, green and hawksbill turtles currently have no special status but are listed among the priority species that are kept under review. Both species have been recommended for inclusion on the 'threatened' list. However, the loggerhead and the leatherback turtles are threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. The flatback turtle is not listed under either Commonwealth or State legislation.

Of the 22 Western Australian species of sea snakes, at least 11 are believed to occur within the study area. The longest is the bar-bellied snake (*Hydrophis elegans*) which grows up to 2 m long. Despite the large size and deadly venom of many sea snake species, they are generally placid animals and do not pose a serious threat to swimmers and divers. They feed on small fish, eels, fish eggs and shrimp, which they immobilise with their strong venom.

Saltwater crocodiles (*Crocodylus porosus*) were historically found in the archipelago and were commercially harvested from around 1945 until 1971. During that time, they were hunted to extinction between Onslow and Broome, but their populations have since started to recover. Recently, saltwater crocodiles have been recorded as far south as Exmouth Gulf and they are occasionally observed swimming great distances out to sea. Saltwater crocodiles require freshwater rivers and lagoons in which to breed, so although there have been a few saltwater crocodile sightings within the study area, it is outside their breeding range.

The saltwater crocodile is specially protected under the *Wildlife Conservation Act* 1950.

Fish

Approximately 600 fish species have been recorded in the Dampier Archipelago/Cape Preston region. None of these are endemic (locally unique) to the region and all can be found in adjacent waters. The fish fauna of the study area is part of a tropical inshore fauna that stretches from Shark Bay to Queensland. It has a prominent component of coral reef species and many species that inhabit mangroves.

The fish fauna supports both recreational and commercial fishing within the study area. Recreational line and spear fishers target reef fish such as coral trout (*Plectropomus* sp.), tusk fish (*Choerodon* sp.) and rock cod (*Cephalopholis* sp.). Game fishing is another popular recreational pursuit, concentrating on deepwater pelagic species such as marlin (*Makaira* sp.), sailfish (*Istiophorus* sp.), spanish mackerel (*Scomberomorus* sp.), golden trevally (*Gnathanodon* sp.) and turrum (*Caranx* sp.).

The diverse fish fauna also helps to support a recreational diving industry by providing participants with close encounters with some colourful and large animals. Charismatic species such as the manta ray (*Manta birostris*) and potato cod (*Epinephelus tukula)* inhabit the study area and delight visitors.

Fish stocks are managed by Fisheries Western Australia through a wide range of management tools, including, size and bag limits, gear restrictions, licenses and closed seasons. Five species of fish are totally protected under Western Australian fisheries legislation and two of these occur within the study area. The potato cod (*Epinephelus tukula)* grows up to 1.4 m long and they are often inquisitive, approaching recreational divers. Another fully protected fish is the whale shark (*Rhincodon typus*) which is the largest fish in the world. A whale shark has been recorded off Cape Preston but large seasonal aggregations do not occur as they do at Ningaloo where they support a flourishing tourist industry.

4.4 Coastal Terrestrial Biota

The terrestrial habitats of the shorelines and islands of the Dampier Archipelago/Cape Preston region provide important breeding sites for turtles and seabirds and also support many other mammals and reptiles. Biogeographical studies have found over 288 plant species from 60 families to occur in the region. The different plant species characteristically occur in different areas and the four main groups of plants, or plant assemblages, are rocky outcrops, sandplain shrubland, flats and drainage lines.

Rocky outcrop assemblages consist of very sparse vegetative cover which includes small stands of trees, such as rock kurrajongs (*Brachychiton acuminatum*), native figs (*Ficus platypoda, Ficus virens*), shrubs, such as *Hakea suberea* and *Grevillea pyramidalis*, and a range of grasses including spinifex or *Triodia* sp.

The sandplain shrubland is dominated by the native wattles *Acacia bivenosa* and *A. coriacea*, over a moderate cover of spinifex grasses (*Spinifex longifolius, Triodia* sp.) and other low lying vegetation including *Myoporum accuminatum* and *Acanthocarpus preissi*. Some of the larger islands support diverse eucalypt communities.

The flatlands are areas of alluvial soils which flood or are waterlogged after rain. These areas are covered with moderate to dense grasses and the occasional shrub. Drainage lines along the rocky slopes on the islands support open bushland communities of *Eucalyptus microtheca*, *E. terminalis*, and *E. patellaris*, sparse shrubland of the yellow-flowering cassias (*Cassia* sp.), and dense *Triodia angusta* spinifex.

Weeds that are established on many of the islands include Buffel Grass (*Cenchrus ciliaris*), Kapok (*Aerva javanica*) and Prickly Pear (*Opuntia stricta*). There are also Tamarisk trees which have been planted to provide shade on West Lewis and Rosemary Islands.

Twenty-one terrestrial mammal species have been recorded in the Burrup Peninsula area, comprising one monotreme (echidna), six marsupials, four native rodents, four bats and six introduced mammals (table 9). In addition, the characteristic mound-like dwellings of the pebble mound mouse (*Pseudomys chapmani*) can still be found throughout the region though the animals themselves are believed to have been locally extinct.

Table 9 Terrestrial mammals found in the study area

Monotreme	
echidna	*Tachyglossus aculeatus*
Marsupials	
little red antechinus	*Dasykaluta rosamondae*
northern quoll	*Dasyurus hallucatus*
pilbara ningaui	*Ningaui timealeyi*
common planigale	*Planigale maculata*
euro	*Macropus robustus*
Rothschild's rock-wallaby	*Petrogale rothschild*
Native rodents	
water rat	*Hydromys chrysogaster*
delicate mouse	*Pseudomys delicatulus*
sandy island mouse	*Pseudomys hermannsbergensis*
pale field-rat	*Rattus tunneyi*
common rock-cat	*Zyzomys argurus*
Bats	
little red flying fox	*Pteropus scapulatus*
common sheath-tailed bat	*Taphozous georgianus*
finlayson's eptesicus	*Eptesicus finlaysoni*

lesser long-eared bat	*Nyctophilus geoffroyi*
Introduced mammals	
House mouse	*Mus musculus*
black rat	*Rattus rattus*
domestic dog	*Canis familiaris*
red fox	*Vulpes vulpes*
feral cat	*Felis catus*

Approximately 50 species of terrestrial reptile inhabit the study area. These include 16 snakes, of which the Pilbara olive python (*Morelia olivacea barroni*) is a threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. The remaining reptile species comprise nine geckos, four legless lizards, four dragon lizards, five goanna lizards and 12 skink lizards. Two species of frogs are also found in the area.

Major threats to these terrestrial inhabitants are industrial land use and fire. Fire on the arid islands of the Dampier Archipelago can be devastating. Luckily however, they are infrequent.

5. HUMAN USAGE

5.1 Cultural history

Aboriginal heritage

The pre-history of Aboriginal habitation in the area dates back 20,000 years, well before the rising sea levels flooded the valleys and separated the islands of the archipelago.

The Dampier Archipelago, Burrup Peninsula and adjacent coastal areas were once home to Aboriginal people known as the Yaburrara or 'island' people. According to Aboriginal elders in the region today, the Yaburrara people originally numbered 100 to 120 but their numbers declined following the introduction of diseases such as smallpox and exploitation of their food and water sources. It is also likely that they, and members of other Aboriginal groups were exploited for labour by whalers and pearlers, and there were violent confrontations with European settlers, climaxing in the Flying Foam massacre of 1868. Some reports suggest that the Yaburrara people had all died by the 1930s or 1940s and others suggest that they died in the 1950s or 1960s. The Yaburrara people used rafts for transport between the islands and their midden sites and fish traps are testimony to their extensive use of marine life for food. Little is known about their language, which may have been a northern linguistic division of the Ngaluma, a neighbouring community, or it may have been a separate language altogether.

Some of the islands in the western archipelago were visited by the Mardudhunera people, who lived on the mainland near Nickol Bay. Remnant Aboriginal campsites in the area contain indigenous shell middens, artefacts and rock art. The Burrup Peninsula, adjacent to the study area, contains hundreds of thousands of Aboriginal rock engravings, providing a rich collection of Aboriginal rock art and some of the earliest examples of art that exists in Australia. The peninsula's indigenous archaeological features include engravings, mythological and ceremonial sites, graves, rock shelters, artefact quarries, factories, burials and middens. The Burrup Peninsula has been described as "the world's oldest and

There are many sites of important historical Aboriginal significance in the area, such as the Flying Foam Massacre site and the Climbing Man site on the Burrup Peninsula. Aboriginal sites are protected under the *Aboriginal Heritage Act 1972*.

There is still a strong Aboriginal identity in the region with individuals and families retaining strong ties to particular sites and land locations. The Ngaluma and Injibandi communities are based in Roebourne and some families have custodianship of the study area. Current Aboriginal usage in the

area includes limited hunting of turtle and dugong. There are several native title claims over parts of the waters and islands of the Dampier Archipelago/Cape Preston region (*see* Native Title section).

European and Maritime history

European ships may have ventured into Pilbara waters from as early as 1618 and, the Dampier Archipelago was first charted in 1628 for the Dutch East India Company.

The earliest recorded European landing in the archipelago was in 1699, when William Dampier used the protected waters of what he named Rosemary Island as an anchorage for the vessel *Roebuck*. It is now agreed that the island, which bears this name today, is not the one originally named by Dampier. Instead, it is thought that Dampier landed on what is now known as Malus Island, which was named by Nicholas Baudin in 1801.

While the earliest recorded landing was not until 1699, it is likely that survivors from the English East India Company ship, the *Trial* (also known as the *Tryal)* landed in 1622. The *Trial* became the first known shipwreck in Australian waters when it struck what are now known as Trial Rocks nine nautical miles north-west of the Montebello Islands. Of the 139 people on board, there was room for just 46 on board the small boats and it was these men who most likely came ashore within the study area in search of water before setting off for Jakarta.

In 1772, St. Allouarn noted Rosemary Island while sailing from the North West Cape to Timor, but no landing was made.

Nicholas Baudin sailed the islands of the archipelago in 1801 aboard the *Geographe* and named them, as a group, Dampier's Archipelago. Legendre, Hauy and Delambre Islands were also named during this visit. Rosemary Island, as it appears on today's charts, is situated approximately 4 km to the north-west of Malus Island, and was so-named by Baudin during this same expedition.

Lieutenant Philip Parker King made a more detailed investigation of the Dampier Archipelago during his 1818 voyage of the north west coast aboard the *Mermaid*. During this visit Enderby, Gidley, the Lewis islands and the Intercourse islands were named, as was Nickol Bay to the east of the archipelago.

In 1851, Lieutenant F.B. Helpman visited the archipelago in search of guano deposits. He made special mention of "…numerous fresh native foot marks on the beach..." and "... three graves lying side by side" on Enderby Island. These gravesites have been located and are believed to be the graves of early whalers. A whaling station was established on Malus Island to process humpback whales. In 1879 Pemberton Walcott made mention of these same gravesites whilst he was searching for survivors of the "*Rosette*". However, he also documented seeing five gravesites which have yet to be documented by the Western Australian Museum.

The pearling industry flourished in the region during the nineteenth century with Cossack, Flying Foam Passage and Dolphin Island used as the main bases for the pearling fleet. Many pearling luggers were wrecked in the Dampier Archipelago during this period and towards the end of the century, the industry moved to Broome leaving relics of their operations in Black Hawke Bay on Gidley Island, where pearling boats were careened and repaired.

The commercial fishing industry was established during the late 1800s. In addition to the harvesting of oysters and longline fishing for finfish, turtles and their eggs were commercially harvested until 1936.

Following the invasion of Singapore by the Japanese during World War II, the 30 tonne yacht *Sedjatra* was wrecked off the north west tip of Enderby Island as it fled from Indonesia en route to Fremantle. During this same period, a PBY 5 Catalina Flying Boat sank on the eastern side of Enderby Island.

This seaplane belonged to the 10th Air Wing of the United States Navy and operated out of Perth, Geraldton and Exmouth. The remains of this craft can still be seen on the shores of Enderby Island.

Much more recently, during Cyclone Orson in 1989, a dredging barge moored off West Lewis Island, broke its moorings and was wrecked on Eaglehawk Island. This large wreck has become a landmark within the study area.

The first Europeans to explore the inland Pilbara region landed at Hearson Cove, on the Burrup Peninsula, in 1861. This party, under the leadership of F.T. Gregory, travelled aboard the *Dolphin* from Fremantle to determine the potential of the north west for agriculture. Gregory named Dolphin Island after his ship. He also named other features after members of his expedition party, such as Cape Lambert, and Pemberton, Walcott and Dixon islands. F.T. Gregory recommended that the land would be suitable for pastoral purposes. He also noted the abundance of iron ore. The first settlers to the region established a pastoral industry in the 1860s and this remained the local economic mainstay until the 1960s. Remains of pastoral buildings and stockyards are visible on West Lewis Island.

Large deposits of iron ore were first mined in the region during the 1960s, and major industrial development began with Hamersley Iron Pty Ltd's iron ore stockpiling and ship loading facilities at Parker Point in 1966. The industry prospered and resulted in the establishment of the towns of Dampier and Karratha. The Karratha townsite was excised from Karratha Station pastoral lease in 1968.

The 1960s also saw the founding of the offshore oil and gas industry. In the late 1970s, the North West Shelf Gas Project developed a liquefied natural gas (LNG) production plant and export wharf. The North Rankin A production platform was constructed and located 130 km north-north-west of Dampier. This facility was connected to the onshore site by pipeline. Natural gas from the region has been supplied to homes and industry since 1984 and LNG has been exported to Japan since 1989.

Salt production in the region began with the establishment of Dampier Salt's activities at Dampier in 1972.

5.2 Administrative Setting

State, Commonwealth and International frameworks

In 1994 the Minister for the Environment released a report entitled "*A Representative Marine Reserve System for Western Australia*". This report identifies 70 areas in the coastal waters of Western Australia that are worthy of consideration for marine reservation under the *Conservation and Land Management Act* 1984 (CALM Act). In the same year, the Government of Western Australia released a document, *New Horizons in Marine Management*, which provided a policy framework for management of the marine conservation reserves system in Western Australia, and foreshadowed legislative changes to the CALM Act with regard to marine conservation and management. These legislative changes came into effect in August 1997 and established;

- the Marine Parks and Reserves Authority (MPRA) which is a vesting, policy and Ministerial advisory body;
- the Marine Parks and Reserves Scientific Advisory Committee;
- a revised consultation process for the establishment of marine conservation reserves; and,
- clear guidelines for commercial activities in marine conservation reserves.

The roles and responsibilities of State Government agencies within marine conservation reserves are also defined and these are summarised in table 10.

Table 10 State Government Agency Roles and Responsibilities

AGENCY	ROLES & RESPONSIBILITIES
Department of CALM	• Manages the marine conservation reserve including: a) preparation of management plans; b) implementation of the management plan; c) co-ordination with other agencies; d) implementation of education and monitoring programs; e) management of flora, fauna and nature-based tourism; and f) lead role in enforcement (non-fisheries issues). • Manages use of adjacent land/island conservation reserves.
Marine Parks and Reserves Authority	• Vesting body for marine conservation reserves. • Provides policy advice to the Minister for the Environment. • Audits management plan implementation by CALM
Fisheries Western Australia	• Manages and regulates commercial and recreational fishing, aquaculture and pearling in marine conservation reserves.
Department of Transport (DOT)	• Regulates boating activities, boat launching facilities, jetties, navigational aids and the safety of coastal marine traffic under the *Marine Act 1983*. • Gazettes areas designated for moorings in consultation with CALM. • Chairs and supports the State Co-ordinating Committee which provides the mechanism to co-ordinate the management of marine pollution incidents.
Department of Environmental Protection	• Assesses development proposals as required under the Environmental Protection Act 1986 on behalf of the EPA. • Regulates waste discharge to the environment.
Environmental Protection Authority	• Provides advice to the minister for the Environment on the impact of development proposals.
WA Maritime Museum	• Protection of pre-1990 shipwrecks and artefacts under the *Marine Archaeology Act 1973.* Shipwrecks over 75 years old are declared and protected under the Commonwealth *Historic Shipwrecks Act 1976.*

If established, a marine conservation reserve within the study area would become part of the National Representative System of Marine Protected Areas (NRSMPA). The NRSMPA is being developed co-operatively by the Commonwealth, State and Northern Territory agencies responsible for conservation, protection and management of the marine environment. The primary goal of the NRSMPA is to establish and manage a comprehensive, adequate and representative system of marine protected areas to contribute to the long-term ecological viability of marine and estuarine systems, to maintain ecological processes and systems and, to protect Australia's biological diversity. The development of an NRSMPA helps fulfill Australia's international responsibilities and obligations as a signatory to the Convention on Biological Diversity. It also provides a means of meeting obligations under the Convention on Migratory Species and bilateral agreements with Japan and China, concerning migratory birds. In addition, it supports the World Conservation Union (IUCN) World Commission of Protected Areas program of promoting the establishment and management of a global representative system of marine protected areas.

At a national level, the conservation of marine biodiversity, maintenance of ecological processes and the sustainable use of marine resources are addressed in an *Intergovernmental Agreement on the Environment.* This is implemented through actions developed under national strategies such as the *National Strategy for Ecologically Sustainable Development, National Strategy for the Conservation of Australia's Biological diversity, National Oceans Policy* and the *Strategic Plan of Action for the National Representative System of Marine Protected Areas.*

Local Government

The study area lies within the Shire of Roebourne, which covers an area of 15,196 km^2. The population of the Shire of Roebourne is about 15,000, though numbers fluctuate greatly depending on local employment associated with large industrial construction projects. The Shire's five major townsites are Karratha, Dampier, Roebourne, Wickham and Point Samson. Dampier is on the coast, adjacent to the study area. The town site and port facilities were established in 1966 by Hamersley Iron Pty Ltd to provide housing for its workforce, and to service its mining operations at Tom Price. Dampier is administered by the Shire of Roebourne but remains within the Hamersley Iron Special Agreement lease and the company still has input into issues affecting the town. A home ownership scheme is currently in progress and private ownership should increase as a result of the area's attractive coastal outlook and broadening of economic activity.

