

# **AQUACULTURE PLAN FOR THE RECHERCHE ARCHIPELAGO**

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Fisheries Western Australia

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Aquaculture Plan  
for the Recherche Archipelago

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*Main Cover picture:*  
Bandy Creek Boat Harbour  
(Department of Land Administration)

*Inset picture:*  
Yabby (*Cherax albidus*)  
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The draft version of the Aquaculture Plan for the Recherche Archipelago, released for public comment, was prepared by consultants Everall Consulting Biologist in association with Fish Unlimited. Analysis of public comments and the development of this final plan was undertaken by Fisheries WA.

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In particular, thanks go to:

The members of Esperance Bay Yacht Club and the Esperance Offshore Angling Club who provided their time and detailed knowledge of the Recherche Archipelago for the User Profiles.

Mr Bill Kent, President of the Esperance Professional Fishermens Association, who provided much wise advice.

Mr Ross Ainsworth MLA, Chairman, and the members of the Recherche Archipelago Consultative Group.

### **Disclaimer**

The information contained in this document is based on sources believed to be reliable. However as no independent verification is possible, Fisheries WA and the consultants (Everall Consulting Biologist and Fish Unlimited) together with their members and employees give no warranty that the said base sources are correct and accept no responsibility for any resultant errors contained herein and any damage or loss, howsoever caused, suffered by any individual or corporation.



## Overview

The waters and hinterland of the Recherche Archipelago near Esperance have significant potential for aquaculture development and interest in the area for aquaculture purposes is increasing. Recent public consultation on aquaculture in the area has raised concerns about the long-term expansion of aquaculture activities and the need for coordinated planning.

The coastline of the Recherche Archipelago features numerous pristine beaches, headlands, islands and sheltered bays. It is a rugged, high-energy coast, with visually impressive white beaches between headlands dominated by dome shaped granite hills and mountains of similar origin to the islands. More than half the coastline is included in the Cape Le Grand and Cape Arid National Parks which contain large tracts of natural bushland. The remainder of the coast comprises a wide belt of vegetated and windblown dunes backing on to cleared agricultural lands of the Esperance Coastal Plain and Sandplains.

Significant activities in the Recherche Archipelago include shipping from the Port of Esperance, commercial and recreational fishing, tourism, scenic and charter tours, diving and coastal recreation.

## Biophysical Environment

The biophysical environment of the Recherche Archipelago is not well known or documented, but aspects of relevance to aquaculture include:

- Sea temperatures are favourable for the growth of many temperate finfish species.
- Strong prevailing winds, swells and storm events in the Recherche Archipelago will require special consideration in the design and location of marine aquaculture structures.
- Currents are mostly wind driven, but with low velocity reducing with depth. Special husbandry techniques will be required to deal with flushing within and around sea cages, particularly during extended calm periods.
- Many of the islands of the Recherche Archipelago have sea bird breeding areas, seal and sea lion breeding and haul-out areas. Marine mammals including whales, dolphins and seals occur in the area. These will impose special management techniques on marine aquaculture operations.
- The benthic habitats of the Recherche Archipelago are not well known and a detailed survey of the location and function of the benthos, including the fauna of sand areas, will be required before marine aquaculture projects can proceed.

## Social Environment and Infrastructure

The investigations and consultations have indicated that the overall prospects for development of the aquaculture industry at Esperance and in the Recherche Archipelago are good. There are adequate water, infrastructure and labour resources to support the development of the industry for the foreseeable future. Power supply and cost, and suitably located land are likely to be initial concerns.

Concerns about the potential impact of urban development on the quality of marine water and ground water needed for use by food producing industries, including both aquaculture and wild fisheries operating in inshore waters, are capable of resolution through strict planning and administrative control, research and monitoring.

Land supply and land cost for aquaculture may become a limiting factor in the foreseeable future. At present, adequate appropriately zoned land is available at reasonable cost. The most prospective land for aquaculture in or near Esperance is where suitable zoned land occurs over saline ground water aquifers or adjacent to the coast. Careful site selection would be necessary to ensure water supply, waste water disposal, services and operational space can be achieved at reasonable cost.

## Community Consultation

A two-phase consultation process was undertaken during the development of this plan. Initial consultations (Phase I Consultation) were undertaken with individuals and groups within Esperance and Perth. The purpose of the meeting was to:

- seek initial general comment on the area's prospects for aquaculture;
- understand the community's feeling towards the industry;
- gather information on fishing effort and locations of importance to each activity;
- seek information on planning schemes, services, infrastructure and land availability;
- discuss the future potential and size of the aquaculture industry, and
- identify issues of concern.

A draft plan was prepared and released for public comment for a period of two months (Phase II Consultation). This plan has been finalised based on the consideration and assessment of all submissions.

Prior to the commencement of this study, Fisheries Western Australia had put forward a proposal to farm Southern bluefin tuna in Esperance Bay, which was subsequently withdrawn. Because of the controversy surrounding tuna farming, many of the consultations tended to dwell on that proposal. Many people saw a clear distinction between tuna farming, perceived as a dirty industry, and other forms of marine aquaculture or sea cage culture, even though they often have many environmental and management problems in common. Land-based aquaculture was generally supported.

## Community Attitudes to Aquaculture

Most of the Esperance community who were consulted, supported the development of an aquaculture industry in their region. They believe that aquaculture, particularly land-based projects, present little or no threat to the natural environment and will add to the town's social and economic base. Some agreed that the development of techniques to culture a range of popular fish species could reduce pressure on existing fish stocks.

Opinion was more divided on large-scale cage farming and many saw a distinction between this and tuna farming, which was perceived by many as a problem industry.

The majority of people consulted considered that tuna farming was a high-value industry which would benefit Esperance and the region, provided environmental problems could be resolved and adequate controls were in place. Others considered the perceived benefits were over-stated. People were also sceptical as to whether the benefits would remain in Esperance if a non-local operator was involved in the industry's development.

There were suggestions that other high-value industries, such as tourism and the commercial fisheries, could be adversely affected by tuna farming, and that an economic impact study or cost benefit analysis would assist community consideration of the proposals.

The major issues raised during the community consultation included:

perceived economic and employment benefits of aquaculture;

- potential negative impacts aquaculture could have on the marine environment;
- perception of sharks and pollution from tuna farms and their effect on other Recherche Archipelago values, in particular recreational diving and tourism;
- pilchard deaths and the lack of knowledge as to the cause;
- entanglements and seal interactions with cages, and
- need for open communication between all parties regarding the development of aquaculture proposals in Esperance.

Nearly every person consulted drew an analogy with the iron ore export facility in Esperance which had originally been proposed as an open loader with attendant dust problems. Community pressure saw the loader contained within a negative pressure shed and it is regarded as a good environmental outcome which preserved the ‘clean, green’ image on which tourism and many of the industries in the town depend.

