MARINE RESERVE IMPLEMENTATION:
PILBARA

PLANNING AND PRE-DECLARATION PROCESSES FOR A MARINE PROTECTED AREA IN THE MONTEBELLO/BARROW ISLANDS REGION

Final Report: MRI/PI/MBI-38/2000

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: WA9702

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Environment Australia
Biodiversity Group
GPO Box 787
CANBERRA ACT 2601
AUSTRALIA

or

The Librarian
Science and Information Division
Department of Conservation and Land Management
PO Box 51
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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 Montebello/Barrow islands region*".

This project is the first stage of the process to establish a marine conservation reserve in the Montebello/Barrow islands area. 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 process 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 Montebello/Barrow islands 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 the *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 43 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 a 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.

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Introduction

CHAPTER 1 INTRODUCTION

Planning and pre-declaration processes for a marine protected area in the Montebello/Barrow islands 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 Montebello/Barrow islands 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, undated), 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 Montebello/Barrow islands 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 $43,000 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 $146 000.

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 Montebello/Barrow islands 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 Montebello/Barrow islands 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 Montebello/Barrow islands marine conservation reserve (Figure 1). This area includes all the islands of the Montebello group and Barrow Island, extending south to the Barrow Island Shoals.

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, comprised of (chapter 6):

- A regional perspectives paper, comprising the conservation, cultural/historical, social and economic values of the candidate area (chapter 5);
- A biological perspectives paper, summarising biological data for the candidate area, and discussing the implications for reserve design (chapter 5);
- Relevant biological, economic and social information layers in GIS format, and;
- 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, and (Chapter 7);

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

Chapter Two

Resource assessment: Benthic habitat mapping

In view of the high standing that the Montebello/Barrow islands 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 $43,000, grant number WA9702, for the Montebello/Barrow islands 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 $146,000.

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 Montebello/Barrow islands 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 Montebello/Barrow islands region, Western Australia (Figure 1).

SITE SELECTION

Potential sites were determined prior to 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 Montebello/Barrow islands 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

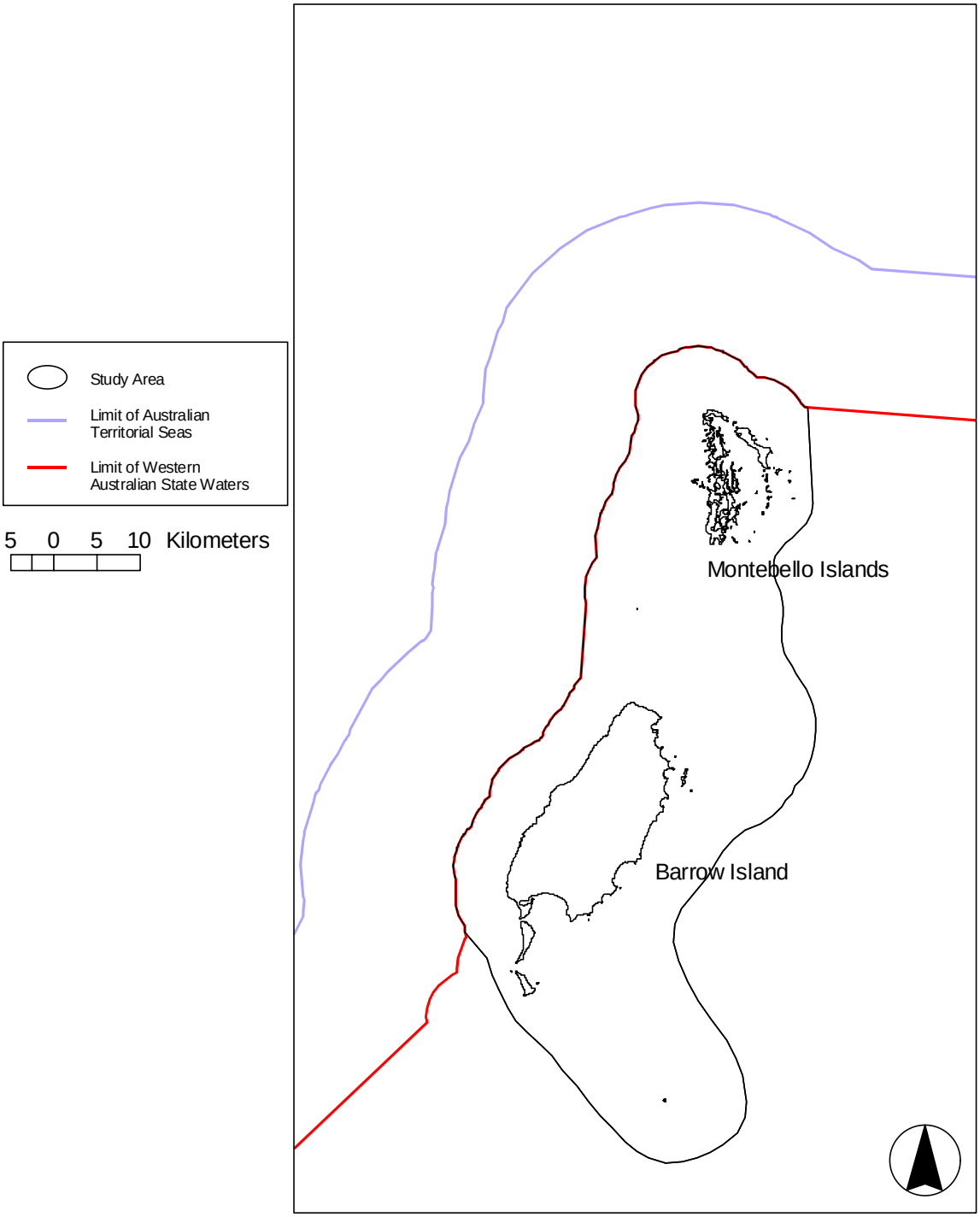

Figure 1 Study area for the proposed Montebello/Barrow islands marine conservation reserve

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.

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 Montebello/Barrow islands 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 57 ground-truthing sites were surveyed in the field from the Montebello/Barrow islands 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.

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.

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]

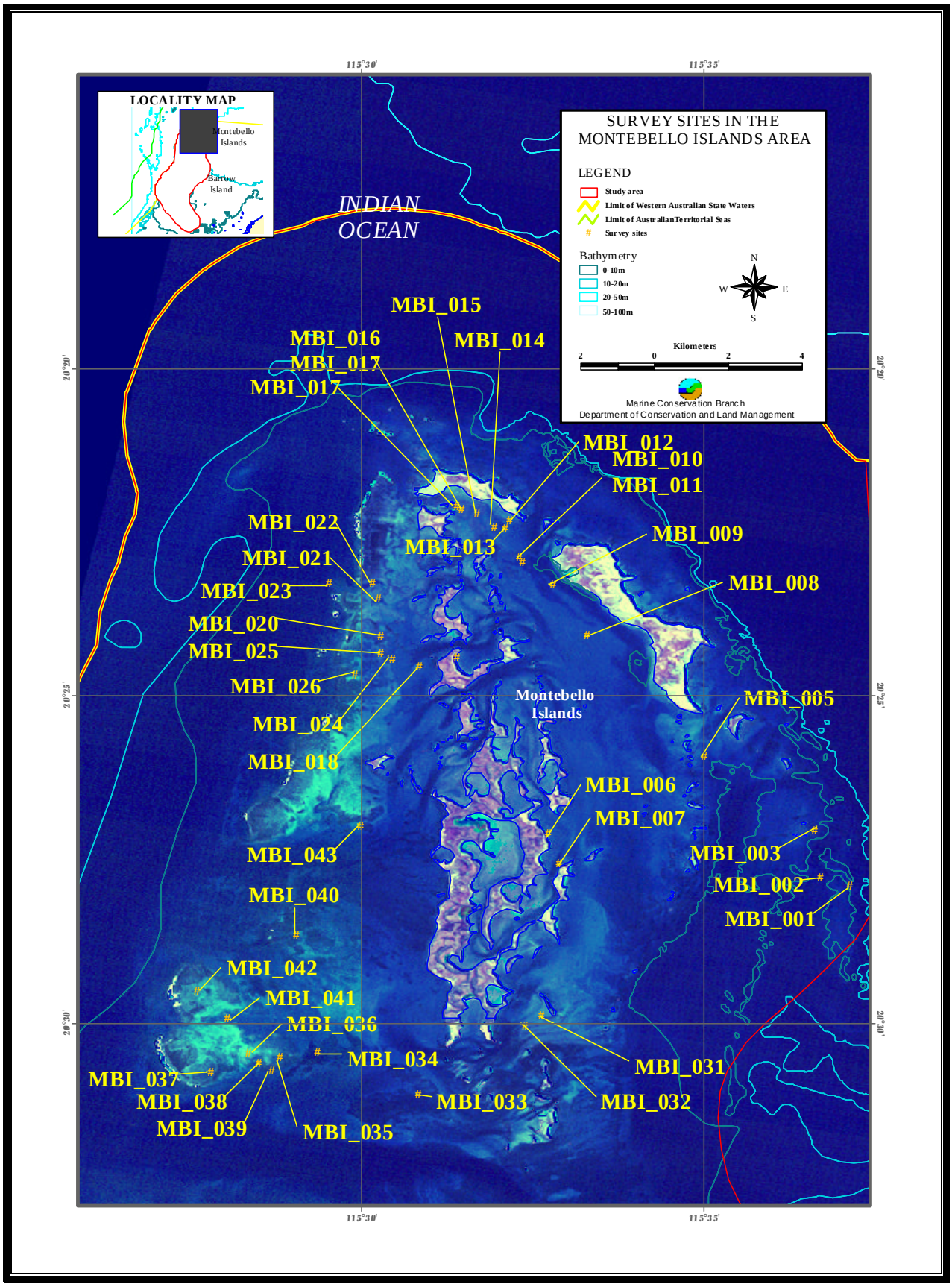

Figure 2 – Benthic habitat ground-truthing sites at the Montebello Islands

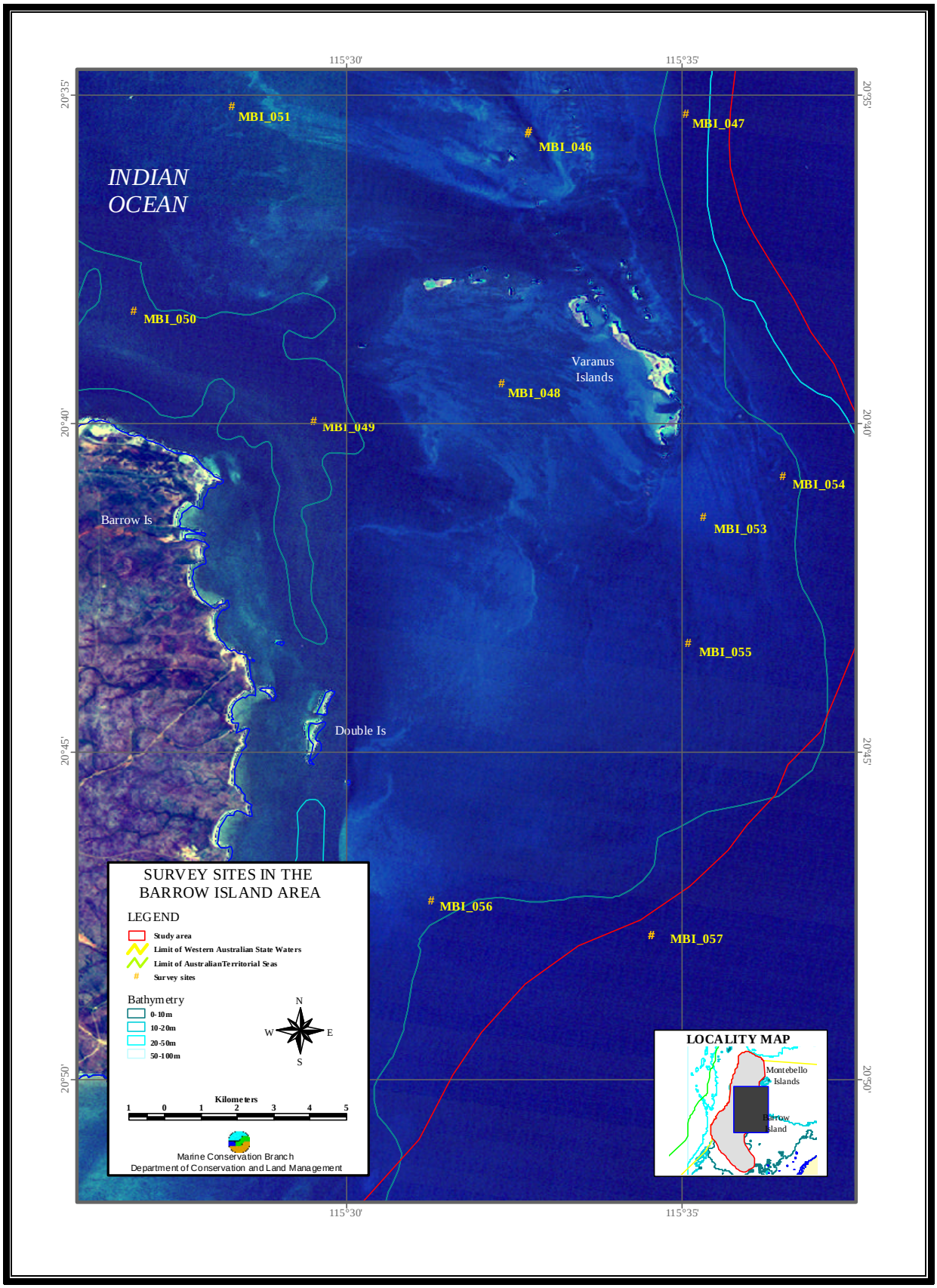

Figure 3- Benthic habitat ground-truthing sites at Barrow island

GIS DATA

Benthic habitat 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
sw_habit_p	North West Shelf	Polygon data with attributes: Habitat and md_code.
monte_mang_p	Monte Bello Islands	Mangroves
var_veg_p	Varanus Island	Additional mangrove areas digitised from aerial photos
a2cdm_p	Monte Bello Islands	Shallow Water Habitat svy 2
a2corub_mod_p	Monte Bello Islands	Coral Rubble svy1 - polygons modified slightly by NGIS Australia
a3cdm_p	Lowendal Islands	Shallow Water Habitat svy 3
a3corub_p	Monte Bello Islands	Coral Rubble svy2
bommies_barrow_pt	Barrow Island - Lowendal Islands	Bommie Point Data - Seismic derived
bommies_lowendal_montes_pt	Lowendal & Montebello Islands	Interpreted by Scot Langtry from CSIRO & Museum data
bommies_serrurier_pt	Serrurier Island	Bommies identified form TP6 Seismic Scouting survey
coast_mudflats_p	North West Shelf	Source: Auslig & 1994 Leprovost Dames & Moore Map
coral_buffered_20m_p	Varanus Island	Coral Reef Buffered 20m
gap_habs_p	Lowendal Islands	SKL interpolated habitats between CSIRO svy 2 & 3
monte_beach_p	Monte Bello Islands	Beaches
monte_shoal_p	Monte Bello Islands	Shoals
museum_habs_p	Monte Bello Islands	Habitats mapped by 1995 Museum Survey
nw_shelf_marine_p	North West Shelf	Source: sw_habitat_p (BHP Dataset) & 1994 Leprovost Dames & Moore Map
tap_oil_habs_p	Mangrove & Mary-Anne Island Groups	Habitats interpreted by BBG for Tap Oil Nolan-1 & Lindsay-1 EMP.

All data courtesy of Apache Energy Pty Ltd

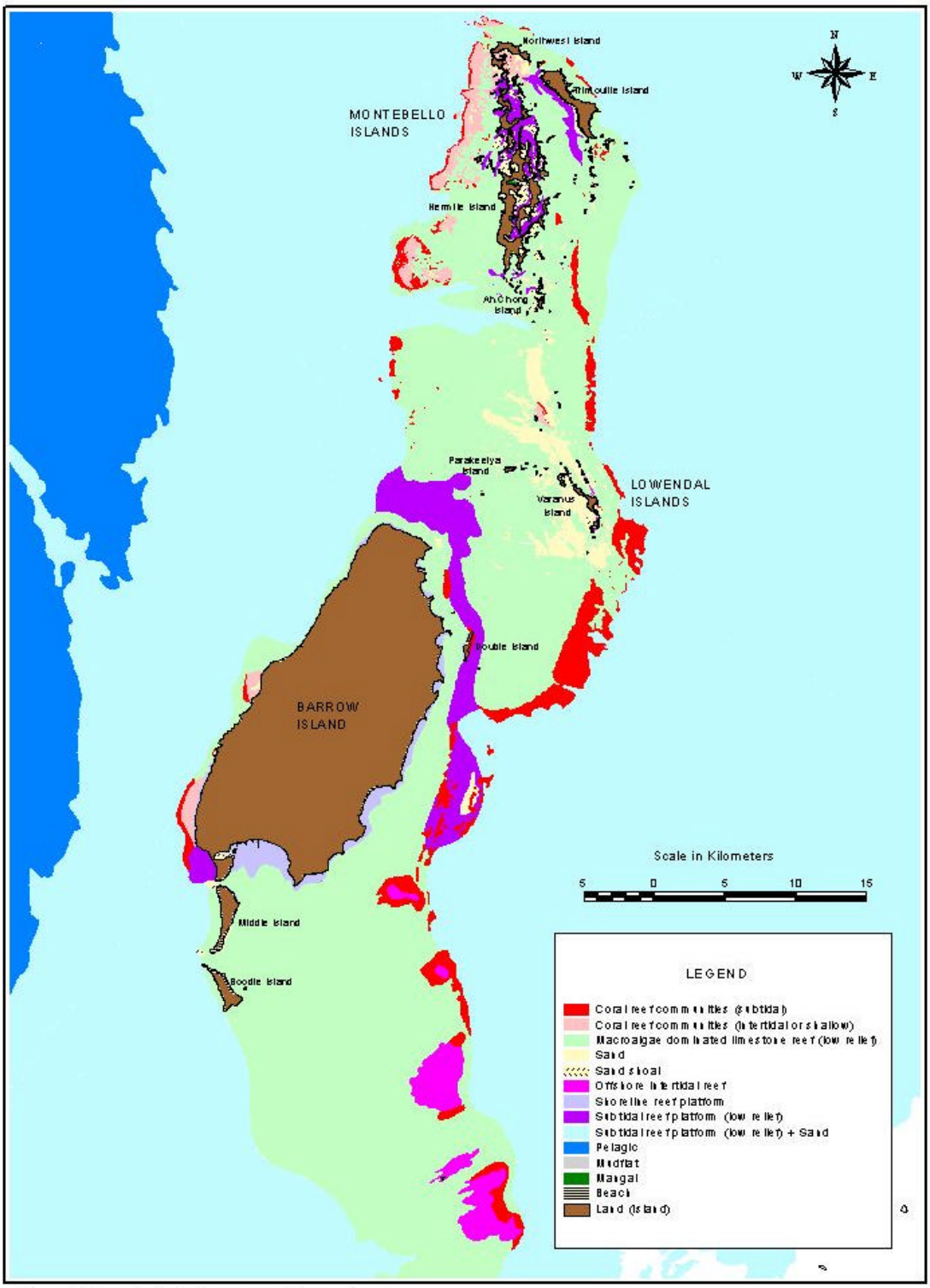

Figure 4 Broadscale habitat map of the study area

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Chapter Three

Resource assessment: Human Usage

CHAPTER 3 RESOURCE ASSESSMENT: HUMAN USAGE

3.1 INTRODUCTION

In 1994 a CALM report *A Representative Marine Reserve System for Western Australia* was released for public comment. It identified 70 areas that, if reserved, would be representative of the major coastal ecosystems of Western Australia. The Montebello/Barrow island region was identified in that report as having ecologically significant marine and terrestrial flora and fauna. As part of the process of establishing a marine park in the region, information was collected about all the human activities in the area, including commercial, industrial and recreational activities. This chapter presents the human usage data and outlines the methods used to collect it.

3.2 SOURCES & METHODS

Data was collected based on the general list in Table 3, which details required socio-cultural datasets for management of marine parks. All data except the recreational data was taken from existing digital datasets from government departments.
Digital data was clipped to the extent of the study area and the projection and datum adjusted as necessary. Table 5 shows the source of each dataset and the source filename. The filename of the modified data is also given, which allows it to be traced within the CALM directory structure. Rows that are left blank indicate that the data is not available at this time.

Andrew Hill of CALM consulted with Craig Thomas of Montebello Safaris to document moorings and campsites on the islands. They also identified surfing and SCUBA diving sites in the study area.

The recreational fishing data was gathered in a three step process.

Step 1. Fisheries WA provided a digital dataset of fishing usage around Montebello, Lowendal and Barrow Islands.

Step 2. The Pilbara Recreational Fishing Advisory Committee was consulted, and their advice was that most recreational fishing in the area took place through commercial tour operations.

Step 3. Consultation took place with seven tour operators who operate in the Montebello Island area. The contributors included:

- Ron Kitcher of Treganna PL
- Hugh Briotti of Deck 'em Charters
- Katie McCabe of Sail-A-Way Charters
- Linley Thomas of Montebello Island Safaris
- Andy Young of Northcoast Charters
- Wayne Stewart of Snappy Gum Safaris
- Brian Johnson of Northwest Training.

3.3 DATA MANAGEMENT

RAW DATA

The recreation and recreational fishing datasets were the only ones for which raw data was collected. The hand drawn and edited maps will be stored in hard copy, at Marine Conservation Branch Office and the CALM Karratha 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

3.4 RESULTS

The available data is summarized in the Table 2 4. For more information about each dataset, consult the metadata in Table 5.