The seven major industries within the Shire of Roebourne are pastoralism, mining, processing, commercial fishing, pearling and aquaculture, tourism and shipping.

Tenure

The seaward limit of the State territorial sea is three nautical miles from the terrestrial sea baseline. In the Dampier Archipelago/Cape Preston region, the baseline varies in relation to different geographical features to encompass offshore reefs and islands. As a result, much of the terrestrial sea baseline is more than three nautical miles from the mainland coastline. The State territorial sea line is shown in Figure 1.

Twenty five of the islands within the study area are vested as nature reserves with the National Parks and Nature Conservation Authority (NPNCA) under the CALM Act. Another two islands and a portion of a third island are 5(g) reserves for conservation and recreation and are also vested in the NPNCA. Land tenure and vestings in the Dampier Archipelago and Cape Preston region are summarised in table 11 below.

Table 11 Vesting and reserve tenure of lands in the Dampier Archipelago/Cape Preston study area.

("A" Class reserve cannot be cancelled or amended without parliamentary approval, "B" class reserve may be altered at the discretion of the Governor in Executive Council but amendment must be notified to Parliament; "C" class reserve may be altered at the discretion of the Minister for Lands).

Reserve	Class	Name	Tenure	Purpose	Vesting	Comment
380	C	Landing Rock Well	Non-CALM Act-General	Public purpose	unvested	
1766	C		Non-CALM Act-General	Public purposes	unvested	
30948	C		Non-CALM Act-General	Airport	Shire of Roebourne W.P.L. and Minister for Land	Approval required (21 years)
33831	B	Great Sandy Island Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark
34944	B	Dolphin Island Nature Reserve	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
36907	C	East Lewis Island, Boiler Rock	5(g) Reserve	Conservation & Recreation	NPNCA	Forms part of Dampier Archipelago Reserve system
36909	C	West Lewis & Whittaker Islands	5(g) Reserve	Conservation & Recreation	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
36910	C	Malus Island	5(g) Reserve	Conservation & Recreation	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
36913	C	Angel, Brigadier, Conzinc, Delambre, Eaglehawk, Egret Gidley, Goodwyn, Hauy, Keast, Kendrew, Lady Nora, Malus, Mawby, Tozer, & Wilcox Islands, and Bare, Collier, Millers & Nelson Rocks, and Elphick Nob	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
36915	A	Enderby & Rosemary Islands	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
36991	C		Non-CALM Act-General	Water supply & pipeline	Water Corporation	

Reserve	Class	Name	Tenure	Purpose	Vesting	Comment
39161	C		Non-CALM Act-General	Quarry	Minister for Works	
39202	C	Cohen Island	Nature Reserve	Conservation of flora & fauna	NPNCA	Gazetted to Low Water Mark & forms part of Dampier Archipelago Reserve system
39777	C		Non-CALM Act-General	Natural gas pipeline purposes	Dbngp Land Access Minister	
40457	C		Non-CALM Act-General	Air traffic control tower	Airservices Aust	
40877	C		Non-CALM Act-General	Marine navigation aid	AMSA	
40896	C		Non-CALM Act-General	Radio communication site	Minister for Mines	
41012	C		Non-CALM Act-General	Natural gas pipeline purposes	Dbngp Land Access Minister	
41636	C		Non-CALM Act-General	Port purposes	Dampier Port Authority	
42311	C		Non-CALM Act-General	Service corridor	Dbngp Land Access Minister	
42820	C	Legendre Island	Non-CALM Act-General	Future industrial purposes	Minister for Resource Development	
43195	C		Non-CALM Act-General	Archaeological site	WA Museum	
43303	C		Non-CALM Act-General	Marine aid to navigation	AMSA	
44922	C		Non-CALM Act-General	Recreation & drainage	Shire of Roebourne W.P.L. & Minister for Land	Approval required (21 years)
3114/464			Special Lease	CL 1976/55	Hamersley Iron Pty Ltd	
3114/1027			Special Lease	CL 1984/453	Chininara Pty Ltd	
3116/464			Special Lease	CL 1976/55	Hamersley Iron Pty Ltd	
3116/716		Mt Welcome Pastoral	Special Lease	CL 1976/335	Mt Welcome Pastoral Company Pty Ltd	
3116/3468			Special Lease	CL 1966/712	Hamersley Iron Pty Ltd	HWM
3116/3469		East Intercourse, Channel & Tidepole Islands	Special Lease	CL 1966/713	Hamersley Iron Pty Ltd	
3116/3471		(channel)	Special Lease	CL 1966/715	Hamersley Iron Pty Ltd	
3116/3806		(channel)	Special Lease	CL 1969/13	Hamersley Iron Pty Ltd	
3116/3807		(Parker Point, Ship Rock)	Special Lease	CL 1970/39	Hamersley Iron Pty Ltd	
3116/3907			Special Lease	CL 1969/14	Hamersley Iron Pty Ltd	HWM
3116/4596			Special Lease	CL 1969/15	Hamersley Iron Pty Ltd	
3116/4598		(Channel Reef)	Special Lease	CL 1974/75	Hamersley Iron Pty Ltd	
3116/4600			Special Lease	CL 1974/76	Hamersley Iron Pty Ltd	
3116/4976		Mistaken & East Mid Intercourse Islands	Special Lease	CL 1978/42	Dampier Salt Pty Ltd	
3116/4984			Special Lease	CL 1975/144	Hamersley Iron Pty Ltd	
3116/5503		(channel)	Special Lease	CL 1974/93	Hamersley Iron Pty Ltd	
3116/5552			Special Lease	CL 1979/318	Hamersley Iron Pty Ltd	HWM
3116/6702		(Courtenay)	Special Lease	CL 1979/146	Hamersley Iron Pty Ltd	
3116/7842			Special Lease	CL 1984/161	Hamersley Iron Pty Ltd	
3116/7936			Special Lease	CL 1985/263	BHP Petroleum Pty Ltd	HWM
3116/8870			Special Lease	CL 1985/26	Hamersley Iron Pty Ltd	
3116/9124			Special Lease	CL 1985/265	BHP Petroleum Pty Ltd	LWM
3116/9125			Special Lease	CL 1989/1822	BHP Petroleum Pty Ltd	
3116/9126			Special Lease	CL 1985/266	BHP Petroleum Pty Ltd	
3116/9127		Mt Wongama	Special Lease	CL 1985/267	BHP Petroleum Pty Ltd	
3116/9129			Special Lease	CL 1985/269	BHP Petroleum Pty Ltd	
3116/9130			Special Lease	CL 1985/270	BHP Petroleum Pty Ltd	
3116/11281			Special Lease	CL 1994/434	AUUA - Carotene Ltd	
3116/11311			Special Lease	CL 1994/527	North West Game Fishing Club Inc	
	Vacant Crown Land	Bezout Island			not vested	
	Vacant Crown Land	Dixon Island			not vested	
	Vacant Crown Land	East Mid Intercourse Island			not vested	
	Vacant Crown Land	Haycock Island			not vested	
	Vacant Crown Land	Intercourse Island			not vested	
	Vacant Crown Land	Pemberton Island			not vested	
	Vacant Crown Land	Roly Rocks			not vested	
	Vacant Crown Land	Walcott Island			not vested	
	Vacant Crown Land	West Intercourse Island			not vested	
	Vacant Crown Land	West Mid Intercourse Island			not vested	

Reserve	Class	Name	Tenure	Purpose	Vesting	Comment
CT 1022/255			Freehold Land		AMSA	

Nature Reserves are for the purpose of wildlife and landscape conservation, scientific study and preservation of natural features. These are areas in which wildlife values may not be commercially exploited and where no recreation that damages natural ecosystems is allowed. Nature reserves within the study area extend to the low water mark and can be classified as either A, B or C Class. The tenure of A Class reserves can be changed only by agreement of both Houses of the Western Australian Parliament. The Governor of Western Australia can change the tenure of B Class reserves without the approval of Parliament, however the Minister for Lands must report the reasons for any change to Parliament. The tenure of a C Class reserve can be changed by the Governor without reference to Parliament, as long as any changes are published in the Government Gazette.

The purpose of 5(g) reserves is normally related to recreation and the conservation of wildlife and historical features. This reserve classification is often used to give an area a temporary reserve classification pending the completion of studies to support a more appropriate permanent classification. Tenure extends to the low water mark and while the class of a 5(g) reserve is determined on a case by case basis, they are usually given B or C Class status.

Native title

Native Title, or the traditional ownership of land and waters by Aboriginal people and Torres Strait Islanders, may be found to exist if it has not already been extinguished, or where the native title claimants have maintained their connection over the land.

In the West Pilbara region, there are many Aboriginal people who claim traditional associations with the local land and sea areas and there are currently four Native Title claims lodged with the National Native Title Tribunal. These claims encompass some or all of the study area (Figure 8) and they are currently awaiting mediation in the Federal Court.
The claims have been made by:

- Ngaluma/Injibandi people for an area of 24 430 sq. km;
- Kurama people for an area of 15 760 sq. km;
- Yaburrara / Mardudhunera people for an area of 13 940 sq. km; and
- Wong-goo-tt-oo people for an area of 20 240 sq. km.

All applications lay claim to coastal waters, three with expansive coverage and one with minor coverage.

5.3 Infrastructure and facilities

Ports

Dampier Port is managed by the Dampier Port Authority, which is a statutory authority established under the *Port Authorities Act 1999*. Port operations are carried out by the private sector with the Authority providing strategic management in line with its functions under the Act. It is the job of the Port Authority to manage the Port safely and efficiently and to control, manage, maintain and develop the Port in a manner that both serves existing trade and attracts additional trade. It is also a function of the Dampier Port Authority to protect and enhance the environment of the Port.

The port boundaries encompass Mermaid Sound and include waters to the north which are used for anchorage of large vessels. The port also includes the waters between Enderby Island to the north and Eaglehawk and Low islands to south to accommodate future development proposals.

Dampier Port moves 75 million tonnes of product each year which is worth 5 to 6 billion dollars or 20 per cent of the State's export earnings. Trade forecasts indicate that the Port will be exporting

94,300,000 tonnes by the year 2004/05, which is a 25 percent increase. This figure does not incorporate any new projects. Nearly all of this cargo is the result of the operations of just three companies, which use their own private wharfs.

By 1966, a port and town site had been constructed to service the iron ore export requirements of Hamersley Iron Pty. Limited. Their first wharf at Parker Point was initially designated to accept vessels of up to 60,000 dead weight tonnes (DWT) and this required the dredging of a 13 m channel. Since that time, Hamersley Iron has continually upgraded their facilities and today Hamersley Iron operates three wharves; Parker Point ore wharf, the East Intercourse Island wharf and a service wharf from which general cargo and petroleum products are handled. The Parker Point ore wharf accepts vessels up to 180,000 DWT and has a departure channel which is 15.5 m deep. The East Intercourse Island ore wharf has accepted vessels of up to 320,000 DWT. The departure channel for this wharf has been dredged to 15.35 m but by working the tides, maximum draughts of some 18.5 m can be achieved. The largest shipment to date is 235,453 tonnes.

During 1972 Dampier Salt commenced operations. Salt is produced by solar evaporation in crystallisation ponds and six million tonnes is exported annually. The bulk of the salt goes to the petrochemical industry in vessels of up to 70,000 DWT. Dampier Salt operates a wharf at Mistaken Island.

In 1980 Woodside Energy and their joint venture owners decided on the Burrup Peninsula as the site for their onshore liquefied natural gas (LNG) production plant and export wharf. The offshore petroleum production platforms were connected by pipeline to the onshore site and the total project is estimated to have cost some $12 billion. A fleet of dedicated 130,000 cubic metre LNG carriers transport 6,000,000 tonnes per annum to Japan. Additionally, some 3,500,000 tonnes of condensate is shipped to various markets elsewhere in the world. Woodside Energy now operates three facilities at Withnell Bay: the loading terminal that handles tankers of capacity up to 150,000 DWT and LNG carriers; a second loading jetty, which is designed to handle liquefied petroleum gas (LPG) vessels and condensate tankers and the King Bay Supply Base, which handles all supply and construction vessels associated with Woodside's North West Shelf project. Actual export tonnages for 1998/99, with estimates for 1999/00 in brackets are: LNG 7,958,099 (7,500,000); LPG 869,000 (650,000) and Condensate 4,385,747 (4,7000,000).

In addition to these private company wharves, the Dampier Port Authority manages a public wharf which is located near to Phillip Point. Seven berths are available at this facility and the largest will accept vessels up to 25,000 tonnes.

A causeway between East Intercourse Island and the mainland coast has created a sheltered harbour adjacent to the township of Dampier called Hampton Harbour. Hampton Harbour is located within the boundaries of Dampier Port and the Port Authority therefore maintains overall responsibility for safety issues in this area. However, the Hampton Harbour Boat and Sailing Club, Department of Transport and the Shire of Roebourne are responsible for infrastructure such as jetties, refuelling facilities and boat ramps within the harbour. Hamersley Iron holds a lease over the sea bed of Hampton Harbour.

A small marina facility exists at the eastern end of Hampton Harbour. This marina was built 25 years ago to berth the port service vessels such as dredges, tugs and oil spill equipment. Today it is run by the Hampton Harbour Boat and Sailing Club, with approximately 33 pens for recreational yachts and other vessels. There are also many moorings within Hampton Harbour for both commercial and recreational vessels and additional tug pens are located on the eastern side of East Intercourse Island and King Bay.

Mermaid Marine is a privately owned company that operate a supply base at King Bay. They currently have land and jetty facilities which cater for tugs, supply and support vessels and service offshore petroleum projects. Commencing this year they will be upgrading their facilities to include boat pens and a slipway.

There are two other shipping facilities in close proximity to the study area. Port Walcott is located at Cape Lambert and services the Robe River Iron Ore operation. Structures at this port facility extend out to sea for 2.8 km and cater for vessels of capacity up 320,000 tonnes. A small coastal harbour at John's Creek, near Point Samson, is managed by the Department of Transport and caters for fishing, prawning and recreational craft. The demands on this facility are likely to expand as a result of increases in local population and tourist numbers, and growth in commercial fishing and aquaculture.

Environmental considerations associated with shipping operations and facilities

The operation of large vessels in shallow confined waters inevitably poses some risks for the marine and coastal environments. Strategies to minimise environmental risks include incident response planning and the adoption of cautious operational procedures. It is for example compulsory that all vessels entering Port Dampier have a pilot on board, unless they are less than 150 tonnes or the Master has current Pilotage Exemption qualifications.

Ballast water poses a risk to marine communities within the study area. Large empty vessels fill their holds with seawater to maintain stability while steaming between ports. This water is pumped out before a new cargo is loaded but seawater from distant ports can contain exotic marine organisms and when ballast water is discharged within the study area it has the potential to introduce foreign organisms into the local environment. There are several introduced marine pests within Australian waters already. Some of these are aggressively competitive and dominate areas where they have become established. Others cause millions of dollars worth of damage to aquaculture industries and submerged superstructures.

The Australian Quarantine and Inspection Service (AQIS) has developed voluntary guidelines for the handling and treatment of ballast water on ships entering Australian waters. These guidelines recommend the chemical treatment and exchange of ballast water in deep offshore waters but because the guidelines are voluntary, they cannot be enforced. The Dampier Port Authority also encourages ship's masters to safeguard against contamination through ballast water discharge. This involves that:

- every effort be made to ensure that ballast water is clean and free from suspended sediment and turbidity upon loading;
- sediment not be disposed of in Australian waters; and,
- a sample of ballast tank sediment be provided for analysis.

Despite the guidelines and requests from the Port Authority and major companies which operate in the area, there are many reports of ballast water discharge and this threat remains of major concern to the local community.

Adverse weather conditions also pose a threat to safe shipping in shallow enclosed waters. There are a number of cyclone moorings in Hampton Harbour and Hamersley Iron have cyclone moorings south of West Lewis Island. Cyclone moorings have also been constructed in Flying Foam Passage and Mermaid Strait. Port procedures require all medium to large vessels (including local vessels) to finish loading and go out to sea in the event of a cyclone.

A variety of hazardous chemicals are carried in Australian waters, with the potential for accidents resulting from spills or fires. Ammonium nitrate is perhaps the most hazardous material currently transported though petroleum products are also volatile. However, new development proposals may result in other hazardous materials being transported through the port. Vessels carrying dangerous goods currently anchor in an area north of Hamersley Shoal. The storage and transportation of hazardous materials is controlled by the Departments of Transport and Minerals and Energy.

There is an oil spill contingency plan for Dampier Port, and some 2 million dollars worth of oil spill combat equipment is kept in storage. This equipment gives the Port the capacity to respond to large

spills, equivalent to 1,000 tonnes of oil or greater. In addition to the equipment which is stored locally, equipment can be brought in from Fremantle and interstate in the event of an emergency. The Port Authority has recently spent $30,000 on oil spill response training. As part of the training program, an international mock oil spill exercise is to be staged in Dampier Port towards the end of 2000. This will result in a high level of preparedness.