The message for aquaculture is that the people of Esperance are prepared to have new industry, but on their terms and only in an environmentally sustainable way.

## User Profile of the Recherche Archipelago and Adjacent Coast

One of the objects of the study brief was to “Identify and map other marine uses in the Recherche Archipelago and their potential to constrain future development of aquaculture.”

This task was undertaken and reported in the *Draft User Profile of the Recherche Archipelago and Adjacent Coast* which was released for public comment in association with the release of the draft aquaculture plan. The revised user profile (based on public comment) has been incorporated in this plan.

Included in the User Profile are eleven charts of the main areas of interest to user groups.

## Species with Potential for Aquaculture at the Recherche Archipelago

A list of candidate species for the Recherche Archipelago has been determined, based on consideration of the following criteria:

- market potential;
- known culturing techniques;
- level of technology required to culture new species;
- any existing (or planned) sources for fry or fingerlings from within the region;
- suitability with the culture systems predicted for the Recherche;
- suitability of the species to the area.

## Executive Summary

Candidate species are divided into the categories of primary and secondary species. Refer to the table below for the species within each category. The primary species are those considered to have good prospects for aquaculture development. The secondary species are those considered to have aquaculture potential in the future, subject to the development of suitable culture technologies.

Profiles of each of these species and a summary of their aquaculture potential are provided.

Common Name	Species name	Culture method
<b>PRIMARY</b>		
<b>SPECIES</b>		
Abalone	<i>Haliotis</i> spp.	Land-based, sea cage
Marron	<i>Cherax tenuimanus</i>	Ponds; land-based
Yabby	<i>Cherax albidus</i>	Land-based dams
Pink snapper	<i>Pagrus auratus</i>	Sea cage; land-based tanks or ponds
Silver perch	<i>Bidyanus bidyanus</i>	Pond/land-based
Southern bluefin tuna	<i>Thunnus maccoyii</i>	Sea cage
<b>SECONDARY</b>		
<b>SPECIES</b>		
Common Name	Species name	Culture method
Oysters	<i>Saccostrea</i> spp. <i>Ostrea</i> spp.	Racks, long lines
Dhufish	<i>Glaucosoma hebraicum</i>	Tank/cage
Marine aquarium spp	various	Tanks
Yellowtail Kingfish	<i>Seriola</i> spp.	Sea cage; land-based
Flounder	<i>Pseudorhombus</i> spp	Sea cage; land-based tanks/ponds
Whiting	<i>Sillago</i> spp	Sea cage; land-based tanks or ponds
Trout	<i>Onchorynchus mykiss</i> (Rainbow) <i>Salmo trutta</i> (Brown)	Sea cage; land-based ponds/tanks; particularly seasonal production.
Black bream	<i>Acanthopagrus butcheri</i>	Sea cage; land-based tanks or ponds

## Potentially Suitable Areas for Future Marine and Land-based Aquaculture

A number of areas which are worthy of further investigation were identified in the course of this planning study.

While some land may be available to the east of Bandy Creek, proponents should consider the potential environmental risks from ground water contamination. Given this, the potential to locate land-based growout facilities east of Esperance at Duke of Orleans Bay should be considered.



Sites which meet the necessary selection criteria include Sandy Hook, the Remark and Mart Groups. The Mart Group is to the east of Esperance Bay.

Marine sites that are suitable for aquaculture tend also to be popular with other user groups.

The Remark Group appears to have superior protection from adverse sea conditions, but is remote from land-based facilities. Currents, and habitats identified as 'sparse seagrass', require further investigation. Conflict with other users, particularly charter diving and recreational fishing, would be expected. The Remark Group is also important to the pilchard and abalone industries. This was highlighted in the comments received during the Public Comment Phase II. The Phase II Consultation also indicated that there is the potential for opposition by pilchard fishers to aquaculture proposed at the Sandy Hook area (part of the Remark Group).

The Mart Group contains a number of sites suitable for the culture of finfish in surface cages. The development of submersible sea cage technology may enable cage culture to occur in more exposed locations throughout the Archipelago. Many sites throughout the Archipelago should prove suitable for the locating of barrels and bottom cages for abalone growout as this form of culturing will have less impact with other user groups in terms of access and amenity.

Further work on potential sites is needed, and should be undertaken by proponents for both land and sea areas as formal proposals are contemplated.

## Prospects for Aquaculture

The view held by some members of the Esperance community that aquaculture will adversely affect the Recherche Archipelago stem from the early history of aquaculture activity overseas and the perceptions of some of the early practices at the Tuna Cage Farm located near Port Lincoln. While there is no denying that poorly managed aquaculture practices present a threat to the environment, as does the effect of poorly managed land-based farming, there are many instances throughout the world where advances in husbandry and nutrition have greatly reduced any environmental impacts. The current legislative framework, which provides the environmental assessment and approval procedures for aquaculture development in Western Australia, has been established to ensure that site selection and farming practices are sustainable, and will not cause any long-term negative effects to the Archipelago.

A greater threat to aquaculture in the Recherche Archipelago may be the potential for contamination of ground water sources from other industrial and urban developments and the potential for pollution from shipping activities or accidents.

The successful integration of aquaculture into the environmental, social and economic fabric of Esperance could present a watershed in this country's short marine farming history. Esperance is a microcosm of the real and perceived issues facing industry development in Australia. An aquaculture industry cannot be developed in the Recherche Archipelago unless it has strong support from the Esperance community. Earning that support through genuine consultation is essential for the development of the industry.

## Procedures for Applying for an Aquaculture Licence

The application and consultation procedures for an aquaculture licence are outlined in *Ministerial Policy Guideline No 8, Assessment of Applications for Authorisations for Aquaculture and Pearling in Coastal Waters*

of Western Australia (FWA 1997). Fisheries Western Australia also has an application pack to assist applicants. **Section 10** contains relevant information on the application procedure.

## Recommendations

The recommendations of the plan are as follows (responsible party in parenthesis):

- 1 Encourage the Recherche Archipelago Consultative Group to progress the formation of an Esperance Aquaculture Group to provide a focal point for industry development and community consultation by Fisheries WA and potential proponents. This group would operate independent of Fisheries WA (Fisheries WA).
- 2 Provide information and undertake ongoing consultations with the Esperance community in relation to aquaculture proposals in the Recherche Archipelago (Fisheries WA/aquaculture operators/aquaculture proponents).
- 3 In consultation with the Department of Conservation and Land Management, support ongoing environmental investigations of the Recherche Archipelago (Fisheries WA/CALM).
- 4 Support the concept of a cold water marine research facility associated with a tertiary institution in Esperance, should such a proposal emerge (Goldfields Development Commission, Shire of Esperance).
- 5 Refer this draft aquaculture plan to the Marine Parks and Reserves Authority for use in future planning for marine parks in the Recherche Archipelago (Fisheries WA).
- 6 Ensure that all licence determinations include the condition that all environmental baseline and monitoring data collected as part of site selection process and ongoing data collected during the operational phase be provided to the Marine Parks and Reserves Authority for use in future marine park planning (Fisheries WA).
- 7 Ensure that appropriate areas and sites for aquaculture are identified in future planning for marine conservation reserves in the Recherche Archipelago (Fisheries WA/Department of Conservation and Land Management/Marine Parks and Reserves Authority).
- 8 Provide this plan to proponents as a guide in the selection of potentially suitable land and sea-based site and species for aquaculture (Fisheries WA).
- 9 Refer all aquaculture applications to the Environmental Protection Authority (Fisheries WA).