TABLE 4 HUMAN USAGE DATA AVAILABILITY

Human Usage Dataset	Available Data
TENURE	
Territorial Water Limits	Yes
Existing Leasehold/Management	
- Conservation Reserves	Yes
- Other Reserves	None in study area
- Private/Leasehold/VCL	Yes (no map because it is all CALM reserve)
Proposed Conservation Area	Current Study Area
Marine Park Zoning	Not Applicable
Petroleum Leases	Yes
Mining Leases	No
Aboriginal Claim Boundaries	Not Applicable
Historical	
- Australian Heritage Commission Sites	
- Aboriginal Sacred and Ceremonial Sites	Yes
- Heritage/Historical Sites	
- Shipwrecks	Yes
URBAN & TOURISM DEVELOPMENT	
Urban Development	
Existing	
Proposed	
Roads	Montebello but not Barrow Island
Airstrips	Yes
Helipads	No
Resort Development	Not Applicable
Existing	
Proposed	
Campsites	Yes
INDUSTRIAL DEVELOPMENT	
Shipping	Yes (on Navigation Chart)
Oil/Gas Exploration	Wells
Oil/Gas Production	Wells
Mining	Not Applicable

MARITIME INFRASTRUCTURE	
Anchorages	Yes (on Navigation Chart)
Shipping Lanes	Yes (on Navigation Chart)
Port facilities	None in study area
Marina facilities	None in study area
Moorings	Yes
Groynes	None in study area
Boat ramps	None in study area
Navigation Markers	Yes (on Navigation Chart)
Fish Attracting Devices	No

COMMERCIAL FISHING	
Trawling	Fisheries Licence Areas
Wetline fishing	No
Netting	No
Fish-trapping	No
Rocklobster	Fisheries Licence Area
Abalone	No
Aquaculture (non-feeding/feeding)	Aquaculture licenses
RECREATION	
Fishing	
Rod & line	Yes
Netting	No
Spearfishing	No
Shell collecting	No
Rocklobster	No
Crabbing	No
Game fishing	No
Bait collection	No
Non-extractive	
Water skiing	No
Jetskiing	No
Parasailing	No
Sailing	No
Powerboats	No
Hovercraft	No
Float planes	Yes (on Mooring/Campsite map)
Paddle boats	No
Kayaks/canoes	No
Windsurfing	No
Beach walking	Yes
Swimming	No
Reef walking	No
Beach launching	No

Surfing areas	Yes
ScubaDiving	Yes
Snorkelling	No
Wildlife Interactions	No
Wildlife Viewing	No

TABLE 5: HUMAN USAGE METADATA

Required Dataset	Theme	Filename	Source	Source Filename	Completeness
Tenure					
Territorial Water Limits	Territorial Water Limits	Mbcoast_ll_wgs.shp	AMBIS	Ambis.shp	Complete
Existing Leasehold/ Management					
Conservation Reserves	CALM Reserves	Mbcalmreserves_ll_wgs.shp	CALM	Landswaters498_ll_agd.shp	complete 4/98
Other Reserves	Not Applicable				
Private/Leasehold/VCL	Cadastre (almost all CALM reserve or VCL)	Mbcadastre_ll_agd.shp	DOLA	SCDB CDROM	Complete
Proposed Conservation Area	Study area	Mbistudyarea_ll_agd.shp	CALM	-	Complete
Marine Park Zoning	Not Applicable				
Petroleum Leases	Petroleum Leases	Mbleases_ll_wgs.shp	DME	Wapmap_0299_ll_wgs84.shp	Complete 2/99
Mining Leases					
Aboriginal Claim Boundaries	Not Applicable				
Historical					
Australian Heritage Commission Sites					
Aboriginal Sacred and Ceremonial Sites	Aboriginal Sacred and Ceremonial Sites	Mbabsites_ll_wgs.shp	AAD	Absites_ll_wgs.shp	Complete
Heritage/Historical Sites					
Shipwrecks	1 site	Mbshipwrecks_ll_wgs.shp	Museum of WA	Shipwrcks_ll.shp	Complete
Urban & Tourism Development					
Urban Development	Not Applicable				
Roads	Yes (for Montebello Is, not Barrow Is)	Mbroads_ll_wgs.shp	Apache		Complete for Montebello
Airstrips	Yes	Mbairstrip_mb_wgs.shp	Apache		Complete
Helipads	Not Applicable				
Resort Development	Not Applicable				
Campsites	Campsites	Mbcamp_ll_wgs.shp			
Industrial Development					
Shipping					
Oil/Gas Exploration	Wells	Mbwells_ll_wgs.shp	DME		Complete
Oil/Gas Production	Wells				
Mining	Not Applicable				

Required Dataset	Theme	Filename	Source	Source Filename	Completeness
Maritime Infrastructure					
Anchorages	Navigation Charts				
Shipping Lanes	Navigation Charts				
Port facilities	Not Applicable				
Marina facilities	Not Applicable				
Moorings	Moorings/houseboat	Mbanchorages_ll_wgs.shp	Local Knowledge		Still being checked
Groynes	moorings				
Navigation Markers	Navigation Charts				
	Navigation Charts				
Boat ramps	Not Applicable				
Fish Attracting Devices	Not Applicable				
Commercial fishing					
Fisheries Licence Areas	Pilbara trap managed fishery	Mbpilbtrapfla_ll_wgs.shp	Fisheries	Fl_ptmf.shp	Complete 1/98
	Tropical Rock Lobster fishery	Mbrocklobsterfla_ll_wgs.shp		Fl_trlf.shp	Complete 1/98
	Pilbara interim trawl managed fishery	Mbtrawlfla_ll_wgs.shp		Fl_pftimf.shp	Complete 7/97
	Onslo Prawn Managed fishery	Mbonslopfla_ll_wgs.shp		Fl_opmf.shp	Complete
Trawling					
Wetline fishing					
Netting					
Fish-trapping					
Rocklobster					
Abalone	Not Applicable				
Aquaculture licenses (non-feeding/feeding)	Aquaculture licenses	Mbaquacult_ll_wgs.shp	Fisheries	Aquacultlicences0899_ll_wgs.shp	Complete 8/99
Recreation					
Non-extractive					
Water skiing	Not Applicable				
Jetskiing	Not Applicable				
Parasailing	Not Applicable				
Sailing					
Powerboats					
Hovercraft	Not Applicable				
Float planes	Shown on mooring map				
Paddle boats	Not Applicable				
Kayaks/canoes	Not Applicable				
Windsurfing	Not Applicable				
Beachwalking					
Swimming					
Reef walking					

Required Dataset	Theme	Filename	Source	Source Filename	Completeness
Beach Walking					
Surfing areas	Surfing sites	Mbsurf_ll_wgs.shp	Local Knowledge		Still being checked
Scuba Diving Snorkelling	Scuba Diving Sites	Mbscuba_ll_wgs.shp	Local Knowledge		Still being checked
Wildlife Interactions					
Recreational Fishing	Recfishing intensities	Mbirecfish_ll_wgs.shp	Fisheries	-	
Netting					
Shell collecting					
Abalone					
Game fishing					
Bait collection					
Rod & line fishing					
Spearfishing					
Crabbing					
Shell collecting					
Rocklobster					

CALM Reserves

There are five CALM managed terrestrial conservation reserves within the study area (figure 5).The five reserves incorporate all islands within the study area.

Aboriginal Sacred Sites

The information provided by the Department of Aboriginal Affairs consists of aboriginal sacred sites and the buffer areas (1or 10 square kilometres) surrounding the sites. Further information is available about the nature of each site with categories such as ceremonial, quarry, midden or artefacts. Most sites are also named and are given an indicator of reliability. The position of each of the buffers is shown in figure 6.

Petroleum Leases

The petroleum leases dataset is correct as at 15 February 1999 and was supplied by the Department of Minerals and Energy. The petroleum leases are shown in figure 7.

Oil & Gas Wells

The location of oil and gas wells in the study area is shown in Figure 8

Navigation Charts

The navigation charts are digital copies of the Royal Australian Navy charts. They provide bathymetry, anchorages, and shipping channel information at high resolution. The charts which cover the study area are shown in figures 9 & 10.

Transport

The transport infrastructure in the study area is indicated in Figure 11

Campsites & Moorings

Popular campsites and locations of moorings in the study area are shown in Figure 12