Tributyl tin (TBT) is used on ships hulls to prevent fowling by encrusting organisms. It is one of the most toxic substances introduced into the marine environment. It continually sloughs off the hull surface and is usually found in the water column and sediment in the vicinity of shipping operations. TBT is such a toxic substance that the recommended water quality guideline for TBT in Australian marine waters is just 2 ng TBT/l. This is equivalent to just two grams of TBT in a billion litres of seawater. Measurements of TBT levels taken by Curtin University in 1997 indicated that concentrations at sites associated with commercial shipping activities were several times higher than the recommended concentration for protection of aquatic ecosystems. Growth deformities in nearby marine snails associated with TBT contamination were also detected.

Dredging requires Department of Environmental Protection approval because it increases water turbidity and can smother marine organisms. To maintain Port operations, there is a requirement for two shipping channels, one of which is maintained by Woodside Energy and the other by Hamersley Iron. The channel maintained by Woodside Energy was initially dredged in 1987 with some remedial dredging undertaken in 1990. Total spoil from the initial dredging operations was approximately seven million cubic metres, some of which was dumped in a spoil ground to the east of the channel in Mermaid Sound, and the rest was dumped ashore. The shipping channel maintained by Hamersley Iron was initially dredged in 1965, with subsequent dredging performed approximately every two years until 1991 and then again in 1998. The spoil ground for this channel is located on the eastern side of East Lewis Island. Applications for additional spoil grounds are currently being considered.

The construction of wharves and causeways can result in significant changes to water flow. Such changes may reduce the flushing rates in enclosed areas, which can cause changes to the temperature, salinity and dissolved oxygen conditions experienced by marine organisms. Changes to water flow patterns are also likely to impact recruitment and dispersal of marine propagules and the dissipation of noxious substances.

Boat ramps

Small dinghies can be launched from sheltered shorelines wherever vehicle access is possible and tides permit. Several undeveloped launching sites are used regularly by boat owners at Back Beach in Nickol Bay, Cleaverville Creek, Cowrie Cove, Withnell Bay, Yowrie Creek, Maitland River, 40 Mile Beach, King Bay Fishing Club, Hearson's Cove and the Fortescue River. However, the high tidal range in the region often limits the use of these facilities to high tide conditions.

Sealed boat ramps have been constructed within Hampton Harbour. One of these ramps is located at the Hampton Harbour Boat and Sailing Club, and two other sealed ramps are located side by side about 1 km to the east. These ramps can be used in all but the very lowest tides.

Shacks

There are a total of 34 shacks within the Dampier Archipelago. Thirty three are licensed by CALM to the Dampier Archipelago Recreational Dwellers Association Inc. (DARDA) and one is leased from the Department of Land Administration (DOLA). All shacks within the Dampier Archipelago are situated in conservation and recreation (5g) reserves and the owners have CALM licences which specify the types of structures which are permitted and ensure that they are maintained and have minimal visual impact. The shacks provide an accommodation base for many recreational users. King Bay Fishing Club has a shack on Malus Island and the Norwest Game Fishing Club has a shack on Rosemary Island, which is leased from (DOLA). Fishers camp on Steamboat, Sholl, Fortescue and

North East Regnard islands during fishing trips. No facilities such as water or toilets are provided on the islands.

CALM has two research stations in the Dampier Archipelago, one on Enderby Island and one on Rosemary Island. These stations are used by research groups and volunteers carrying out work on CALM projects.

There are also two shorebases used by the pearling/aquaculture industry on Dolphin and West Lewis islands. The use of these facilities is managed through licences issued under the CALM Act.

Roads

There are no sealed roads on the islands of the archipelago. However, there is a substantial track from the Norwest Game Fishing Club Shack to an old airstrip on Rosemary Island. Along the adjacent coast, residents and visitors have created many four-wheel-drive tracks providing access to fishing and camping sites. These tracks have the potential to cause environmental damage, particularly if their use increases. A sealed road provides access to 40 Mile Beach.

The North West Coastal Highway is a major route for industrial and private transport connecting the Dampier region with Perth and Port Hedland.

Airports

Karratha airport is the only licensed airport close to the study area. There are unlicensed airports at Roebourne and Wickham.

Sewerage

Hamersley Iron Pty Ltd has a wastewater treatment plant located at Dampier. This plant has a 50 metre sewerage outfall pipe into Hampton Harbour. The treatment plant was designed and licensed to treat a maximum volume of 600 cubic metres per day of sewerage. However, the daily discharge rate may not be the full licensed amount as some wastewater is used to water parks and gardens. The wastewater treatment plant is designed to treat wastewater to a secondary standard prior to discharge. Wastewater passes through an Imhoff tank, trickling filter and clarifier, prior to discharge. Three monthly surveys must be conducted by Hamersley Iron to test the water quality near the discharge pipeline and every six months, surveys are carried out to monitor the levels of heavy metals. These data are submitted to the Department of Environmental Protection. The Shire of Roebourne also monitors water quality in the area.

Both Dampier and Karratha are also serviced by deep sewerage. The effluent is treated in oxidation ponds and reticulated to various irrigation uses. Surplus effluent treated in this manner is disposed of in evaporation ponds.

5.4 Commercial activities

Commercial fishing

Commercial fishing makes an important contribution to the regional economy. Currently, the major commercial fishing activities in the Dampier Archipelago/Cape Preston region are prawn and fish trawling, trapping and wet lining.

Commercial fishing vessels operate out of the ports of Dampier, Onslow and Point Samson, the latter primarily supporting the finfish fishery. There is a finfish processing facility located at Point Samson.

Prawn trawling is generally restricted to inshore areas of the coast. There are two prawn fisheries within the Dampier Archipelago/Cape Preston region. The Onslow Prawn Managed Fishery extends

from south of Dampier to Onslow. The major trawling grounds associated with this fishery lie north of Enderby Island, west of West Lewis Island and around islands near to Onslow. The Onslow Prawn Managed Fishery currently comprises 31 licensed vessels, 12 of which are also licensed to fish in the Exmouth Gulf Prawn Fishery and 12 are also licensed to fish in the Nickol Bay Prawn Managed Fishery. The Onslow Prawn Managed Fishery has an estimated annual value of $1.2-1.4 million. Catch figures for 1995/6, 1996/7 and 1997/8 are given in Table 12.

The Nickol Bay Prawn Managed Fishery extends east from Dampier to longitude 120° E which is east of Port Hedland. The Nickol Bay Prawn Managed Fishery has 14 licensed vessels, 12 of which are also licensed to operate in the Onslow Prawn Managed Fishery. The Nickol Bay Prawn Managed Fishery operates over trawling areas covering most of Nickol Bay, with an estimated annual catch value of $1.6-2 million. Catch figures for 1995/6,1996/7 and 1997/98 are given in Table 12.

Table 12 Catch information for the Onslow Prawn Managed Fishery (OPMF) and the Nickol Bay Prawn Managed Fishery (NBPMF).

Fishery	Year	King Prawn (t)	Tiger Prawn (t)	Endeavour Prawn (t)	Banana Prawn (t)	Total Penaeids (t)
OPMF	1995-96	34.0	42.0	15.0	6.0	97.0
OPMF	1996-97	51.8	8.8	6.8	27.0	94.4
OPMF	1997-98	19.0	5.0	5.0	91.0	120.0
NBPMF	1995-96	25.0	19.0	2.0	109.0	115.0
NBPMF	1996-97	34.4	4.3	2.7	122.2	163.6
NBPMF	1997-98	20.0	4.0	<1.0	212.0	237.0

The Pilbara finfish industry involves trawl, line and trap fishing, with its boundaries stretching from west of Onslow (114°09'36" E) to east of Port Hedland (120°00'00" E). The industry has an estimated annual value of $10.3 million and an approximate annual catch of 3000-3400 tonnes.

The Pilbara Trawl Interim Managed Fishery currently involves 11 licensed fishing boats. The amount of time during which a boat may fish is determined in accordance with the number of time/gear units associated with the relevant licence Currently, the total level of effort available in the fishery is 21096 trawl hours. The waters of the study area are currently closed to fin fish trawling.

The Pilbara Trap Managed Fishery currently involves six licensed boats. This fishery targets demersal scalefish such as snapper, grouper, emperor and jobfish species. Waters landward of a line generally following the 30 m isobath are closed to trapping. The only areas within the study area that are open to trap fishing are the deep waters off Legendre to Rosemary islands.

Commercial line fishing is permitted throughout the study area. Line fishing vessels use droplines, longlines and handlines and target similar species to those caught in the trap fishery.

The North Coast Shark Fishery currently has eight operators and seven have access to the waters of the study area. This fishery stretches from Onslow (114°06' E) to the Northern Territory border and has an annual catch of approximately 200 to 250 tonnes which is worth about $0.6 million. Fishers use hook and line techniques; either drop lines, which are set vertically through the water column or long lines which are set horizontally. They target a wide range of species including black tips, spot tailed, hammerhead, milk sharks and a variety of whalers. The focus of the fishery is on small edible specimens and the meat is sold mainly to the local market.

Trawling for Beche-de-mer (trepang or sea cucumbers) is not permitted in Western Australia, but there are currently seven licences authorising collection by hand. Collectors wade in shallow water or use hookah diving equipment to locate mainly three species: the sand fish (*Holothuria scabra),* the black teat fish (*Holothruia nobilis*) and the white teat fish (*Holothuria fuscogilva).* In 1998, 345 tonnes of

product were taken, primarily from the Kimberley and exported to Asian markets where it is considered a delicacy.

The tropical rock lobster fishery is closed between Cape Lambert and Cape Preston, out to the 200 m isobath. Commercial fishers therefore do not have access to the study area for this activity. Fisheries Western Australia has issued four commercial mud crab licences. However, there is a closure to commercial mud crabbing between Cape Preston and the Jones River.

Fisheries Western Australia has issued 32 commercial shell collecting and 13 aquarium fish collecting licences. These collectors have access to waters throughout the State and periodically operate within the study area.

Commercial fishing in Western Australia is managed under the *Fish Resources Management Act*, by Fisheries Western Australia. A range of management techniques are used including limitations on fishing gear, closed areas, limits to the number of licences issued and the monitoring of catch and stock levels.

In line with the State Government's multiple-use policy, commercial fishing is provided for in marine conservation reserves. Government policy relating to commercial fishing in marine conservation reserves can be summarised as follows;

- Commercial fishing will be provided for in marine management areas and in certain zones in marine parks.
- Commercial fishing will not be permitted in sanctuary, recreation and certain special purpose zones of marine parks.
- No fishing will be permitted in marine nature reserves.
- Commercial fishing in marine conservation reserves will continue to be managed by Fisheries Western Australia.
- The Minister for the Environment requires the consent of the Minister for Fisheries before creating any marine conservation reserve or management zone within a marine park or marine management area.
- If the commercial value of an authorisation is apparently diminished by the establishment of a marine nature reserve or exclusion zone in a marine park, then the holder of the authorisation will be eligible to apply for compensation.

Pearling and aquaculture

Pearling began in Western Australia in the 1850s, when natural pearls were found at Shark Bay, and later at Nickol Bay. At that time, pearlers mainly collected the mother of pearl, which is the shiny layer inside the shell, and counted themselves lucky if they found a pearl inside the shell as well. In the 1890s, an industry pioneer, G. S. Streeter, tried to 'culture' a pearl, that is, create it artificially. However, the State Government feared this might undermine the mother of pearl industry and banned artificial pearl cultivation.

By 1910 almost 3500 people were fishing for shell to harvest mother of pearl. This was an industry fraught with danger with many divers being lost through the 'bends' after spending too many hours underwater. Others fell victim to shark attacks or drowned during storms and cyclones. Many Japanese and Aboriginal divers were exploited by the early pearlers, who often abused or did not pay their workers.

The manufacture of plastics heralded the demise of the mother of pearl industry. By World War 1 the price of mother of pearl shell had plummeted and by 1940 the industry had almost collapsed. However, in the 1950s the ban on cultured pearl production was lifted and the industry regained its former strength. Today it is worth around $200 million a year.

Pearls develop when a nucleus, such as a piece of grit, finds its way inside a shell. To stop the irritation, the oyster lays down lustrous coatings of nacre, a form of calcium carbonate, around the fragment. Cultured pearls are created when an irritant, usually a piece of Mississippi mussel shell, is placed into the flesh of the oyster. Shape, colour, size, and lustre determine how much a pearl is worth. Oysters that grow closer to the equator produce duller pearls than those produced at higher latitudes and for this reason, sites within the study area are some of the best in the world for the growth of high quality pearls.

Today, the pearling industry refers generally to the culturing of pearls in certain species of oysters, which are either collected from the wild or grown in hatcheries. Oyster shells are seeded with irritant fragments and then replaced on the seabed in panels. During this phase of the process, the panels are turned regularly to aid the formation of round pearls. After a few months the panels of oysters are taken to farms, and hung from long ropes, which are located in areas of high tidal movement where microscopic planktonic food is abundant. They stay in these grow-out areas for about two years, by which time the pearls have grown to a harvestable size and quality. While the pearls are growing, the oyster shells become encrusted with sedentary marine organisms, which have to be scraped off at regular intervals. Most of the pearls, which are grown within the study area are sold to Japan, but some go to the United States, Hong Kong and Europe.

Leases for cultivating the oyster *Pinctada maxima* in State waters are issued under the *Pearling Act 1990*. However, licences for the cultivation of other pearl oyster species; *Pteria penguin, Pinctada margarifera,* and *Pinctada albina,* are issued under the *Fish Resources Management Act 1994* and from a technical point of view are therefore considered as “aquaculture” rather than pearling.

There are three existing or proposed pearling leases and four existing or proposed aquaculture licences for the culture of pearls within the Dampier Archipelago/Cape Preston region (figure 11). To support pearling activities, buildings and other structures (shorebases) have been permitted on Dolphin and West Lewis islands.

As with all human activities, pearling and aquaculture have the potential to impact the natural environment and the granting of licences and leases is just one form of control over this industry. Additional management strategies include quotas and size limits on the collection of wild oysters. The entire industry has an annual quota of 572 units, where one unit is generally equivalent to 1000 shells. However, in 2000, each quota unit is equivalent to 1,100 shells. Wild oysters can only be gathered when they reach the minimum size of 120 mm. The optimum size of oysters is between 120 and 160 mm. If the oysters are greater than 160 mm, they are left as breeding stock. There are also restrictions on breeding pearl oysters for hatchery production. Production of baby oysters or spat is controlled by licence. The original allocation was for 20,000 spat to each licensee plus an extra 10,000 to a licensee who already had a hatchery. The quota is also transferable and so a licensee may hold much more than 20,000 spat if they can secure a quota from another licence.

Distances between pearl oyster farms and holding or grow-out areas are controlled carefully. Disease can be transmitted from one oyster to another, so if farms are close together, diseases may be transported through the movement of water.

The study area has the potential to support other forms of aquaculture. Land based aquaculture has been slow to develop in the region with the only licences issued to date being for the production of algae (*Dunaliella salina*) associated with the solar salt fields at Karratha and red claw crayfish (*Cherax quadricarinatus*) production near Karratha Airport.

The production of algae (*Dunaliella salina)* occurs in Nickol Bay, about 2 km from Karratha. Currently the production area is 304 ha, with an application for an additional 604 ha. The algal culture is grown in ponds that are about 200 to 400 mm deep. The algae are grown for their beta carotene component which is used in a variety of products including pet food, human dietary supplements and food colourings.

Environmental concerns associated with pearling and other forms of aquaculture include the potential for grow-out panels and cages to shade benthic flora and fauna. All plants require light to grow and any reduction in light will cause a reduction in productivity. In cases of severe light depletion an area may become unsuitable for plant growth altogether. Shell grow-out panels, aquaculture cages and the associated ropes and markers all have the potential to entangle marine wildlife and if these structures break loose during storms, they can litter the water column and nearby beaches, causing a further hazard to wildlife. Lights associated with pearling and aquaculture industry facilities can attract and disorientate birds and turtles and prevent hatchlings from reaching the open ocean. In addition, vessels servicing pearling and aquaculture facilities have the potential to transport feral animals and weeds onto the islands.

Cultured stock and food species, which are brought into the study area from elsewhere have the potential to carry diseases and not only affect the industry but also to infect local wild populations. The addition of nutrients into the marine environment also has the potential to affect natural populations and some aquaculture activities require the addition of food substances. Additional nutrients stimulate plant growth, and algae can smother other forms of marine life when nutrient levels are artificially raised. The location of aquaculture facilities which involve the addition of nutrients in well flushed areas reduces the risk of nutrient build up. The nutrient loading (additional phosphorous and nitrogen) associated with effluent from the beta-carotene facility in Nickol Bay is considered negligible.

Public access to pearl grow-out areas is stipulated in the lease conditions, though it is usually restricted to protect the public from entanglement and to maintain pearl farm security. Access must however be maintained through and within the site at all times for legitimate uses and all sites must be marked and lit to ensure navigational safety. The development of pearl oyster farms is restricted by natural factors such as tidal ranges, water quality and oceanic swells. They therefore cannot always be located in places where other users do not wish to go and the study area provides some of the best conditions for pearling in the State. The planning process for a marine conservation reserve provides an opportunity for all user groups to establish solutions to conflicts over resource sharing and issues of access in the marine environment.

In line with the State Government's multiple-use policy, pearling and aquaculture are provided for in marine conservation reserves. The State Government's policy on pearling and aquaculture in marine conservation reserves can be summarised as follows:

- Aquaculture and pearling will be provided for in marine management areas and in certain zones in marine parks.
- Fishing, aquaculture and pearling in marine conservation reserves will continue to be managed under fisheries legislation.
- Existing authorisations for aquaculture and pearling will continue to be valid if the area to which they apply becomes a marine conservation reserve. If an area becomes a marine nature reserve, or, for example, a sanctuary zone in a marine park, the authorisation will continue until its expiry date.
- If the commercial value of an authorisation is apparently diminished by the establishment of a marine nature reserve or exclusion zone in a marine park, then the holder of the authorisation will be eligible to apply for compensation.
- The Minister for the Environment requires the consent of the Minister for Fisheries before creating any marine conservation reserve or management zone within a marine park or marine management area.