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# PART A: INTRODUCTION, BACKGROUND AND METHODOLOGIES

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## 1 INTRODUCTION

### 1.1 Significant Features of the Esperance and the Recherche Archipelago

The Archipelago of the Recherche was discovered in 1627 by Peter Nuyts in the *Gulden Zeepard*, visited by George Vancouver in the *Discovery* in 1791, and was subsequently named by Bruni d'Entrecasteaux of the ships *Recherche* and *Esperance*. Initial exploration and remarkably accurate charting of the Recherche Archipelago was undertaken by Matthew Flinders in the *Investigator* in 1820.

The Recherche Archipelago extends over 230 km from Figure of Eight Island, west of Esperance, to Spindle Island, off Israelite Bay in the east (**Figure 1**). It lies between Longitude 121° 30' E and 124° 15' E and comprises about 105 islands and 1500 islets and exposed reefs. The southernmost islands are Termination and Salisbury Islands, which lie about 60 km off the coast, near the edge of the continental shelf.

The islands are all nature reserves (under the *Conservation and Land Management Act 1984*) and are mostly inaccessible because of their steep dome-shaped sides and heavy seas. Only two islands, Sandy Hook and Middle Islands, have beaches with easy access, and one, Woody Island in Esperance Bay, has accommodation and tourism facilities.

Many of the islands and islets have seabird rookeries as well as haul-out and breeding sites of the Australian Sea Lion and New Zealand Fur Seal. The islands have many notable plants, birds, reptiles and mammals and there appears to be a high degree of endemism, although the flora and fauna are not well studied.

The coastline of the Recherche Archipelago features numerous pristine beaches, headlands, islands and sheltered bays. It is a rugged, high energy coast, with spectacular white beaches between headlands dominated by dome shaped granite hills and mountains of similar origin to the islands. More than half the coastline is included in the Cape Le Grand and Cape Arid National Parks which contain large tracts of natural bushland. The remainder of the coast comprises a wide belt of vegetated and windblown dunes backing on to cleared agricultural lands of the Esperance Coastal Plain and Sandplains. Several small creeks and rivers arise in the sandplain and flow to lakes and interdunal lagoons near the coast. Some occasionally flow to the sea.

Significant activities in the Recherche Archipelago include shipping from the Port of Esperance, commercial and recreational fishing, tourism, scenic and charter tours, diving and coastal recreation.

### 1.2 Aims of the Plan

The aims of this plan are to:

1. provide a direction for the future development of a viable aquaculture industry in the Recherche Archipelago;
2. guide potential aquaculture proponents as to suitable species, locations, systems and environmental management measures;

3. guide the Executive Director of Fisheries WA in his decision-making role relating to the determination of future aquaculture applications.

## 2 CONSULTATIVE METHODOLOGY

### 2.1 Overview

Major inputs into the development of this plan were a thorough literature review and an intensive public consultation phase. Based on information gathered from these sources, the following tasks were undertaken:

- identification of potential areas for aquaculture in the Recherche Archipelago and adjacent coastal areas through determining:
  - (1) areas where aquaculture would not be acceptable due to statutory constraints;
  - (2) areas with significant known constraints which make approval of aquaculture unlikely based on current technology and government policies; and
  - (3) areas with no known constraints which preclude aquaculture and in which it is recognised that site specific investigations may uncover constraints which would prevent the Executive Director of Fisheries Western Australia from approving an aquaculture licence;
- identification of suitable production systems;
- identification of management measures designed to mitigate potential environmental impacts of aquaculture activities in the Recherche Archipelago and adjacent coastal areas.
- identification of species with the potential for future marine based aquaculture in the Recherche Archipelago and adjacent coastal areas based on their environmental requirements, economic advantages and their compatibility with each other and the local environment, and
- identification and mapping of other marine uses in the Recherche Archipelago in order to determine their potential to constrain the future development of aquaculture;

The development of this plan involved two phases of consultation. These phases are discussed separately below.

### 2.2 Phase I Consultations

#### 2.2.1 Outline of the Process

Phase I involved consultations with industry, community and government groups in Perth and Esperance. A list of all the organisations and individuals involved in the consultation process are listed in **Appendix A**. All those listed were written to and invited to submit a position paper to the study or to meet with the consultants.

Consultations in Perth commenced in November 1998 with several meetings with relevant government agencies and representatives of commercial industry associations and recreational fishing and diving organisations. Consultations in Esperance were undertaken between the 8th and 15th of December 1998 and involved a series of meetings and individual consultations with Esperance Shire Council, local representatives of Fisheries Western Australia, the Department of Conservation and Land Management, local industries, community organisations and individuals. The purpose of the meetings was to:

- seek initial general comment on the prospects of the area for aquaculture;

- understand the community's feeling towards the industry;
- gather information on fishing effort and locations of importance to each activity;
- seek information on planning schemes, services, infrastructure and land availability;
- discuss the future potential and size of the aquaculture industry, and
- identify issues of concern.

A summary of the issues raised can be found in the related document *Report on Community Consultations for the Draft Aquaculture Plan for the Recherche Archipelago* (Fisheries WA, 1999).

A meeting of the Recherche Archipelago Consultative Group (RACG), chaired by Mr Ross Ainsworth MLA, was attended on Monday 14 December 1999. In total, 53 members of the Esperance community were met individually (**Appendix A**).

A paper entitled *An Overview of the Aquaculture Industry In Western Australia* (**Appendix B**) was available to assist discussions. During the consultations, advice was sought on other people who may have information for the study, or views which should be taken into consideration.

Prior to the commencement of this study, Fisheries Western Australia had put forward a proposal to farm Southern Bluefin Tuna in Esperance Bay. This proposal has since been withdrawn, however consultations included discussions on this issue. Due to the controversy surrounding tuna farming, many of the consultations tended to dwell on that proposal.

### 2.2.2 Draft User Profile of the Recherche Archipelago and Adjacent Coast

Through consultations with the Esperance community, the RACG, industry and local business, a Draft User Profile was prepared for the area which documented and mapped the following uses:

- tourism;
- recreational diving;
- recreational boating and fishing;
- surfcasters;
- charter boats and cruises;
- commercial fishing.