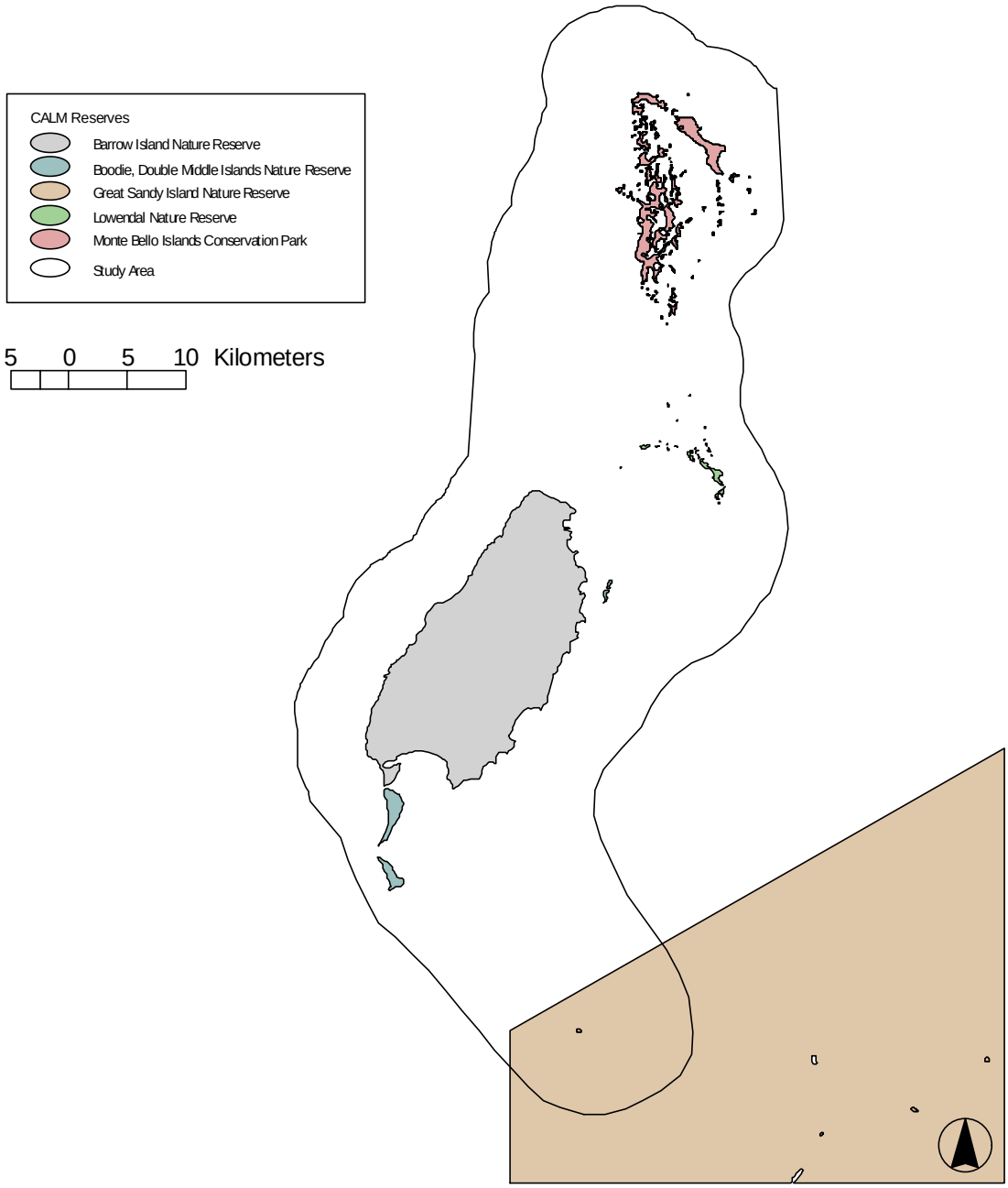

Figure 5 Calm managed terrestrial conservation reserves in the study area

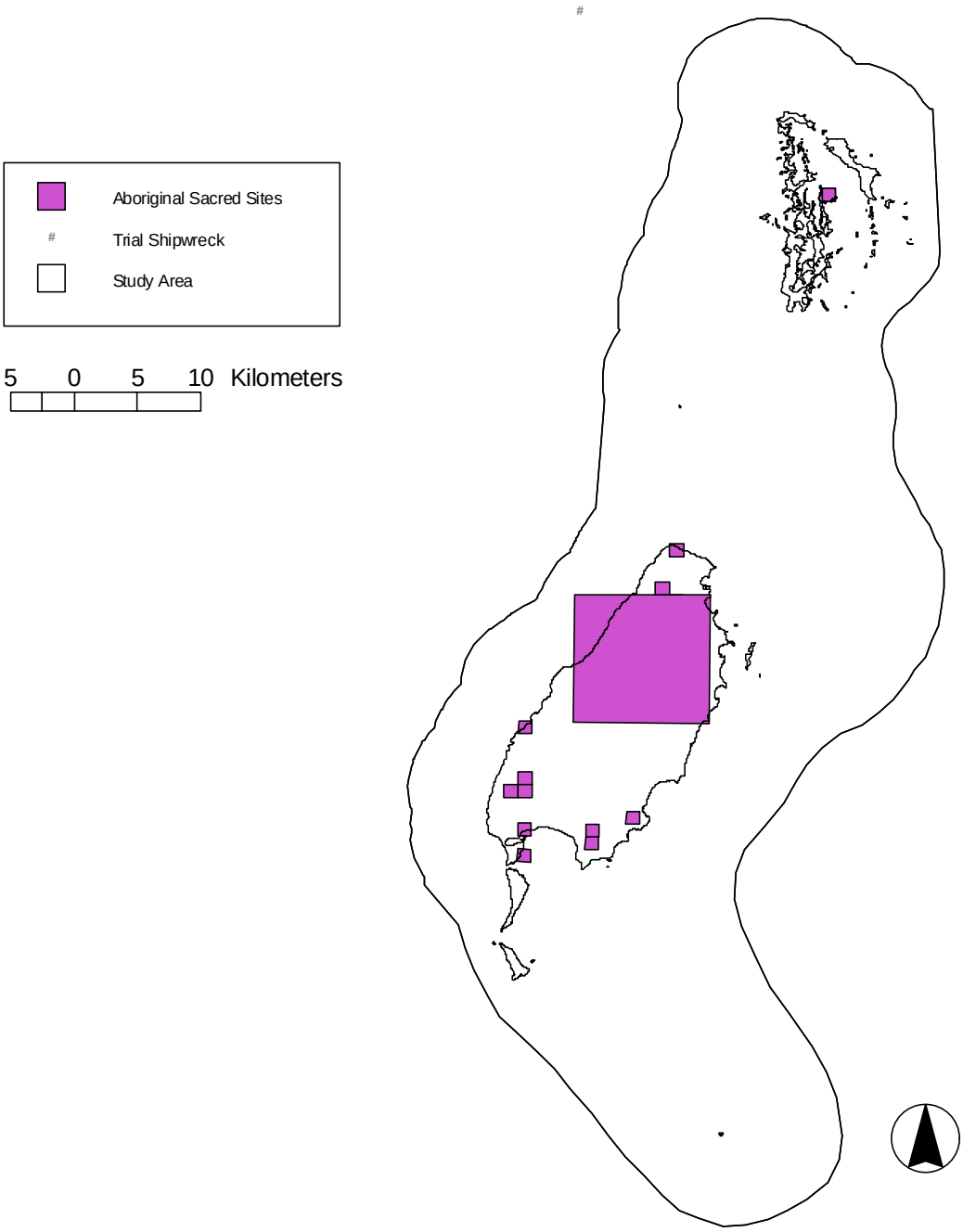

Figure 6 Culturally significant sites – shipwrecks and aboriginal sacred sites

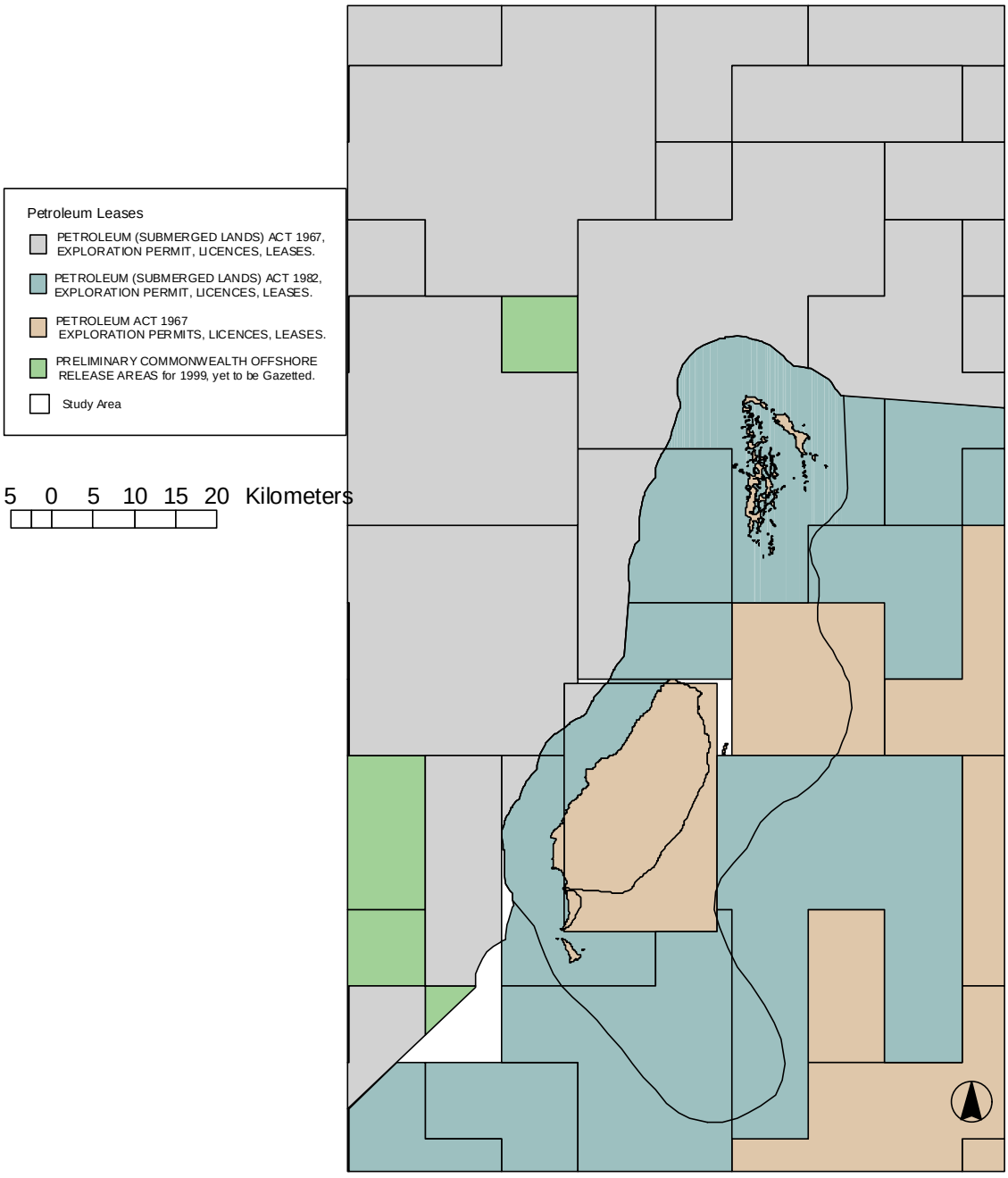

Figure 4: Petroleum Leases - data supplied by Department of Minerals & Energy

Figure 7 Petroleum leases in the study area

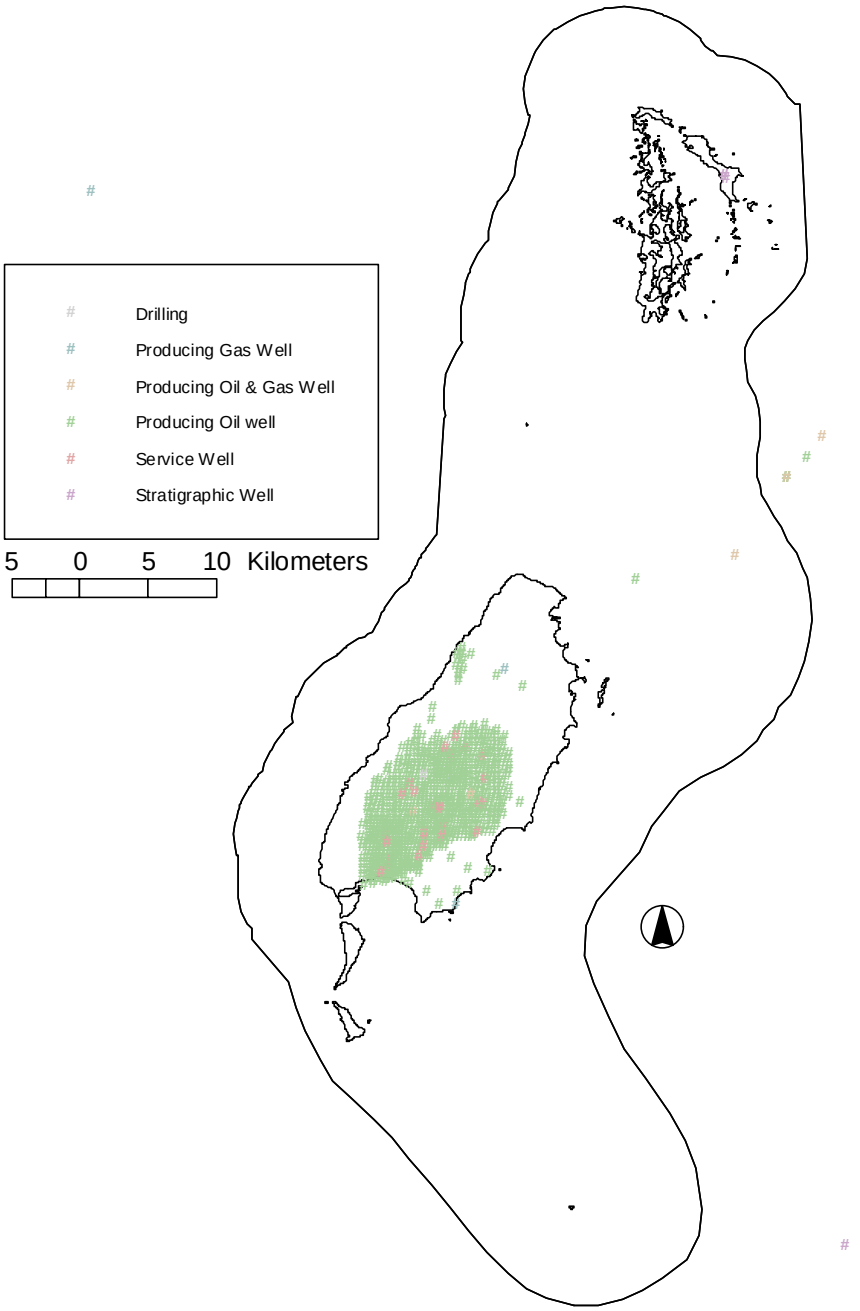

Figure 5: Oil and Gas Wells

Figure 8 Oil and gas wells in the study area

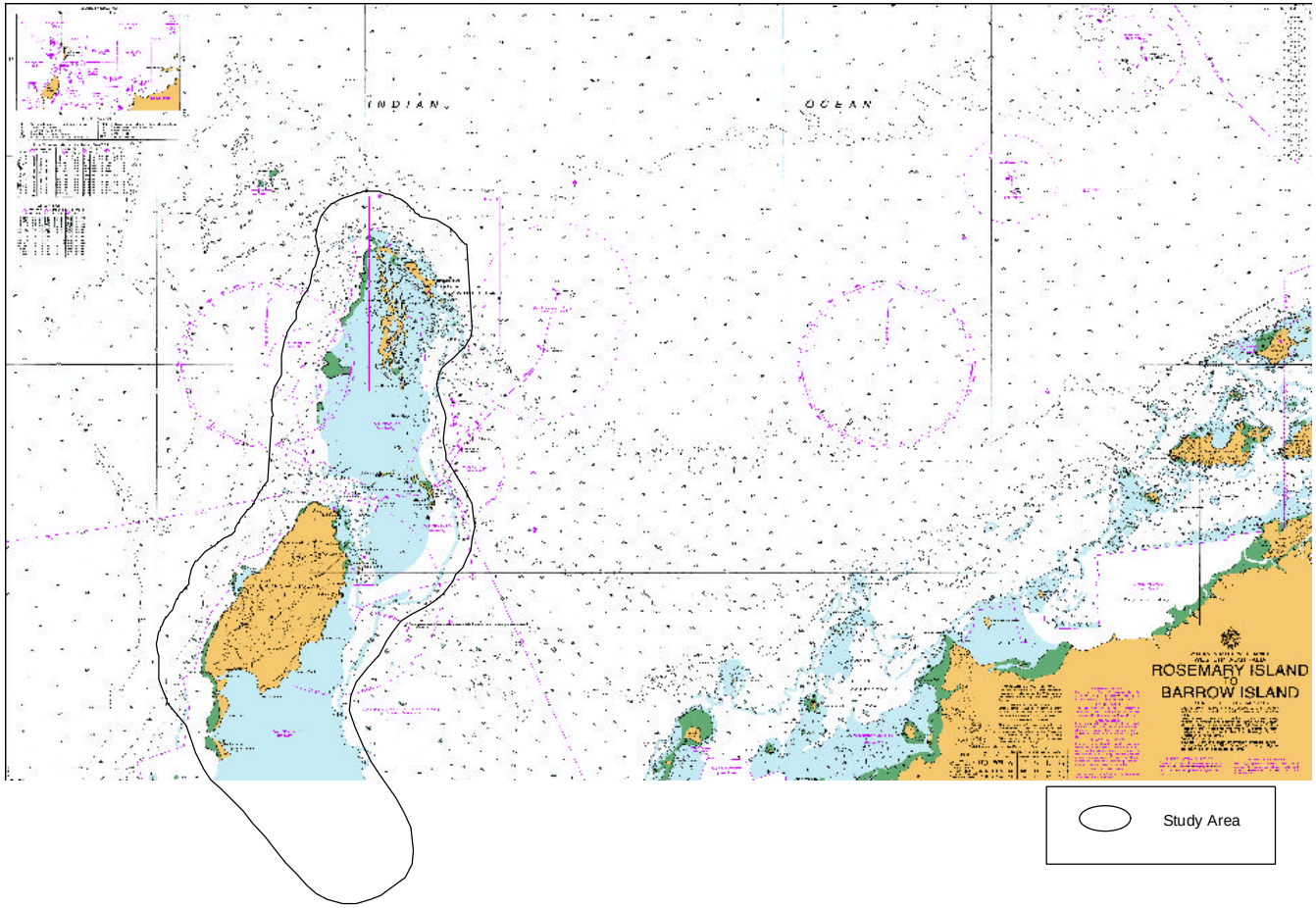

Figure 6: Navigation Chart - supplied by RAN

Figure 9 Chart of the study area

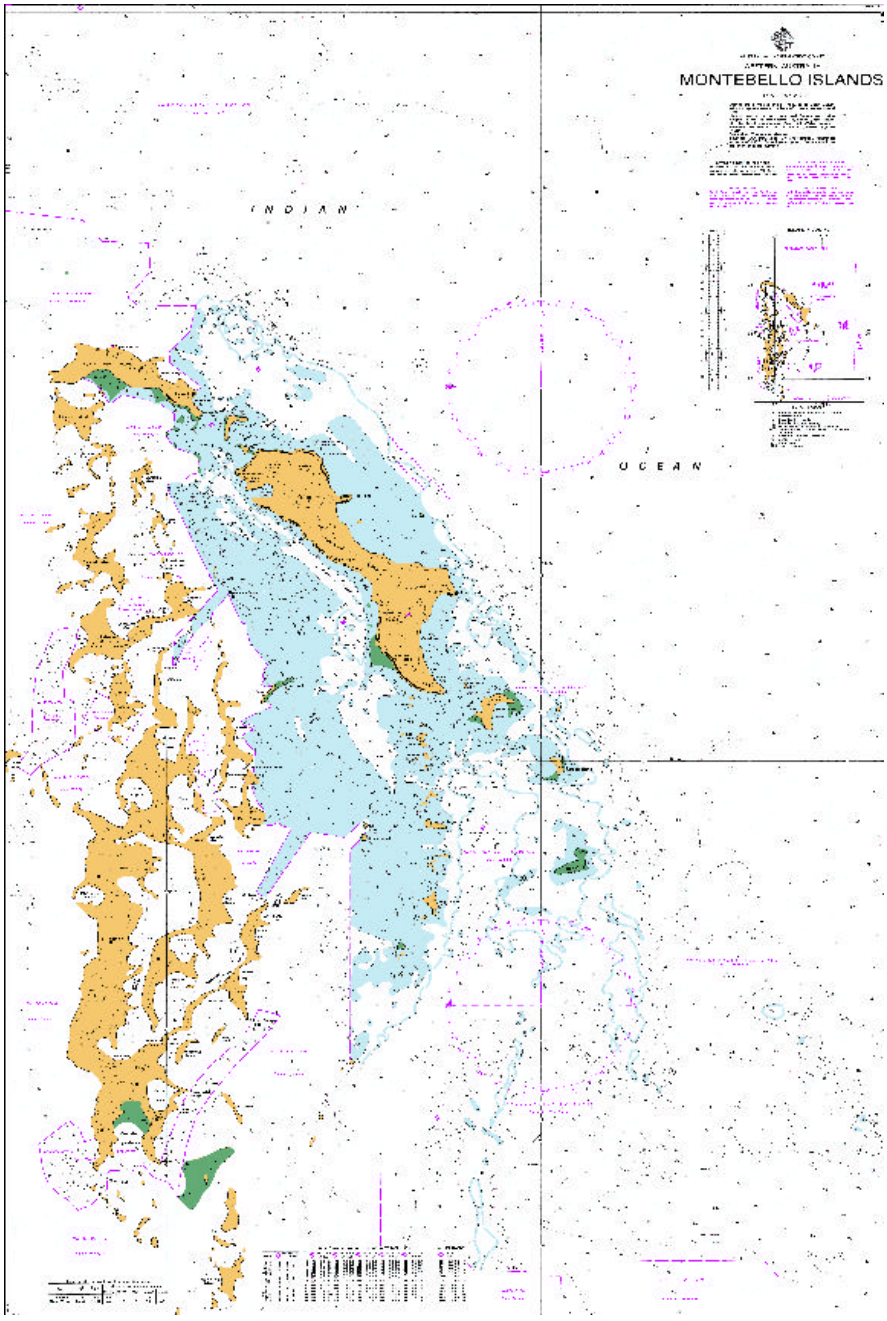

Figure 7: Montebello Islands Navigational Chart

Figure 10 Chart of the Montebello Islands

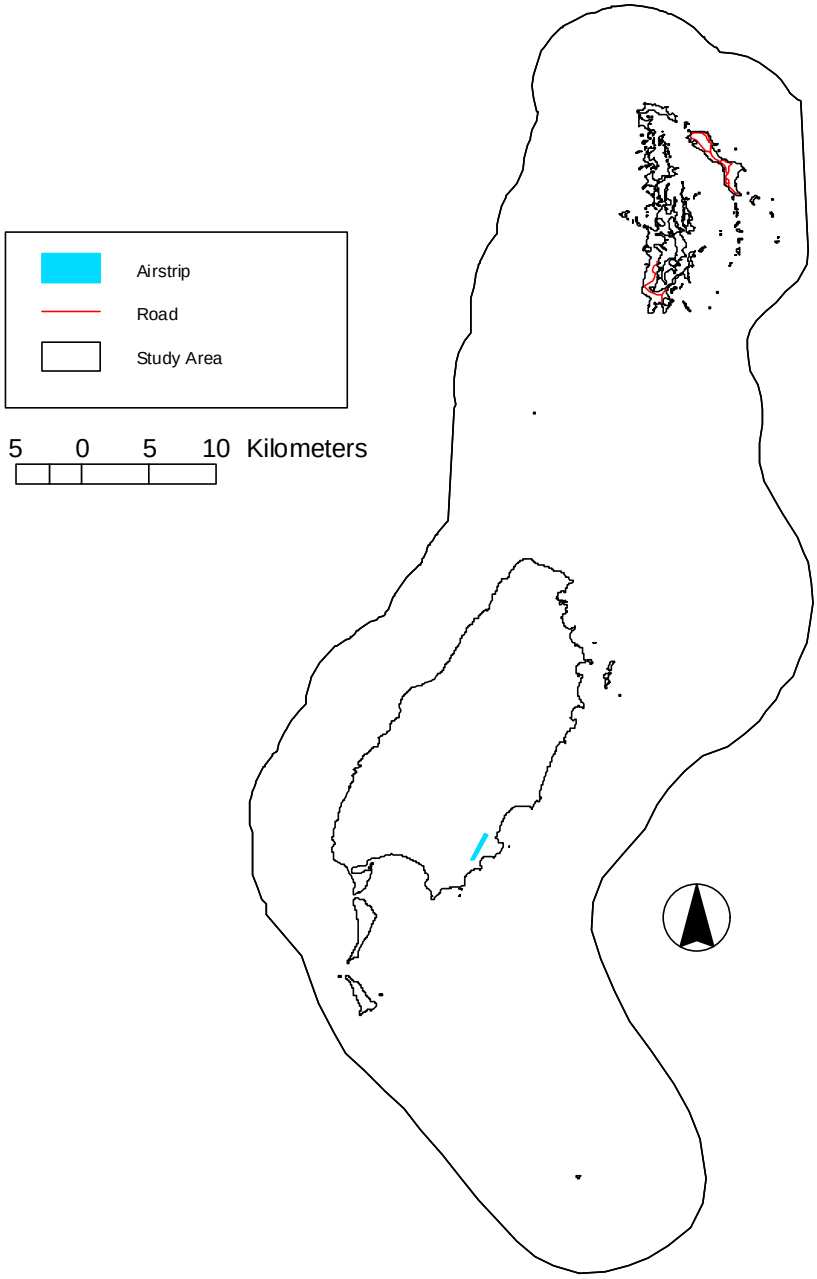

Figure 8: Transport

Figure 11 Transport Infrastructure in the study area

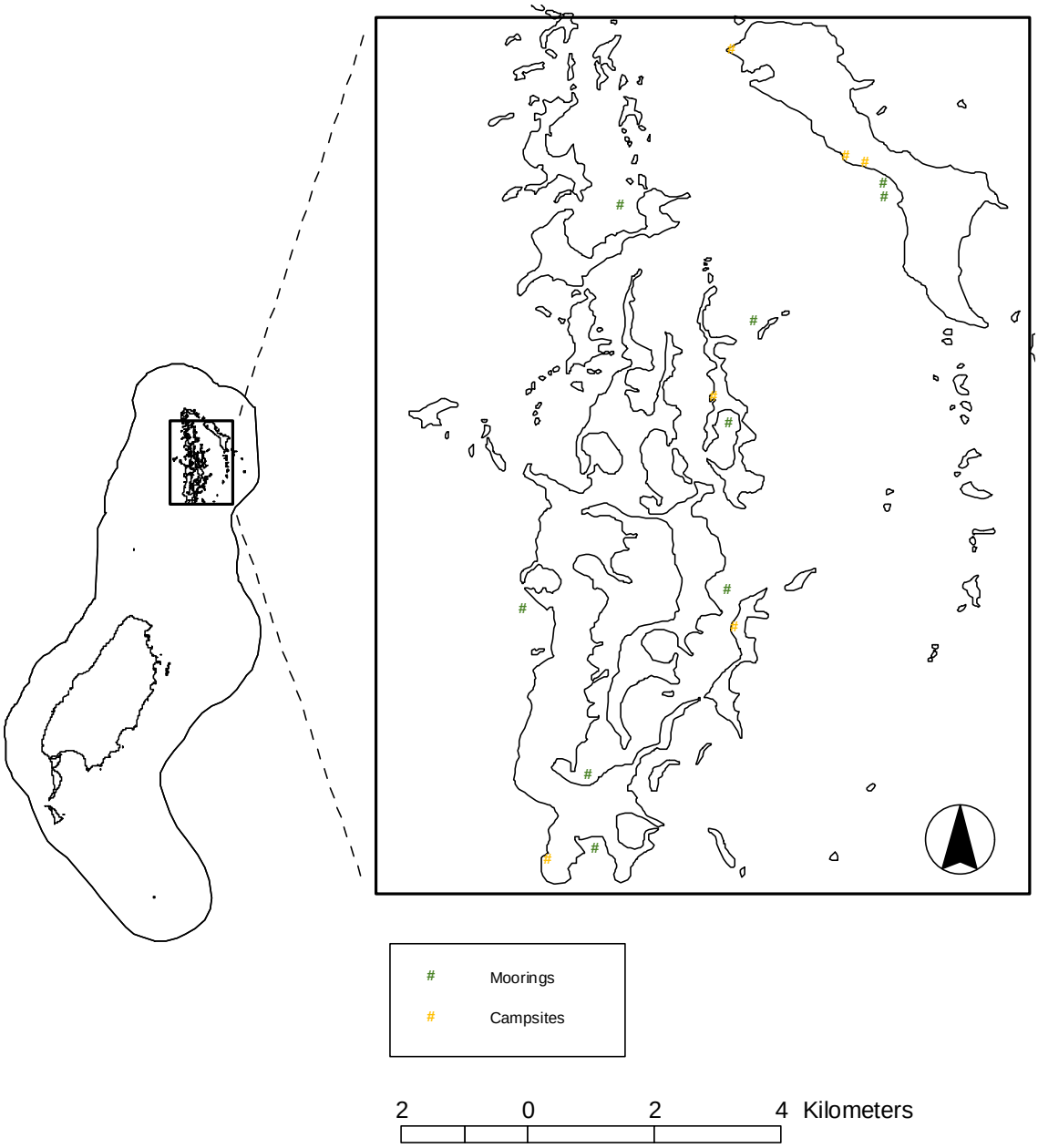

Figure 9: Campsites and Moorings

Figure 12 Campsites and moorings in the study area

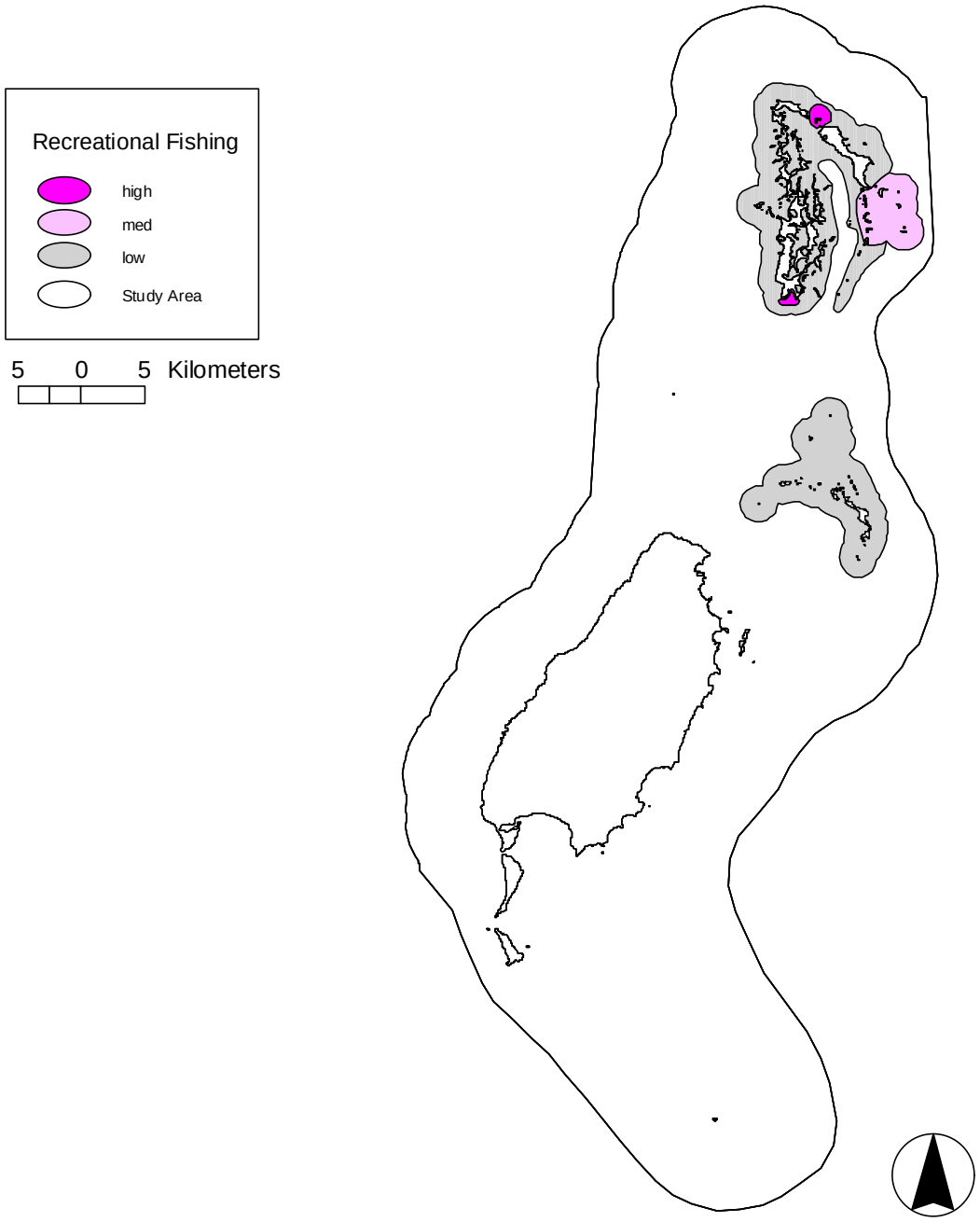

Figure 10: Recreational Fishing - Data supplied by Fisheries Department

Figure 13 Recreational fishing activity in the study area

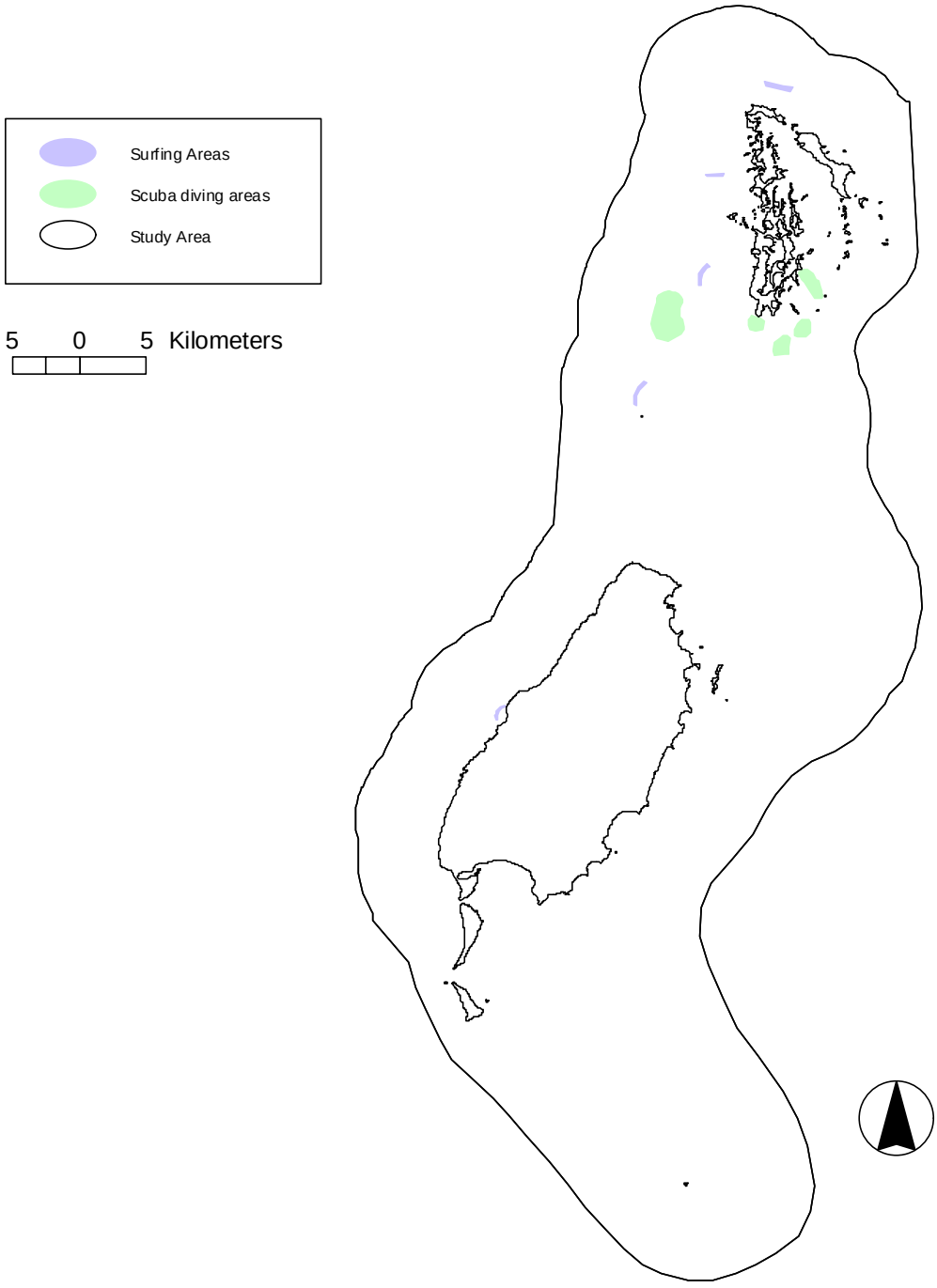

Figure 11: Non-extractive Recreation

Figure 14 Non-extractive recreation activities

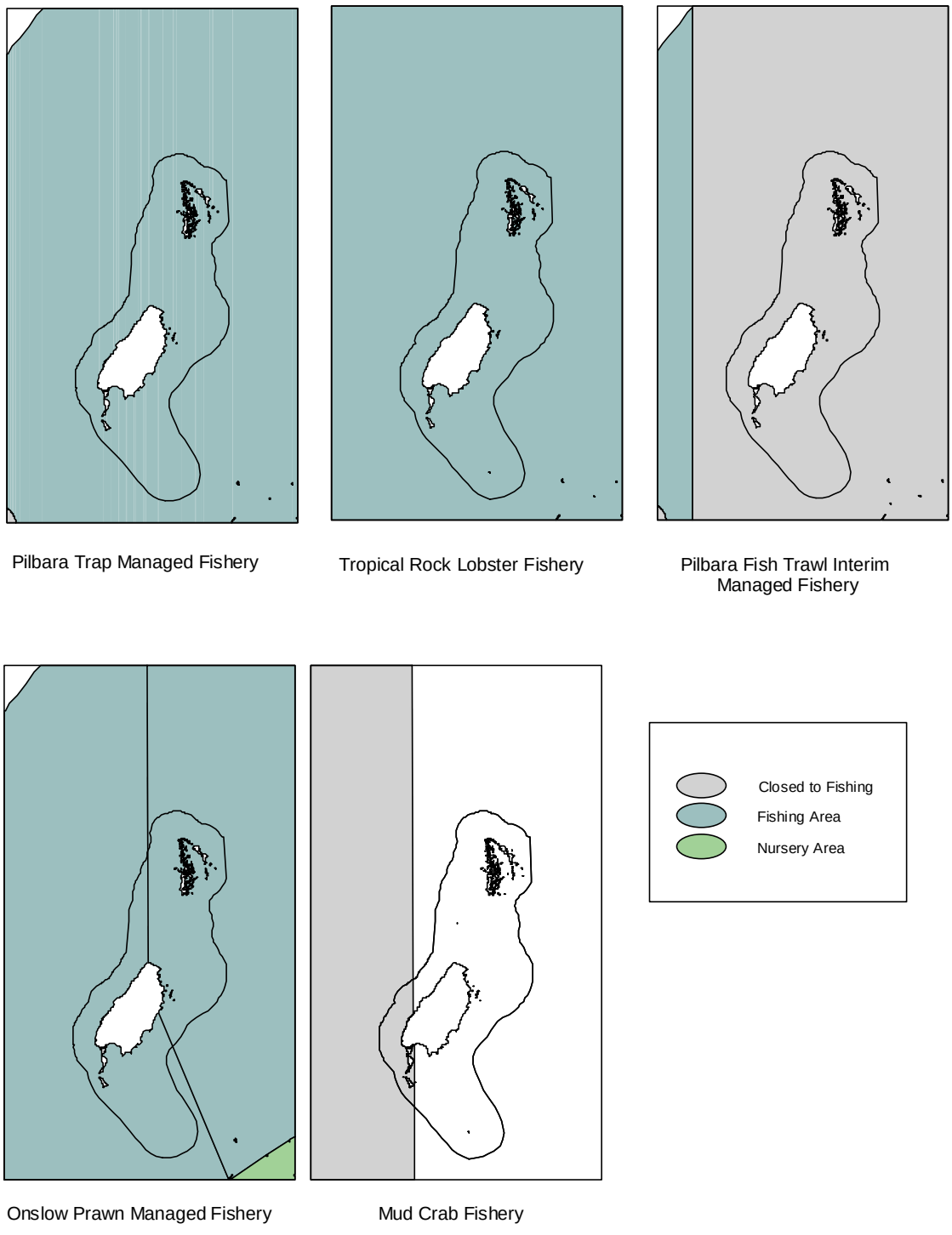

Figure 12: Fisheries Licence Areas

Figure 15 Fisheries licence areas

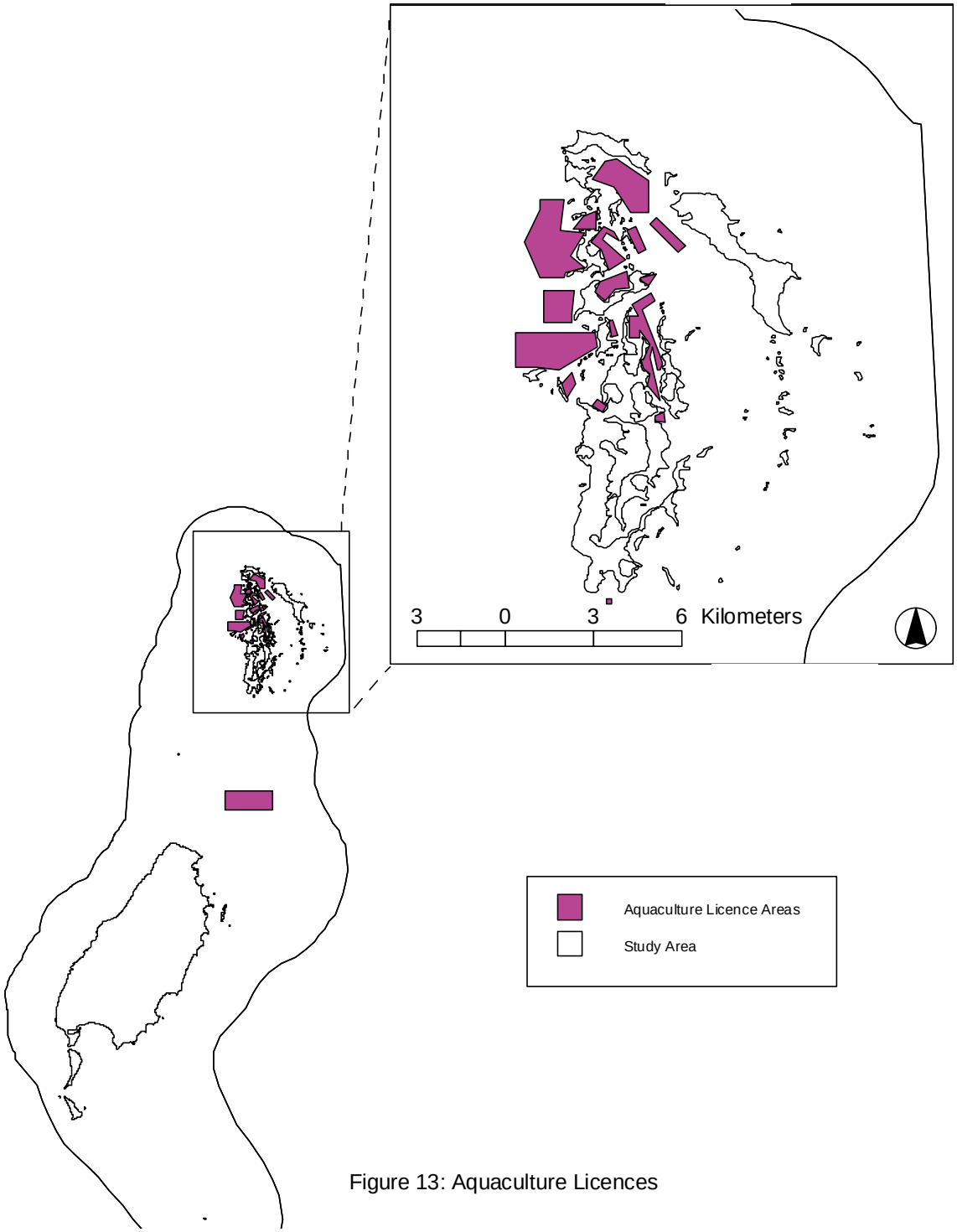

Figure 13: Aquaculture Licences

Figure 16 Aquaculture licences

Recreational Fishing

The intensity of recreational fishing in the study area is shown in figure 13. The majority of recreational fishing effort is concentrated in the Montebello Islands complex.