Tourism

Tourism is a major industry in Western Australia, valued at $2.1 billion in 1993/94, and accounting for 4.8 percent of the State's Gross State Product. Of this, $1.8 billion was attributable to the domestic market.

A Western Australian Tourism Commission survey in 1996 estimated the value of tourism in the Pilbara region at $59.5 million. Total tourist numbers to Karratha and Dampier have not been quantified, but numbers for the entire Shire of Roebourne were estimated at 58,700 during 1993-94. The Karratha Tourist Bureau estimated that almost 543,000 tourists used its services in 1999, a conservative estimate of the total number of tourists to the region. Almost half of the visitors to the Pilbara, 48 per cent, were from elsewhere in Western Australia, 41 per cent came from interstate and 11 per cent were from overseas.

The study area offers a wide variety of attractions and therefore has significant tourism potential. The natural rugged beauty, attractive underwater scenery and both the variety and abundance of native fauna, including large marine wildlife, provide valuable experiences for visitors who enjoy the natural environment and wildlife viewing. The study area also offers a range of recreational opportunities for those who enjoy the outdoors. These include diving, fishing, boating, camping and four wheel driving. The large scale industrial developments also attract interest and visitor lookouts and tours have been developed to cater for this market. A well appointed visitor centre has been built overlooking the liquid natural gas processing plant at Withnell Bay. This centre houses a display, which explains the petroleum industry's activities in the area. Tourism is also generated through interest in cultural heritage and history. The Aboriginal rock art on the Burrup Peninsula and living culture within the local communities together with European historical buildings at Cossack and Roebourne all enrich the tourist experience.

The great potential for tourism within the Dampier Archipelago/Cape Preston region is illustrated by its identification as part of the Pilbara *Priority Tourism Destination Area* which is identified by the Western Australian Tourism Commission in its Western Australian Tourism Strategy. The high ecotourism potential of the region has also been identified in the Pilbara Development Commission's *Pilbara Gascoyne Offshore Islands Ecotourism Management Strategy*.

To cater for the tourism market within the study area, there are currently five tourism-based charter boat companies operating out of Dampier and these provide fishing, diving, snorkelling, swimming and island tours. Charter fishing is becoming increasingly popular and companies based in the study area are establishing a local eco-tourism charter association. There is presently one helicopter operator and one fixed-wing aircraft operator providing scenic tours over the study area. The Western Australian Tourism Commission expects the number of visitors to the study area to continue to increase and this is particularly likely if the profile of the area is raised as a result of the declaration of a marine conservation reserve. If this does occur, the number of tour operators will also increase. In light of this fact CALM is currently negotiating with proponents for island based, low-key tourism accommodation.

Nature-based tourism has the potential to make a major contribution to protecting the State's unique ecosystems, especially in coastal environments. Providing high quality experiences of the natural environment will foster greater understanding of the environment. However, unless carefully managed, increased visitation to the region also has the potential to cause environmental damage.

Many visitors to the study area enjoy wildlife observation. Whales, dugong, dolphins, turtles, birds and whale sharks are fully protected and it is an offence to disturb any of these animals. To prevent disturbance, and for visitors' safety, human interactions with wildlife are controlled through codes of conduct. Visitors are required to maintain a minimum distance between themselves and the animals. There are also maximum boat speeds within the vicinity of some animals. Nesting turtles are particularly vulnerable to disturbance and visitors are required to keep still, quiet, and minimise lighting near nesting females. Sea, and shorebirds use the islands and shores within the study area

during migrations and for nesting, but they are easily disturbed by noise and the presence of people. Visitor access therefore needs to be carefully managed to avoid disturbance.

Careless anchoring and mooring can cause physical damage to benthic communities, in particular corals. Appropriate anchoring practices may need to be the focus of an education program as usage increases. Trampling of vegetation and coral plus over-fishing and over-collecting of shells and other species can also cause localised environmental damage.

State Government policy recognises the relationship between the marine conservation reserve system and the tourism industry. Appropriate tourism development will be encouraged to maximise the opportunity for visitors to enjoy marine conservation reserves while ensuring such development does not adversely affect the conservation values or conflict with other uses. Commercial tourism activities within marine conservation reserves require a license.

Mining

The Pilbara mining industry accounted for 51.2 per cent of Western Australia's mineral production in 1997/98, making it the State's major mineral producing region. Dampier is a major exporting base for

There are major oil and gas exploration and production sites within 60 km of Karratha and the western boundary of the study area includes sections of three petroleum leases.

Salt production is a major industry in the Dampier area. Dampier Salt Pty. Ltd. holds a 15,000 hectare lease in which evaporation ponds have been constructed. Salt is extracted from sea water by a simple process which relies on natural evaporation. The hot, dry climate increases the salinity of ponded sea water to a level at which salt crystals are formed and drop out of solution. The hypersaline waste water, called bitterns, is then disposed of and the salt crystals are dried and scooped up by bulldozers.

The Dampier Salt operation produces 3.7 million tonnes of salt per year which is worth 60 million dollars. Fifty percent of the salt produced in Dampier is exported to Japan and the rest goes to south east Asia, Europe, America and a small amount is exported to Africa. Salt from Dampier is used in the production of glass, chlorine and caustic soda. It is also used to de-ice roads during northern hemisphere winters and of course it is used as table salt.

The initial construction of evaporation ponds altered natural water flow and alienated the area for mangroves. The company now monitors the volume and density of bitterns which is discharged and there is also an aerial surveillance and on site monitoring program of the nearby marine and coastal environments both in the mangroves to the west of the salt operations and on the eastern side of the Burrup Peninsula in Nickol Bay.

Processing

A fish processing factory is located at Port Samson. It is at this facility that fish are frozen in preparation for transport.

Secondary processing of minerals and petroleum adds value to the basic raw materials. The establishment of Woodside Energy's liquid natural gas facility south of Withnell Bay on the Burrup Peninsula is one of the largest processing projects of the region.

There is currently a lull in development in the Dampier area. However, additional industrial areas are now in advanced planning. The Maitland Estate will comprise a mainland industrial site of approximately 4500 hectares with additional sites on West Intercourse Island, West Mid Intercourse Island and the southwest Burrup. Corridors and causeways crossing tidal channels between the islands and mainland sites would need to be constructed to service these facilities.

Industries that are likely to locate in these estates are those that will further process local and regional raw materials such as iron, salt and gas, and may include:

- Petroleum (gas) processing into products like liquid natural gas, methanol, ammonium nitrate/urea and synthetic oils;
- Salt processing into caustic soda and ethylene dichloride;
- Downstream processing of iron ore into products like hot briquetted iron and steel;
- Power-intensive industries producing ferro manganese, silicon-manganese, manganese sulphate, ferro-silicon, chrome and nickel alloys.

A number of potential iron ore processing, base metals processing, LNG, petrochemicl and chemical companies have and are continuing to look at sites in the Dampier/Karratha area.

In addition, a range of support industries is expected to establish to service the major resource processing projects. Examples include fabrication workshops, industrial machinery hire companies, laboratories and fuel distribution depots.

Expansion of processing and other industrial facilities has implications for management of the adjacent waters. These include increased shipping activity and the need for additional port infrastructure. Processing facilities may also result in changes to water quality through the introduction of contaminants and changes to water temperatures.

Pastoral/Agriculture

Three pastoral leases border the study area. Karratha Station is leased to Hamersley Iron. Mt Welcome Station is leased to the Mt Welcome Pastoral Company and Mardie Station is leased to Chininara Pty Ltd. These stations are used predominantly for cattle and sheep farming and the leases remain current until 2015.

5.5 Recreational activities

The waters and islands of the study area provide opportunities for land and sea based recreational pursuits. The climate is conducive to outdoor activities between April and November and even the scorching temperatures of summer are moderated by sea breezes. Local boat ownership is very high and recreational fishing is popular, as are diving, snorkelling, surface water sports and wildlife viewing.

Recreational fishing

In Western Australia, recreational fishing is enjoyed by about 30 per cent of the population across all groups over 16 years - about 600,000 people. The Pilbara region has the highest rate of boat ownership per capita anywhere in Australia and consequently local residents have good access to local recreational fishing sites within the study area. Several different methods of recreational fishing are used including line fishing, netting and spearfishing.

Line fishing can be further divided. Game fishers target very large species such as marlin and sailfish in deeper offshore waters. Sport fishers troll for smaller pelagic species such as tuna and mackerel. General line fishers target mainly coral trout, spangled emperor, black snapper, and trevally and shore based line fishers target bream and trevally. The areas which are accessed by recreational line fishers depend on the tides and prevailing weather conditions. Sites, which are distant and predominantly exposed to rough weather, are fished less than areas which are sheltered and close to boat launching and harbour facilities. The recreational line fishery is managed by Fisheries Western Australia through a system of size restrictions and bag limits.

Netting in the study area is mainly a shore based activity. Haul and cast nets are allowed in some areas, but there is a prohibition on set netting north of Beadon Creek near Onslow. Fisheries Western Australia requires recreational netters to obtain a recreational netting licence. The recreation net

fishery is also managed through a system of size and bag limits, forbidden catch species, gear restrictions and closed areas.

Spearfishing is carried out while SCUBA diving or snorkelling. Spearfishers operate mainly in the clearer waters offshore where they target coral trout, snapper and cod species. Size and bag limits apply to spearfishing. Divers also take the tropical ornate rock lobster by hand or by loop but the spearing of lobster is not permitted. There is no closed season for this species of lobster. However, size and bag limits apply and other catch and processing restrictions are in place.

Certain species of fish are completely protected under Western Australian fisheries legislation. Of these, the potato cod, hump head maori wrasse and whale shark occur within the study area. In addition, all large specimens of rock cod species (over 1200mm) must be returned undamaged to the water.

Crabbing for mud and blue manna crabs is a popular activity in the study area. Mud crabs are mainly caught near mangroves and the blue manna crabs are caught mainly in Nickol Bay. Recreational crabbing is managed by controlling the catch method and implementing size restrictions and bag limits. Spawning females are protected.

Recreational prawning in the region is controlled through the method of catch and through the implementation of bag limits.

Cleaverville Beach is a popular fishing and camping location. Forty Mile Beach is another popular camping, swimming and fishing location.

Fisheries WA is responsible for the conservation and development of the State's fish resources, and will shortly prepare a Regional Recreational Fishing Strategy for the Pilbara and Kimberley. This planning process will aim to protect the future quality of recreational fishing throughout the Pilbara and Kimberley. A community based consultative committee will be established to have input into the development of the strategy, which will provide a blueprint for the long-term management of recreational fishing in the north-west.

Fisheries Western Australia is introducing licensing and management arrangements for the Aquatice Charter Industry throughout Western Australia. Two new types of licence are to be introduced; Fishing Tour Operators Licences and Aquatic Eco-Tourism Operators Licences. These operations are to be managed under recreational fishing rules. However, region specific charter management arrangements are likely to be developed in accord with Regional Recreational Fishing Strategies.

Boating

Boating is a popular recreational activity in Western Australia, with 57,000 private vessels registered with the Department of Transport. Coastal towns of the Pilbara have the highest rate of boat ownership per capita in Australia. The study area offers excellent boating opportunities given the good shelter afforded by the islands and bays. Combined with ideal weather and sea conditions for much of the time, recreational boating is an extremely popular recreational activity with residents and tourists.

The Departments of Transport is responsible for all boating regulations including licensing, safety standards, marker buoys, moorings and jetties. However, mooring controls can be delegated to other agencies. The Department of Transport registration figures for 1998 show that in Dampier and Karratha alone, there were nearly 1200 registered vessels with 98 per cent being less than 9 m in length and nearly 50 per cent being open vessels under 5 m in length.

Small boats can be launched at many locations where vehicle access is possible and formed boat ramps are located in Hampton Harbour. For more information about boat ramps, refer to the boat ramp section of infrastructure and facilities earlier in this document.

The Department of Transport has designated areas where boating is restricted within Hampton Harbour. An area prohibiting boat access has been declared adjacent to the beach to protect swimmers and further off shore in the harbour, an eight knot speed limit applies. Access in waters surrounding wharves is also restricted.

Boating can result in environmental damage as a result of careless anchoring and mooring on fragile communities, in particular corals. The discharge of toilet waste and rubbish from small vessels as well as fuel spills during refuelling also have the potential to degrade the environment in some locations.

Swimming and Diving

Beaches around the islands within the study area face in all directions so there is just about always a beach somewhere which is sheltered. Calm, relatively clear water in a warm to hot climate provides the ideal combination of conditions for swimming. Hearson Cove is a perhaps the most popular swimming beach on the mainland, but just about any sandy beach in the archipelago and on the Burrup Peninsula are used recreationally. The Department of Transport has designated a no swimming area in close proximity to the public boat ramps in Hampton Harbour.

An estimated 15,000 SCUBA divers are trained in Western Australia each year. Many come from overseas and a significant number remain for diving holidays after training. The study area offers a variety of unspoilt coral reefs and other attractive marine habitats with a variety of large marine mammals, turtles and other charismatic wildlife. Fast tidal currents however, can make diving and snorkelling dangerous for inexperienced people.

Large numbers of divers can degrade the environment through careless anchoring, the direct breakage of fragile structures like corals and the excessive collection of trophies and mementos. As diving and snorkelling become more popular with the projected population growth associated with proposed developments, monitoring of dive sites and education programs to minimise environmental damage will become essential.

Surface water sports

Sailing is a popular recreational activity in the sheltered waters of the archipelago and there are two sailing clubs. Hampton Harbour Boat and Sailing Club members race in Hampton Harbour on a regular basis and members of the Wickham Yacht Club conduct an annual race out and around Delambre Island. In addition, the camp school at Dampier conducts sailing expeditions into the Dampier Archipelago for school children. Strong tidal currents require participants to be cautious.

Water skiing is undertaken occasionally throughout the study area where calm conditions prevail. In addition, the Department of Transport has designated a water skiing area along the south-eastern edge of East Intercourse Island. Jetskiing, waterskiing and the use of kneeboards and “biscuits” occur throughout the Dampier Archipelago with speed and access restrictions in the harbour and around wharves applying.

The calm waters also provide good conditions for sea kayaking and a small number of people venture throughout the archipelago. Strong tidal currents however, make this a dangerous activity for inexperienced people.

Windsurfing is popular within Hampton Harbour and occasionally people go further afield within the archipelago. There is a surf break on the northern end of Angel Island but there are few other surf breaks within the study area.

Coastal land based activities

The Burrup Peninsula, islands of the archipelago and general Pilbara coast offers a wide range of land-based recreational opportunities including walking, camping, photography, picnicking, the study of

Aboriginal art and nature study. There are 34 privately owned shacks on islands of the archipelago and these, together with conventional tents provide accommodation for campers. Campers along the mainland coast often use caravans. Cleaverville Beach is a popular fishing and camping location and Forty Mile Beach is another popular camping, swimming and fishing location.

All the shacks within the Dampier Archipelago are situated in recreation reserves. In addition fishers camp on Steamboat, Sholl, Fortescue and North East Regnard islands during fishing trips.

5.6 Educational values

Many of the attractions which were discussed in the tourism industry section of this document are valuable as educational resources. In fact, nature-based tourism often provides an educational experience and educational groups could be considered as a specialist sector of the tourism market. The study area offers educators a wide range of natural and cultural resources which provide 'hands on' experiences for students undertaking courses in geology, coastal geomorphology, marine and terrestrial biology, Aboriginal culture, European history and industry. Protected sheltered waters also provide opportunities for less academic courses in water sports and other marine skills.

Karratha has primary and secondary schools and there is also a TAFE college. Dampier, Roebourne and Wickham all have primary schools and Wickham has a secondary school. Secondary school children from other towns either have to commute to Karratha or board further afield. In addition, groups from other schools visit the area because of its educational resources. The majority of these visiting school group are based at the Dampier Camp School where dormitory accommodation, catering and limited classroom facilities are available. The Pilbara Camp school runs educational programs which are primarily designed for school groups between years seven and ten. The students participate in a variety of outdoor activities and marine studies are sometimes included in the program.

Chapter Six

ADVISORY COMMITTEE: INFORMATION PACKAGE

CHAPTER SIX ADVISORY COMMITTEE: INFORMATION PACKAGE

A stakeholder advisory committee information package has been compiled which aims to provide the advisory committee members with a sound background knowledge of the legislation under which marine reserves are established, the concept of marine conservation reserves, the values of the study area, and the role of the advisory committee in marine reserve implementation. The package includes:

(i) a folder cover;

(ii) posters detailing accurate spatial information on uses and values in the area

(iii) a *Landscope* article titled "*Oceans of Wealth*" which discusses the role of the Marine Conservation Branch (Simpson, D'Adamo & Thompson, 1996);

(iv) the legislative guidelines for establishing marine conservation reserves in Western Australia (CALM, undated-a);

(v) "*New Horizons*" which is the State Government's policy for marine conservation in Western Australian (WA Government, 1998);

(vi) a map and relevant text for the area of interest from the Marine Parks and Reserves Selection Working Groups report (CALM, 1994);

(vii) relevant text for the area of interest from the report of public submissions on the Marine Parks and Reserves Selection Working Group report (CALM, 1997a);

(viii) "*Pilbara marine conservation reserves*" brochure (CALM, 2000a)

(ix) "Marine Management. Working Together on the North West Shelf (EPAWA, CALM & FWA, 2000)

(x) "*Coral reefs of Western Australia*" booklet (EPAWA, 1987);

(xi) "*Marine conservation reserves in Western Australia*" pamphlet (CALM & MPRA, undated-a);

(xii) "*Marine conservation reserves management concepts in Western Australia*" pamphlet (CALM & MPRA, undated-b);

(xiii) "*Marine life in Western Australia*" CD-ROM (CALM, 1998);

(xiv) the marine reserve provisions of *the Conservation and Land Management Act 1984*;

(xv) "*A framework for prioritising the implementation of marine conservation reserves in Western Australia*" (Simpson & Bancroft, 1999);

(xvi) generic information requirements for the management of marine reserves in Western Australia (CALM, 1997b).