The Draft User Profile was released for public comment for a period of two months in conjunction with the release of the Draft Aquaculture Plan. Based on comments received, the profile was amended and incorporated into this document, principally in **Section 7 – Social Environment** and in **Appendix C**.

The profiles presented are largely based on meetings and interviews with informed local people and some reference to published material. The sources of the data are listed in **Appendix C**. The data and its interpretation was the responsibility of the consultants who undertook the consultations. Use of the data for planning thus has limitations, but it highlights the dearth of information available for planning in the Recherche Archipelago. There is a need for records to be kept of the numbers of participants in the various activities, for example, boat ramp usage, creel surveys, beach surveys and the like.

The profiles include eleven charts of the main areas of interest to the above user groups.

The constraints mapping and user profiles will also be useful for future marine park planning activity.

### 2.2.3 Phase I Consultation Outcomes

A brief overview of the matters raised and community attitude relating to aquaculture are presented below. A full account of the consultation outcomes is presented in the *Report on Community Consultations* (Fisheries WA, 1999).

- Most of the Esperance community who were consulted supported the development of an aquaculture industry in their region. They believe that aquaculture, particularly land-based projects, present little or no threat to the natural environment and will add to the town's social and economic base. Some agreed that the development of techniques to culture a range of popular fish species could reduce pressure on existing fish stocks.
- Opinion was more divided on large-scale cage farming and many saw a distinction between this and tuna farming, which was perceived by many as a problem industry.
- The majority of people consulted considered that tuna farming was a high-value industry which would benefit Esperance and the region, provided environmental problems could be resolved and adequate controls were in place. Others considered the perceived benefits were overstated. They were also sceptical as to whether the benefits would remain in Esperance if a non-local operator developed the industry.
- There were suggestions that other high-value industries, such as tourism and the commercial fisheries, could be adversely affected by tuna farming, and that an economic impact study or cost benefit analysis would assist community consideration of the proposals.
- The major issues raised during the community consultation included:
  - a) the potential economic and employment benefits of aquaculture;
  - b) the concern about potential negative impacts aquaculture could have on the marine environment;
  - c) Perception of attracting sharks and pollution arising from tuna farms and their effect on other Recherche Archipelago values, in particular recreational diving and tourism;
  - d) The pilchard deaths and the lack of knowledge as to the cause;
  - e) Entanglements and seal interactions with cages, and
  - f) The need for open communication between all parties regarding the development of aquaculture proposals in Esperance.
- Nearly every person consulted drew an analogy with the iron ore export facility in Esperance which had originally been proposed as an open loader with attendant dust problems. Community pressure saw the loader contained within a negative pressure shed and it is regarded as a good environmental outcome, which preserved the 'clean, green' image on which tourism and many of the industries in the town depend.

**The message for aquaculture is that the people of Esperance are prepared to have new industry, but on their terms and only in an environmentally sustainable way.**

## 2.3 Phase II Consultations

A draft version of this plan was released in April 1999 for a public comment period of two months. This plan has been finalised based on the consideration and assessment of all submissions made during this period. A copy of the summary of submissions is contained in **Appendix D**.

## PART B FEATURES, MANAGEMENT AND CONSTRAINTS

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### 3 PHYSICAL ENVIRONMENT

#### 3.1 Climate and Weather

Esperance and the Recherche Archipelago has a Mediterranean-type climate with mild to hot, very dry summers and cool wet winters. The mean annual rainfall is 623 mm with 50 per cent of rainfall occurring between May and August. Average annual evaporation is about 1600 mm and is greatest during the summer months.

Average minimum and maximum temperatures in summer range from 16-26°C with a maximum of 35°C in January and February, while average winter temperatures from June to August range from 8-17°C, with the minimum being 7°C.

The dominant wind direction in summer is from the south-east and afternoon sea breezes occur from October to March. In January and February, over 25 per cent of sea breezes exceed 30 km/h. During winter south-west winds frequently prevail and north-west storm events occur, with calmer periods between fronts. Periods of calm are few, but may occur in autumn and winter.

**Appendix E** contains wind roses provided by the Bureau of Meteorology for 9am and 3pm for each month of the year.

#### 3.2 Geomorphology

The geology, hydrogeology and geomorphology of the mainland, coast and islands of the Recherche Archipelago is described in Hydrogeology of the Esperance-Mondrain Island 1:250,000 Sheet published by the Water and Rivers Commission, (Johnson and Baddock 1998) and in *A Representative Marine Reserve System for Western Australia – Report of the Marine Parks and Reserves Selection Working Group* (The Wilson Report) (CALM 1994).

In broad terms, the physiography is characterised by a flat to gently undulating sandplain which rises gradually from sea level. The conspicuous mountains near the coast, together with the islands of the Recherche Archipelago, are composed of granites and gneisses which are remnants of an ancient Proterozoic land surface. Inland, this surface is overlain by the sands, sediments and limestones of the Esperance Coastal Plain and the Esperance Sandplain.

#### 3.3 Water Resources

Several small streams rise in the Esperance Sandplain and flow into the Coastal Plain, where most end in salt lakes. Bandy Creek has a large catchment but experiences erratic seasonal flow. Elsewhere, rainfall contributes to the substantial groundwater resources of the Esperance Sandplain.

Most of the groundwater in the area is saline and there are several different aquifers; the ones of most interest to aquaculture occur in the sediments of the Coastal Plain. The coastal dunes are best developed to the west of

Esperance and contain significant fresh water resources, some of which are used for the town scheme. Underlying the fresh water in the unconfined aquifer eastward toward Cape Le Grand, and possibly beyond, is saline water that may have potential for aquaculture.

### 3.4 Bathymetry

Offshore, the sea floor is relatively flat with an average depth of 40 metres. The islands rise steeply from the sea floor and only two, Sandy Hook and Middle Islands, have beaches which permit easy landing. The continental shelf is about 70 kilometres from the coast. The outer islands near the edge of the shelf rise from about 70 metres depth.

Bathymetry coverage for the Recherche Archipelago is available in ArcInfo GIS digital format in the Coastal Resource Atlas maintained by the WA Department of Transport, Coastal Management Branch. This coverage does not have the same degree of accuracy as the standard charts published by the Australian Hydrographic Service, Royal Australian Navy. Many parts of the Recherche Archipelago are shown as “unsurveyed” or “inadequately surveyed” on these charts.

### 3.5 Oceanography

The Recherche Archipelago is affected by a strong, relatively consistent swell from the southwest for most of the year. These swells can be reinforced by wind generated waves, producing a net eastward littoral drift along the south coast.