Non-extractive recreation

Non-extractive recreation activities are confined to the Montebello islands complex, a result of this area being the primary charter boat destination. Data is presented in Figure 14.

Fisheries Licence Areas

Licence areas as defined by Fisheries WA are shown in Figure 15. Fisheries WA supplied the datasets, which were created in July 1997.

Aquaculture Licences

Fisheries WA supplied the data on aquaculture licences in the study area. The licence areas are shown in Figure 16.

Chapter Four

Significant Wildlife Values

CHAPTER 4 SIGNIFICANT WILDLIFE VALUES

The region in which the proposed Montebello/Barrow islands marine conservation reserve lies is significant for a variety of wildlife 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.

A total of 15 species of seabirds breed on the majority of the islands in the study area, with significant populations of wedgetail shearwaters, crested terns, bridled terns, and roseate terns 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 it is likely that nearly all of the sandy beaches in the study area are used for nesting. Major turtle nesting sites occur on Middle and Boodie Islands, the west and east coasts of Barrow Island, and on Trimouille and North West Islands of the Montebello group.

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. It is thought that the seagrass meadows around Lowendal Islands support significant dugong populations. Dugongs are specially protected under the *Wildlife Conservation Act*, but not listed under Commonwealth legislation.

Significant conservation values for the proposed Montebello/Barrow islands marine conservation reserve are shown in Figure 17.

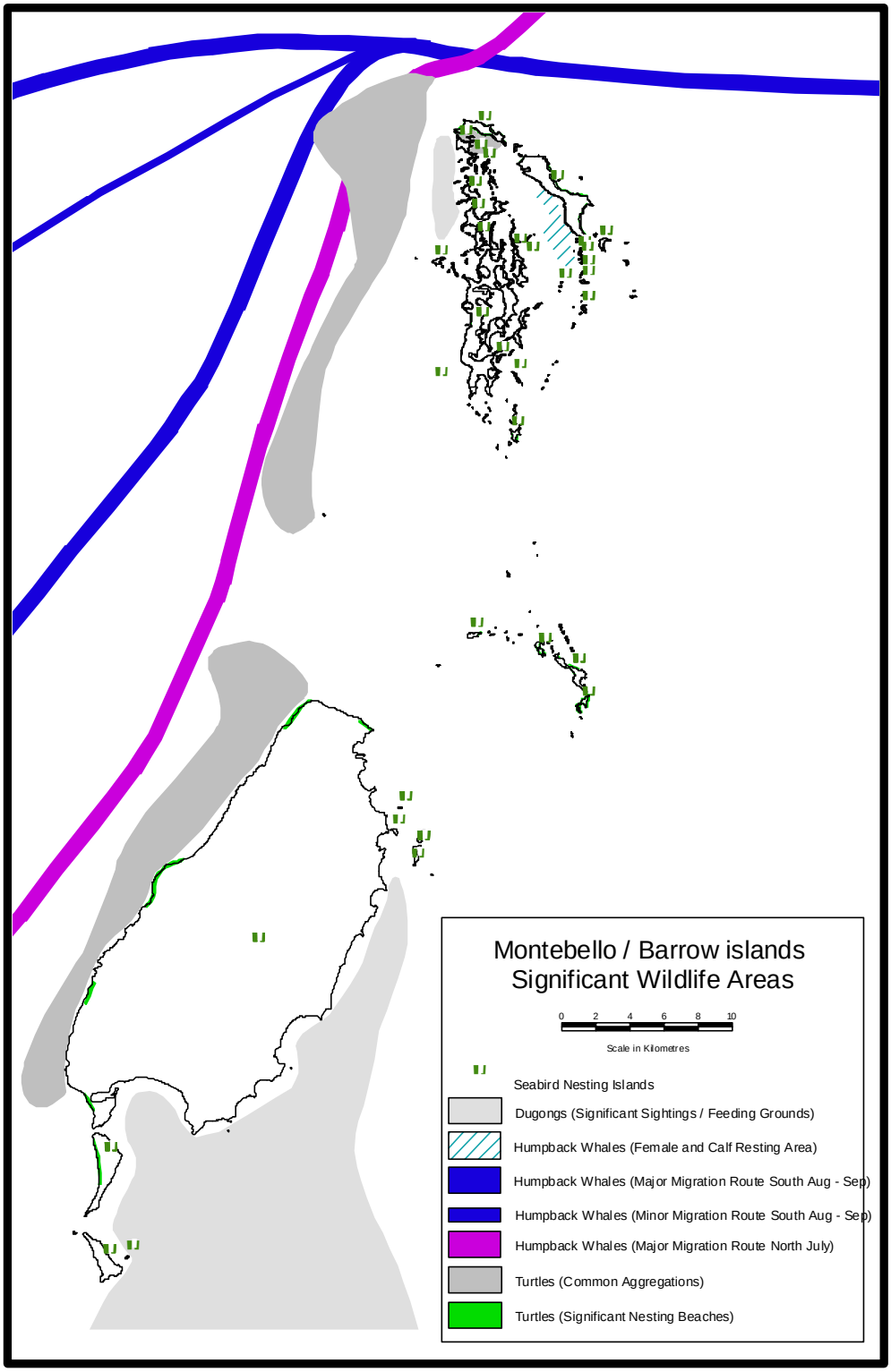

Figure 17 Significant wildlife values

Chapter Five

A Regional Perspective

CHAPTER 5 A REGIONAL PERSPECTIVE

5.1 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, algae-covered rocky reefs and both soft sediment and oceanic communities. 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 Montebello/Barrow islands region was identified in the Marine Parks and Reserves Selection Working Group report for its ecologically significant marine and terrestrial flora and fauna. The region is located in the clearer offshore waters of the Pilbara coast and contains distinctive features not present elsewhere on Australia's north west coast. At the same time, the Montebello/Barrow islands region has a colourful cultural history and is important to Western Australia's economy, supporting major petroleum, pearling and fishing industries.

Apart from involvement in these industries, current levels of human visitation are relatively low. This is due mainly to the remoteness of the islands and the current lack of infrastructure to support tourism. However, the stunning beauty of the region and the presence of charismatic wildlife, such as turtles and whales, are likely to attract increasing numbers of visitors in the future.

The natural environment of the Montebello/Barrow islands region supports a diversity of commercial and recreational activities. While the environment has the capacity to sustain a level of human activities without unacceptable levels of degradation, management strategies are required to ensure that current and subsequent human use of the area does not overload the environment and reduce the options for present and future generations. The establishment of a multiple-use marine conservation reserve provides one such management option. Historically, human activities in marine and coastal environments have been managed by a number of separate agencies and with limited involvement from the general community. Marine conservation reserves however, provide a management framework for both government and the community to consider the total impact of all human activities on each other and on the natural environment.

The Western Australian Government is committed to full and open consultation before areas are dedicated as marine conservation reserves and there is a statutory requirement for public participation in the planning process. There are to be two phases of public participation in the planning process for the proposed marine conservation reserve in the Montebello/Barrow islands region. The first phase focuses on a planning advisory committee. Committee membership is community based and includes a wide range of experts with knowledge and interest in the proposed area. Members contribute technical expertise and exchange ideas both amongst themselves and with the broader community in a collaborative process to develop their 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 and a minimum three month submission period is made available for the receipt of written submissions.

This chapter provides an overview of the environmental, cultural, commercial and recreational values within the area and complements a series of booklets and brochures which address other topics associated with marine conservation reserve planning and management (see chapter 6 &10)

5.2 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 Montebello/Barrow islands region. Before planning 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 boundaries of the study area. These boundaries define the deliberations of the advisory committee but will not necessarily correspond with reserve boundaries once the community consultation process is complete. However, reserve boundaries will not encompass areas outside the study area unless there is a very clear justification for doing so.

The study area is located off the Pilbara coast between latitudes 20.29° S and 21.16° S, and longitudes 115.25° E and 115.64° E. It includes the waters surrounding the Montebello/Barrow islands region, stretching from the State Territorial limit in the west and north, to the 10 m depth contour in the east and south (Figure 1). The islands are situated to the north of Onslow and range in distance off the mainland coast from 50 to 90 kilometres. The study area totals 2099 square kilometres (sq. km), which comprises 268 sq. km of land and 1831 sq. km of sea. It encompasses the coastal reefs on the west coast of Barrow Island and the Barrow Island Shoals in the south. The 10 m depth contour roughly corresponds with a submerged limestone platform known as the Montebello, Lowendal and Barrow Island Subtidal Ridge.

5.3 PHYSICAL ENVIRONMENT

GEOLOGY AND GEOMORPHOLOGY

The surface layers of rock within the study area are predominantly limestone. The limestone was formed from the compressed skeletons of millions of plants and animals which fell to the bottom of the sea during the past 65 million years, or what is known as the Tertiary and Quaternary periods. Beneath these ‘young’ layers of limestone is concealed an ancient and varied history of times when dinosaurs roamed, when extensive ice sheets covered the land, and when Australia was part of the supercontinent, Gondwana. The key events in the geological history of the Montebello/Barrow islands region have taken place during the past 600 million years.

One significant geological development was the formation and accumulation of petroleum deposits. These deposits were formed from the organic remains of terrestrial and marine plants and animals that lived between 300 and 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. The area was at higher latitudes and experiencing much colder conditions.

The organically rich deposits were transformed into petroleum products by specific heat and pressure conditions known as the hydrocarbon-generating window. At that stage, the deposits were buried thousands of metres deep 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 an impermeable seal formed by domes or faults in the layers of rock. Beneath the study area the impermeable layer is Muderong Shale, formed from fine mud deposits. This lies on top of about 1000 m of porous sandstones and shales that formed from a buried river mouth or delta system. This delta drained from what is now the Exmouth Gulf region about 140 to 70 million years ago when the area would have provided habitat for primitive flowering plants, birds and even dinosaurs, though their numbers were declining at that stage.

It was also during the Jurassic and Cretaceous periods that the great southern supercontinent of Gondwana split apart. This began with the formation of rift valleys that became wider and wider as the

continental plates separated and drifted apart. Australia slowly turned to its present orientation and drifted northwards. These massive movements of the earth's crust created cracks and faults within the study area, into which molten igneous rocks were injected, forming structures called dykes. By the end of the Cretaceous period, 65 million years ago, the Australian continent became more stable with less crustal movement.

As the continent drifted north, it eventually made contact with the Indonesian continental plate. The pressure of contact caused the rocks to bend forming folds and faults. A series of folds occur along the North West coast of Western Australia including Cape Range, Rough Range and the submerged ridge which forms the backbone on which the Montebello, Lowendal and Barrow islands are located. This submerged ridge extends north from the mainland near Onslow and is called the Montebello, Lowendal and Barrow Island Subtidal Ridge. Today it has a fairly flat top about 10m below the sea's surface. To the south, it is interrupted by Mary Anne Passage that divides the ridge into northern and southern portions. The study area covers the northern portion.

The ridge comprises an extensive area of subtidal limestone pavement, with numerous shallow banks and three island complexes - Barrow, Lowendals and Montebellos. To the south east and south west, the ridge adjoins habitats that are characteristic of the middle of the continental shelf, having depths of 10-20 m and relatively turbid waters. To the west and north-east the ridge adjoins steeply sloping habitats with clear waters up to 30 m deep and characteristic of the outer shelf.

The shallow subtidal pavement on top of the ridge is partly covered by dynamic sheets and ribbons of limestone sands of varying thicknesses. The sands are generated both by the continuing erosion of the islands and from the skeletal remains of marine organisms. The sands are moved and dispersed by prevailing tidal currents and by storms and cyclones.

Today, the clearer waters of the shallow ridge support living coral reefs along the north western edge adjacent to the Montebello Islands, along sections of the west side of Barrow Island and in the south eastern corner of the study area. A series of large coral bommies occur along the eastern edge of the ridge.

The study area has experienced significant changes in sea level through recurring ice ages, the most recent of which took place just 18,000 years ago. At that time, the sea level was 150 m lower than it is today and Aboriginal people lived on the exposed land mass. The subsequent rise of sea level was rapid, reaching a level 1.5 metres higher than present day levels 7000 years ago. At that time many of the islands exposed today would have been submerged or much smaller. The sea level dropped to its present level about 4500 years ago exposing the islands as we know them today.

The Montebello Islands are dominated by lagoons, channels, intertidal embayments, intertidal shorelines, barrier reefs and shallow limestone platforms exposed to open ocean conditions. The islands are generally irregular with convoluted coastlines forming an estimated total shoreline length of 210 km. The islands lie close to one another, separated by narrow channels and lagoons. They are low lying and, of the 265 distinct islands, islets and reefs, only 95 are greater than 50 m in length. They are composed of limestone and cross-bedded sandstones that are less than two million years old and are capped in places with sand dunes, some up to 40 m high. Most are characterised by bare rocky terrain fringed with undercut limestone rocky shores and occasional sandy beaches.

The Lowendal Island group contains over 40 islands, islets and rocky stacks comprising eroded limestone that is less than two million years old. Shorelines are typically steep and the larger islands, including Abutilon, Varanus, Bridled and Parakeelya, have both dunes of white sand and depression deposits of orange sand. The smaller islands comprise low, steep-sided and mostly bare rocky islets and stacks, many exhibiting wave-cut platforms formed during previous interglacial periods.

Barrow is the largest island within the study area, around 25 km long, 10 km wide and 62 m at its highest point. Its surface is comprised almost entirely of limestone outcrops and deposits overlain by

sands. Most of the surface limestone is 26-57 million years old though in the centre of the island erosion has exposed older limestone deposits called giralia calcarenite. Much of its coastline has steep undercut limestone rocky shores that connect with intertidal limestone pavements. Its eastern intertidal pavements are usually covered with sand or mud but on the more exposed western side, there are wave-cut rock platforms. There are also nine smaller islands in the Barrow Island region, Middle, Boodie, Pasco, Boomerang, Mushroom, Prince, Pelican, and North and South Double Islands.

DRAINAGE AND GROUNDWATER

Little is known about the freshwater hydrology beneath the islands. Rainfall is low and extremely variable and apart from occasional cyclones, freshwater input is likely to be low. There are no major watercourses, swamps or other surface water features on most of the islands. Barrow Island however, has some creeks and claypans that hold water after rain events. It is likely that subsurface mounds of freshwater exist but their volumes, persistence and drainage patterns are unknown.

Any subtle changes to natural drainage or groundwater quality may affect limestone cave ecosystems that support rare cave dwelling animals (see *Cave-dwelling fauna* section under Island Biota).

CLIMATE

The climate of the study area is both arid and tropical, with seasonal characteristics mainly controlled by the large high-pressure cells that pass from west to east across the Western Australian coastline. As a result, there are two broadly defined climatic seasons over north western Australia: a warm 'winter' from May to September and a hot 'summer' from October to April. Most rain falls during October to April when the southern course of high-pressure cells allows the tropical low-pressure rain-bearing depressions into the north west regions of the state.

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. 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 knots near the coast in the vicinity of the Montebello/Barrow islands and can occasionally peak at 60 knots further offshore over the study area.

During summer, the high-pressure cells are further south, allowing a dominance of westerly to south westerly winds generated by the interaction of low-pressure monsoonal depressions with the southern high-pressure systems. The summer onshore winds are more constant in direction than in winter. Summer sea breezes reinforce and night-time land breezes moderate the prevailing onshore winds. Coastal wind patterns are characterised by onshore sea breezes during the day and offshore winds at night.

Winds are at their weakest and most variable during the seasonal changeovers between summer and winter, around April and August, and it is then that the weather is most favourable for recreational activities in the area. Winds typically blow from the south west to the south east during these periods.

Extreme winds during cyclones can exceed 150 knots. On average, about two or three cyclones occur within 350 km of the islands each summer. Fewer cyclones approach within the closer radius of 220 km and records indicate that between 1977 to 1996, 23 cyclones passed within this distance of the islands. Cyclones bring destructive winds, heavy rains, large surges in coastal water levels, large and violent waves, strong currents and substantial movements in coastal sediments. Cyclones are important ecologically because the waves they generate can damage corals and other benthic, or seabed-attached, communities. They may also re-suspend and transport sediments, which scour and smother marine organisms or lead to uncharacteristic transport patterns of larvae and other biological material.

Cyclone events also influence the design and location of infrastructure associated with the petroleum, pearling and tourist industries.

Mean annual rainfall at the Harriet Oilfield near Varanus Island is about 330 mm, with over half occurring during the January to March period. Rainfall varies from year to year, depending on the number of rain-bearing systems that pass close to the area. There are no evaporation data for the islands, but annual rates are likely to be similar to those at Dampier, about 3000 mm, which far exceeds rainfall.

Air temperatures at the islands are generally more moderate than the adjacent mainland, and range between 34.2 °C and 24.8 °C in summer, and between 25.2 °C and 17.1 °C in winter.

The mildest and most conducive conditions for tourism and recreational activities occur during winter and spring. Climatic forces are important when considering the design of infrastructure and properly assessed contingency plans need to be in place to protect not only life and property, but also the environment.

OCEANOGRAPHY

Oceanography is a comprehensive science that incorporates chemical, physical, biological and geographical principles in studying the world's oceans. The biological values of the Montebello/Barrow islands region are described in the natural history section of this document so we will focus here on the chemical and physical attributes of the waters within the study area.

Studies of the regional oceanography of the North West Shelf have been motivated mainly by the need to calculate engineering design parameters for offshore structures such as rigs and platforms and for risk analyses associated with contamination events such as oil spills. These studies have focussed on tides, internal waves, wind driven circulation and tropical cyclones. A broad understanding of the physical and chemical attributes however, are best described by considering all of the main components of water movement and water quality.

WATER LEVEL

Tides are caused by the gravitational pulls of both the sun and the moon on our 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 pulls of the sun and moon complement one another, the tides are referred to as spring tides, which are characterised by large tidal ranges. When the gravitational pulls from the sun and moon counter, or work against one another, the tidal range is much lower and they are referred to as neap tides.

The tides of the Montebello/Barrow islands region are 'semi-diurnal', that is, they go through two peaks and two troughs – or highs and lows - per day with a predicted water level range of about 3.3 m during spring tides and about 0.75 m during neap tides.

Combined meteorological effects such as winds and barometric pressure can also change water levels significantly. For example, water levels recorded during storms between January and March 1996 rose by about 0.1m, with one particular cyclone causing a rise of about 0.4 m in February 1996.

The large tidal ranges have a major influence on the distribution of marine and coastal organisms. Large areas of intertidal substrates are exposed for long periods during low tides and only those species, which can withstand sustained drying or can move to the shelter of deeper water in rock pools or offshore can inhabit these areas. Even below low tide levels, organisms which are continually submerged are influenced by waves and wind-induced mixing in conditions of very shallow water at low tides.

WAVES

There are many sources of energy which create waves in the ocean including tides and seismic activity, but wind is the primary energy source of ocean waves. In areas where there are high winds or storms, 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. Waves of short wavelength 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 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 shallowing continental shelf to be directed more towards the west-north-west as it approaches the coastline.

Normal ocean swells are about 2 m high in winter and 1 m in summer with periods of about 12-16 seconds between waves. However, the swells experience significant loss of size and energy en route to the coastal zone as a result of bottom friction over the shallowing sea bed, breaking over reefs and blocking by islands and promontories. Oceanic swells can be reduced to less than half of their original size due to these factors. Computer modelling predicts that a 3 m offshore swell from the west-south-west will arrive at the Montebello/Barrow islands region with a height of about 2 m and with a direction from the west-north-west.

Monsoonal swells can reach heights of 6-10 m offshore and generally approach the coast from the west-north-west. Swell waves generated in deeper water during storms and cyclones can reach heights well over 10 m.

Winter easterlies generate 1-2 m waves with frequencies of six to eight seconds in the open waters off the mainland coastline. They become fully developed over the mid-shelf, just offshore from the Dampier Archipelago, and can influence the sea conditions in the study area.

Internal waves occur below the sea surface and are generated by sub-sea impulses of water such as changing tides or underwater seismic activity. They travel between horizontal layers of water of differing density - a warm layer residing on a cold layer or fresher water residing on sea water of higher salinity. Internal waves approaching shallow areas steepen and break underwater just as surface waves do when they approach the shore. Divers may experience the turbulence, updrafts and downdrafts within a breaking internal wave.

Both the movement of waves over the seabed and the breaking of waves in shallow water, releases energy. The distribution of marine organisms reflects their adaptations to withstand these high energy zones along for example coral reef crests and exposed rocky shores. The varying sizes and energy levels of waves caused by topographic effects, such as shallowing sea-bed, islands, or reefs, can also influence the ecology of marine communities by causing sediment rates to vary from place to place and by sorting or separating out sedimentary particles of different sizes. During storm events, when energy levels are higher than usual, wave action can cause significant direct damage to fragile ecosystems such as coral reefs. They may also damage benthic communities by re-suspending large amounts of fine sediment. This in turn can smother organisms and reduce light penetration which may inhibit the growth of marine plants.

The design and construction of structures associated with the petroleum and other industries are greatly influenced by the predicted sizes and directions of both surface and internal waves. The amount of energy within a large wave is enormous and structures which, if broken, pose significant threats to the safety of people or the environmental have to be engineered to withstand the worst predicted scenario.

CURRENTS

Unlike waves which bring about virtually no net water transport in unconfined conditions, 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 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 Montebello/Barrow islands region is located in an area considered to be the headwaters of the Leeuwin Current. This relatively narrow coastal current which is usually less than 50 km wide south of the North West Cape, moves southwards transporting substances such as eggs and larvae from reef habitats to more southerly destinations. This suggests that the Montebello/Barrow islands region may be an important source for recruits of tropical species along the west coast. Similarly, the study area may be hydrodynamically and biologically connected to other ecosystems to the north, such as the Rowley Shoals, by flows such as the Leeuwin Current and the Indonesian Throughflow. There is still much to be learnt about the role of regional currents in moving water over the mid-near continental shelf. They are however, undoubtedly significant in a regional context as they transport living organisms to and from the study area and assist in the recruitment process for fauna such as fish and corals in the Montebello/Barrow islands.