(xvii) the CALM aquaculture guidelines (Simpson, 1998);

(xviii) an A3 summary map of the Marine Parks and Reserves Selection Working Group recommendations (*see* CALM, 1994);

(xix) the organisational structure of the Department of Conservation and Land Management;

(xx) CALM policy guidelines for advisory committees (CALM, undated-b);

(xxi) the Interim Marine and Coastal Regionalisation for Australia marine bioregions map (IMCRA, 1998);

(xxii) "*No take areas in marine management*" discussion paper (Colman & Simpson, 1999);

(xxiii) a regional perspective paper (CALM, 2000b) which provides a broad regional perspective on the ecological, cultural and socioeconomic setting of the Dampier Archipelago/Cape Preston region. It includes a biological perspective summarising biological information of the area and discusses the implications for marine conservation reserve design. The regional perspective paper will provide background information for the Advisory Committee for the proposed Dampier Archipelago/Cape Preston marine conservation reserve and for the general community who have an interest in the marine environment of the area.

Chapter Seven

ADVISORY COMMITTEE: IMPLEMENTATION

CHAPTER SEVEN ADVISORY COMMITTEE: IMPLEMENTATION

A call for expressions of interest for membership of the Advisory Committee for the proposed Dampier Archipelago/Cape Preston marine conservation reserve was advertised on 15 May 1999 (see appendix c) and letters sent to Government agencies, community groups, industry and local authorities seeking nominations for the committee. A total of 22 nominations were received.

All nominations were reviewed and recommendations made to the Minister for the Environment. The emphasis was on choosing nominees with a high level of local knowledge of the area and the aim was to make the committee non-representative of various sector interests. As such, nominees were chosen in their own right.

Subsequent to Cabinet approval received on 11/5/2000, the Minister for the Environment announced the appointment of the 13 member Advisory Committee for the proposed Dampier Archipelago/Cape Preston marine conservation reserve on the 8 June 2000 at the CALM Karratha Office (see appendix d).

The members of the Advisory Committee for the proposed Dampier Archipelago/Cape Preston marine conservation reserve are: Trevor Ruland (Chair), Greg Oliver, Len Vertigan, John Kraus, Dennis Bryan-Smith, Noel Parkin, John Lally, Nicholas Miller, Simon Bennison, Andrew Heyward, Stephen van Leeuwen, Irene Stainton and Kent Buddle.

It is anticipated that the Advisory Committee will have its inaugural meeting in August in Karratha and it is envisaged that a field trip to familiarise the Advisory Committee members with the study area will be undertaken at this time.

The committee will progressively develop a proposal for the marine conservation reserve over the next twelve months.

Chapter Eight

PUBLIC PARTICIPATION PROGRAM: ISSUE ANALYSIS

CHAPTER EIGHT PUBLIC PARTICIPATION PROGRAM: ISSUE ANALYSIS

8.1 INTRODUCTION

The Western Australian Government is committed to the conservation of our marine environment and the sustainable use of our natural resources. A major component of the State's marine conservation and management strategy is the establishment of a statewide system of marine conservation reserves.

Most Western Australian (WA) marine conservation reserves cater for fishing and other human activities. They reflect a balanced approach by preserving representative ecosystems and habitats, while providing a management framework to ensure that recreational and commercial uses are managed in an equitable, integrated and sustainable manner.

In 1994, the Marine Parks and Reserves Selection Working Group published a report entitled *A Representative Marine Reserve System for Western Australia*. This report identified about 70 areas around the WA coast as being worthy of further consideration for reserve status. In December 1997, the WA Government announced that an area within the Pilbara inshore region centred around Dampier Archipelago to Cape Preston was a priority and since that date an assessment has been undertaken to determine the area's values, natural marine resources and commercial and recreational uses. The location and boundaries of the proposed Dampier Archipelago/Cape Preston marine conservation reserve is provided in the map in figure 1.

The WA Government is committed to full and open consultation before areas are declared as marine conservation reserves, and there is a statutory requirement for public participation in the planning process.

The **goal** of the public participation program (PPP) in the planning and management of WA marine conservation reserves is to develop community ownership, stewardship, and understanding of marine conservation reserves.

The **objective** of the PPP is to encourage and facilitate effective public involvement in the planning process and day-to-day management of WA marine conservation reserves.

An overview of the strategies and stages associated with the PPP in marine reserve planning and management is provided in the document *Draft Operational Procedures for Public Participation in Marine Conservation Reserves* and is summarised in Table 13 below.

Table 13. Summary of public participation process for WA marine conservation reserves.

PPP Phase	PPP Task
1. Initial public consultation	• Establish community contact data base • Provide information about the reserve concept and planning process to key individuals, organisations and groups • Facilitate planning advisory committee process • Undertake issue analysis • Prepare public consultation plan (based on results of the issue analysis)
2. Pre –notice of intent to declare reserve	• Facilitate the development of guidelines for the community planning advisory committee • Formulate consultation agreements with key interest and user groups

	• Develop & distribute information and educational material • Facilitate broad community input into the reserve planning process
3. Post –notice of intent to declare reserve	• Produce and distribute the draft plan plus summaries and explanatory information • Facilitate the preparation of public submissions • Prepare a report summarising public submissions
4. Gazetted marine conservation reserve	• Establish community management advisory committee • Facilitate the establishment of friends group • Support on-going community extension program

Phase 1 of the PPP includes an *issue analysis*. The term issue analysis is used to describe the task of undertaking and analysing discussions between CALM staff and representatives from the wide range of interest and user groups within the community. The objective of the issue analysis is to develop a community profile by:

- **Identifying community visions and aspirations in relation to marine conservation and management**;
- **Assessing community attitudes towards the marine reserve proposal** - Before members of the community can have effective input into the reserve planning process they need to have a cooperative attitude. People who are strongly negative or hostile will not consider other points of view or accept new information. The achievement of an appropriate attitude is therefore an essential step towards facilitating effective public input into the planning process;
- **Estimating levels of knowledge and understanding of the marine reserve concept, planning process and roles of both Government and the community** - People who do not have a minimum level of understanding of the marine reserve concept and planning process will not be able to participate effectively in the planning process;
- **Identifying issues of concern to stakeholder and interest groups** – An identification of issues will facilitate the planning process by providing a focus for education and negotiation; and
- **Identifying relationships between and within sectors of the community -** Conflicts within the community which relate directly to the marine reserve proposal need to be addressed during the planning process in an attempt to reach a resolution which is satisfactory to all parties.

A community profile provides the basis for sector communication and liaison planning with each of the interest and stakeholder groups. The issues identified also provide a focus for negotiation during the reserve planning process.

8.2 METHODS

To determine the community profile, discussions were conducted with key community representatives from relevant user and interest groups both within the local Pilbara community and within the peak bodies and Statewide interest groups based in the metropolitan Perth area. Discussions were conducted during April and May of 2000. Contact was primarily face to face with individuals or small groups, and a small number of discussions were conducted by phone. Interviewing staff used open questions and active listening to assess attitude, levels of knowledge and understanding of marine conservation reserve concepts and to identify issues, aspirations, concerns and alliances. Assessments were recorded on the standard forms in Appendix E, which were filled in from memory as soon after the discussion as possible.

Attitude was recorded as receptive, cautious or negative towards the proposal of a marine conservation reserve and an assessment was made both at the beginning and at the end of the discussion.

An assessment was made during each interview regarding the adequacy of knowledge and understanding displayed by the interviewee. The following areas or concepts were assessed:

- The range of values of the proposed marine conservation reserve;
- Representativeness;
- Sustainability;
- Multiple-use;
- Zoning;
- No-take;
- Integrated Management;
- The reserve planning process; and
- The roles of Government ane community in the planning process.

To maintain the flow of the discussion and avoid it sounding like an interrogation, it was not always appropriate to assess knowledge and understanding of all of the above concepts in every interview. A more detailed definition of adequate levels of knowledge and understanding is available in *Issue Analysis: Notes for Participating Staff* (Appendix F)

The interviewees concerns and issues were recorded on the standard forms in Appendix E and later grouped under the following headings: environmental degradation, planning outcomes, planning process and resource issues. Community aspirations, sector alliances and conflicts were similarly identified and grouped together where appropriate.

Some people who were interviewed represented more than one user or interest group. For example, a local recreational fisherman may also be a local government councillor or be a member of a recreational diving club. In these cases, the discussion results were used just once to determine the overall community profile, but the same discussion results were included in all relevant community sector analyses when determining separate profiles for each community sector.

8.3 RESULTS & DISCUSSION

A total of 106 interviews were conducted and because some interviews involved more than one person, a total of 164 people were sampled. The numbers of interviews undertaken and people sampled within each community sector are illustrated in table 14. While the sample sizes for many sectors provide a sound basis for analysis, the numbers of recreational divers, shack owners and commercial fishers were low. Extensive efforts were made to contact Aboriginal community members but with little success. The involvement of many Aboriginal people in very important and time consuming land claim issues has made it extremely difficult for them to focus on the marine reserve proposal. The timing of this reserve proposal is therefore unfortunate in terms of facilitating and encouraging extensive Aboriginal involvement in the planning process.

Table 14. Numbers of interviews conducted and people sampled within each community sector with interests in the Dampier Archipelago/Cape Preston marine reserve proposal.

User Group	No. of interviews	No. of people
COMMUNITY MEMBERS		
Local residents and ratepayers	15	22
Aboriginal communities	4	4
Vacation visitors	1	11
Community service groups	8	21
RECREATIONAL ACTIVITY GROUPS		
Boating	6	7
Diving	2	2
Fishing	10	19

Four wheel driving	2	2
Shack owners	3	4
INTEREST GROUPS		
Conservation	4	9
Science	9	10
Education	3	5
GOVERNMENT		
Local	8	9
State	16	25
Commonwealth	5	5
COMMERCIAL ACTIVITY GROUPS		
Fishing	3	3
Aquaculture & Pearling	6	8
Tourism	24	31
Industry	10	13
PRESS	2	2

About 30% of those interviewed represented more than one interest or user group and the multiplicity of user group representation within the sample is shown in figure 20.

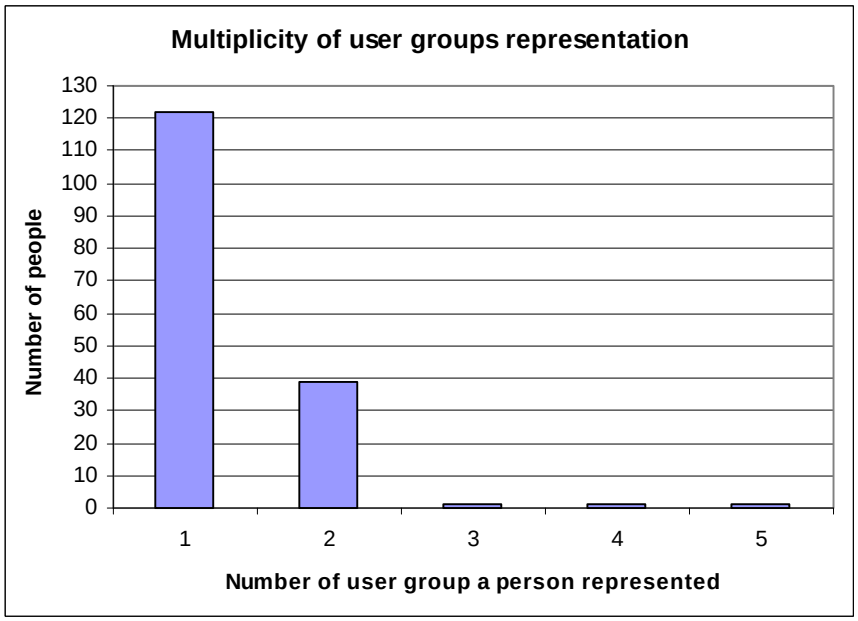


Figure 20 Multiplicity of user group representation

Attitude

A summary of attitudes across the whole community is presented in figure 21.

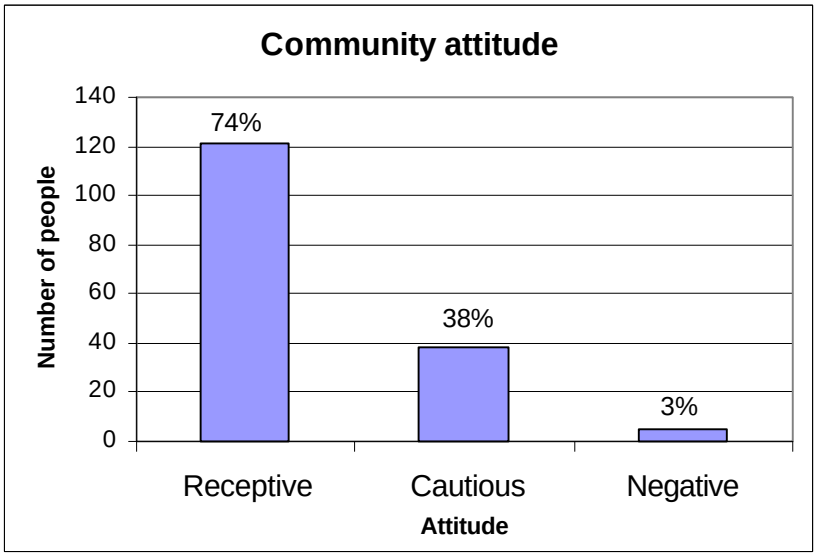


Figure 21. The numbers and percentages of people in each of the three attitude categories at the commencement of discussions.

These results represent the attitudes of interviewees at the commencement of discussions and therefore best represent the attitudes of the broad community. Three quarters of the people interviewed had a receptive attitude and only 5 people were negative or hostile to the proposal of a marine conservation reserve in the Dampier Archipelago/Cape Preston area.

The attitudes of people within each of the community sectors are summarised in table 15 below.

Table 15. Summary of attitudes recorded during the beginning of discussions with each sector of the community.

User Group	Receptive	Cautious	Negative	Total
Community members				
Local residents and ratepayers	22	-	-	22
Aboriginal communities	3	-	1	4
Vacation visitors	-	11	-	11
Neighbouring land owners	-	-	-	-
Community service Groups	12	5	4	21
Recreational activities				
Boating	7	-	-	7
Diving	2	-	-	2
Fishing	15	-	4	19
Four wheel driving	1	1	-	2
Shack owners	2	2	-	4
Interest groups				
Conservation	4	5	-	9
Science	10	-	-	10
Education	5	-	-	5
Government				
Local	8	1	-	9
State	17	8	-	25
Commonwealth	4	1	-	5
Commercial groups				
Commercial fishing	2	1	-	3
Pearling/Aquaculture	8	-	-	8
Tourism	29	2	-	31
Industry	10	3	-	13
Press	2	-	-	2

One member of the Aboriginal community who was interviewed had a negative attitude, which remained throughout the discussion. There were 4 negative interviewees from the community service user group and the recreational fishing user group. However, these were the same 4 people with both sectoral interests. At the end of their discussions, they had all become less negative and their attitudes were recorded as cautious.

Eleven vacation visitors were initially cautious, but at the end of the discussion they were receptive. Interviewees who were initially cautious from the four-wheel driving, shack owners, conservation, local Government, Commonwealth Government, commercial fishing and tourism user groups were all receptive at the end of the interview. Of these, one person represented both the shack owners and the local Government sectors.

Of the five people representing the community service sector who were cautious at the beginning of the discussion, only one became receptive at the end of the discussion and the others had remained cautious. The one person who had shifted attitude also had an interest as a shack owner.

Eight people representing the State Government sector were cautious at the commencement of discussions and at the end, three of these were recorded as receptive, while the other five remained cautious. The three industry representatives who had cautious attitudes at the beginning of discussions were still cautious at the end of the discussions.
The low incidence of negativity within the community indicates that most people are ready for an education program and there is no requirement to develop strategies to specifically address unreceptive attitudes.

Levels of knowledge & understanding

An overall summary of the adequacy of community levels of knowledge and understanding is presented in figure 22.