After rounding Cape Leeuwin in Autumn, the Leeuwin Current flows eastward toward the Great Australian Bight along the outer continental shelf, with the strongest currents being just beyond the shelf break. It is characterised by strong thermal fronts as the tropical water meets the cooler Southern Ocean Waters. Between October and March a nearshore current called the Capes Current (Pearce and Pattiaratchi, 1997) flows westward along the south coast and northward around the Capes, under the stress of prevailing easterlies. In contrast with the winter situation where the Leeuwin Current is close inshore near Cape Leeuwin, the Leeuwin current swings offshore in summer as the Capes Current penetrates northward against the coast.

Within the Recherche Archipelago, little is known of current movements. Tides are diurnal and the maximum spring tidal range is 1.1 metres. While some tidal currents may be experienced locally between islands or other constrictions, tidal currents are likely to be insignificant compared with those generated by the wind. Current velocities near the sea bed are likely to be significantly lower than at the surface. Some modelling of waves and currents has been undertaken by the UWA Centre for Water Research in connection with recent proposals by Fisheries Western Australia to establish tuna farming in Esperance Bay (Fisheries WA, 1998).

The waters of the Recherche Archipelago are known to have low nutrient status, in common with other oceanic waters of the South West region of WA. However, no records or data have been located on this. Sea temperatures range from 14°C in winter to 21°C in summer (L. Hudson Pers com).

### 3.6 Summary

- Sea temperatures are favourable for the growth of many temperate finfish species.
- Strong prevailing winds, swells and storm events in the Recherche Archipelago will require special consideration in the design and location of marine aquaculture structures.

- Currents are mostly wind driven, but with low velocity reducing with depth. Special husbandry techniques will be required to deal with flushing within and around sea cages, particularly during extended calm periods, and
- The main limiting factor is the extent to which marine resources can be secured for the industry, and the capability of the inshore marine environments to support marine farming in an environmentally sustainable manner.

## 4 BIOLOGICAL ENVIRONMENT

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### 4.1 Biological Resources

Most of the biological information on the Recherche Archipelago has been collected during various scientific expeditions to the area, but few comprehensive surveys of the environmental resources have been undertaken. The most recent review and description of natural resources in the Recherche Archipelago is contained in *South Coast Terrestrial and Marine Reserve Integration Study* produced by the Department Conservation and Land Management (CALM 1998).

Several coverages for natural resources in the Recherche Archipelago are available in ArcInfo GIS digital format in the Coastal Resource Atlas maintained by the WA Department of Transport, Coastal Management Branch. They include:

- bathymetry;
- sea bird breeding areas;
- New Zealand Fur Seal and Australian Sea Lion haul out and breeding areas;
- benthic habitats;
- National Parks;
- nature reserves;
- ANCA and Ramsar wetland areas.

The potential impact to these natural resource values and resultant management requirements would be required to be investigated and documented by the proponent of an aquaculture application in the area.

### 4.2 Benthic Habitats

Broad-scale mapping and classification of the major benthic habitats of Australia's coastline at a scale of 1:100,000 has been carried out by Dr Hugh Kirkman, CSIRO Division of Marine Research (Kirkman in CALM 1998). The maps were prepared using the blue band or band 1 of the Landsat TM satellite. Digitising of the maps in ArcInfo GIS format was undertaken by the WA Department of Transport, Coastal Management Branch for inclusion in the Coastal Resource Atlas. Ground truthing of benthic habitats around the islands in the Recherche Archipelago was undertaken in March 1994, and was done by 'bounce' diving, vertical video observation, or grab sampling of benthic material. Currently the ground truth of a particular area is about 80 per cent accurate (*Op. cit.*). In the CSIRO mapping, the benthic habitats are divided into eight categories:

- dense seagrass;
- medium seagrass;
- sparse seagrass;
- patchy seagrass;
- bare sand;
- flat platform or low profile reef;
- heavy limestone reef;
- granite reef.



Further ground truthing was undertaken near Mondrain Island during a voyage of the STS Leeuwin in February 1998, using drop down TV (Colman, unpub. in CALM 1998).

As part of the present study, the consultants were engaged to undertake a benthic habitat survey of five island groups within the Recherche Archipelago, which had been identified as having some potential for aquaculture, particularly sea cage culture. The aim of the field survey was to provide marine habitat information to support the following objectives:

- Identification of benthic habitat types at potential sea cage sites at the York, Mart, Remark, Tory and Mondrain Islands in the Recherche Archipelago;
- Ground truthing of CSIRO mapping by overlaying plotted transects;
- Increase of data certainty for a future submission on aquaculture to the Marine Park study;
- Provision of a basis for future interpretation of high resolution imagery in collaboration with CALM or CSIRO;
- Provision of a basis for future detailed analysis of species and habitats present by Fisheries Western Australia or aquaculture proponents, and
- Provision of a baseline record for each site.

Transect surveys of the benthic marine habitats were undertaken over four days between the 22nd and 25th of January 1999 using underwater video equipment. The benthic habitat survey was recorded at broad habitat level, however the videotape record of the survey contains a wealth of information which could be analysed at a much more detailed level with species identification and further classification of habitats into more relevant groups than the CSIRO mapping which was used for this study. The results of the survey have been reported in a paper entitled *Benthic Habitat Survey of the Remark, Mart, Mondrain, Tory and York Island Groups* (Fisheries WA, 1999).

### 4.3 Conservation

The study area contains Cape Le Grand and Cape Arid National Parks. All but one of the islands of the Recherche Archipelago are nature reserves being part of 'A' Class Reserve No. 22796. Woody Island is a 'B' Class Reserve.

The same environmental qualities which make the Recherche Archipelago prospective for aquaculture and marine farming are also those which give the nearby offshore waters very high conservation value, such that they are proposed as a multiple purpose marine park to be representative of the temperate marine environments of the South Coast (CALM 1994).

### 4.4 Summary

- Many of the islands of the Recherche Archipelago have sea bird breeding areas, seal and sea lion breeding and haul out areas. Marine mammals including whales, dolphins and seals occur in the area. These will require special management techniques on marine aquaculture operations;
- The benthic habitats of the Recherche Archipelago are not well known apart from the survey work described above;
- Land-based aquaculture and support facilities are not normally permitted on island nature reserves or coastal National Park lands.