Also at the regional scale, internal tides moving below the sea surface towards and up onto the shelf may transport deep ocean nutrients up towards the surface. This manner of introducing nutrients onto the shelf, where they can be moved to shallower water habitats by wind and tide, is a feature of oceanography that is poorly understood at present. However, this phenomenon is potentially important to the overall ecology of the region and is the focus of current research.

High tidal ranges within the study area generate strong current flows. These broad scale flow patterns are diverted, or steered by the uneven seabed and intricately shaped coastlines. Tidal flows which are funnelled between the islands produce much stronger localised currents than over the more exposed shelf areas surrounding the islands. Spring tides can drive currents of up to 4 knots in the shallow channels of the Montebello Islands, while south of Barrow Island, currents have been recorded to reach speeds of about 1-1.5 knots during spring, and about 0.2-0.5 knots during neap tides. Strong tidal flows also cause eddying and re-circulation in the lee of islands. These swirls can lift material up from the bottom leading to sediment re-suspension.

An important feature of tidally driven water circulation within the study area is the tendency for water to oscillate rapidly back and forth over ebb/flood tidal cycles. However, water does not return to exactly the same spot at the end of each tidal cycle. There is instead a small net drift away from any one particular location. So even though current speeds may be high and water is moved over large distances, the actual flushing or exchange of original water from a particular site, may be relatively slow. During spring tides, the effect of wind-driven flushing is usually dominated by tidal circulation and water returns to nearly the same spot, with net drift typically less than about 3 km per day. However, when tides are weak such as during neap tides, the wind plays a more important role in flushing water through the region and enhances the net draft away from a site.

It is likely that the lateral spreading due to mixing processes is more important in flushing eggs, larvae, sediments and contaminants than the oscillatory movement driven by tidal currents. Over short periods, a cluster of eggs or larvae may be spread more by lateral mixing processes such as turbulent swirls and wave-induced mixing than by the movement of water in current fields. This is a topic of the oceanography of the region that warrants further investigation.

The capacity of marine ecosystems to regenerate after damage is enhanced by the movement of water-borne planktonic larvae. Communities with species which have long-lived larval dispersal stages may

depend on 'upstream' sources for their recruitment. Most corals and many fish and crustacean species fall into this category and the long-term sustainability of a local reef community, such as that on Biggada Reef, may depend on planktonic larvae that originate in the Montebello Islands or the Rowley Shoals. It follows that ecosystem management of marine communities requires a sound knowledge of oceanographic processes.

Strong tidal currents also influence recreational potential within the study area. Navigation in fast flowing channels can be hazardous and caution is required when diving and participating in other water sports.

TEMPERATURE

Sea-surface temperatures around the islands range from about 20 °C in winter to about 30 °C in summer, with temperatures up to 33 °C occurring in the shallowest areas.

Temperature is generally constant throughout the water column, due to tidal stirring that prevents the formation of any significant layering in temperature.. However, under certain conditions, water may cool to form cold and therefore dense water pools in lagoons. Cold water can sink to the bottom of depressions creating vertically layered conditions where the bottom layers of water are trapped. The same can apply to salinity stratification, as described below. Poor flushing due to vertical stratification over sustained periods may cause temperature stress to bottom dwelling communities. There is also the potential for pollutants to accumulate within the trapped waters at the bottom of depressions. Poor flushing due to vertical stratification needs to be considered when assessing development proposals which would increase nutrient levels in the water.

Corals can show signs of stress, such as bleaching, during prolonged exposure to low (<18 °C) or high (>32 °C) water temperatures. The known temperature climate of the Montebello/Barrow islands region indicates that corals in the area survive within a temperature range close to their natural limits. Human activities that could significantly alter water temperatures for sustained periods therefore need to be managed carefully.

Prolonged exposure to direct sunlight, high temperatures and desiccation (drying) can cause significant stress to corals in inter-tidal zones. Such conditions may occur during daytime low spring tides, when there is the greatest threat of mortality due to drying, overheating or de-oxygenation in trapped pools and puddles.

Natural broad-scale mortality of marine organisms as a result of oxygen depletion occurred at Dugong Reef to the south east of Barrow Island in 1991. This occurred when a dense slick of coral spawn depleted the dissolved oxygen supply and died. The oceanographic conditions at the time were characterised by a sustained period of weak circulation, consequent poor flushing and elevated temperatures. More recently, there have been reports of broad-scale coral bleaching which is believed to have been caused by a combination of global warming and natural increases in water temperatures during El Niño events.

SALINITY

Studies indicate that salinity is generally constant throughout the water column around the islands, again due to the action of vigorous tidal stirring that prevents significant salinity layering from forming. The presence of moderate to strong winds also assist vertical mixing. However, water may evaporate to form hypersaline pools (high salt concentrations) in sheltered lagoons among the islands. Dense hypersaline water can occasionally sink to the bottom of deep depressions, creating vertically layered conditions. The ecological consequences of this on plants and animals are similar to those described above for temperature stratification.

Horizontal density gradients, formed when areas of water have patches with different temperatures and/or salinities, may drive water circulation. Under these conditions, dense waters and buoyant waters flow in interleaving patterns.

TURBIDITY

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

Turbidity around Barrow Island is characterised by a coastal boundary layer of turbid water out to 15 m depth along the west coast with clear water offshore. Water within the tidal channel north of the island is slightly turbid while the coastal waters along the east side and around Dugong Shoal are clear.

The central chain of broken reefs within the Montebello Islands is dissected by channels which connect the eastern and western lagoons allowing direct throughflow. The channel beds are of coarse sand and rubble substrates, created by strong currents that prevent sustained settling of fine materials. Because of energetic flows and mixing in these channels there is little opportunity for fine sediments to accumulate and turbidity is relatively low.

The lagoons and inter-tidal embayments which flank the central chain of the Montebello Islands are influenced mainly by tides. Because flushing is limited in these lagoons fine sediments are not carried away and the areas are characterised by fine, sandy substrates and turbid water. The water is also very turbid between the top of the central chain and North West and Primrose Islands to the north and north-west.

The western barrier reef protects the inner portions of the Montebello Islands and acts as an effective breakwater to the strong swells of the open ocean. It is broken along its length by several deep channels, which allow strong throughflow with the adjoining lagoon. The shallow open ocean habitats to the west of the Montebello Islands are subjected to relatively high wave and current action, creating extensive areas of exposed limestone pavement and reef, interspersed with patches of sand overlaying the pavement. Turbidity is relatively low compared with the lagoons and channels.

The turbidity characteristics of the study area are not well understood at present. Because of the importance of the light climate to the ecology of benthic communities in the region, further studies to accurately detail the characteristics of the turbidity are warranted.

5.4 NATURAL HERITAGE VALUES

5.4.1 REGIONAL CONTEXT

The marine flora and fauna of Western Australia belong 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 widespread throughout much of the Indo-West Pacific Region which 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) divides the marine environment of Australia into 60 different biogeographical regions, 18 of which occur in Western Australia. The Montebello/Barrow islands region lies within the Pilbara Offshore Bioregion, which covers the waters seaward of the 10 m contour between North West Cape and Cape Keraurdren. This region is characterised by a series of limestone islands on a section of coast where the continental shelf is wide. The fringing coral reefs of the region are characteristically extensive and species-rich and the

burrowing invertebrate fauna of the island sand flat habitats are also diverse and abundant. The Pilbara Offshore Bioregion also contains a low diversity of mangroves which occur in small, species-poor mangrove communities and as scattered mangrove trees on the sheltered sides of islands. Although the majority of species present within the Pilbara Offshore Bioregion area are widespread throughout the Indo-West Pacific, there is a significant number of species that are found nowhere else.

The Western Australian Government is committed to establishing a system of reserves in which all bioregions are represented. There are currently no marine conservation reserves within the Pilbara Offshore Bioregion, but the Marine Parks and Reserves Selection Working Group recommended that the following areas be given consideration: the waters around the Murion Islands, and around Serrurier and Bessieres Islands in the south west; around the Montebello and Barrow Islands, and to the north east, around Bedout and North Turtle Islands. A marine conservation reserve within the Montebello and Barrow islands study area would be the first to represent the special habitats and biota of the Pilbara Offshore Bioregion, and because of its extensive size and central location within the Bioregion, the study area is well placed to represent the habitats and species of the whole Pilbara Offshore Bioregion.

High diversities of marine animals have been recorded within the region. During a 1993 survey of the Montebello area by the Western Australian Museum, lists were made of 457 fish species, 635 molluscs, 85 crustaceans (crabs, crayfish, shrimps and kin), 170 echinoderm (seastars, sea cucumbers, sea urchins and kin) and 150 coral species. As the amount of research in the area increases, it is likely that the numbers of species cited will also increase.

There have been several studies to determine the types and geographical locations of marine habitats within the study area. A combination of mapping techniques have been used including satellite imagery, aerial photography, diver observations and under water remote video cameras. The habitat map presented in figure 4 is an amalgamation of data which was gathered using these techniques. This map provides a useful tool for planning a new marine conservation reserve. However, not every square metre of sea bed has been surveyed and 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.

Marine habitats are defined by physical environmental influences, substrate type and dominant marine biota. For the purpose of planning a marine conservation reserve, the major marine habitats within the study area can be described as:
rocky shores and intertidal limestone pavement;
intertidal mud/sand beaches;
mangrove communities.
coral communities; and
subtidal sand/rubble and limestone pavement with macroalgae & seagrass.

5.4.2 MARINE HABITATS

Rocky shores and intertidal limestone platforms

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.

The island shores within the study area are predominantly of limestone. Physical, chemical and biological processes often erode limestone faster in a horizontal direction than in a vertical direction and horizontal rock platforms commonly develop between tide levels. At the shoreward limit of the platform, a characteristic 'notch' is eroded, undercutting the rock face. Most of the limestone cliffs are

only a few metres above high water level but on the west coast of southern Barrow Island, they reach 30 m high.

In the upper intertidal zone, the undercut may have a zone of rock oysters (*Saccostrea cucullata*) with further characteristic vertical zonation of invertebrates such as *Leptograspus* crabs, molluscs and barnacles.

Beneath the undercut cliffs, the intertidal limestone rock platforms extend seaward for up to 100m. These platforms are inundated much of the time and during low tide many organisms are protected from desiccation in shallow pools. A wide range of bivalve shells, snails, crabs, worms and some small fish are found on intertidal limestone platforms and at high tide, larger fish and other marine animals come in to feed on these organisms from deeper water. 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 grow on the outer edges. In areas of low wave action such as the east coasts of Barrow, the Lowendals, and the Montebello Islands, the platforms have less algal turf and are often covered by a layer of mud or sand. The distribution of particular plant and animal species is largely dependent on the amount of mud or sand.

The abundance of invertebrate life on rocky shores provides a valuable food source for shore birds. Their use of this habitat remains largely undisturbed, as human visitation within the study area is currently low. However, if human usage patterns were to change significantly, the accessibility of rocky shores to collectors would place them under greater pressure. While direct human impact is low, these habitats are vulnerable to pollution from floating debris and contaminants, and a significant strandline litter problem poses a threat to wildlife, which can become entangled.

Intertidal mud/sand beaches

Many of the sandy beaches within the study area are used by sea turtles and a few beaches provide nesting sites for wedge-tailed shearwaters. The burrowing ghost crab *Ocypode sp*. is the most conspicuous invertebrate and a species of marine snail, *Amoria macandrewi*, a member of the attractive volutidae family, is endemic to the study area.

Most of the more exposed beaches are characterised by sand with a relatively low organic content. While some invertebrate species live buried within these sediments, their diversity is low in comparison to more sheltered conditions.

Sheltered beaches between rocky headlands and along the narrow channels between islands are inundated at high tide, but at low tide, fine-grained sands are exposed. The beaches shelve gently and large expanses of intertidal sands are exposed at low tide. These areas are covered with a surface film of microorganisms, a rich food source for marine snails, crabs and other organisms. These in turn are eaten by larger fish that swim over the area at high tide. Many of the species, which live in this habitat, are buried in the substrate itself. These include bivalve shells, lampshells or brachiopods, worms, crabs and sea urchins. Their burrowing activities regularly turn over the sediment.

Extensive sand and mud flats also occur over intertidal limestone platforms in sheltered conditions. Again, these habitats support a high diversity of organisms including species that live on the surface and those that burrow into the substrate.

The abundance of invertebrate life on intertidal sand and mud substrates provides a valuable food source for shore birds. Current levels of human use provide no threat to this activity. Turtle nesting also remains undisturbed, though 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 such as twine poses a threat to wildlife.

Mangrove communities

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

Six species of mangroves have been recorded in the Montebello/Barrow islands region. They are the white mangrove (*Avicennia marina*), ribbed-fruit orange mangrove (*Bruguiera exaristata*), yellow-leaf spurred mangrove (*Ceriops tagal*), red mangrove (*Rhizophora stylosa)*, club mangrove (*Aegialitis annulata*) and river mangrove (*Aegiceras cornculatum*).

Small mangrove communities occur in the protected bays of all three island groups. They range in size from isolated mangrove trees (usually *A. marina*) to multi-species mangrove stands. The largest mangrove community in the study area is found at the end of Stephenson Channel on Hermite Island. This community covers 15 hectares, with some trees up to 5 m high. Stunted mangrove trees are found in narrow fringing strips along the shores of embayments such as on the east coast of Barrow Island. In the Lowendal group, *Avicennia* trees occur on the west side of Varanus Island and on Bridled Island there are pockets of mixed *Avicennia* and *Rhizophora* communities.

Because of the arid climate, none of the mangrove communities within the study area are influenced by freshwater run-off. However, the mangrove communities with mixed species are characterised by a distinctive pattern of zonation associated with their tolerance to seawater inundation. In these communities, shrub lands of *A. marina* occur on the landward edge, usually around high water spring level while at greater depths, where there is more frequent inundation by high tides, closed forests of either *R. stylosa*, or a mixture of *A. marina*, *R. stylosa* and sometimes *B. exaristata* occur.

The main source of food that fuels mangrove ecosystems is leaves from the mangrove trees themselves. When the leaves fall onto the mud, they become a food source for microscopic organisms. These in turn provide 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 and fish. The most prominent species 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. Many organisms live within the muddy substrate and the most conspicuous borrows are those of the mud crab *Scylla serrata.* Mangrove communities also provide valuable nurseries for juvenile fish.

Mangrove communities are affected by natural events such as cyclones and coastal erosion. Of greater concern is their vulnerability to pollution, particularly oil pollution 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 cause a hazard to wildlife. Mangrove communities are targeted by recreational fishers in search for mud crabs.

Coral communities

Rigorous coral growth is dependent on a mutually beneficial, or symbiotic partnership between plant and animal. Single celled organisms called zooxanthellae occur within the coral animal tissues. These microscopic plants supply up to 98 per cent of the coral animal's carbohydrate requirements. The zooxanthellae also take up much of the coral animal's waste products and assist in creating 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 25ºC and 29ºC and at normal ocean salinity.

Reef-building coral species are found along the entire Western Australian coast 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 sponges, seastars, sea urchins, crustaceans, bivalve and snail shells, worms and fish.

Coral communities occur throughout the study area but are best developed on a fringing reef to the west and south west of the Montebello Islands, Biggada Reef on the west side of Barrow Island, and right along the eastern edge of the subtidal ridge on isolated bommies and more extensive patch reefs. The coral species diversity and community structure vary with the different environmental conditions such as exposure to wave action, currents and water clarity. For example, plate corals of the genus *Acropora* spp. are dominant on the western reefs, while slow growing *Porites* spp. and favids are dominant on bommies to the east of the study area. Delicate branching coral species occur in sheltered lagoonal locations. Very high percentages of live coral cover have been recorded at South West Reef. However, coral communities in lagoonal areas with higher turbidity typically have much lower live coral cover.

Although knowledge of coral abundance and diversity within the study area is incomplete, research indicates fairly high diversities with 54 genera and 150 species already recorded in the waters around the Montebello Islands and 38 genera and 117 species of hard corals recorded at Biggada Reef alone. Most corals are found in moderately clear water conditions, but five genera occur in turbid inshore waters. No doubt as further research is undertaken, the number of recorded coral species will increase to narrow the apparent discrepancy between the species richness within the study area and the 300 coral species recorded at Ningaloo Reef

Surveys of patch reefs between Varanus Island and the Montebello Islands have revealed some 41 genera and 127 species to date. Many of the patch reefs were comprised of both living and dead corals, and were frequently derived from and/or composed of a number of large *Porites* spp. colonies, with smaller areas of diverse coral communities on or around the base of each patch reef. The species-richness of the patch reefs ranged between 34 and 63 species at each survey site but the community structures were similar at most sites.

Coral communities are affected by storms and other natural events. Severe storms and cyclones sometimes cause significant coral breakage and further damage results from suspended sediments. Other causes of mass coral mortality include bleaching and oxygen depletion of the seawater.

Bleaching occurs when corals become stressed by extreme conditions such as high temperatures. Under these conditions, corals expel the zooxanthellae from their tissues leaving only the colourless animal tissue and the white skeleton beneath. Corals sometimes recover from bleaching events, but there is concern that the frequency and magnitude of these episodes will increase 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 the levels of dissolved oxygen below what is required to sustain marine life. When this occurs, it is not only the corals that perish but also a multitude of snails, worms, starfish, fish and other organisms as well. A significant deoxygenation event associated with mass coral spawning occurred at Dugong Reef in 1991.

Coral communities can 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.

The study area is within the natural ranges of both the crown of thorns starfish *Acanthaster planci*, and the coral eating snail *Drupella cornus.* Population outbreaks of these species have been reported on the western and eastern sides of the Montebello Islands. 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 be significantly altered.

Whether the outbreaks of crown of thorns and *Drupella* snail are induced by humans or are part of a natural cycle remains under debate. However, apart from these outbreaks, the coral communities within the study area are in good condition with very little human disturbance. They are an important ecological value and are a major attraction for visitors. They also have pharmaceutical potential. Within the central Indo-Pacific region, 70 per cent of all coral reefs have experienced some human induced degradation, so there is a great responsibility on Australia to ensure the conservation and good management of its coral reefs.

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

This group of habitats covers the most extensive area under consideration. The flat topped limestone ridge forms the backbone on which these subtidal habitats occur. In some places, the limestone rock is exposed on the seabed. In other locations, the limestone is covered by sand or rubble deposits. The exact locations and thicknesses of sand sheets and banks can vary as these mobile sediments are shifted during storms. The habitats are also subject to seasonal changes associated with algal cycles of growth and senescence. This group of dynamic subtidal habitats occurs at depths between 5 to 10 m.

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, such as those belonging to worms, are quite small, while others, like that of the fearsome mantis shrimp, are significant with adjacent mounds up to 15 cm high. Fish, such as flathead, rays and flounder, together with echinoderms, crustaceans, bivalve molluscs and gastropods or sea snails also occur on or above the substrate surface.

Large species of algae, or macroalgae, grow on areas of limestone pavement and on stable rubble surfaces. Algae are simple plants that require light to grow and occur at a variety of densities from sparse to dense algal beds. Brown algae from the genera *Sargassum, Turbinaria,* and *Pandina* are the most dominant types. Green algae from the genera *Caulerpa* and *Cladophora* are also quite common. At some sites, strong tidal currents provide good conditions for filter feeding animals including sponges, coral colonies, sea whips and sea squirts or ascidians. These are found among the algal plants and together they provide important habitat for bivalve shells, snails, sea urchins, sea stars, crabs and fish, and nursery grounds for juvenile fish.

Seagrasses are also present on the subtidal limestone ridge habitats. They do not form extensive meadows but rather 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*. In the deeper waters over the edge of the limestone ridge, seagrass distribution is unknown. However, *Halophila spinulosa* has been recorded to depths of 20 m. The most extensive areas of seagrass within the study area are located around the Lowendal Islands. Seagrasses provide an important food source for turtles and dugong.

The balance between algal and seagrass species has been affected by elevated nutrient levels elsewhere in Australia. Nutrient-rich discharges from agriculture and industry have resulted in excessive algal growth which smothers and kills the seagrass leaves. While this is not currently an issue within the study area, aquaculture developments requiring 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 human visitation levels increased significantly.

5.4.3 MARINE WILDLIFE

While many marine taxa are represented by a high diversity of species, public attention often focuses on the larger, vertebrates, many of which migrate vast distances, and some of which suffer an insecure population status. In many cases, fisheries and tourism are dependent on the maintenance of the large marine vertebrate populations, and these in turn are dependent 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. Seven species of toothed whale and three species of baleen whales have been recorded in the Montebello/Barrow islands region but it is likely that most of the 36 Indian Ocean species occasionally visit the study area.

Despite the exploitation of toothed whales elsewhere in the world, there are limited concerns regarding their conservation status in Western Australia. Sperm whales are the largest toothed whales in the world and adult males may reach a length of 20.5m. Male killer whales grow to lengths of 9.5 m and have distinctive dorsal fins up to 1.8 m high. Killer whales are known as 'wolves of the sea' as they often hunt together in a coordinated, cooperative way for fish, sea birds, seals and sea lions and other cetaceans even species much larger than themselves. False killer whales are smaller, more slender and lack the striking white markings of killer whales.

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.

Populations of large baleen whales generally migrate south at the onset of the austral summer and back towards the tropics in winter, to take advantage of both the availability of abundant food in the antarctic seas during the summer months and the warm, calm tropical waters during winter. The Bryde's whale however is limited to temperate and subtropical oceans where it hunts coastal fish. Minke whales are more prevalent at high latitudes in summer. However, 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, 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. During this migration, humpbacks swim past the west and north coasts of Barrow Island and the Montebello Islands. They sometimes give birth within the study area, though the main calving area is further east off the Kimberley coast.

Humpback whales were once the mainstay of the Western Australian whaling industry and continued whaling in their Antarctic feeding grounds has pushed their populations to the brink of extinction. A moratorium on hunting humpback whales currently exists. Humpback whales are threatened species declared to be specially protected under the Western Australian *Wildlife Conservation Act 1950*. They are declared "*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', which is when they leap out of the water. Cetaceans are sometimes disturbed by boating and swimming so to protect them from unwelcome human company, there are regulations under the *Wildlife Conservation (Close Season Notice for Marine Mammals) Notice 1998*, which specify appropriate interactions.

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, depend primarily on seagrass, and may live for 70 years or more. 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 kg and reaches a length of up to 3 m.

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 or dense concentrations seen further south in Exmouth Gulf or Shark Bay. Current knowledge on the size, distribution and migratory habits of dugong populations in the region is limited. However, the seagrass beds around the Lowendal Islands are thought to support significant populations.

Elsewhere, dugong are hunted by indigenous people and their vulnerability to injuries from boat propellers causes concern in areas of high boat usage. The dugong is 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.

Birds

Marine birds can be 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 Montebello/Barrow islands region are known breeding grounds for a variety of seabirds. A total of 15 seabird species is known to nest on these islands and the distribution of their rookeries is listed in table 6.