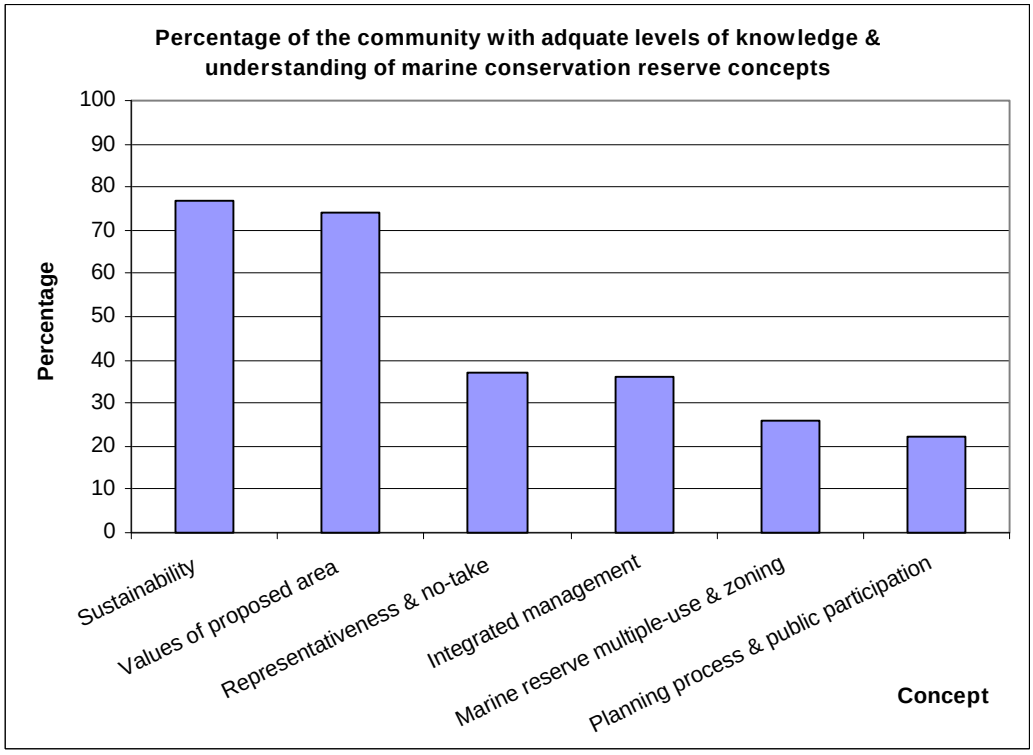


Figure 22. The percentages of the community with adequate levels of knowledge and understanding of marine conservation reserve concepts.

While the broad community has a reasonable level of knowledge and understanding of the concept of sustainability and the multiplicity of values within the proposed reserve area, the levels of knowledge and understanding of representativeness and no-take areas, integrated management, marine reserve multiple-use and zoning and the planning and public participation processes are all too low to anticipate effective participation by the broad community in the planning process.

The knowledge and understanding of representatives in each of the separate community sectors is recorded for all marine reserve concepts in Appendix G and summarized as an average of the percentages of people with adequate knowledge in each of the marine reserve concepts in figure 23.

The conservation, science and education interest groups are the best informed. The nine conservation representatives had an average level of knowledge of 87% across all reserve concepts and a lowest level of understanding of 67% in relation to integrated management. Only five education sector representatives were interviewed but their average level of knowledge across all reserve concepts was 77%. This was indicative of a broad understanding with the lowest level of knowledge being as high as 60% in relation to marine reserve multiple-use and zoning, representativeness and no-take and the planning and public participation processes. The ten scientists had an average level of knowledge of 74% across all reserve concepts but only 44% of those interviewed had an adequate level of understanding of integrated management. These results indicate that there is little need for a basic education program targeting members of these three interest sectors. Education material can assume a basic knowledge of the values of he proposed reserve and the planning public participation processes and concentrate on the progress of the planning process and the specific issues being negotiated.

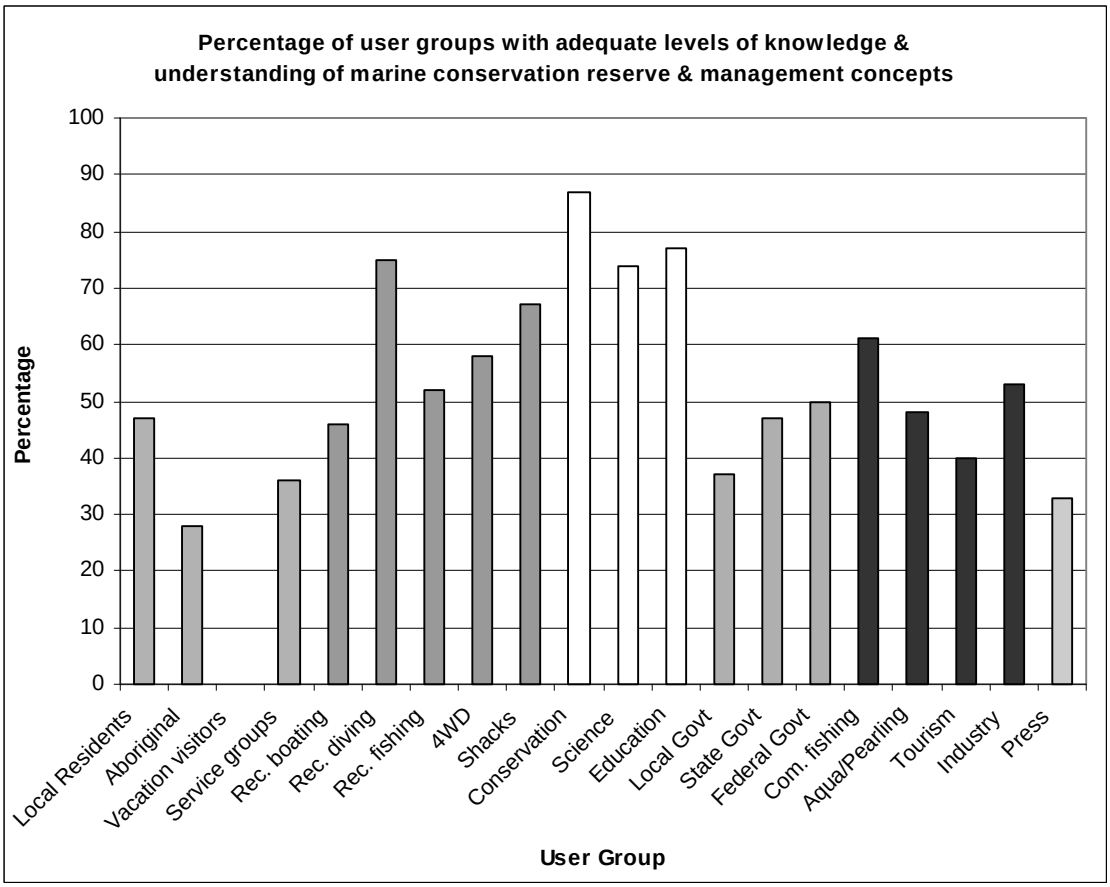


Figure 23. Mean percentages of levels of adequate knowledge and understanding of marine conservation reserve and management concepts. (General community groups are shaded with diagonal stripes, recreational groups are shaded with a checkered pattern, interest groups have no shading, government groups have a bold check pattern, commercial groups have dark shading and the press has vertical stripes.)

The recreational diving, shack owner and commercial fishing sectors look reasonably well informed but the numbers of people interviewed were low and may not have been indicative of overall levels of knowledge and understanding within these sectors. Of the other sectors with average levels of knowledge and understanding of 50% or higher, only two people were interviewed from the four wheel driving sector, while of the 19 recreational fishers, less than a third had adequate knowledge and understanding of marine reserve multiple-use and zoning or the planning and public participation processes. Of the five Commonwealth Government representatives interviewed, only one had adequate knowledge of the marine reserve multiple-use and zoning framework or the planning and public participation processes. Among the 13 industry representatives, only a quarter had adequate understanding of integrated management or the planning and public participation processes.

These results indicate that although the average levels of knowledge and understanding across all reserve concepts is reasonably high for some sectors of the community, none have high enough levels of knowledge and understanding to participate effectively in reserve planning without a basic education program to explain the multiple-use concept and zoning plus the planning and public participation processes.

All other sectors had average levels of knowledge and understanding of less than 50% with many having no representatives with adequate understanding of some reserve concepts. The vacation visitors recorded the lowest levels of knowledge and understanding and all representatives had inadequate levels in all reserve concepts. This may be a result of having had no access to recent local press articles and community activities, which would have raised the awareness of other local

residents. A basic education program is required for all these remaining sectors before they will be able to participate effectively in the planning process.

Hopes & Aspirations

The community expressed a wide range of view points relating to their hopes and aspirations for the future including subdividing and developing all over the islands and cutting down all the mangroves. However, these were minority aspirations for the future and a more broadly supported community vision can be summarised as one in which the natural resources are sustainably managed and available for enjoyment and use. Many members of the community see a future with some no-take areas and some suggested appropriate sites. Many of those who described their vision for the future felt that to maintain the values of the area, the islands themselves should remain much as they are now but that there is room for some low key tourist resort facilities on some islands. Many people see a future with additional industrial development on the adjacent mainland even if they do not support it.

The community expressed strongly their aspiration for balance and equity in zoning outcomes and for government agencies to work effectively together in managing the area. There is also a very high number of people who hope that extensive educational material will be made available to the public as part of the planning, establishment and ongoing management of a marine reserve. The hopes and aspirations of community members are listed in Appendix H.

Issues & concerns

A wide range of issues and concerns were identified by members of the community. The most frequently identified issues are grouped and presented in Appendix I. They are summarized in table 16.

Table 16. Issues and concerns most frequently identified by interviewees with the percentages of people who identified concerns within each subject area.

Issues and concerns	Percent
Environmental impacts & degradation: including fish stock depletion ,by-catch & other environmental damage from trawling, ballast water discharge, developments changing water circulation patterns and TBT antifouling	**61%**
Planning outcomes: the fear of changes, which could limit recreational access, or industrial operations, might seem inequitable or ineffective in protecting the environment	**59%**
Planning process: its capacity for equitable involvement of all sectors in a climate of some powerful players & a cynical/apathetic community.	**65%**
Resources: source & allocation for day-to-day management	**14%**

Clearly the community is concerned about the health of the marine environment with 54% identifying concerns over fin fish stock depletion, 35% expressing concern over bycatch and other environmental damage resulting from trawling and 21% of those interviewed identifying ballast water discharge from big ships as a serious environmental issue in the area. Several other specific environmental issues were identified relating to water quality and over exploitation and it appears that some environmental degradation is of sufficient magnitude to be obvious to a significant proportion of the community. It is

also of interest that these concerns were expressed by representatives from a wide range of community sectors and it is not therefore only members of the conservation and science sectors that see the need for sound environmental management.

Concerns relating to the need for protection of the marine and coastal environments were those most frequently identified by community members. A management framework that addresses these issues is therefore likely to be supported even if the necessary management strategies require some additional restrictions.

Concerns relating to the planning process focused mainly on the ability, and willingness of local community members to commit their time and energy to it. It was considered likely, by 21% of those interviewed, that the large proportion of short-term residents in the Pilbara coastal towns would result in a low level of community ownership and interest in long term conservation of the area. Sixteen percent of those interviewed were concerned that previous poor community consultation processes had left people feeling cynical and unwilling to get involved again and 15% were concerned that very few people currently know about the reserve proposal and are therefore unable to get involved. Once again, these concerns were expressed by representatives from a wide range of community sectors. They highlight the need for a broad community education program to encourage and facilitate community involvement. They also emphasise the need for the reserve planning process to be open and truly participatory because it will take very little to put a slightly apathetic and cynical community with negative experiences of previous community consultation exercises off side.

A wide range of issues were identified by members of the community relating to marine reserve planning outcomes. Eleven percent of the people interviewed expressed concern that the different community sectors would not have equal power in the planning process with a marine reserve zoning scheme being more the result of economic forces than environmental rationale. A further 9% were concerned that no take areas wouldn't be justified through the provision of an environmental rationale. There was some concern among 11% of interviewees that aquaculture licences for the culture of pearls would continue to be issued without extensive consultation and a further 11% of those interviewed were concerned about the possibility of restricted access within a reserve. These concerns were expressed by several sectors of the community and they emphasise the need for a completely open, accountable approach to planning with the provision of clear rationales for decisions. An open accountable approach will also help members of the community come to terms with possible changes, which alter their use of the area.

Fewer members of the community expressed concern over the practical management of an established marine conservation reserve, but 15% of those interviewed felt concerned about the adequacy of resources to develop and maintain a reserve and 5% feared the introduction of fees. Clearly the issue of funding will come up during the planning process and strategies to involve the community in addressing these concerns need to be considered.

Although some alliances and conflicts were identified among sectors of the community, few were mentioned more than once. However, animosity between the pearl culture industry and recreational fishers, boat owners or local residents was identified by 16 people. Conflict between commercial fishers (a crayfisher and trawlers) was identified by five people and some mistrust was mentioned by three people between recreational fishers and either commercial fishers or CALM.

8.4 SUMMARY OF MAIN POINTS

- The timing of the Dampier Archipelago/Cape Preston Marine Conservation Reserve planning process coincides with Aboriginal land claim negotiations. This makes it difficult for members of the Aboriginal community to be actively involved in the reserve planning process until the land claim issues are resolved.

- The majority of people have a positive attitude towards the commencement of a marine reserve planning process and there is no need to implement strategies to specifically address negative attitudes within the community.

- Members of the conservation, science and education sectors have a reasonable knowledge and understanding of the marine reserve concept and planning process. All other sectors of the community have an inadequate knowledge and understanding to participate effectively in the planning process and a broadly based education program is required.

- Community hopes and aspirations for the proposed reserve varied but perhaps the most broadly supported vision is one in which the natural resources are sustainably managed and available for enjoyment and use. Many people felt that the islands should remain much as they are now but that there is room for some low key tourist resort facilities. Many people see a future with additional industrial development on the adjacent mainland even if they do not support it. The community is hoping for balance and equity in zoning outcomes and for Government agencies to work effectively together in managing the area.

- The most frequently identified issues, which concerned members of the community, related to environmental degradation and the need for sustainable management. Clearly some degradation is apparent to members of the community and, on the whole, they would like to see this degradation arrested and repaired.

- The public participation program will need to be easily accessible to members of a community who may be reluctant to participate in planning because of low levels of ownership, cynicism towards the process or be just too busy.

- The process must be open, with clear and active communication pathways between decision makers on the community advisory committee and community members at grass roots level.

- Rationales for decisions need to be broadly distributed and explained.

Chapter Nine

PUBLIC PARTICIPATION PROGRAM: COMMUNITY CONSULTATION

CHAPTER NINE PUBLIC PARTICIPATION PROGRAM: COMMUNITY CONSULTATION

The community consultation process has been underway for several months, and has involved staff from both Marine Conservation Branch and from CALM's Karratha Regional office. The community consultation program has so far comprised:

- Meetings with regional CALM staff, regional State Government staff, local government, community groups, major resource companies and indigenous representatives.

- Initial consultation with government agencies eg Fisheries WA, Dampier Port Authority, Minerals and Energy, Resources Development, Environmental Protection Authority, Pilbara Development Commission, and arrangements made for the formation of an inter-governmental working group to provide government input to the community advisory committee and planning process.

- Press releases announcing the consideration of the Dampier Archipelago/Cape Preston area for reservation (appendix J)

- Interviews on talkback radio

- A newsletter "Marine Matters" produced by CALM's Marine Conservation Branch which contained articles on the proposed reserves and which was distributed to a wide audience.
- A Community Awareness Day was held at the Karratha City Shopping Centre on Saturday 18 March 2000. A number of community groups, government agencies and fund raising bodies had stalls throughout the shopping centre. CALM set up a display to promote the upcoming marine reserves process in the Dampier Archipelago/Cape Preston region. Four posters were produced outlining the proposed areas for reservation, protection of the marine environment, access to reserve areas and how to be involved in the planning process. These were displayed, together with posters showing the zones within marine reserves and the consultation process for new marine reserves, advertising the Wild about WA CD and the Marine Life CD. There was also a table with brochures and pamphlets with information about marine reserves and marine fauna. Approximately 50% of people interested in the display asked questions, and the vast majority of people were positive about the concept and some seemed to be interested in getting involved further.
- A display was exhibited at the Karratha Youth Festival, which comprised marine posters, information on the marine reserve planning process and proposed Dampier Archipelago/Cape Preston marine conservation reserve.
- Liaison with peak industry and recreation groups such as WAFIC, APPEA and Recfishwest

Chapter Ten

PUBLIC PARTICIPATION PROGRAM: EDUCATION/ INTERPRETATION MATERIALS

CHAPTER TEN PUBLIC PARTICIPATION PROGRAM: EDUCATION/INTERPRETATION MATERIALS

- Interpretive panels, posters and electronic presentation products are being produced. General posters will be produced which will be used to inform the community of the values of the area and to facilitate community discussion of the issues. Other posters will be prepared detailing accurate spatial information on uses and values in the area, which will provide the base information for negotiations and discussions with key stakeholders.

- A Pilbara reserves brochure has been produced (CALM 2000a), as has a joint CALM/FWA/DEP brochure outlining the planning processes occurring in the Pilbara region (EPAWA, CALM & FWA, 2000). The aim of these brochures is to give the community an understanding of which area would be considered for marine reservation and to provide a broad outline of the marine reservation process. The second brochure aims to inform the public of the different planning processes being undertaken in the marine environment by CALM, DEP and FWA. It is hoped that this will minimise confusion as to which agency is responsible for what and how the various proposals interact and relate to each other. Brochures are attached in appendix k.

- A collaborative project has been undertaken with students from Murdoch University's Media School to record interviews of key people in the community on digital video. This video footage, as well as still images of the study area, will be used for audio-visual presentations.

Chapter Eleven

PROGRESS REPORT SUBMISSION

CHAPTER ELEVEN PROGRESS REPORT SUBMISSION

11.1 BACKGROUND

The Dampier Archipelago/Cape Preston area was recommended in the *Report of the Marine Parks and Reserves Selection Working Group* (CALM, 1994) as worthy of consideration for reservation.

The *Conservation and Land Management (CALM) Act* allows for the establishment of multiple-use marine conservation reserves for the purposes of conservation of marine flora and fauna and public recreation. Commercial activities, such as fishing, aquaculture and petroleum exploration and production, are also acceptable within specific zones of multiple-use marine conservation reserves. The Western Australian Fisheries Department manages commercial and recreational fisheries in marine conservation reserves.