## 5 MARINE CONSERVATION RESERVES

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### 5.1 Proposed Conservation Reserves

In June 1994 the report of the Marine Parks and Reserves Selection Working Group (MPSRWG) – *A Representative Marine Reserve System for Western Australia* (The Wilson Report, CALM 1994) identified the Recherche Archipelago as an area worthy of consideration for reservation as a marine conservation reserve (marine reserve). The Working Group’s recommendations were as follows:

*“While acknowledging the paucity of information about the marine flora and fauna of the Recherche Archipelago, the Working Group believes that reservation of these waters can be justified on the grounds that habitats are diverse and that added protection would be provided for the Sea Lion, Fur Seal and seabird colonies. Protection of areas for the purposes of recreational diving and development of the commercial dive tour industry can also be justified.*

*“However, with the limited information available, the Working Group was unable to identify parts of the Archipelago which are particularly worthy of reservation. It was concluded that selection of specific areas would be unwise and that reservation of the entire area as a multiple-use marine reserve is warranted. Subsequent surveys in the course of preparation of a management plan would identify areas of particular importance for conservation, recreation and commercial fishing and appropriate zoning would resolve potential conflicts between these activities.*

Accordingly the Working Group recommends that:

*“the waters of the Recherche Archipelago between Butty Head in the west and Israelite Bay in the east extending to the limit of the State Territorial Sea, including the areas of State waters surrounding the outer islands but excluding the Port of Esperance, should be considered for reservation as a marine reserve for multiple purposes including the conservation of flora and fauna and public recreation.”*

### 5.2 Proposed Marine Reserve for the Recherche Archipelago

Recent consideration by the Marine Parks and Reserves Authority of a number of the Wilson Report’s recommendations, including the Recherche Archipelago, has not identified the Archipelago as a current priority, but it is envisaged that marine reserve planning may be initiated for the Archipelago within the next five to ten years.

Both the Phase I and Phase II consultation indicated that there is strong community support for a marine conservation reserve within the Recherche Archipelago. There was also some suggestion that aquaculture should not proceed prior to the development of the marine conservation reserve. It should be noted that Fisheries WA is required to consider competent application for aquaculture licences, under the *FRMA* and *Ministerial Policy Guideline No. 8*.

Aquaculture, commercial fishing and recreational fishing are considered to be compatible with marine reserves through appropriate zoning within the proposed park. The requirements for incorporating the needs of the aquaculture industry into the marine reserve planning process are clearly established in the legislation. This will

afford substantive protection for aquaculture interests. There is provision for Fisheries Western Australia and stakeholders to be included on advisory committees and be involved in the consultative process for the development of Marine Reserve management plans.

As acknowledged by the MPRSWG, the paucity of information on the area is a limiting factor to the marine reserve planning process. It should be noted that the identification of priority areas for aquaculture in marine reserves is the role of Fisheries WA and as such, this planning exercise is not outside the marine reserve planning process.

Furthermore, this aquaculture plan provides sound baseline information for future marine planning including the documentation of current users of the Recherche. In addition, benthic surveys assist both the aquaculture applications and the future marine park planning.

## 6 SOCIAL ENVIRONMENT – USER PROFILE

This user profile of the Recherche Archipelago documents existing marine and terrestrial users of the area considered in this aquaculture plan. For each user, a scope of activity is provided together with a description and chart of principle localities where the relevant activity is undertaken.

### 6.1 Tourism

#### 6.1.1 Scope of Activity

Studies have shown that tourism in Esperance and the Recherche Archipelago relies on the recreational opportunities afforded by the dramatic coastal scenery and the area's 'clean, green' image which has been carefully nurtured. Visitors enjoy a wilderness-style experience.

Tourism at Esperance and the Recherche Archipelago has a number of components including:

- accommodation;
- diving (**Section 6.2**);
- boating and fishing (**Section 6.3**);
- beach activities including camping, fishing and swimming (**Section 6.4**);
- charter boats and cruises (**Section 6.5**);
- scenic driving to beauty spots and historic sites;
- environment appreciation;
- expeditions;
- coach tours;
- scenic flights (**Section 6.5**), and
- wildflowers, walks, museums and other land-based attractions.

The *Strategic Plan for the Tourism Industry in the South East Region of Western Australia* (SERTS) notes that the South East has potential for significant tourism growth. It has a diversity of good tourism products with emphasis on natural beauty and recreational activity. The coastal and islands environment is the outstanding tourism attraction of the South East region. The key elements of this environment are:

- the spectacular coastline with its rugged headlands and quality beaches
- the islands close to the coast
- activities associated with these physical features, ie
  - sailing
  - island visits
  - boating and boat trips
  - fishing
  - diving
  - whale, seal and marine birdlife viewing
  - swimming
  - coastal walks
  - coastal drives
  - camping (coastal, island).

The report indicates that services providing for the utilisation of these assets are limited. Utilisation of these assets could be further developed in a sustainable manner. In particular there is need for a development or facility which can provide a focal point for the coastal islands' assets. The report proposes a major Marine Interpretation Centre focusing on the Archipelago, marine issues, fishing, whales, seals, and history (including Aboriginal, Sanko Harvest wreck, sealing and pirate 'Black Jack' Anderson). This would be prominently located and preferably be an element of the proposed foreshore development in Esperance.

The surveys identified that the coast/water was a prime reason for tourists visiting the area, but provide no breakdown of specific activities. It would be useful to have some details of current patterns of boating and fishing activities, types of boats in the area and types brought to Esperance by visitors. The Esperance District Recreation Association has applied for a grant to conduct a review and plan of the leisure industry in the Region.

Details of the facilities on Woody Island and accommodation, special events, the tourism season and tourism participation demographics are included in **Appendix C**.

### 6.1.2 Principal Tourism Areas & Resources

Localities of importance to Tourism include:

- lookouts;
- roads and scenic areas;
- National Parks and nature reserves;
- caravan parks and camping areas. Lucky Bay is a most popular site;
- Woody Island;
- beaches;
- Duke of Orleans Bay;
- jetties, groynes, boat ramps and fishing areas, and
- historic sites.

## 6.2 Recreational Diving

### 6.2.1 Scope of Activity

The crystal clear waters and diversity of habitats and marine life in the Recherche Archipelago provide a diving resource of major significance. The many reefs, islands and sheltered bays with different aspects permit diving under most conditions and offer a variety of diving experiences from adventure diving on the wreck of the *Sanko Harvest* to shore-based and boat-based nature appreciation and underwater photography. The components of the activity include:

- skin diving or snorkeling;
- scuba diving;
- nature appreciation and photography;
- wreck diving;
- spearfishing;
- abalone diving;

- shell diving;
- tourism;
- diving charter boats;
- learning to dive and diving instruction, and
- compressed air supply.

A significant proportion of boats classed as recreational fishers also undertake diving and spearfishing. Most of the information in this profile was provided by diving charter operators.

Esperance Diving and Fishing is the only full time diving charter service in Esperance. Others visit from other areas (Desert Divers of Kalgoorlie, Perth Diving Academy and Scuba 2). Esperance Diving and Fishing provides diving instruction and scuba tank filling and has the only scuba tank testing facility in Esperance. The main centre of operations is in Esperance Bay, but interest extends to Salisbury Island at the eastern end of the Recherche Archipelago.