TABLE 6. THE DISTRIBUTION OF NESTING SEABIRDS IN THE MONTEBELLO/BARROW ISLANDS REGION

	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 Cormorant** (***Phalacrocorax varius***)	**Pied Oystercatcher** (*Haematopus longirostris*)	**Roseate Tern** (*Sterna dougallii*)	**Silver Gull** (*Larus novaehollandiae*)	**Sooty Oystercatcher** (*Haemotopus fuliginosus*)	**Wedge-Tailed Shearwater** (*Puffinus pacificus*) #	**White-bellied Sea-Eagle** (*Haliaetus leucogaster*) *
20 30 92 S 115 31 64 E															
Abutilon Island			●									●			
Ah Chong Island				●				●						●	
Ah Chong-1st Islet to NW				●											
Ah Chong-Islet to SSW								●							
Alpha Island				●				●						●	
Barrow Island		●				●		●		●					
Birthday Island														●	
Black Rock															
Bluebell-2nd Islet to N								●							
Bluebell-Islet to N				●				●							
Bluebell-Islet to NW					●										
Bluebell-Islet to S				●										●	
Bluebell-Islet to W								●							
Bloodwood Island						●		●							
Boodie Island				●		●		●				●		●	●
Boomoorang Island								●					●		
Bridled Island			●						●			●		●	
Bridled-2 Island to NE									●						
Brooke Island												●		●	●
Buttercup						●		●							
Campbell Island								●							
Carnation-Island to SW					●			●				●			
Carnation-Islet to S								●							
Carnation-Islet toW									●						
Crocus Island		●													
Crocus-Islet to E								●							
Da Delion Island			●									●			●
Dahlia Island			●								●				
Dahlia-Islet to W											●				
Daisy Island					●			●							
Dandelion Island				●							●				
Delta Island															
Double Island						●		●		●			●	●	●
Epsilon Island					●										
Fairy Tern Island				●			●	●							
Flag Island				●	●								●	●	
Flag-Islets to south											●				
Foxglove Island				●				●							
Gannet Island											●				
Gannet-Islet to N											●				
Gardenia Island				●				●				●		●	
Gossypium			●					●						●	
Hermite Island								●							●
Hermite Islet to S				●											
Hermite Islet to W															
Hibbertia Island				●			●								
Hollyhock Island								●		●					
Howe Island															
Ivy Island				●				●							
Ivy-Islet to ESE											●				
Jonquil Island															
Kincup Island														●	
Marigold Island															
Melaleuca Island															
Middle Island	●	●		●			●	●		●		●	●	●	
North Double Island						●		●						●	
North West Island								●							●

	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 Cormorant** (***Phalacrocorax varius***)	**Pied Oystercatcher** (*Haematopus longirostris*)	**Roseate Tern** (*Sterna dougallii*)	**Silver Gull** (*Larus novaehollandiae*)	**Sooty Oystercatcher** (*Haemotopus fuliginosus*)	**Wedge-Tailed Shearwater** (*Puffinus pacificus*) #	**White-bellied Sea-Eagle** (*Haliaetus leucogaster*) *
Overhanging Rock															
Pansy Island			●											●	
Parakeelya Island			●									●		●	
Pasco Island															●
Primrose-Islet to NE				●											
Primrose-Islet to N								●							
Renewal Island				●				●		●		●			
Rose Island															
South East Island			●									●		●	●
South Double Island	●					●		●						●	
Spar Island															
Trimouille Island	●			●				●							●
Tringa Rock															
Varanus Island	●		●	●	●				●	●	●			●	

NB. Shaded rows indicate either lack of information or absence of nesting birds
* CAMBA agreement # JAMBA agreement

Wedge-tailed shearwaters, crested terns, bridled terns and roseate terns have large nesting populations on North West Shelf islands. The population of shearwaters in the region is estimated to be around 100,000 breeding pairs. In July and August, shearwaters return to their breeding islands to clean out their burrows and laying occurs during 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 have been observed offshore from their colonies, in dense flocks, called 'rafts'.

At the change of season, particularly in March, the waters to the west of the Montebello Islands are used by many migrating sea birds. Some of these are listed in table 7.

TABLE 7 MIGRATORY BIRDS USING THE MONTEBELLO/BARROW ISLANDS

Name of migratory bird	Migration information
Streaked Shearwater	From Japan
Hutton's Shearwater	From New Zealand
Bulwer's Petrel	From the tropical northern Pacific
Wilson's Storm Petrel	In passage from the Timor Sea to the Antarctic
White-faced Storm Petrel	From south western islands of Western Australia to the Arabian Sea
Bridled Terns	From south western islands of Western Australia
Brown Noddies	From the Abrolhos Islands

Large nesting colonies of crested terns of up to 5,000 pairs occur in the Montebello Islands. They nest during late summer and winter. A significant number of pairs of lesser crested terns have been observed interspersed among nesting crested terns on Bedout Island. Larger numbers (about 700 pairs) have been recorded breeding with crested terns on Beacon Island, part of the Lowendal Islands.

Bridled tern colonies occur on many of the islands and rocks of the Lowendal group and southern Montebello Islands. Bridled Island has a large colony of around 4,000 breeding pairs, but the total population in the region could be around 15-20,000 breeding pairs. The bridled terns of north west Western Australia are migratory, wintering in the northern Indo-Pacific. Egg laying starts in mid

December, fledging occurs in March and after the breeding period, the terns start their winter migration in May.

The largest roseate tern colonies recorded anywhere in Western Australia are found in the Montebello Islands. Colonies of up to 4,000 pairs nest in winter and large flocks can be found in the island group all year round. They also nest on the Lowendal islands. In addition, large flocks of fairy terns feed in the local waters which probably indicates significant breeding populations of this species too.

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 and 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.

No bird surveys have been undertaken in the study area during the spring and autumn months which are the peak periods for citing migratory waders elsewhere along the Kimberley and Pilbara coasts. However, casual observations indicate that the study area is an important resource for a variety of migratory bird species that rest in the area and feed on the buried worms, bivalves and other animals in the sand and mud flats.

One of the resident waders found within the study area is the beach stone curlew *Esacus magnirostris*. This species is of interest because of its uncertain conservation status, and the independent ornithological organisation, Birds Australia, regards it as 'vulnerable'. There are many resident pairs of beach stone curlews within the study area all year round.

Many of the sea and shore birds within the study area are covered by international treaties with Japan and China, and Australia therefore has an international obligation to protect these species.

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.

Marine reptiles

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

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 only one or two survive to breed.

Of the six species of marine turtles, five species have been observed within the study area. These are the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), flatback (*C. depressa*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*). 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.

Green turtles are found throughout tropical and subtropical waters but are heavily exploited in many parts of the world 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.

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. There is concern that their populations are declining in Australia too, possibly because they are drowning in trawl nets. The number of nesting loggerheads within the study area is lower than that of green turtles and the Montebello/Barrow islands region is the northern limit of their Western Australian breeding range. 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. They feed on shellfish, crabs, sea urchins and jellyfish.

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 the species remaining in the entire Indian Ocean. None of the tagged hawksbill turtles 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.

Flatback turtles occur mainly in the tropical waters of northern Australia with low numbers recorded in Indonesia and Papua New Guinea. They breed only in Australia and nesting females tagged in 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.

Leatherback turtles are the largest species of marine turtle. They grow to a length of 1.6 m and weigh up to 500 kg. Only a small proportion of the world's leatherback population is observed in Australia, with only a few nesting in Western Australia. 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.

It is likely that nearly all of the sandy beaches within the study area are used for nesting but the major nesting sites occur on Middle and Boodie islands, the west and east coasts of Barrow Island and on Trimouille and North West islands of the Montebello Islands group. Favoured beaches are those that face away from the island groups towards the open ocean rather than those facing the intricate channel systems.

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. There are also concerns that lights used at petroleum industry facilities within the study area can disorientate turtles. Fortunately, turtles appear insensitive to the yellow/red end of the colour spectrum, so gas flares have little impact. However, fluorescent and other lights attract hatchling turtles which then fail to go out to sea. Consequently, many of the lights used at petroleum industry facilities have yellow filters or are screened from the coast. Where possible, low vapour pressure sodium lights are used, as they produce hardly any light at the blue/green end of the spectrum.

The uncertain conservation status of sea turtles has been recognised in wildlife legislation. All five species of marine turtle that occur within the study area are included in a Draft Recovery Plan

prepared by the Commonwealth Government. Green, hawksbill and leatherback turtles are declared as "*vulnerable*" under the Commonwealth *Endangered Species Protection Act 1992* and the loggerhead is listed as "*endangered"*. Under Western Australian legislation, green and hawksbill turtles are not afforded any special status but are listed among the priority species to be kept under review. Loggerhead and leatherback turtles are threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. The flatback turtle is not listed under Commonwealth legislation or State legislation but is treated as "*rare or insufficiently known*" in the Draft Recovery Plan.

Of the 22 Western Australian species of sea snakes, 11 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.

Saltwater crocodiles (*Crocodylus porosus*) have been recorded as far south as Exmouth Gulf and they are occasionally observed swimming for great distances out to sea. Saltwater crocodiles require areas of freshwater in which to breed and while it is possible that they may occasionally visit the study area, it is generally outside their range.

Fish

A 1993 Western Australian Museum survey of the Montebello Islands reported a total of 457 fish species belonging to 76 families, an assemblage slightly richer than the fish fauna of the inshore Dampier Archipelago. Most of the species have relatively wide distributions throughout the Indo-West Pacific region but a small number of species are found only in the north west region. Two of the fish species listed, *Doryrhamphus multiannulatis* and *Phoxocampus belcheri,* from the pipefish family Sygnathidae, represent new records for Australia.

Nearly all of the fish species listed have either eggs or larvae that are dispersed in the water column so it is possible that the majority of juveniles found in the study area come from elsewhere, such as the Dampier Archipelago, Rowley Shoals and outer reefs upstream in the Leeuwin Current. Similarly, the eggs and larvae produced within the study area may be of importance for recruitment in areas further west and south.

Some of the fish species found within the study area are important to commercial and recreational fishers. These include sharks, north west snapper (*Lethrinus* spp.), Spanish mackerel (*Scoberomorus* spp.), red emperor (*Lutjanus sebae*), coral trout (*Plectropomus* spp.), sea perch (*Lutjanus* spp.), golden trevally (*Gnathanodon speciocus*) and cod (*Epinephelus* spp. and *Cephalopholis* spp.).

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 some 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 delighted recreational divers. The hump head maori wrasse (*Cheilinus undulatus)* can grow up to 2.3 m long and also occurs within the study area. Another fully protected fish is the whale shark (*Rhincodon typus*) which is the largest fish in the world. In a recent survey of the Great Sandy Island Nature Reserve, a whale shark was recorded off Cape Preston and it is likely that they also visit the study area but have not been encountered.

5.4.4 ISLAND BIOTA

Although the landscape of the study area is dominated by spinifex (*Triodia* spp.) there are over 100 different kinds of plants which have adapted to live in the harsh dry and hot conditions on these islands. The native island animals however have not prospered so well.

In the late nineteenth century, pearlers camping on the islands were probably responsible for introducing both cats (*Felis catus*) and the black rat (*Rattus rattus*). These introduced animals

subsequently caused extensive damage to native wildlife. Not even the atomic tests on the Montebello Islands in the 1950s eliminated the feral cats and rats from these islands but served instead to demonstrate their resilience and surprisingly, the resilience of many of the other plant and animal species. Cats and rats have only recently been eradicated following an intensive and prolonged program by CALM scientists.

Biological surveys of land fauna were made prior to the introduction of the cat and the black rat, and both before and after the atomic explosions. The golden bandicoot disappeared from Hermite Island prior to 1912, and the spectacled hare-wallaby disappeared between 1912 and 1950. Some bird species, such as the crimson chat and rufous whistler also disappeared before the atomic explosions, and again the cat and rat are likely culprits. The spinifex bird and the black and white wren were last recorded on the Montebellos in 1950 and it is likely that the extensive fire that followed the atomic explosions, together with predators rendered the area unsuitable for these predominantly grassland birds. Burrowing fauna, such as reptiles (and rats) that were underground at the time of the atomic testing, were able to survive its effects. The Hermite Island worm lizard (*Aprasia rostrata rostrata*) has been recorded only once, in 1952, and a threatened species declared to be specially protected under the *Wildlife Conservation* Act 1950.

When the eradication of cats and rats on Hermite Island is scientifically confirmed, re-introductions of the golden bandicoot and spectacled hare-wallaby will be undertaken. One reintroduction that appears to have taken place naturally is that of the native water rat (*Hydromys chrysogaster*). This large rat has a body length of 30 cm plus a tail length of 30 cm and it weighs up to one kilogram. Water rats have webbed feet and are very good swimmers so it is likely that they swam to the Montebello Islands from Barrow Island. They live by scavenging along the seashores. However, they have not been recorded for several years.

In 1998 thirty Mala (Rufuos Hare- Wallaby *Lagorchestes hirsutus* – central Australian subspecies) were translocated to Trimouille Island. The rufous hare-wallaby is a threatened species declared to be specially protected under the *Wildlife Conservation Act 1950*. Reintroduction's to the Tanami Desert have failed mainly due to predation by feral cats. Monitoring in June 1999 indicated that the translocation to Trimouille Island was successful and that the animals were breeding. The Shark Bay mouse (Djoongani – *Pseudomys fieldi*) was translocated to North West Island in May 1999. Monitoring in September 1999 indicated that the population was faring well.

Rats were introduced to Barrow Island in the 1890's and were eradicated in 1991. The house mouse was also introduced to the island and has since been eradicated. Today the island supports a rich flora and fauna that has been relatively undisturbed by introduced animals and atomic bombs. In fact the high diversity of small and medium sized marsupials that survive on Barrow Island provides a glimpse of what the adjacent Australian mainland was like before the introduction of foxes, cats and other introduced animals that have drastically damaged our ecosystems.

Like the Montebello Islands, Barrow Island is mainly covered in spinifex (*Triodia* spp.) but there are also fig, wattle, *Erythrina* and eucalypt trees. Some of the eucalypts grow to 3 m tall and one small clump of *Eucalyptus xerothemica* reaches four metres tall. Barrow Island has a total of about 300 species of plants and 13 species of land mammals, 78 birds, 43 reptiles and two frogs with additional species expected to be found as more research is carried out.

The wildlife on Barrow Island can only be preserved in the absence of introduced plants and animals. The current petroleum lease prohibits public landing on the island so it is unlikely that introductions will be carried ashore by tourists. The movement of goods and personnel onto the island associated with petroleum activities is subject to stringent hygiene conditions which include fumigating, sealing and labelling goods and placing baits and flour trays in transport barges to look for the footprints of unwanted stowaways. Staff are trained to remove all seed materials from their clothing before coming onto the island and to keep a look out for foreign weeds or animals that may have been accidentally transported from the mainland.

Nearby Middle, Boodie and Double Islands are spinifex covered and support significant colonies of Caspian terns and wedge-tailed shearwaters. Boodie Island provides significant breeding and nesting grounds for nine species of marine birds. Boodie Island is also home to the boodie (*Bettongia lesueur*) and Middle Island supports a population of golden bandicoots.

The burrowing bettong or boodie (*Bettongia lesueur*), the Barrow Island spectacled hare wallaby (*Lagorchestes conspicillatus conspicillatus*) and the Barrow Island euro (*Macropus robustus isabellinus*) are threatened species declared to be specially protected under the *Wildlife Conservation Act 1950*. The Barrow Island Black and White Fairy Wren (*Malurus leucopterus leucopterus*) are also threatened species declared to be specially protected under the Wildlife Conservation Act 1950.

The Lowendal Island group supports 78 species of plants, 39 bird species and 13 reptiles. No terrestrial mammals or amphibians have been recorded.

5.4.5 CAVE-DWELLING FAUNA

Extensive cave systems exist beneath both Barrow and Varanus islands and there may be other systems yet to be discovered on other islands within the study area. Below a certain depth, these caves are flooded. Both freshwater mounds and seawater wedges flood the caves and brackish water is formed where the two water sources mix. The life in these cave systems and similar systems beneath Cape Range on the North West Cape have been the focus of Western Australian Museum studies for several years.

Most natural ecosystems rely on green plants to convert the energy from sunlight into carbohydrate material that can then be consumed by other organisms. Some of the energy that drives the cave ecosystems undoubtedly comes from plant material washed down sinkholes from surface plant material above. However, some of the energy comes from special sulphur bacteria that use the energy from chemical processes that take place in total darkness. These are called chemoautotrophic bacteria.

The energy from plant debris and chemoautotrophic bacteria support a surprising diversity of animals adapted to live in caves and which have very limited distributions. Two of these are crustaceans, the Barrow Island Liagoceradocus (*Liagoceradocus subthalassicus*) and the Barrow Island Bogidomma (*Bogidomma australis*) are threatened species declared to be specially protected under the *Wildlife Conservation Act 1950*. So far research has focussed on caves at Cape Range where 34 animal species have been recorded including several found nowhere else in the world. Two of these are fish; the blind gudgeon (*Milyeringa veritas*) and a blind eel (*Ophisternon candidum*) which are threatened species declared to be specially protected under the *Wildlife Conservation Act* 1950. It is likely that the caves within the study area have equal conservation value so any activities that might alter the conditions, particularly in the brackish interfacial zone within the cave systems, need to be given careful consideration.

Other crustaceans that have been recorded in the study area that are listed as "*rare or likely to become extinct*" under the *Western Australian Wildlife Conservation Act*. are; *Nedsia fragilis, Nedsia humphreysi, Nedsia hurlberti, Nedsia macrosculptilis, Nedsia straskraba, Nedsia urifimbriata* and also the Barrow Island Millipede (*Speleostrophus nesiotes*).

6. HUMAN USAGE

6.1 CULTURAL HISTORY

Aboriginal history

Recent research has produced archaeological evidence that confirms Aboriginal occupation of the Montebello Islands from about 30,000 years ago until the most recent sea level rises about 7,500 years ago. Aboriginal artefacts, such as stone items, and associated terrestrial and marine animal remains have been recovered from shallow sedimentary deposits in several small caves on Campbell Island, in the central part of the Montebello Islands chain and on Barrow Island.

The results of Montebello cave excavations suggest that the diets of indigenous inhabitants comprised mainly terrestrial species, although marine snails, bivalves and fish were also eaten. The remains of terrestrial animals in cave sediments confirms that there used to be a much greater variety of native species. The marine species contained in the sedimentary deposits indicate, as elsewhere in northern Australia, that animals from mangrove communities make up a significant dietary component.

During the period of Aboriginal occupation, the Montebello and Barrow islands were part of one large island separated from the mainland by a narrow channel only a few kilometres wide. Occupation ceased after the last rise of sea level, which further isolated the islands, rendering them beyond the reach of Aboriginal people. There is no evidence of Aboriginal habitation immediately prior to or during the European contact period.

Maritime history

In 1622, the English East India Company ship the *Trial* (also known as the *Tryal*) en route to Batavia, became the first known shipwreck on Australian shores when it struck what are now known as Trial Rocks, nine nautical miles north west of the Montebello Islands. Ten men left the stricken vessel in a small skiff and a further 36 boarded the long boat leaving 93 to die when the ship broke up and sank. The two small boats landed on the Montebello Islands where the survivors searched for water before setting off for Batavia, finally arriving one month later. The *Trial* wreck site is protected by the Commonwealth *Historic Shipwrecks Act 1976* and also has National Estate status. While the Trial Rocks lie just outside the study area, there are a number of other uncharted wrecks believed to be lying within the study area including pearling luggers lost over the years during cyclones.

The *Wild Wave*, a wooden brig under the command of Captain Fothergill, was wrecked in 1872 while carrying a load of sandalwood, mining equipment and 27 passengers, including the captain's wife and children. All passengers and crew of 15 Malays reached shore safely on the Montebellos, eight nautical miles to the east. The captain and a passenger set out in a small boat to find help and came across the *Mary Ann* in Flying Foam Passage near Dampier. This vessel was dispatched to rescue the remaining passengers and crew.

An unidentified boat was lost in 1893, and in 1905, the *Marietta* was scuttled. Little is known about this vessel, but it is likely that she was a pearling lugger that had reached the end of her working life. In the late 19th century other luggers may also have been lost in the area during cyclones.

The French explorer Baudin named the Montebello Islands in 1803 to commemorate the French victory at the battle of Montebello in northern Italy, over the Austrian army in 1800.

In 1818 Lieutenant Phillip Parker King conducted a British hydrographic survey throughout the study area in the *Beagle*. King named Barrow Island after John Barrow, second secretary of the British Admiralty. The *Beagle* revisited the area in 1840 under Captain John Clements Wickham to make observations of the fauna of Barrow Island and John Hart Stokes chartered the Montebellos and Trial rocks. Naturalists did not visit the area again until 1900, when J.T. Tunney collected birds and mammals on behalf of the Western Australian Museum.

The natural resources within the study area have been harvested for many years. American and British whalers are believed to have worked in the region as early as the late 18th century. Turtle fishing leases were first granted in the 1870s. Turtles continued to be taken commercially until 1973, when concern over the decline of green turtle populations led to the cancellation of licences.

Between 1902 and 1913 a pearling lease was held over waters around the Montebello Islands by Mr Thomas Haynes. North Delta Island, previously named Campbell Island was reserved for the 'Water Pearling Industry' and remnants of Haynes' buildings and other structures can still be seen there. An experimental pearl farming pen was established in Faraday Passage in 1906 and later, in the 1970s, the lagoon was modified for pearl culture experiments. In 1986 a pearling lease was granted to Morgan and Co. at the Montebello Islands and a short time later to Cossack Pearls at the Lowendal Islands.

Military History

In 1952 and 1956, a total of three British nuclear weapon tests were conducted at the Montebello Islands. The 1952 operation, called Operation Hurricane, saw a 25 kiloton device exploded inside the hull of the *HMS Plym*, a frigate which was anchored in 40 feet of water, 400 yards offshore from Trimouille Island. The explosion left a saucer shaped crater on the sea bed, 20 feet deep and 1,000 feet across. In 1956 during Operation Mosaic, two more devices were exploded, one on Trimouille Island and the other on Alpha Island. The 15 kiloton bomb on Trimouille was exploded at the top of a 31m tower. The bomb, which was detonated on Alpha Island, was originally stated to be a 60 kiloton device. However, recent access to documentation confirms that it was 98 kiloton, making it the largest nuclear weapon tested in Australia. Since the size of this device broke an assurance made personally by English Prime Minister Eden to Robert Menzies, that the size would not exceed 2.5 times that of Operation Hurricane, the true size was concealed until 1984.

At the height of the military operation, more than 5000 servicemen were based on and around the islands with a further 5000 supporting the operations on the mainland. Surviving ex-servicemen describe the area as being destroyed after the tests. The islands were levelled or cropped, with no surviving vegetation left. Eyewitness accounts say that the bodies of thousands of marine turtles were washed up on the beaches.

Today, many servicemen who took part in the tests say they were not warned about the dangers of radiation and some are involved in legal action against the British Government.
Remains of the military activities during the 1950's include scrap steel, disused roadways and the foundations of former British operational headquarters on the south of Hermite Island. Continuing radiation hazards limit the recommended length of time people can remain safely on parts of Trimouille and Alpha islands. Limited investigation of the *HMS Plym* site has been undertaken by the Maritime Museum of Western Australia and the site is considered to be of historic significance.

6.2 CURRENT 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"* which 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*. 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), a vesting and Ministerial advisory body
- the Marine Parks and Reserves Scientific Advisory Committee
- revised statutory consultative protocols for the establishment of marine reserves and,

- clear guidelines for commercial activities in marine reserves.

The roles and responsibilities of State Government agencies within marine conservation reserves are also defined and these are summarised in table 8.

TABLE 8 STATE GOVERNMENT AGENCIES WITH ROLES AND RESPONSIBILITIES IN THE STUDY AREA

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 to protect Australia's biological diversity. The development of an NRSMPA helps fulfil Australia's international responsibilities and obligations as a signatory to the Convention on Biological Diversity. It also helps to provide a means of meeting obligations under the Convention on Migratory Species and to fulfil responsibilities under bilateral agreements for migratory birds with Japan and China. 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*, the *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 Authority

Two shire councils are responsible for land in the study area (local government has no jurisdiction over marine waters). The Montebello Islands lie within the municipality of the Shire of Roebourne, and the Lowendal and Barrow Islands are within the Shire of Ashburton. The local government authorities are responsible for health and some building matters on the islands. No land-based infrastructure of relevance to the Shire of Roebourne currently exists on the Montebello Islands. However, the Shire of Ashburton conducts inspections twice a year on Barrow and the Lowendal islands where petroleum companies have constructed several buildings. Both councils take an interest in environmental issues concerning the islands, commenting on environmental matters and working cooperatively with other management agencies.

Port Areas and Shipping Routes

There are two crude oil loading terminals in the study area; at Varanus and Barrow islands. The crude oil loading terminals for Varanus and Barrow Islands are located about four and 10 km offshore, respectively. Tankers are moored near the end of submarine pipelines for loading. The Varanus Island port covers a circular area, centred at the end of the submarine pipeline and with a radius of 3.2 nm. The Barrow Island port covers a hemispherical area centred at the pipeline landfall, and has a radius of 7 nm extending from the northern-most point of the island (Cape Dupuy) to almost the south-western tip of the island. As ships round the north-western tip of the study area, the major shipping route passes between the Montebello Islands and Trial Rocks.

The southern end of Stephenson Passage, adjacent to Hermite Island, is used to shelter from cyclones. There are three moorings presently at this site.