The *CALM Act* specifies the statutory process for the reservation of marine conservation reserves, including a public planning process for the development of management zoning schemes that allow for the spatial separation of incompatible activities in a marine park. In anticipation of this process the major marine resources and current uses of a number of the areas recommended for reservation in the Marine Parks and Reserves Selection Working Group report, are being identified. As part of the statutory marine conservation reserve pre-declaration process, it is required that the biological, economic, social and cultural resources of a proposed marine conservation reserve be assessed before the Notice Of Intent (NOI) is issued. This process has been designed to improve the community's awareness of the issues concerned with the creation of a marine conservation reserve prior the release of the NOI. The data layers provide the basic information for a consultative process resulting in the determination of preliminary boundaries and zonings, so that current users have a clear appreciation of how the proposed marine reserve will affect their current and future activities.

In December 1997, the Western Australian Government, following advice provided by the Western Australian Marine Parks and Reserves Authority, announced that the Dampier Archipelago/Cape Preston region as priority areas for the establishment of marine conservation reserves under the *CALM Act*. Designation of the waters of Dampier Archipelago region as a marine conservation reserve was also recommended in the Karratha Area Development Strategy (WAPC, 1998).

Currently, there is no other marine conservation reserve in the "Pilbara Inshore" Interim Marine and Coastal Regionalisation for Australia bioregion (IMCRA, 1998).

The Marine Conservation Branch (MCB) of the Department of Conservation and Land Management (CALM) is conducting this project as part of the Marine Reserve Implementation program, and is being conducted in collaboration with CALM's Pilbara Region in Karratha.

The aims of the project are:

1. to initiate planning and pre-declaration processes for the proposed Dampier Archipelago/Cape Preston marine conservation reserve;

2. to compile the ecological and socioeconomic information necessary for planning;

3. to provide advice to the WA Government, through the stakeholder/community advisory committee process, on the suitable reserve category, boundaries and management zoning options, and;

4. to develop and implement a community consultation process.

This report details progress achieved on Project No WA9701 “Planning and pre-declaration process for a Marine Protected Area in the Dampier Archipelago/Cape Preston region” up to September 1999.

11.2 AREA OF INTEREST

The are of interest (Figure 1) referred to as the Dampier Archipelago/Cape Preston region, falls in the Pilbara Inshore IMCRA bioregion.

The area of interest is covered by:

- AUSLIG Topographic Series 1:250,000 SF50-2 Dampier, SF50-3 Roebourne and SF50-6 Yarraloola, and;
- AUSLIG Topographic Series 1:100,000 2156 Preston, 2256 Dampier, 2257 Legendre, 2356 Roebourne and 2357 Delambre.

The following latitudes and longitudes cover the extent of the area of interest.

Table 17 Coordinates of the study area

Bearing	Latitude	Longitude
North	20° 18’ 00” S	116° 49’ 48” E
North west	20° 25’ 48” S	116° 31’ 12” E
West	20° 46’ 48” S	116° 06’ 00” E
South west	21° 01’ 48” S	116° 24’ 00” E
South	20° 45’ 00” S	116° 56’ 24” E
South east	20° 39’ 36” S	117° 06’ 00” E
East	20° 30’ 00” S	117° 24’ 00” E
North east	20° 23’ 24” S	117° 06’ 36” E

11.3 PROGRESS AGAINST PROJECT SCOPE ITEMS

Progress against scope items have been satisfactory (see below)

Table 18 Project progress

	Task	% Achieved	Details	Information attached
1.	Review and collation of existing information layers and acquisition of additional layers.	80%	• Literature reviews have been undertaken.	
		70%	• Data have been acquired from appropriate government departments and agencies.	
		70%	• Resource assessment of region was undertaken.	
2.	Preparation of advisory committee information package	70%	• A regional perspectives paper is well progressed.	
		70%	• Procedural guidelines for Western Australian marine reserve planning and management legislation.	
		80%	• Relevant biological, economic and social information layers have been acquired from appropriate government departments and agencies. A number of products are being produced: Broad scale habitat map, tenure, commercial and recreational fishing.	
3.	Establishment of the community/ stakeholder advisory committee	100%	• Calls for expression of interest for membership of the community advisory committee advertised in the West Australian dated 15/5/99.	(a) Advertisement attached (Appendix c)
		40%	• The selection process is well progressed with the scheduled inaugural meeting of the Dampier Archipelago/Cape Preston Advisory Committee currently waiting for approval by the State Minister for the Environment.	
4.	Implementation of community consultation program	10%	• Program has been initiated.	
		20%	• Interpretive posters are being designed.	
		50%	• Interpretive brochures are well progressed.	

11.4 EXPENDITURE TO DATE

Table 19 Expenditure

Item	Funding	Expenditure	Balance
NHT funds received 1998/99	$48,000		**$48,000**
Expenditure 1998/99		$13,753	**$34,247**
Funds on progress report (Oct 1999)	$0		**$34,247**
Expenditure 1999/2000 (to Sep 1999)		$6,831	**$27,416**
Residual expenditure 1999/2000		$43,416	**($16,000)**
Funds on final report 1999/2000	$16,000		**$0**
Totals	**$64,000**	**$64,000**	**$0**

11.5 WORK SCHEDULE

NHT funding was not accessible until late December 1998, which resulted in a three month delay in starting the project. When considering the delay, this project is still within time limits. It is envisaged that the Dampier Archipelago/Cape Preston advisory committee will hold their inaugural meeting in late July – early August 2000.

Table 20 Work Schedule

Tasks	Oct 98	Nov 98	Dec 98	Jan 99	Feb 99	Mar 99	Apr 99	May 99	Jun 99	Jul 99	Aug 99	Sep 99	Oct 99	Nov 99	Dec 99	Jan 00
Review and collation of existing information layers and acquisition of additional data	●	●	●	●	●											
				➡	➡	➡	➡	➡	➡	➡	➡	➡				
Preparation of an information package, comprising regional and biological perspectives papers; relevant information layers in GIS format and procedural guidelines	●	●	●	●												
					●											
					➡	➡	➡	➡	➡	➡	➡	➡	➡			
Progress Report						●	●									
											➡	➡				
Establishment of community advisory committee process	●	●	●	●	●	●	●	●	●							
					➡	➡	➡	➡	➡	➡	➡	➡	➡			
Implementation of a community consultation program				●	●	●	●	●	●							
								➡	➡	➡	➡	➡	➡	➡	➡	➡
Prepare final draft NHT funding report for comment and submit final report to EA									●	●	●					
														➡	➡	➡

● Work plan as outlined in September 1998

➡ Actual and predicted work plan as of September 1999

Chapter Twelve

STATEMENT OF EXPENDITURE

CHAPTER TWELVE STATEMENT OF EXPENDITURE

Table 21 Expenditure by Agency

Item	MPAP funding	MPAP Expenditure ($)	CALM Expenditure ($)	Total Expenditure ($)
NHT funds received 1998	$48,000			**$0**
Expenditure to 1998/1999		$13,753	$53000	**$66753**
Expenditure 1999/2000		$50,247	$97000	**$147247**
Funds on final report 2000	$16,000			
Totals	**$64,000**	**$64,000**	**$150000**	**$214000**

REFERENCES & INFORMATION SOURCES

REFERENCES & INFORMATION SOURCES

Bancroft, K.P. (1999a). Resource assessment field survey of the Montebello/Barrow islands and the Dampier/Cape Preston regions: 14-25 June 1999. Field Program Report MRI/PI/MBI & DA-20/1999. June 1999. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia. (Unpublished report).

Bancroft, K.P. (1999b). Planning and pre-declaration processes for a marine protected area in the Dampier Archipelago/Cape Preston region. Progress Report MRI/PI/DA-21/1999. September 1999. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia. (Unpublished report).

Bancroft, K.P. & Davidson, J.A. (2000). Broadscale habitat map and resource assessment of the Montebello/Barrow islands and the Dampier/Cape Preston regions. Data Report MRI/PI/MBI & DA-34/2000. February 2000. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia. (Unpublished report).

CALM (undated-a). Procedural guidelines for Western Australian marine reserve planning and management legislation-*Act Amendment (Marine Reserves) Act 1997*. Department of Conservation and Land Management, Perth, Western Australia.

CALM (undated-b). CALM policy guidelines for advisory committees. Department of Conservation and Land Management, Perth, Western Australia.

CALM (1994). A representative marine reserve system for Western Australia. Report of the Marine Parks and Reserves Selection Working Group. June 1994. Department of Conservation and Land Management, Perth, Western Australia.

CALM (1997a). Analysis of public submissions on the report of the Marine Parks and Reserves Selection Working Group. October 1997. Department of Conservation and Land Management, Perth, Western Australia.

CALM (1997b). DRAFT. Generic information requirements for the management of marine reserves in Western Australia. June 1997. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

CALM (1998). Marine life in Western Australia: An identification guide to common marine plants and animals. CD-ROM. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

CALM (2000a). Pilbara marine conservation reserves. Brochure. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

CALM (2000b). Dampier Archipelago/Cape Preston: Regional perspective. February 2000, Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

CALM & MPRA (undated a). Marine conservation reserves in Western Australia: zoned for many uses. Pamphlet. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia and the Marine Parks and Reserves Authority, Perth, Western Australia.

CALM & MPRA (undated b). Marine conservation reserves management concepts in Western Australia. Brochure. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia and the Marine Parks and Reserves Authority, Perth, Western Australia.

Colman, J.G. & Simpson, C.J. (1999). 'No take' areas in Western Australia's multiple-use marine conservation reserve system: A discussion paper. Marine Management Series Report No 1. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia and the Marine Parks and Reserves Authority, Perth, Western Australia.

Daly T. W. and Cary J. L. (1999). Marine Management Support Program (Pilbara). Establishment of long-term monitoring sites in Ningaloo Marine Park: August 1999. Field Program Report MMSP/MW/NMP-17/1999. (Marine Conservation Branch, Department of Conservation and Land Management, 47 Henry St., Fremantle, Western Australia. 6160). Unpublished report.

Department of Conservation and Land Management (1989). Ningaloo Marine Park Management Plan 1989 - 1999. Management Plan No. 12 Department of Conservation and Land Management, Perth, Western Australia.

EPAWA (1987). Coral reefs of Western Australia. Bulletin 285. October 1987. Environmental Protection Authority, Perth. Western Australia.

EPAWA, CALM & FWA. (2000) Marine Management. Working Together on the North West Shelf February 2000 Brochure. Released by the Department of Environmental Protection, the Department of Conservation and Land Management and Fisheries WA.

IMCRA (1998). Interim marine and coastal regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Report by the Interim marine and coastal regionalisation for Australia Technical Group. Version 3.3. Environment Australia, Department of the environment, Canberra, Australian Capital Territory.

Simpson, C.J. (1998). Environmental guidelines and procedures in relation to CALM advice on the marine aspect of aquaculture and pearling proposals in Western Australia. Report No: MPC-01/1998. December 1998. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

Simpson, C.J. & Bancroft, K.P. (1999). A framework for prioritising the implementation of marine conservation reserves in Western Australia. Marine Conservation Branch, Department of Conservation and Land Management, Fremantle, Western Australia.

Simpson, C., D'Adamo, N. & Thompson, C. (1996). Oceans of wealth. Landscope. Autumn 1997. pp.10-15.

WA Government (1998). New Horizons, the way ahead in marine conservation and management. Prepared for the Western Australian Government by the Department of Conservation and Land Management, Perth, Western Australia.

WAPC (1998). Karratha area development strategy. Western Australian Planning Commission. April 1998. 82p.

APPENDICES

APPENDIX A. PROJECT DETAILS AND WORK SCHEDULE

PROJECT DETAILS

Project No. and Title: WA9701 Planning and pre-declaration process for a MPA in the Dampier region.

Project Supervisor:	**Dr Chris Simpson**
Agency:	CALM, Marine Conservation Branch
Contact Address:	47 Henry Street FREMANTLE WA 6160
Telephone:	(08) 9432 5101
Facsimile:	(08) 9430 5408
Email:	chriss@calm.gov.au
Environment Australia Liaison Officer:	**Edward Kleverlaan**
Agency:	Environment Australia
Contact Address:	Marine Conservation Section GPO Box 787 CANBERRA ACT 2601
Telephone:	(02) 6274 1750
Facsimile:	(02) 6274 1771
Email:	edward.kleverlaan@ea.gov.au

Aims

- To initiate the planning and pre-declaration processes for the proposed Dampier Archipelago marine reserve.
- To compile the ecological and socio/economic information.
- To determine, through the stakeholder advisory committee process, suitable reserve category, boundaries and management zoning options.
- To develop and implement a community consultation program.

Scope

Specific Tasks

1. Review and collation of existing information layers, and acquisition of additional data.
2. Preparation of an information package, comprised of:
   (i) A regional perspectives paper, summarising the conservation, cultural/historical, social and economic values of the candidate area.
   (ii) A biological perspectives paper, summarising biological data for the candidate area, and discussing the implications for reserve design.
   (iii) Relevant biological, economic and social information layers, in GIS format.
   (iv) Procedural guidelines for reserve implementation.
3. Prepare and submit a Progress Report.
4. Implementation of the statutory community/stakeholder advisory committee process.
5. Implementation of a community consultation program, including public meetings and the preparation of educational/interpretative materials.
6. Prepare draft Final for comment and submit Final report.

Financial Payments and Reporting Schedule

The total financial payment for the project is $64,000 payable by the instalments specified in Table 1:

Table 1

Payment	Report	Date	Amount
Initial	Work Schedule	October 1998	$48,000
	Progress	April 1999	$0
	Draft Final	June 1999	$0
Final	Final	August 1999	$12,000
		Total	$64,000

Reporting Requirements

The Proponent must prepare and provide to Environment Australia reports as follows, by the dates specified in Table 1 above.

Work Schedule

Provide a Work Schedule in Microsoft Project, Microsoft Excel or any similar software package. Information should include:

- Tasks as per Scope (providing detailed breakdown of tasks).
- Timelines for each specified task.
- Milestones.

See Attachment 1 for an example of work schedule.

Initial payment will be dependant upon provision of the Work Schedule.

Progress Report

One (1) unbound copy of the report. The report shall address all Scope items and refer to progress against the Work Schedule.

In addition to the Progress Report, the Proponent shall provide:

- Mapping coordinates that define the project's extent. These coordinates should be given in latitude and longitude, to the nearest degree, minute and second. A coordinate for the northern, northeastern, northwestern, eastern, western, southern, southwestern and southeastern extent of the project shall be given. To ensure accuracy, please use the finest scale map possible when calculating coordinate readings (ie use a 1:10,000 map sheet when calculating coordinates for a 1 hectare project region).
- Name of 1:100,000 or 1:250,000 map sheets covering the study area, unless the project is state-wide
- IMCRA region name/s.

Draft Final Report

The Draft Final Report should be formatted and presented as in the Final Report. It is to be provided at least **2 months prior** to submission of the Final Report to allow adequate time for assessment of the report.

Final Report

Four (4) copies of the report (one unbound).

The Final Report should be a stand alone document which can be used for information and dissemination purposes on the operation, mechanisms and processes employed in the Project.

The Final Report of the Project must include summaries of the major activities undertaken by the Proponent, in particular:

- an assessment and evaluation of the Project against the criteria set out in "Evaluation" below;
- an examination of the degree to which the Project's stated objectives have been achieved; and
- an outline of any demonstration/communication activities undertaken

The Final Report shall include text similar to the following italicised text, amended as appropriate:

(a) Research and the collation of information presented in this report was undertaken with funding provided by Environment Australia. The project was undertaken for the Marine Protected Areas Program.
(b) Copyright in this report is vested in the State of Western Australia.
(c) The views and opinions expressed in this report are those of the authors and do not reflect those of the Commonwealth Government, the Minister for the Environment or the Director of National Parks and Wildlife.
(d) The report may be cited as "Planning and pre-declaration process for a MPA in the Dampier region".
Copies of the report may be borrowed from the library: Environment Australia, GPO Box 787, CANBERRA ACT 2601 AUSTRALIA

In addition to the Final Report, the Proponent shall provide:

- a summary of not more than two hundred and fifty (250) words summarising the significance and limitations of the study findings covered by the Scope of the project.
- one (1) copy of the summary on digital media, on 3.5 inch diskettes formatted to IBM compatible specifications, or in a digital format as agreed between the Project Supervisor and the Environment Australia Liaison Officer.
- a copy of data that is brought into existence as part of, or for the purpose of performing the Consultancy Services, is to be supplied in a digital format as agreed between the Project Supervisor and the Environment Australia Liaison Officer if requested.
- colour transparencies (and a descriptive caption) as agreed between the Project Supervisor and the Environment Australia Liaison Officer, in publication quality, thirty-five millimetre, non-textual format of the highlights arising from the project.

Evaluation

The matters to be included in the evaluation of the Project in the Final Report are listed below.

1. Outcomes
The degree to which the Project has achieved the outcomes.

2. Appropriateness
The appropriateness of the approaches used in the development and implementation of the Project.

3. Effectiveness
The degrees to which the Project has effectively met its stated aims.

4. Transferability
The degree to which the approach used to establish, implement and administer the operations of the Project could be applied to other jurisdictions.

The Proponent must also include any other matters, relating to the evaluation in the Final Report, which Environment Australia specifies to be included in the Final Report. Any such requirement will be notified to the Proponent at least 30 days before the Final Report is due.

Insurance

The Proponent shall be responsible for effecting all insurance required under Worker's Compensation legislation and for taking all other action required or appropriate in relation to its employees or agents in undertaking the agreed Project.