Diving is undertaken throughout the year but the main season is in summer, from November to April/May. Winter diving is undertaken when conditions permit.

During the consultations it was suggested that there are 10-15 local professional divers in Esperance, and 150 sport divers. Some of these divers have hookahs. A significant proportion of boats classed as recreational fishers also undertake diving and spearfishing. It is difficult to identify individual divers or to assess their preferred dive sites and numbers involved, however the South East Regional Tourism Strategy report (SERTS) suggests that each year nine per cent of visitors, or 12,510 people, may go snorkelling and one per cent, or 1,390, are scuba divers.

The *Southern Image* (16m) owned by Esperance Diving and Fishing is the town's only dedicated dive charter vessel and carries an average of 12-15 passengers for charters. Total diving and fishing days have varied over a four-year period between 188 and 230 days per year.

Esperance Diving and Fishing advised that its dive log record for the period January 1996 to December 9 1998 showed 4,611 dives had been undertaken in the two-year period, of which 3,228 were at the Remark Island Group, amounting to 70 per cent of the time. Figure of Eight Island is visited 15 times per year.

Esperance Diving and Fishing estimates that their charter operation logs an average of 2,300 dives per year. The logged dives refer to diver's entries to the water. Two dives are usually undertaken by each diver on each voyage.

Based on the above information it is probable that up to 8,000 dives are undertaken in the Recherche Archipelago each year. Most of those dives would be in summer, within Esperance Bay and near Duke of Orleans Bay. Charter operations would account for about a quarter of the diving effort in the Recherche Archipelago. The remainder would be accounted for by:

- shore-based diving;
- private dive boats;
- training, instruction and inshore diving activities.

## 6.2.2 Principal Diving Localities

**Figure 2** shows the main charter diving locations in Esperance Bay and other locations advised in the consultations.

For charter operations, the choice of dive site is related to the economics of distance versus diver numbers. The site needs to be not too deep for ‘no decompression diving’ and to cater for a variety of divers. It is important that clients are not always taken to the same dive site. Dives are scheduled several days ahead and cannot easily be postponed, because of the need for a regular and reliable service. On a bad day, charters will generally still run, but seek sheltered sites. Most charter diving is undertaken within a 45-minute radius out from Esperance.

An important dive site is at Harvest Reef, 18 km from Esperance. This is the site of the wreck of the *Sanko Harvest*, which is the second largest dive wreck in the world. A frequent method of operation is to dive on *Sanko Harvest*, then come in and have lunch and dive in the shallow areas around Remark and Frederick Islands which are protected from the sea breeze. Esperance Diving and Fishing uses the Remark Island Group 70 per cent of the time, because of its protected nature and proximity to Harvest Reef. Other factors are the variety of aspects for all sea and wind conditions, biological interest and diversity of experiences. Other relevant diving features of the Remark Island Group include the occurrence of the protected Leafy Sea Dragon at three sites, the wreck of the *Lapwing* north of Long Island, and spectacular wall and canyon diving with species such as black coral.

Wildwest Sports at Kalgoorlie advised that when they take students they dive Esperance Bay (near the tanker jetty) and Cape Le Grand. Occasionally dives will be undertaken in the Remark Group on the way back from the *Sanko Harvest*. When beginners are involved they don’t dive the *Sanko Harvest* as it is over 20 metres deep. Boat dives (off the *Southern Image*) are generally undertaken at:

- Woody Island
- Cull Island
- Long Island
- Magistrates Rock

Other important diving sites include:

- the artificial reef near the Esperance Tanker Jetty
- Lion Island, which features caves and coral
- Remark and Frederick Islands which have safe dive walls to 18 metre depth.
- Remark Island which has abundant coral.

CALM has advised that it does not favour diving at Kimberly and McKenzie Islands which are seal haul-out sites. It is an offence under the *Wildlife Protection Act* to interact with the seals.

## 6.3 Recreational Boating and Fishing

### 6.3.1 Scope of Activity

Recreational boating is a popular activity and the main means of private access and travel within the Recherche Archipelago. It is likely to interact with aquaculture and marine farming if the industry is developed in the Esperance area. For the purposes of analysis, the activity can be divided into four components:

- Offshore and Deep Sea Fishing. Usually in well equipped vessels of over 5 metres long, going up to 40 nautical miles from shore. Red snapper (or nannygai), pink snapper, harlequin fish, samson, fish, sharks, silver trevally, breaksea cod and queenfish are the main fish of recreational interest to the deep sea fishers who fish the reefs, lumps and bommies up to 30-40 nm out. Some vessels are also used for diving, spearfishing and cruising.
- Inshore Boating and Fishing. Generally smaller vessels operate near the bays and islands, up to 10 nm from shore. The smaller boats tend to operate within 30-60 minutes steaming time from Esperance and other ramps. Generally, these operations fish for King George whiting, sand whiting, pink snapper, snook, sweep and herring. They also engage in diving, family and other recreational pursuits.
- Offshore Cruising under Sail or Power. The Recherche harbours some larger local and visiting yachts including east-west yachting traffic.
- Dinghy Fishing. Trailable or car top dinghies capable of being launched on informal ramps or across the beach and generally limited to sheltered bays. This group is dealt with in more detail in **Section 6.4 – Surfcasting**.

There are four yachting, fishing and boating clubs in the Region including:

- Esperance Bay Yacht Club
- Esperance Deep Sea Angling Club
- Middle Island Fishing Club (not a formal club and only visits now and then)
- Esperance Surf Casters Club

Windsurfing is also a popular activity at Esperance particularly in January and February, because of the strong breezes and variation in beach aspect to the wind. Popular locations are within Esperance Bay, Nine Mile Beach, Twilight Beach, and Yokinup Bay at Cape Arid.

### 6.3.2 Principal Boating and Fishing Localities

All of the island groups are of importance to this sector, however the islands within 10 nautical miles of Esperance and Duke of Orleans Bay appear to be the most frequently visited. It was reported that Figure of Eight Island has very good fishing, and that the Mart and Twin Peaks Island Groups are popular fishing and diving areas. The Duke of Orleans Bay is popular because the snapper are caught close to the shore.

The offshore group tend to remain in open waters and fish the reefs and lumps, as well as the reefs and bommies on the seaward side of the outer islands. The reefs and bommies around Remark Island are said to provide good fishing. Some boats occasionally shelter in the lee of the outer islands for lunch and diving.

It was reported that the Duke of Orleans Bay caravan park accommodates 700 people during the school holidays, and is booked out from the first day. There are normally 65 boats operating out of the caravan park. During this period, with 30 boats going out each day from December to the end of March. Many Kalgoorlie people leave their boats at the caravan park on a permanent basis (44 boats).

### 6.3.3 Anchorages and Navigation Routes

The only landing areas with beaches in the Recherche Archipelago are at Middle Island and Sandy Hook Island. Middle Island is the safest shelter with a north facing beach and anchorages. It is used by local vessels and east-west yachting traffic.