Tenure

Within the Montebello/Barrow islands region there are two conservation parks and four island nature reserves. They are the two sections of the Montebello Islands Conservation Park, the Barrow Island Nature Reserve, the Lowendal Islands Nature Reserve, Middle, Boodie and Double Islands Nature Reserve and the Great Sandy Island Nature Reserve (Figure 5). These parks and reserves are vested in the National Parks and Nature Conservation Authority (NPNCA).
The Montebello Islands Conservation Park comprises over 100 islands, islets and rocks of the Montebello archipelago. The islands, covering 1446 hectares, are reserved as A Class conservation park (reserve N^{o} 42196) to the high water mark, with the area between the high and low water marks being a C Class conservation park (reserve N^{o} 42197).

The Barrow Island Nature Reserve is an A Class nature reserve (N^{o} 11648). It covers the land above the low water mark and has an area of approximately 23,483 ha. Barrow Island was reserved for conservation in 1908 following a faunal survey that highlighted its diversity in1900.
The Lowendal Islands Nature Reserve is a C Class nature reserve (N^{o} 33502) which extends to high water mark and comprises 40 islands, islets and rocks with an area of 445 ha.

Middle, Boodie, Pascoe, Boomerang and Double Islands make up a C Class nature reserve (N^{o} 38728) which covers all the land above the low water mark and has an area of approximately 588 ha.

The Great Sandy Island Nature Reserve is a Class B nature reserve (Nº 33831) comprising all of the islands and sand cays between the delta of the Fortescue River, approximately 40 km south-west of Dampier, and Gnoorea Point, approximately 50 km north-east of Onslow. The reserve is vested in the NPNCA and managed by CALM to conserve flora and fauna. The reserve extends to the low water mark in all areas and includes one of the sand cays known as the Barrow Islands Shoals, which is located within the study area.

Closer to the mainland, there are several island nature reserves including the Airlie Island, Little Rocky Island, Thevenard Island and Weld Island Nature Reserves. Land tenure in the Montebello/Barrow islands region is summarised in Table 9.

TABLE 9. VESTMENT AND TENURE OF LANDS IN THE MONTEBELLO/BARROW ISLANDS REGION

Reserve	Class	Name	Tenure	Purpose	Vesting Authority	
11648	A	Barrow Island	Nature Reserve	Conservation of flora and fauna	NPNCA	Gazetted to LWM
33902	C	Lowendal Islands (which include Abutlion, Bridled, Parakeelya & Varanus Islands, and Overhanging Rock).	Nature Reserve	Conservation of flora and fauna	NPNCA	Gazetted to LWM; CALM Lease 1902/100 granted to Bond Corp. and others over portion of the reserve
38728	C	Boodie, Double & Middle Islands	Nature Reserve	Conservation of flora and fauna	NPNCA	Gazetted to LWM
40828	C		Non-CALM Act-General	Marine Navigation Aid	AMSA	
41080	C		Non-CALM Act-General	Marine Navigation Aid	AMSA	
42196	A	Montebello Islands (which includes Ah Chong, Alpha, Buttercup, Bluebell, Brooke, Campbell, Carnation, Crocus, Daisy, Dandelion, Delta, Epsilon, Flag, Foxglove, Gannet, Gardenia, Hermite, Hollyhock, Howe, Ivy, Jonquil, Karangi, Kincup, Marigold, Northwest, Pansy, Primrose, Rose, Southeast, & Trimouille Islands):	Conservation Park	Conservation Park	NPNCA	Gazetted to HWM; Includes all islands and rocks; Excludes 40828 & 41080; CALM Lease granted to Woodside Offshore Petroleum Pty Ltd over portions of Trimouille Island.
42197	C	Montebello Islands (which includes Ah Chong, Alpha, Buttercup, Bluebell, Brooke, Campbell, Carnation, Crocus, Daisy, Dandelion, Delta, Epsilon, Flag, Foxglove, Gannet, Gardenia, Hermite, Hollyhock, Howe, Ivy, Jonquil, Karangi, Kincup, Marigold, Northwest, Pansy, Primrose, Rose, Southeast, & Trimouille Islands):	Conservation Park	Conservation Park	NPNCA	Includes all islands and rocks; Legal area gazetted is indeterminable; Between HWM & LWM
	Vacant Crown Land	Mushroom Island			not vested	
	Vacant Crown Land	Prince Island			not vested	

Reserve	Class	Name	Tenure	Purpose	Vesting Authority	
	Vacant Crown Land	Boomerang Island			not vested	
	Vacant Crown Land	Pasco Island			not vested	

Native title

There are no native title claims lodged with the National Native Title Tribunal which cover land or waters within the study area.

6.3 COMMERCIAL ACTIVITIES

The Petroleum Industry

Western Australia's petroleum industry began more than 40 years ago and today, annual state production exceeds 100 million barrels of oil and condensate (one barrel is 159 litres), 65 million barrels of liquefied gas and over 23,000 million cubic metres of gas. In 1999 the industry was valued at $5000 million per annum, making it the State's most valuable commodity. It employs 2500 people directly with an estimated 17,000 employed by companies servicing the industry.

The Pilbara region is the State's most productive petroleum area with 99.3 per cent of its oil and 92.2 per cent of its gas production. All Pilbara production is offshore with the exception of one small mainland project.

Oil was discovered on Barrow Island in 1964, and brought into production in 1966. However, interest in the region remained low until the early 1980s when fields were discovered south of Barrow. The Harriet fields off Varanus Island in the Lowendal Islands were developed in 1983 and the gas fields of Campbell, Sinbad and Rosette were subsequently brought into production.

There are two major petroleum projects within the study area, the Barrow Island Project operated by Chevron Australia Pty. Ltd., previously known as Western Australian Petroleum Pty. Ltd (WAPET) and the Harriet and east Spar projects on Varanus Island, operated by Apache Energy (Figure 7 & 8). More than 307 million barrels of oil have been produced from fields in the area between 1966 and 1996.

The Barrow Island Project is the State's largest oil-producing project (34 per cent of total State production) and some gas is produced as well (two per cent of total State production). There are 451 production wells on the island, which also supports infrastructure including accommodation, an airport, five 200,000-barrel oil storage tanks, plus separation and compression facilities.

Although Barrow is a nature reserve, Chevron Australia's lease covers virtually the whole island and the company is responsible for ensuring that operations do not negatively impact on the island's conservation values. The oil field has an estimated production life of a further 25 years.

The Harriet and East Spar projects produce gas, condensate and oil. The project comprises the Harriet, Agincourt, Campbell, Tanami, Sinbad, Rosette, East Spar and Wonnich fields, all of which are linked to the Varanus facilities. The two projects produce approximately six per cent of the State's oil production and twenty five per cent of domestic gas production. Condensate and oil are sold to the domestic and international markets, while gas is sold to the domestic market. Liquid products are loaded onto tankers offshore and natural gas is piped from the island to link into the Goldfields and Dampier to Perth Gas Pipelines. Apache Energy uses approximately 0.4 km^2 of Varanus Island for industrial facilities. Gas, condensate and oil are produced from eleven wells, seven located on platforms or monopods to the north east of the island, 2 onshore and 2 at sub sea buoys. Liquids are stored in three 250,000-barrel tanks on the island before transfer via a submarine pipeline to the offshore terminal.

Other petroleum finds within the study area yet to be developed include the Ulidia, Pascoe, Gorgon and Bambra discoveries and the presence of east-west faults with the potential to trap oil and gas make the area highly prospective.

The Department of Minerals and Energy is responsible for managing petroleum activities and administering the relevant Acts. Petroleum operations on land are controlled through the *Petroleum Act 1967*. On the water, operations are controlled though the *Petroleum (Submerged Lands) Act 1982*. Both Acts provide for the issue of exploration permits (seismic and drilling) and production licences. With the exception of a few small blocks, exploration permits or production leases cover the entire study area.

The *Petroleum Pipelines Act 1969* governs the construction, operation and maintenance of petroleum pipelines. Companies are required to obtain a Pipeline Licence to construct a pipeline. Apache Energy's Harriet and East Spar projects have the most extensive submarine pipeline system. These pipes transport oil from the Agincourt and Harriet A, B and C platforms and gas and condensate from the Campbell, Sinbad and Wonnich monopods to production and storage facilities on Varanus Island. Condensate and oil are delivered via a 4 km long submarine pipeline to the loadout terminal, while gas is transported along a 90 km long pipeline to the mainland for connection to the Dampier to Perth gas pipeline.

The State Government's policy on petroleum exploration and development in marine conservation reserves is summarised below.

Petroleum drilling and production will be prohibited in marine nature reserves, both sanctuary and recreation zones of marine parks, and in those special purpose zones of marine parks where such activity would be incompatible with the conservation purpose of the zone.

Petroleum drilling and production will be permitted in parts of general use and special purpose zones of marine parks subject to assessment through the *Environmental Protection Act*.

Petroleum drilling and production can be undertaken in marine management areas subject to assessment through the *Environmental Protection Act.*

Seismic surveys may be permitted in marine parks and marine management areas subject to environmental impact assessment processes agreed by the Environmental Protection Authority in consultation with CALM and Fisheries Western Australia.

The Minister for the Environment requires the consent of the Minister for Mines before creating any marine conservation reserve or management zone within a marine park or marine management area.

All Western Australian marine conservation reserves are limited to a depth of 200 m below the seabed. This enables directional drilling as part of petroleum exploration and production activities below the 200 m limit while preserving the integrity of the reserves.

Environmental issues

As with all human activities, the petroleum industry has the potential to impact the natural environment, and perhaps the scenario of greatest concern to the public is the unlikely event of an oil spill or shipping accident. Fortunately, the oil produced within the study area is a light crude which evaporates quickly in the tropical temperatures and strong breezes. However, engine oils that could leak from damaged vessels are heavy, evaporate slowly and have the potential to cause significant environmental damage.

All petroleum companies that operate within the study area have comprehensive oil spill contingency plans, which include oceanographic models to predict the drift of spilt materials. The companies also stockpile equipment for combating oil spills with additional equipment being available at Fremantle and elsewhere. In addition, regular exercises and practice drills are conducted to ensure that the equipment functions and staff are adequately trained to cope with and oil spill emergency.

Seismic surveys to investigate underground geological formations and prospective drilling locations use a pulse of energy directed down into the rock layers. Explosives were once used to create the pulse but this method caused significant environmental damage so today, air guns are used. The environmental impacts of air guns are not well understood but research is currently being undertaken to investigate the effects on a wide range of marine animals including whales and turtles.

During drilling, the drills require lubricant fluids to reduce friction. Petroleum companies within the study area use water based fluids where possible and avoid the more toxic oil and synthetic based fluids except for particularly difficult rock formations. The tailings, or cuttings brought to the surface during drilling are covered in drilling lubricants and can smother plants and animals growing on the surrounding seabed. In very sensitive locations, companies sometimes re-inject the cuttings into the drill hole to minimise environmental damage. This technique, called annular re-injection was carried out at an exploration well near Dugong Reef within the study area.

When oil is pumped to the surface, water and gas are contained in the mixture. This mixture is pumped into a tank and placed under pressure to separate the three components. The water goes to a storage tank where further oil is skimmed off. The remaining water still contains low levels of petroleum and sometimes heavy metals. WAPET produces 60,000 to 70,000 barrels of water and 13,000 to 14,000 barrels of oil per day indicating that about 80 per cent of the day's production is water. The production water on Barrow Island has been re-injected into the ground to a depth of about 160 m but now the company is about to implement a new system of deep re-injection to about 1000 m. Until recently, the production water on Varanus Island was discharged into shallow water bores, but it too is now re-injected deep into the ground. Production water from offshore wells within the study area is discharged into the ocean and is monitored and managed by the Department of Environmental Protection.

Many facilities are lit up at night and there are concerns that birds and turtles can become disorientated by artificial lights. Fledging shearwaters are drawn to lights on the horizon and some are lost each year around flares, particularly on Thevenard Island. Fortunately, the gas flares have limited impact on turtles, which appear relatively insensitive to the yellow/red end of the colour spectrum but fluorescent and other white lights attract hatchlings which then fail to go out to sea. Today, research is continuing, but in the interim many of the lights used at petroleum industry facilities have yellow filters or are screened from the coast and low vapour pressure sodium lights are used where possible.

While not directly related to the petroleum industry, shipping also poses a potential risk to the environment through the pumping of bilges. Large empty vessels fill their holds with ballast seawater to maintain stability at sea. This is pumped out before a new cargo is loaded thereby transporting significant volumes of seawater between ports. 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. All tankers visiting Chevron Australia's marine terminals in the Pilbara are informed of the guidelines and the company collates statistics on the source and volume of ballast water discharged at the Barrow Island facility. This information is provided in table 10. Vessels entering the Varanus Island loading terminal discharge roughly 9,000 tonnes of ballast water a month. These tankers are also requested to comply with the AQIS guidelines.

TABLE 10 BALLAST WATER SUMMARY AT BARROW LOADING FACILITY IN 1998

Number of ships	Origin	Ballast treatment	Volume discharged (tonnes)
1	Overseas	Ballast exchange at sea	31,000
2	Overseas	Ballast exchange at Sea (flow through method)	22,726
2	Overseas	Ballast not treated	36,760
13	Australian Ports	Ballast not treated	263,359

Tributyl tin (TBT) is used on ships hulls to prevent fouling by encrusting organisms. It continually sloughs off the hull surface and is one of the most toxic substances introduced into the marine environment. TBT is usually found in the water column and sediment in the vicinity of shipping operations. However, there is no monitoring of TBT levels near the Varanus or Barrow loading facilities.

Commercial fishing

The Pilbara demersal finfish fisheries target red emperor, rankin cod, scarlet perch, red snapper, jobfish, spangled emperor, blue spot emperor, flagfish and threadfin bream. The greatest finfish catch throughout the Pilbara is taken by the trawl fishery. However, the study area is located within a trawling exclusion area and is therefore not currently used by this fishery. Two other commercial techniques are used to catch demersal finfish within the study area: fish trapping and line fishing.

The Pilbara Trap Managed Fishery, established in 1992, lies north of 21º 44' south latitude and between 114º 9'36" east longitude and 120º east longitude between the 200 and 30 m depth contours. The number of licences was reduced from twelve to six in 1996. In 1997, the total number of traps which could be used in the fishery was restricted to 78. In that year, the catch was 234 tonnes worth $1.4 million, with red emperor having made up the greatest proportion of the catch. At the commencement of the year 2000 licensing period, a new system of effort regulation based on the allocation of time/gear units was introduced. A time gear unit is equal to one fish trap used for a given time period (currently one day). For the year 2000, a total of 5867 trap days were allocated.

Line fishing is unrestricted throughout the study area and in 1997, 49 commercial line fishers operated in this fishery. Issues associated with unrestricted access by commercial line fishers to the Pilbara are discussed in a paper (Fisheries Management Paper 111) that considers management options to address these concerns. In 1997, the line fishing catch was 109 tonnes worth $0.7 million and the species that made up the greatest proportion of the catch was jobfish.

Some of the commercial line fishers also troll for the valuable Spanish mackerel in waters of 20 m and more. In 1997, trolling off the Pilbara coast landed 152 tonnes of pelagic fish worth $1.1 million.

The North Coast Shark Fishery has access to the study area and in 1997, landed approximately 250 tonnes worth an estimated $240,000. There are currently eight licensed operators within this fishery, seven of which have access to the study area. They use hook and line techniques; either drop lines which are set vertically, or long lines which are set horizontally through the water column. 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.

Zones 2 & 3 of the Onslow Prawn Managed Fishery fall within the Montebello/Barrow islands region. There are 31 operators licensed for the region: 12 can only fish in zone 2; 12 can only fish in zone 3, and seven have access to both zone 2 and 3. However, prawn trawling is generally restricted to inshore areas near to the mainland coast so operators do not currently use the study area.

There are four commercial fishers with mud crab licences, but although mud crabs occur within the study area, there is a closure to commercial mud crabbing west of Yardi River near Coolgra Point.

There is a closed area for tropical rock lobsters between Onslow and Cape Preston that includes the Montebello Islands. However, the fishery has access to waters west of Barrow Island.

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 hooker diving equipment to locate mainly three species: the sand fish (*Holothuria scabra)*, the black teat fish *(Holothuria nobilis)* and the white teat fish *(Holothuria fuscogilva)*. In 1998, the Beche-de-mer fishery landed 345 tonnes wet weight of product, most of which was taken in the Kimberley. The product is exported to Asian markets where it is considered a delicacy.

Commercial boats operating in Commonwealth-managed fisheries such as tuna longliners, can access the waters of the study area but are currently not active in the region.

Fisheries Western Australia has issued 32 commercial shell collecting and 13 aquarium fish collecting licences in Western Australia although only a few of the operators fish commercially full time. This industry tends to focus on the mainland coast where access is easier. However, the endemic marine gastropod *Amoria macandrewi* is targeted in the study area but actual numbers taken are not known.

Commercial fishing in Western Australia is managed under the *Fish Resources Management Act 1994* 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. The Government's policy on commercial fishing in marine conservation reserves is summarised below:

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 within 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 of exclusion zone in a marine park, then the holder of the authorisation will be eligible to apply for compensation.

Pearling

Pearling began in Western Australia in the 1850s when natural pearl oysters were found in Shark Bay and later at Nickol Bay near Karratha. At that time, pearlers collected the mother of pearl, the shiny layer inside the shell, and counted themselves lucky if they found a pearl inside the shell. In the 1890s, 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 in the Broome area. This was an industry thwart with danger and many divers were exploited and lost their lives.

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 pearl cultivation was lifted and the industry regained its former strength. Today it is worth around $200 million a year.

Pearling is the production of pearls from particular species of oysters, which are either collected from the wild or grown in hatcheries. Shells are seeded, then allowed to recover for several months before being transported to farms to grow out for several years. During the grow-out period the shells are tended very carefully to create beautiful pearls.

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 layers a lustrous coating called nacre around the fragment. Nacre is a form of calcium carbonate. 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 close to the equator tend to produce duller pearls than those produced at higher latitudes. This is one of the reasons why sites within the study area are some of the best in the world for the production of high quality pearls.

There are approximately 60,000 shells at the Montebello Islands pearl farm alone and large numbers are also held at the Lowendal pearl farm. Juveniles are brought from Carnarvon, as there are no hatcheries within the study area. After seeding, the oysters are replaced on the seabed in panels, which are turned regularly to aid the formation of round pearls. A few months later, the panels of oysters are suspended from long ropes in the water column to grow out. The panels are placed in areas of high tidal movement, where microscopic planktonic food is abundant. They stay in the grow-out area for about two years by which time, the pearls have grown to a reasonable size and quality. During this period, the shells become encrusted with sedentary marine organisms which have to be scraped off at regular intervals. Most of the pearls produced within the study area are sold to Japan, but some go to the United States, Hong Kong and Europe.

The six pearl farming leases currently held in the Montebello/Barrow islands region are listed in table 11 and their boundaries are illustrated in figure 16. A further 12 applications from Morgan & Co Pty Ltd have been approved for pearling lease but only for a period of three years, while the proposed marine conservation reserve is being planned. These leases are in the north west of the Montebello

Islands and cover approximately 1230 ha. Cossack Pearls Pty. Ltd. Currently holds a 1231 ha lease to the west of the Lowendal Islands.

TABLE 11 PEARLING LEASES IN THE STUDY AREA

Lessee	Area	Location
Cossack Pearls	1231 ha	NW Lowendal Is.
Morgan & Co	3 ha	Claret Bay, Montebellos
Morgan & Co	363 ha	Bunsen Channel, Montebellos
Morgan & Co	59 ha	Crocus Is, Montebellos
Morgan & Co	16 ha	Chianti Bay, Montebellos
Morgan & Co	48 ha	Faraday Channel, Montebellos

Leases for cultivating *Pinctada maxima* in State waters are issued under the *Pearling Act 1990.* Licences for cultivating other pearl oyster species, *Pteria penguin, Pinctada margarifera,* and *Pinctada albina* are issued under the *Fish Resources Management Act 1994* and are considered as aquaculture rather than pearling.

As with other human activities, pearling has the potential to impact the natural environment and the granting of licences is just one form of control over the 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. In the year 2000, the unit size within the study area is to increase to 1,100 shells. Wild oysters can only be gathered when they reach the minimum size of 120 mm. The optimum size for harvesting oysters is between 120 and 160 mm. If the oysters are greater than 160 mm, they are left to form breeding stocks. There are also restrictions on breeding pearl oysters for hatchery production. Production of baby oysters or spat is controlled with a limit of 20,000 spat per licence.

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

Other concerns associated with pearling include the potential for grow-out panels to shade benthic flora and fauna. All plants require light to grow and any reduction in light will cause a reduction in productivity to the extent that severe light depletion will result in an area becoming unsuitable for plant growth. Shell grow-out panels and the associated ropes and markers have the potential to entangle marine wildlife and if they break loose during storms they can litter the water column and nearby beaches causing a further hazard to wildlife. Lights associated with pearling industry facilities can attract and disorientate birds and turtles and for hatchling turtles this has the potential to prevent them from reaching the open ocean. In addition, although the majority of facilities are located on house boats and pontoons, there is demand for shore-based facilities for seeding and storage of equipment. This demand may place pressure on adjacent reserves and vessels servicing island pearling facilities have the potential to transport and reintroduce feral animals onto the islands.

Public access to pearl grow-out areas is stipulated in the lease conditions, though some areas may be 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 conditions 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 negotiate solutions to conflicts over resource sharing and issues of access in the marine environment.

The State Government's policy on aquaculture and pearling in marine conservation reserves is summarised below:

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 and recreation

The study area offers a range of possibilities for recreation and tourism. The climate is pleasantly warm and sunny in winter, while breezes in summer temper the hot temperatures experienced on the mainland. Stunning island scenery is complemented by blue seas and productive coral reefs that support prized table fish. Although the area was damaged by the atomic tests and currently supports major petroleum and aquaculture industries, it still has an untamed beauty which is sought by many people. This wilderness supports a wealth of charismatic species including, whales, dolphins, dugong, turtles and birds that delight tourists and have the potential to support nature based tourism.

Recreational boating, diving, fishing, collecting and wildlife observation all occur within the study area, but remain at low levels. The area's isolation from major mainland centres prohibits all but a few private boat owners from venturing out so far. In addition the atomic tests in the 1950s have left some areas of the Montebello Islands unsafe to visit for more than a few hours while access to other islands is restricted.

Petroleum leases prohibit public access on Barrow Island and Varanus Island of the Lowendal group. The other Lowendal Islands are gazetted as Nature Reserves, and while camping is prohibited, public access for day visits is allowed. Currently, there is no potential on the Barrow and Lowendal islands for tourism development. However, the accommodation facilities for company staff could be converted for tourists when petroleum production on Barrow Island ceases. The Montebello Islands are gazetted as a conservation park, but there is no management plan at present. Upon the completion of a management plan, opportunities for ecotourism activities and low key wilderness accommodation on the Montebello Islands may be made available.

Very few of Western Australia's 500,000 recreational fishers visit the study area. The few who do target spangled emperor, red emperor, Spanish mackerel, coral trout, mangrove jacks and trevally. Visitors also take mud crabs, oysters, squid and other edible organisms.

Recreational fishing is managed by Fisheries Western Australia through a variety of management tools to limit catch levels within sustainable levels. Bag and size limits apply to most species of fish and a license is required to take crayfish. Potato cod, whale sharks and hump headed maori wrasse are fully protected and large specimens of all cod species must be returned undamaged to the water.

Fisheries Western Australia has commenced work on a Regional Recreational Fishing strategy for the whole North West Shelf region. This study will review the sizes and status of fish resources and identify human activities that threaten them. Management strategies will be reviewed to ensure that fishing pressure remains within sustainable limits. A significant component of this study will involve community input and in 2001, a consultative committee will be established to commence work.

In line with the State Government's multiple-use policy, recreational fishing will be provided for in marine conservation reserves. Recreational fishing will not be permitted in marine nature reserves or in sanctuary and certain special purpose zones in marine parks. However, access will be maintained in marine management areas plus general use zones, recreation zones and some special purpose zones within marine parks. Recreational fishing in marine conservation reserves will continue to be managed under fisheries legislation.