Intellectual Property

Clause 6 of the Standard Terms and Conditions in Attachment B of the Partnership Agreement will apply.

Publicity

Further to Section 10 of the Memorandum of Understanding, projects receiving *Coasts and Clean Seas* funding shall give appropriate acknowledgment to *Coasts and Clean Seas* as the source the source of those funds.

Project Variation

Environment Australia should be notified of any proposed variations to project details, budget, timeline or contacts. No variation to this agreement is binding unless it is agreed in writing between all parties.

Attachment 1

WORK SCHEDULE

Planning and pre-declaration processes for a MPA in the Dampier Archipelago region.

Objectives/Aims of Project:

- To initiate the planning and pre-declaration processes for the proposed Dampier Archipelago marine reserve.
- To compile the ecological and socio/economic information.
- To determine, through the stakeholder advisory committee process, suitable reserve category, boundaries and management zoning options.
- To develop and implement a community consultation program.

Final Product Required:

Written report.

Specific Tasks:

1. Review and collation of existing information layers, and acquisition of additional data.
2. Preparation of an information package, comprised of:
   (i) A regional perspectives paper, summarising the conservation, cultural/historical, social and economic values of the candidate area.
   (ii) A biological perspectives paper, summarising biological data for the candidate area, and discussing the implications for reserve design.
   (iii) Relevant biological, economic and social information layers, in GIS format.
   (iv) Procedural guidelines for reserve implementation.
3. Prepare and submit a Progress Report.
4. Implementation of the statutory community/stakeholder advisory committee process.
5. Implementation of a community consultation program, including public meetings and the preparation of educational/interpretative materials.
6. Prepare draft Final for comment and submit Final report.

Work Timetable

Tasks	Oct 98	Nov 98	Dec 98	Jan 99	Feb 99	Mar 99	Apr 99	May 99	Jun 99	Jul 99	Aug 99	Sep 99
Review and collation of existing information layers, and acquisition of additional data.												
Preparation of an information package, comprising regional and biological perspectives papers; relevant information layers, in GIS format and procedural guidelines for reserve implementation.												
Progress Report												
Implementation of the statutory community/stakeholder advisory committee process.												
Implementation of a community consultation program.												
Prepare draft Final for comment and submit Final report												

APPENDIX B. VARIATION TO CONTRACT

ENVIRONMENT AUSTRALIA

VARIATION TO CONTRACT FOR CONSULTANCY SERVICES

Below are the revised scope items, reporting and payment schedule, and conditions for the project **Planning and pre-declaration process for a MPA in the Dampier Region**, funded under the Marine Protected Areas (MPA) Program and subject to a Consultancy Agreement between Environment Australia and the Department of Conservation and Land Management, dated 24 November 1998 (copied attached).

Project Supervisor:	**Dr Chris Simpson**
Agency:	CALM, Marine Conservation Branch
Contact Address:	47 Henry Street FREMANTLE WA 6160
Telephone:	(08) 9432 5101
Facsimile:	(08) 9430 5408
Email:	chriss@calm.wa.gov.au
Environment Australia Liaison Officer:	**Edward Kleverlaan**
Agency:	Environment Australia
Contact Address:	Marine Protected Areas –National System GPO Box 787 CANBERRA ACT 2601
Telephone:	(02) 6274 1750
Facsimile:	(02) 6274 1771
Email:	edward.kleverlaan@ea.gov.au

Scope

Specific Tasks

1. Review and collation of existing information layers, and acquisition of additional data.
2. Preparation of an information package, comprised of:
   - A regional perspectives paper, summarising the conservation, cultural/historical, social and economic values of the candidate area.
   - A biological perspectives paper, summarising biological data for the candidate area, and discussing the implications for reserve design.
   - Relevant biological, economic and social information layers, in GIS format.
   - Procedural guidelines for reserve implementation.
3. Prepare and submit a Progress Report.
4. Implementation of the statutory community/stakeholder advisory committee process.
5. Implementation of a community consultation program, including public meetings and the preparation of educational/interpretative materials.
6. Prepare draft Final for comment and submit Final report.

Work Timetable

Tasks	Feb 99	Mar 99	Apr 99	May 99	Jun 99	Jul 99	Aug 99	Sep 99	Oct 99	Nov 99	Dec 99	Jan 00	Feb 00
Review / collation of existing information layers; acquisition of additional data.													
Preparation of an information package, comprising regional and biological perspectives papers; relevant information layers, in GIS format and procedural guidelines													
Progress Report													
Implementation of the statutory community/-stakeholder advisory committee process.													
Implementation of a community consultation program.													
Prepare draft Final for comment and submit Final report													

Financial Payments and Reporting Schedule
The total financial payment for the project is $64,000 payable by the instalments specified in Table 1:

Table 1

Payment	Report	Date	Amount
Initial	Work Schedule	October 1998 (Paid)	$48,000
	Progress	September 1999	$0
	Draft Final	December 1999	$0
Final	Final	February 2000	$16,000
		Total	$64,000

This variation is made on the .....day of 1999

Signed on behalf of Environment Australia by:

.....
(Full Name)

.....
(Signature)

Signed on behalf of the Department of Conservation and Land Management by:

.....
(Full Name)

.....
(Signature)

and witnessed by:

.....
(Full Name)

.....
(Signature)

.....
(Full Name)

.....
(Signature)

APPENDIX C. CALL FOR ADVISORY COMMITTEE NOMINATIONS

APPENDIX D. PRESS RELEASE- ANNOUNCEMENT OF THE ADVISORY COMMITTEE

APPENDIX E. STANDARD ISSUES ANALYSIS INTERVIEW FORM

APPENDIX F. ISSUES ANALYSIS - NOTES FOR PARTICIPATING STAFF

APPENDIX G. PERCENTAGES OF ADEQUATE LEVELS OF KNOWLEDGE AND UNDERSTANDING OF MARINE CONSERVATION RESERVE CONCEPTS WITHIN EACH COMMUNITY SECTOR

Contact Group	Level of knowledge & Understanding	Number of people	Number with adequate understanding	% with adequate understanding
COMMUNITY	SECTORS			
Local residents & rate payers	Values of proposed area	22	20	91
	Marine reserve multiple-use & zoning	22	4	18
	Representativeness and no-take	15	6	40
	Sustainability	21	21	100
	Integrated management	12	1	8
	Planning process & Public Participation	22	5	23
Aboriginal Communities	Values of proposed area	2	2	100
	Marine reserve multiple-use & zoning	3	0	0
	Representativeness and no-take	1	1	100
	Sustainability	1	1	100
	Integrated management	1	0	0
	Planning process & Public Participation	3	0	0
Vacation visitors	Values of proposed area	11	0	0
	Marine reserve multiple-use & zoning	11	0	0
	Representativeness and no-take	11	0	0
	Sustainability	11	0	0
	Integrated management	11	0	0
	Planning process & Public Participation	11	0	0
		11	0	
Community service groups	Values of proposed area	21	12	57
	Marine reserve multiple-use & zoning	21	3	14
	Representativeness and no-take	21	8	38
	Sustainability	21	15	71
	Integrated management	20	7	35
	Planning process & Public Participation	21	0	0
RECREATIONAL SECTORS				
Boating	Values of proposed area	7	5	71
	Marine reserve multiple-use & zoning	7	1	14
	Representativeness and no-take	7	2	29
	Sustainability	6	6	100
	Integrated management	6	2	33
	Planning process & Public Participation	7	2	29
Diving	Values of proposed area	2	2	100
	Marine reserve multiple-use & zoning	2	1	50
	Representativeness and no-take	2	2	100
	Sustainability	1	1	100
	Integrated management	2	1	50
	Planning process & Public Participation	2	1	50
Fishing	Values of proposed area	19	14	74
	Marine reserve multiple-use & zoning	19	6	32

	Representativeness and no-take	12	6	50
	Sustainability	18	13	72
	Integrated management	10	5	50
	Planning process & Public Participation	19	6	32
Four wheel drive	Values of proposed area	2	2	100
	Marine reserve multiple-use & zoning	2	1	50
	Representativeness and no-take	2	1	50
	Sustainability	1	1	100
	Integrated management	1	0	0
	Planning process & Public Participation	2	1	50
Shack owners	Values of proposed area	4	4	100
	Marine reserve multiple-use & zoning	4	3	75
	Representativeness and no-take	4	3	75
	Sustainability	4	4	100
	Integrated management	4	1	25
	Planning process & Public Participation	4	1	25

INTEREST GROUPS

Conservation	Values of proposed area	9	9	100
	Marine reserve multiple-use & zoning	9	7	78
	Representativeness and no-take	9	9	100
	Sustainability	9	9	100
	Integrated management	9	6	67
	Planning process & Public Participation	9	7	78
Science	Values of proposed area	10	10	100
	Marine reserve multiple-use & zoning	10	7	70
	Representativeness and no-take	10	10	100
	Sustainability	10	10	70
	Integrated management	9	4	44
	Planning process & Public Participation	10	6	60
Education	Values of proposed area	4	4	100
	Marine reserve multiple-use & zoning	5	3	60
	Representativeness and no-take	5	3	60
	Sustainability	5	5	100
	Integrated management	5	4	80
	Planning process & Public Participation	5	3	60

GOVERNMENT REPRESENTATIVES

Local Government	Values of proposed area	9	7	78
	Marine reserve multiple-use & zoning	9	1	11
	Representativeness and no-take	9	2	22
	Sustainability	7	6	86
	Integrated management	8	2	25
	Planning process & Public Participation	9	0	0
State Government	Values of proposed area	25	17	68
	Marine reserve multiple-use & zoning	25	4	16
	Representativeness and no-take	25	5	20
	Sustainability	20	13	65
	Integrated management	19	17	89
	Planning process & Public Participation	25	6	24
Commonwealth Government	Values of proposed area	5	5	100
	Marine reserve multiple-use & zoning	5	1	20
	Representativeness and no-take	5	3	60
	Sustainability	4	3	75
	Integrated management	4	1	25

	Planning process & Public Participation	5	1	20

COMMERCIAL SECTORS

Commercial Fishing	Values of proposed area	3	3	100
	Marine reserve multiple-use & zoning	3	1	33
	Representativeness and no-take	3	1	33
	Sustainability	3	3	100
	Integrated management	3	1	33
	Planning process & Public Participation	3	2	67
Aquaculture & Pearling	Values of proposed area	8	8	100
	Marine reserve multiple-use & zoning	8	2	25
	Representativeness and no-take	8	2	25
	Sustainability	8	8	100
	Integrated management	8	2	25
	Planning process & Public Participation	8	1	13
Tourism	Values of proposed area	31	22	71
	Marine reserve multiple-use & zoning	31	8	26
	Representativeness and no-take	29	9	31
	Sustainability	25	20	80
	Integrated management	30	5	17
	Planning process & Public Participation	31	4	13
Industry	Values of proposed area	13	12	92
	Marine reserve multiple-use & zoning	13	5	38
	Representativeness and no-take	11	5	45
	Sustainability	11	10	91
	Integrated management	12	3	25
	Planning process & Public Participation	13	3	25

PRESS

Press	Values of proposed area	2	2	100
	Marine reserve multiple-use & zoning	2	0	0
	Representativeness and no-take	2	0	0
	Sustainability	1	1	100
	Integrated management	2	0	0
	Planning process & Public Participation	2	0	0

APPENDIX H. SUMMARY OF HOPES AND ASPIRATIONS OF THE COMMUNITY

Areas people would like to see Sanctuary zones & no-take placed	**Number of people**
Around Cleverville	11
Sailfish reef	4
Rosemary Island	4
Sea Ripple Passage	3
Northern end of East Lewis Island	2
Southern end of East Lewis Island	2
Whalers Bay	2
Malus Island	2
Nickol Bay	2
Goodwin Island	1
Nelson Rocks	1
Eaglehawk Island	1
Behind Mistaken Island	1
No-take areas	**Number of people**
Would like to see more no take areas as they are a good concept	38
Hope to see no-take areas spread around	1
Would like to see a percentage of the marine reserve be no-take	1
Public Participation Program	**Number of people**
Hope to see more educational material about marine conservation reserves and the marine environment in general	51
Would like to see the process eventuate in a marine reserve	18
Hope to see greater community input	7
Hopefully statewide ownership of a marine reserve in the area would be an outcome	5
Hope to get involved in the process	3
Hope that short term visitors will have adequate education about the region to develop an ownership of the area	3
Would like to see Government come out and talk to local people more often	3
Will be better informed more as a result of the process	2
That more women are encouraged to participate in the process	1
Management of a marine reserve	**Number of people**
Greater integrated management	6
That access to the islands and the Burrup Peninsula will be made easier	6
Would like to see more research and longitudinal studies carried out	4
Hope to see a greater presence of Government policing the area	3
Would like to see mangroves in the area protected	2
The oil and gas industry not be allowed in marine reserves	2
Zones and boundaries to be clearly marked on the water	2
Commercial trawling be excluded from the Archipelago	2
That the reserve is balanced and multiple –use	3
That management provides stability for the region	1
Hopefully sensitive areas will be strictly controlled	1
Future development	**Number of people**
Hopefully tourism will be facilitated with some low key accommodation and facilities on some islands.	25
Would like to see the islands left pristine and untouched	7
Would like to see the islands sub-divided and sold	1

APPENDIX I. ISSUES AND CONCERNS MOST FREQUENTLY IDENTIFIED BY COMMUNITY MEMBERS

Concern	Number of people	User Group with concern
Environmental impacts & degradation		
The noticeable decline in the level of fish stocks	54	L1 L3 L4 R1 R2 R3 R4 I1 I2 I3 G1 G2 G3 C3 C4
Trawling damaging the marine environment & the issue of by-catch	35	L1 L3 L4 R1 R2 R3 I1 I3 G2 G3 C3 C4
Ballast water discharge polluting the marine environment and introducing marine pests	21	L1 R1 R2 R3 R4 I1 I2 I3 G3 C2 C3 C4
Overharvesting of marine organisms for the aquarium industry	16	L1 L3 R2 R3 R4 I1
Causeways blocking water flow and aiding the build up of sediment	14	L1 R1 R2 R3 R4 I1 I2 G3 C3 C4
Poor water quality in the Archipelago – from pollution & sediment	14	L1 R3 I1 I3 C3
General degradation of the marine environment as a result of human use	14	L1 R1 R2 I1 C2 C3
Dust from iron ore operations polluting the marine environment	12	L1 R1 I1 I3 G1 G2 G3 C3
Habitat decline on limestone platforms	11	L3
Anti-fouling agents such as TBT polluting the marine environment	9	L1 R1 I1 I2 I3 G1G3
Planning outcomes		
Zones in the reserve being determined by economic reasons rather than environmental reasons	11	R3 I1 I2 C3
Being restricted	11	L1 L4 R3 I2 C3 C4
Pearling leases are granted without adequate consultation	11	L1 R2 R3 R4 I1 G1 C3 C4
No take areas not being justified or explained	9	L4 R1 R3 R5 I1 I2 C3
There not being balance & equity in the zoning scheme	9	L1 L4 R1 R3 R4 G2 C3
Access to areas being affected	8	L1 L4 R1 R3 I3 G2
People will only accept minimal changes and therefore the marine reserve will not be as affective in protecting the environment	7	L1
No take areas not being accepted by the community	6	L4 R3 G1 G2 C3
Shacks being removed	6	L4 R1 R5
The reserve having an impact on development and industry proposals	5	I1 G2 C3 C4
That access for recreational users is being eroded by industry and aquaculture & pearling	5	L5 R3 C3 P
Planning process		
The transient or short term residents not developing a sense of ownership of the marine environment	21	L1 R1 R3 I1 I2 G2 C3 C4
Past experience with poor consultation has left the community feeling cynical about the consultation process and will not get involved	16	L1 L5 R1 R3 G1 G2 C3

People being unaware of the marine reserve proposal	15	L3 I2 G1 G2 C2 C3
There will be a limited number of people with the time or the inclination to get involved in the process and this will affect the outcome and management of a marine park	9	L1 R1 R3 R4 I3 G1 G2
The apathetic nature of the community	7	L5 R1 R3 G2
The fact that only a small percentage of the population use the Archipelago and will have all the say	7	L1 R1 R3 R4 I3 G1 G2
With the population increasing there will be more pressure put on the environment and there will be no management of this	6	R1 R5 I1 I2 I3 C3
A lack of balance of expertise on the advisory committee	5	L1 R1 R3 R4 G1 C3
The lack of research conducted in the area	5	L1 I1 I2
The objectives of the report A representative marine reserve system for Western Australia have been lost	5	I1
Resources & Policing		
There being inadequate resources to develop and maintain a reserve	15	R3 I1 I2 G1 G2 G3 C2
Resource allocation	8	I1 I2 G2 C2
That there will be inadequate policing of the reserve	6	L1 R2 I1 I2 G1 G2 C3
Fees being implemented	5	L1 R3 I1

L1 – Local residents
L2 – Aboriginal
L3 – Vacation Visitors
L4 – Community service Groups
R1 – Rec. Boating
R2 – Rec. Diving
R3 – Rec. fishing
R4 -4WD
R5 – Shacks
I1 – Conservation
I2 – Science
I3 – Education
G1 – Local Gov
G2 – State Gov
G3 – Federal Gov
C1 – Comm fishing
C2 – Aqua/pearling
C3 – Tourism
C4 – Industry
P - Press

APPENDIX J. ANNOUNCEMENT OF THE CONSIDERATION OF THE DAMPIER ARCHIPELAGO/CAPE PRESTON REGION AS A MARINE CONSERVATION RESERVE

APPENDIX K. BROCHURES PREPARED FOR COMMUNITY CONSULTATION