Boating is a popular recreational activity in Western Australia, with a total of 57,000 private vessels registered with the Department of Transport. Pilbara coastal towns have the highest rate of boat ownership per capita in Western Australia. Despite the large number of private vessels on the adjacent mainland coast it is estimated that only about 50 yachts and 30 other vessels visit the study area each year for recreational activities which include fishing, diving and wildlife viewing.

If boating increases in the future, disposal of effluent and other rubbish, plus the misuse of anchors and moorings in sensitive habitats have the potential to impact the marine environment.

The Department of Transport is responsible for all boating regulations including licensing, safety standards, marker buoys, moorings and jetties. This management responsibility remains with the Department of Transport within marine conservation reserves. However, mooring controls can be delegated to other agencies.

An estimated 15,000 SCUBA divers train in Western Australia each year. Many come from overseas and a significant number remain for diving vacations after training. Beautiful corals and other underwater scenery together with the variety and profusion of large marine wildlife attract divers and snorkellers to the study area but the absence of public flights and accommodation in the study area keep their numbers low.

There is currently very little use of the study area for surface water sports. Surfing, sea kayaking and wind surfing could take place around the islands, though fast tidal currents would make these activities dangerous for inexperienced visitors.

Many visitors to the study area enjoy wildlife observation. Whales, dolphins, dugong, 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 interaction during wildlife viewing is 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 and the use of flash cameras near whale sharks requires a license. Nesting birds and turtles are particularly vulnerable to disturbance and visitors are required to keep quiet, keep still and minimise lighting near nesting turtles.

In addition to the marine wildlife that already attracts visitors, the elimination of feral cats and rats and the reintroduction of native animals that are rare on the mainland has the potential to attract more wildlife viewers to the region.

Tourism in the whole Pilbara region was estimated to be worth $59.5 million in 1996 and visitation figures indicate that this amount would have increased. Staff accommodation on Barrow Island may be converted to tourist facilities when petroleum production ceases, but current options for overnight tourist accommodation are limited to visiting charter vessels, camping ashore, and one small houseboat in Claret Cove, Hermite Island.

The wide variety of wildlife and the wild, natural appearance of the land and seascapes within the study area have the potential to support nature based tourism. The high nature based tourism potential was identified in the Pilbara Development Commission's ecotourism management strategy for the Pilbara and Gascoyne offshore islands. Providing high quality experiences for visitors could make a major contribution towards protecting the State's unique ecosystems, especially in coastal environments, by fostering a greater understanding of nature.

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

Chapter Six

Advisory Committee: Information Package

CHAPTER 6 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, undated);

(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 (prepared by EPAWA, CALM & FWA)

(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 Montebello/Barrow islands 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 Montebello/Barrow islands 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 7 ADVISORY COMMITTEE: IMPLEMENTATION

A call for expressions of interest for membership of the Advisory Committee for the proposed Montebello/Barrow islands 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 21 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 16/5/2000, the Minister for the Environment announced the appointment of the 10 member Advisory Committee for the Montebello/Barrow islands 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 Montebello/Barrow islands marine conservation reserve are: Norm Halse (Chair), Iva Stejskal, Russell Lagdon, Guy Leyland, John Baas, Craig Thomas, Noel Parkin, John Jenkin, Kellie Pendoley and Vicki Long.

The Advisory Committee will have its inaugural meeting in August on Barrow Island 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 8 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 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 December 1997, the State Government announced that the Montebello/Barrow islands region was a priority area for consideration for reservation as marine conservation reserve. An assessment has been undertaken to determine the area's values, natural marine resources and commercial and recreational uses.

The Western Australian Government is committed to full and open consultation during the consideration of an area as a marine conservation reserves, with a statutory requirement for public participation in the planning process.

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

The **objective** of the PPP in the planning and management of WA marine conservation reserves is to encourage and facilitate effective public involvement in the planning process and daily management of a proposed marine conservation reserve.

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 12.

TABLE 12 STAGES AND TASKS OF PPP

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

	• Support on-going community extension program

Phase One of the PPP includes an *issue analysis*. The term issue analysis is used to describe the task of gathering and analysing discussions between CALM staff and representatives from the wide range of interest and user groups in the community. The objective of the issues 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 all relevant user and interest groups. 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.

Attitude was assessed as receptive, cautious or hostile towards the proposal of a marine conservation reserve. Attitude was assessed because people with a hostile attitude are unable to absorb information or consider other perspectives. If a significant proportion of members or very influential members of a

sector were hostile towards the reserve proposal, a community liaison strategy would be needed to address this problem before educational material was distributed or negotiations commenced.

To allow for effective community debate and input into reserve planning, members of the community need to have an understanding of, and agree with, the objectives of the process. They also need to have an adequate level of understanding of the following marine conservation and management concepts if they are to develop a common vision for the successful establishment of a marine conservation reserve:

- 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 and community in the planning process.

An assessment was made of each interview regarding the adequacy of knowledge and understanding displayed by the interviewee. It was not always appropriate to assess knowledge and understanding of all of the above concepts in every interview. Levels of knowledge and understanding were assessed by interviewers by asking open-ended questions and levels recorded along a sliding scale for each topic. Notes were provided to interviewing staff to assist in the consultation process (appendix f) A minimum level of understanding for each topic was defined as an individual having an understanding of the following:

Values of the proposed area: At least three value attributes from the following list in relation to the proposed area:

commercial fishing	scientific
tourism	educational
recreation	scenic/amenity
wildlife	conservation

Multiple-use and zoning:

- WA marine reserves allow for many uses, both commercial and recreational.
- Different activities are separated into geographically distinct areas
- The types of marine reserve and zoning options in WA.

Representativeness and no-take:

- Diversity of ecosystem types around the State and the concept of samples being represented within a state-wide reserve system
- Diversity of habitat types within reserve proposal area and the concept of samples being represented within no-take zones.
- Reasons for no-take areas and issues of zone scales for the different reasons.

Sustainability:

- Primacy of conservation for sustainable use
- Cumulative impacts of multiple use.

Integrated management:

- Many agencies have management jurisdiction in the marine environment.
- Marine reserves provide a management framework to coordinate the activities of all these agencies.

Planning process & public participation:

- Advisory committee has community-based membership.
- Advisory committee substantially develops the indicative management plan.
- Public input into the initial stages of planning is primarily through advisory committee members.
- After the issuance of the draft indicative management plan there is a statutory public submission period for written submissions direct to CALM.

Assessments of levels of knowledge and understanding, together with the interviewees aspirations, concerns, issues and alliances were recorded on standard forms, an example of which is in appendix E.

8.3 RESULTS

The issues analyses for the proposed Montebello/Barrow islands marine conservation reserve was conducted in March - May 2000 with some 33 discussions regarding the proposed reserve, with 43 people from 15 user groups, undertaken. The number of discussions undertaken with each user group are listed in Table 13, though it must be noted that some interviews were with more than one person, representing more than one user group.

TABLE 13 NUMBERS OF DISCUSSIONS CONDUCTED WITH USER GROUPS OF THE MONTEBELLO/BARROW ISLANDS REGION.

User Group	Number of discussions	Number of people
COMMUNITY MEMBERS		
Local Residents & Ratepayers	6	6
RECREATIONAL ACTIVITY GROUPS		
Boating	3	3
Diving	1	1
Fishing	3	5
INTEREST GROUPS		
Conservation	2	6
Science	4	4
Education	2	3
GOVERNMENT		
Local	1	1
State	4	6
Federal	1	1
COMMERCIAL ACTIVITY GROUPS		
Fishing	2	2
Aquaculture/Pearling	3	4
Tourism	9	10
Industry	4	4
PRESS	1	1

Community and stakeholder attitudes towards the proposed Montebello/Barrow islands marine conservation reserve were varied, however the majority of people interviewed were receptive to the proposal. Given the low percentage of negative attitudes encountered, the public participation program does not need to include strategies to address unreceptive attitudes. Attitudes of the interviewees are shown in figure 18.

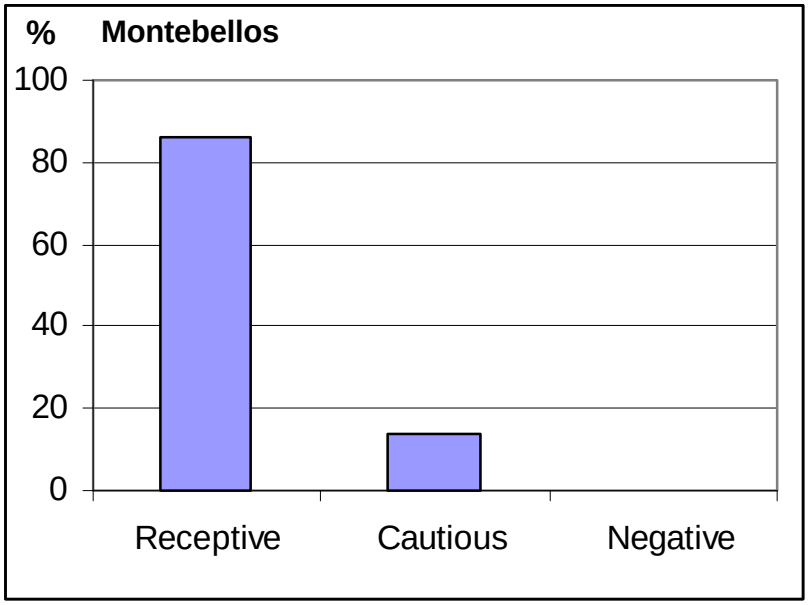

Figure 18: Community attitudes to the Montebello/Barrow islands marine conservation reserve proposal.

Levels of knowledge and understanding among the community of reserve concepts was generally low, and is considered to be inadequate for effective participation in planning. The exception to this is community understanding of sustainability and values of the proposed area, which was comparatively high in comparison to understanding of the other concepts. Levels of knowledge and understanding in the community are shown in figure 19.

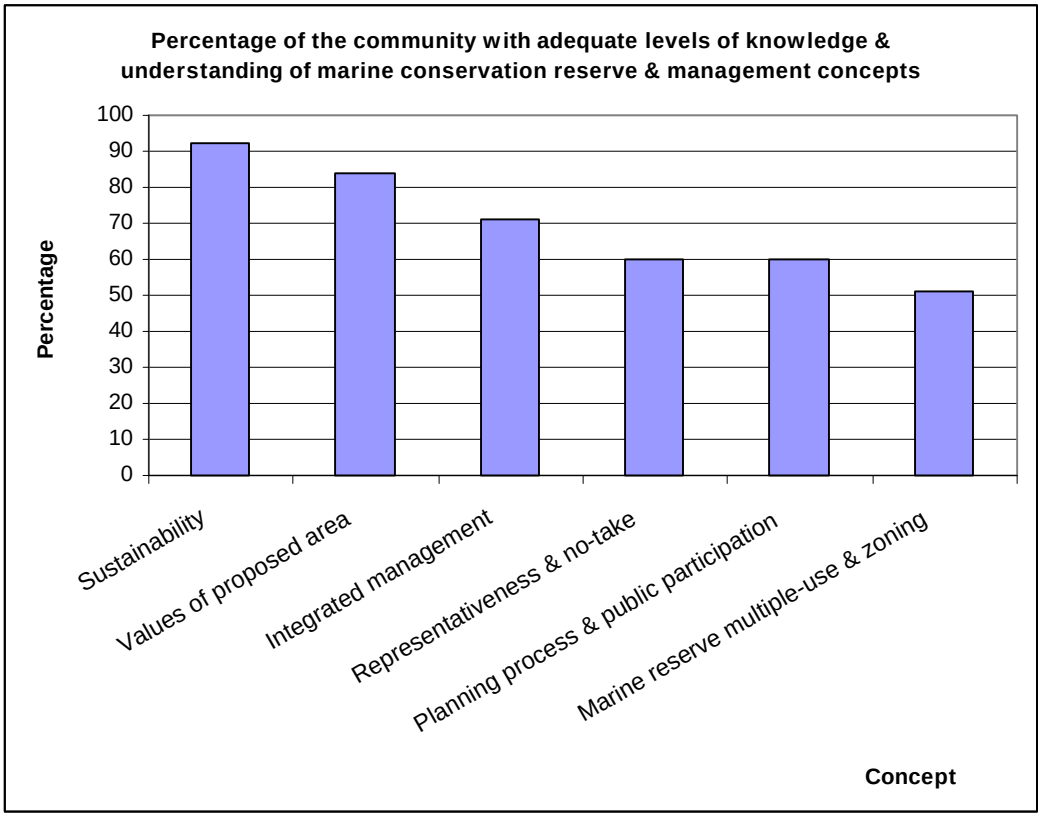

Figure 19 Community understanding of marine reserve concepts

Community levels of knowledge and understanding were also assessed by user group. Although mean levels of knowledge were high for some user groups, no group had a broad understanding of all concepts. Tourists had the lowest level of understanding which indicates that preliminary educational and media work has been more effective with user groups resident in the area. Indications are that the public participation program needs to include a significant educational component across all sectors. Knowledge and understanding of user groups is presented in figure 20.

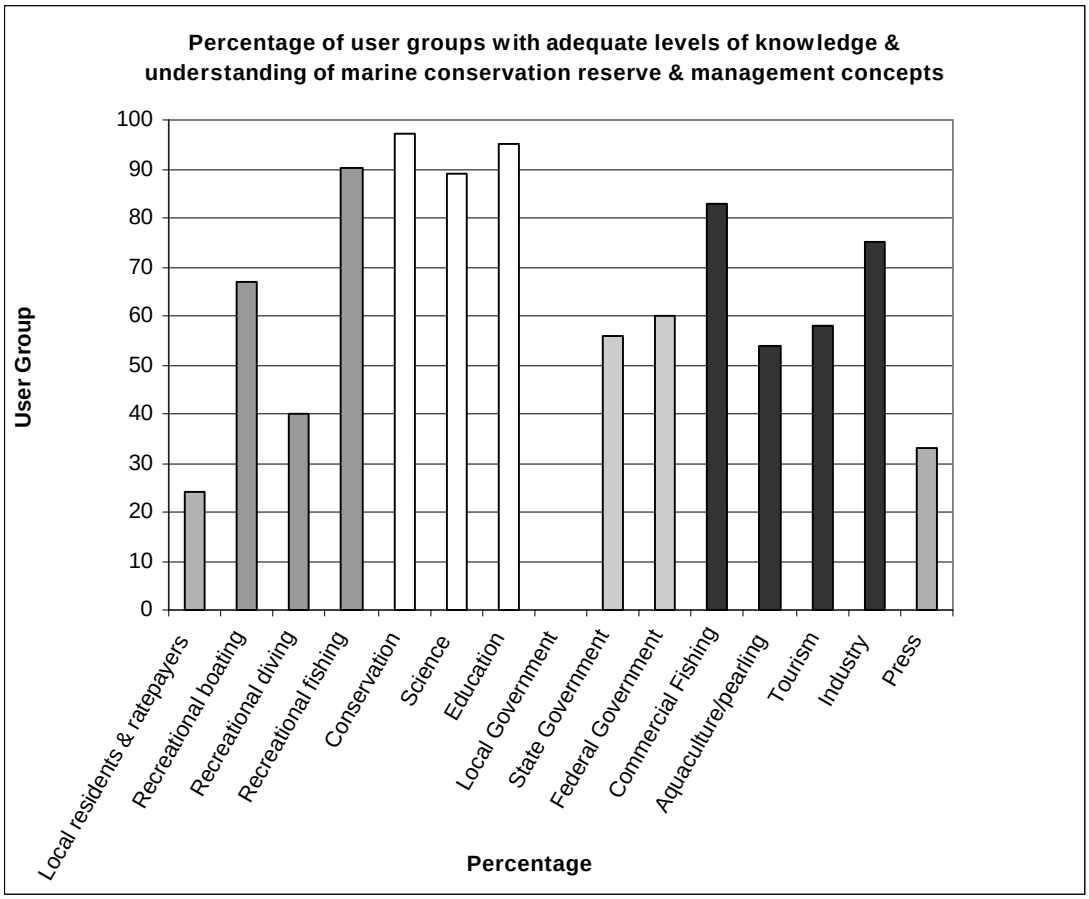

Figure 20 Knowledge and understanding of user groups

Interviewees were also given the opportunity to raise any issues or concerns they had about the marine environment and the proposed marine conservation reserve. The most commonly recorded concern was that of impacts on the marine environment, including fish depletions. The primary concerns are summarised in table 14.

TABLE 14 ISSUES AND CONCERNS IN THE COMMUNITY.

Issue	Number of times a concern of this nature was recorded
Planning – who, what, why, when & how	38
Environmental concerns – degradation of the environment as a result of human activity	35
Overfishing/Overharvesting/Stock depletion	34
No take areas – concept and structure	20
Community attitudes affecting the planning process & overall outcome for the proposed marine reserve	15
Zoning – concerns with concept and structure	11
Resources- are there enough to make and support a marine reserve	10

Consultation – the effectiveness of it	9
Advisory committee & how it will work	8
Policing & compliance of the marine reserve	7
Access- Effects on use of the marine environment	7
Effect on the current use of the marine environment by industry	4
Effect on future developments in industry	3
Reserve – size of area	1
Integrated management not currently working	1
MPRA – not being representative enough of the community	1
Pearling- industry, leases & misconception	1

8.4 DISCUSSION

Results of the issues analysis conducted for the proposed Montebello/Barrow islands marine conservation reserve indicate that the public participation program and community consultation for this study area needs to focus on the below points:

- Increasing community understanding of the public participation process in marine conservation reserve planning ie. how the community can get involved.
- Increasing community understanding of marine reserve multiple use and zoning concepts
- Increasing community understanding of integrated management as a concept
- Increasing community understanding that there are a range of different ways in which people use the marine environment and that the way an individual values the area is no more important than the way others value it ie. commercial use is not more important than recreational use.
- Taking the transient nature of the population into consideration in planning
- Improving consultation with Aboriginal groups, which can often be difficult due to conflicting land claims.

Chapter Nine

Public Participation Program: Community Consultation

CHAPTER 9 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 Montebello/Barrow islands area for reservation (see appendix G)

- 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 Montebello/Barrow islands 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, as well as information about 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 becoming further involved.

- A display was exhibited at the Karratha Youth Festival, which comprised marine posters, information on the marine reserve planning process and proposed Montebello/Barrow islands 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 10 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 detail 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 (see appendix H for brochures).

- 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 11 PROGRESS REPORT SUBMISSION

11.1 BACKGROUND

The Montebello/Barrow islands 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 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 Montebello/Barrow islands region as priority areas for the establishment of marine conservation reserves under the *CALM Act*.

Currently, there is no other marine conservation reserve in the "Pilbara offshore" 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 Montebello/Barrow islands 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.

This report details progress achieved on Project No WA9702 "Planning and pre-declaration process for a Marine Protected Area in the Montebello/Barrow islands region" up to September 1999.

11.2 AREA OF INTEREST

The are of interest (Figure 1) referred to as the Montebello/Barrow islands region, falls in the Pilbara Offshore IMCRA bioregion.

The area of interest is covered by:

- AUSLIG Topographic Series 1:250,000
  - SF50-1 Barrow, and;
  - SF50-2 Dampier.

- AUSLIG Topographic Series 1:100,000
  - 1955 Airlie;
  - 1956 Barrow;
  - 1957 Tryal;
  - 2055 Mardie, and;
  - 2056 Sholl.

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

TABLE 15 COORDINATES OF THE STUDY AREA

Bearing	Latitude	Longitude
North	20° 17’ 24” S	115° 31’ 12” E
North west	20° 28’ 48” S	115° 24’ 00” E
West	20° 50’ 24” S	115° 15’ 00” E
South west	21° 00’ 36” S	115° 19’ 12” E
South	21° 09’ 00” S	115° 28’ 12” E
South east	21° 01’ 48” S	115° 32’ 24” E
East	20° 42’ 00” S	115° 37’ 48” E
North east	20° 21’ 36” S	115° 37’ 12” E

11.3 PROGRESS AGAINST PROJECT SCOPE ITEMS

Progress against scope items have been satisfactory (see below)

TABLE 16 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.	(a) Field programme report (Appendix a)
2.	Preparation of advisory committee information package	80%	• A regional perspectives paper is well progressed.	(b) Draft table of contents attached (Appendix b)
		70%	• Procedural guidelines for Western Australian marine reserve planning and management legislation.	(c) Draft attached (Appendix c)
		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.	(d) Advertisement attached (Appendix d)
		40%	• The selection process is well progressed with the scheduled inaugural meeting of Montebello/Barrow islands Advisory Committee currently waiting for approval by the State Minister for the Environment.	
4.	Implementation of community consultation programme	10%	• Programme has been initiated.	
		20%	• Interpretive posters are being designed.	
		50%	• Interpretive brochures are well progressed.	

11.4 EXPENDITURE TO DATE

TABLE 17 EXPENDITURE TO PROGRESS REPORT

Item	Funding	Expenditure	Balance
NHT funds received 1998/99	$32,250		**$32,250**
Expenditure 1998/99		$13,561	**$18,689**
Funds on progress report (Oct 1999)	$0		**$18,689**
Expenditure 1999/2000 (to Sep 1999)		$6,482	**$12,207**
Residual expenditure 1999/2000		$22,957	**($10,750)**
Funds on final report 1999/2000	$10,750		**$0**
Totals	**$43,000**	**$43,000**	**$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 Montebello/Barrow islands advisory committee will hold their inaugural meeting in late October or early November 1999.

TABLE 18 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 programme				●	●	●	●	●	●							
								➡	➡	➡	➡	➡	➡	➡	➡	➡
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 12 STATEMENT OF EXPENDITURE

TABLE 19 TOTAL EXPENDITURE BY AGENCY

Item	MPAP funding	MPAP Expenditure ($)	CALM Expenditure ($)	Total Expenditure ($)
NHT funds received 1998	$32,250			**$0**
Expenditure to June 1999		$13,561	$48,000	**$61,561**
Expenditure 1999/2000 (to February 2000)		$29,439	$98,000	**$128,039**
Funds on final report 2000	$10,750			**$000**
Totals	**$43,000**	**$43,000**	**$146,000**	**$189,600**

References and Information Sources

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APPENDICES

APPENDIX A. PROJECT DETAILS AND WORK SCHEDULE

PROJECT DETAILS

Project No. and Title: WA9702 Planning and pre-declaration process for a MPA in the Montebello Islands-Barrow Island region.

Project Supervisor:	**Dr Chris Simpson**
Agency:	Department of Conservation and Land Management (CALM), Marine Conservation Branch
Contact Address:	47 Henry Street FREMANTLE WA 6160
Telephone:	(08) 9432 5101
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Environment Australia Liaison Officer:	**Edward Kleverlaan**
Agency:	Environment Australia
Contact Address:	Marine Conservation Section GPO Box 787 CANBERRA ACT 2601
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Aims:

- To initiate planning and pre-declaration processes for the Montebello Islands-Barrow Island 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 a stakeholder advisory committee information package, comprised of:
   (i) A regional perspectives paper, comprising 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 marine 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 $43,000 payable by the instalments specified in Table 1:

Table 1

Payment	Report	Date	Amount
Initial	Work Schedule	October 1998	$32,250
	Progress	April 1999	$0
	Draft Final	Jul 1999	$0
Final	Final	Aug 1999	$10,750
		Total	$43,000

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 Montebello Islands-Barrow Island 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 process for a MPA in the Montebello Islands-Barrow Island region

Objectives/Aims of Project:

- To initiate planning and pre-declaration processes for the Montebello Islands-Barrow Island 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 a stakeholder advisory committee information package, comprised of:
   (i) A regional perspectives paper, comprising 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 marine 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 Montebello Islands – Barrow Island Region**, funded under the Marine Protected Areas (MPA) Program and subject to a Financial Agreement between Environment Australia and the Department for Conservation and Land Management, dated 24 November 1998 (copied attached).

Project Supervisor:	**Dr Chris Simpson**
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Environment Australia Liaison Officer:	**Edward Kleverlaan**
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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 $43,000 payable by the instalments specified in Table 1:

Table 1

Payment	Report	Date	Amount
Initial	Work Schedule	October 1998 (Paid)	$32,250
	Progress	September 1999	$0
	Draft Final	December 1999	$0
Final	Final	February 2000	$10,750
		Total	$43,000

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 PRESS RELEASE- ANNOUNCEMENT OF THE CONSIDERATION OF THE MONTEBELLO/BARROW ISLANDS FOR RESERVATION

APPENDIX H BROCHURES PREPARED FOR COMMUNITY CONSULTATION