Sandy Hook Island is popular because of its attractive beach and anchorage which is sheltered from southwest and northwest winds. The anchorage and beach is reported to receive a reasonable amount of visitation despite a CALM sign warning of death adders. The anchorage at Woody Island is reportedly used by smaller boats as a base for visits to Sandy Hook Island and the Remark Group when conditions are suitable.

Remark Island is the highest island, marked as a ‘conspicuous dome’ on the chart to show it can/should be used as a navigation marker as it can be seen from most points of the compass. It stands out in fog which often occurs in March and April. Vessels without radar or other aids use Remark Island as a lead into and out of Esperance, to the Sanko Harvest and outer islands. The attached charts show:

- Main reefs and lumps fished by the offshore group (**Figures 3, 4 and 5**);
- Main anchorages and navigation routes (**Figures 6, 7 and 8**)
- Boat ramps, access points and camping areas (**Figures 9, 10, 11 and 12**).

## 6.4 Surfcasters & Beachside Recreation

### 6.4.1 Scope of Activity and Season

The coastline of the study area extends over 200 kilometres from Butty Head, west of Esperance, to Israelite Bay in the east, and features numerous pristine beaches, headlands, islands and sheltered bays. Almost half the coastline abuts the Cape Le Grand and Cape Arid National Parks offering visitors high-value outdoor recreation experiences.

The components of the activity include:

- beach activities including swimming, diving, fishing;
- formal caravan parks in Esperance, Lucky Bay, Alexander Bay, and Duke of Orleans Bay;
- formal and informal camping areas at several points;
- dinghy fishing in sheltered bays, and
- formal and informal boat ramps and launching areas;
- beach access roads and tracks, some suitable only for four-wheel drive vehicles, and vehicular access along many beaches.

Day fishing is popular but many family groups and fishing parties camp for various periods. It has been said that every family fishes at some time during a holiday at Esperance. Fishing activity is commonly undertaken by targeting the holes and gutters along the beaches and the rocks at their ends for species such as herring, skippy, whiting and salmon. Other species including mulloway (at night) and abalone (a licence is required) can be taken from the different marine environments of the coast.

Clubs based in or visiting the region include Esperance Surf Casters Fishing Club which has a hut at Kennedy’s and Middle Island Fishing Club (based in Kalgoorlie).

The main recreational fishing season occurs between November and April with the largest numbers fishing in the school holidays after Christmas and at Easter and the April School holidays. It is similar to the recreational boating season although more extended because it is less constrained by the weather. Some activity occurs throughout the year.

Further details on participation and fishing efforts contained in **Appendix C**.

### 6.4.2 Principal Surf Casting and Beach Recreation Localities

Figures 9, 10, 11 and 12 show:

- main beaches classified as high, medium and low fishing effort/ popularity;
- boat ramps, access points and camping areas;
- dinghy fishing areas;

Important sites include:

- The fuel jetty at Esperance;
- Bandy Creek Harbour and groynes;
- Cape Le Grand Beach;
- Tagan Point;
- Alexander Bay;
- Kennedy's (hut built by Surfcasters);
- Wharton Beach;
- The Duke of Orleans Bay is popular because the snapper may be caught close in;
- Lucky Bay is said to be the most popular camping site, and
- Israelite Bay is notable for King George Whiting, and Cape Arid for mulloway.

Table 1 accompanies the charts having notes on most features.

## 6.5 Charters & Cruises

### 6.5.1 Scope of Activity

The marine charter industry in the Esperance Region is characterised by two levels of operation. There are several part-time operators who only conduct charters during the summer months, and four full-time charter companies operating throughout the year under favourable conditions. Air charters and scenic flights are included in this profile.

Charters are conducted to support the following recreational pursuits:

- **Fishing Parties.** The majority of the fishing charters carried out in the Recherche Archipelago are day trips with an average steaming distance from Esperance of 25 to 30 nm. Most fishing activity occurs over lumps or bommies and generally away from the islands to avoid echoing wave action. Operators seek the shelter of the islands for lunch breaks; or fishing, if their customers are not dedicated fishers and prefer the comfort of a sheltered bay with less spectacular fishing. In recent months there has been an increase in interest expressed by companies outside the region wanting to establish charter operations during the summer months in Esperance.
- **Diving.** There is only one dedicated dive charter vessel operating in the Recherche Archipelago, *The Southern Image*, which is owned by Esperance Diving and Fishing. Other charter operators indicated that while they were happy with their current customer profile they would cater for divers if the demand existed. The majority of the dive charters are day trips with on board overnight charters on request.

- **Air Charter-Sightseeing.** Of the two charter companies operating out of Esperance only Esperance Air Charter offers a regular sightseeing service over islands within the Recherche Archipelago. Goldfields Air Services provides charter flights on request.
- **Sightseeing and Eco-tourism.** MacKenzie's Island Cruises (*Seabreeze*) conduct a full-time tourist charter operation which comprises a number of different sightseeing cruises in the Archipelago. The Woody Island nature experience culminates with a stopover on Woody Island where the company has established a permanent base. Facilities on the island include ablutions, up market tent camping and an interpretative/tearoom centre. *Tammy II*, operated by Mr A. Cummings, is a fishing charter vessel which also conducts eco-tourism charters on demand. *The Southern Image* (Esperance Diving and Fishing), provides scenic cruises on demand and has a whale watching licence.

Further information on fishing, diving and air charter are contained in **Appendix C**.

## 6.6 Commercial Fishing

### 6.6.1 Scope of Activity

The current value of the southern ocean fishery (from Cape Leeuwin to the south Australian Border), is estimated to be just over \$6.03 million (Fisheries WA, 1999) involving 44 vessels. Annually the largest commercial components are shark, pilchards, southern rock lobster and abalone. Other species caught are queen snapper, red snapper, blue groper and scallops. Commercial fishing activity in the Recherche Archipelago comprises the following managed fisheries in addition to fish species caught under a fishing boat licence:

- South Coast Purse Seine Fishery;
- Southern Demersal Gillnet and Demersal Long line Fishery;
- South Coast Estuarine Fishery;
- Esperance Rock Lobster Managed Fishery;
- South Coast Inshore Trawl;
- Zone 1 and 3 Abalone.

Further information about the participation and effort of each of these commercial fisheries is contained in **Appendix C**.

### 6.6.2 Principal Fishing Localities

Principal commercial fishing localities for the relevant operations are:

- **South Coast Purse Seine Fishery.** The purse seine fishers of the Esperance zone generally fish inshore areas within 30 nm of the Bandy Creek Harbour. As pilchards, the main target species, must be processed within 3-4 hours, the boats return daily and unless a mother ship is introduced they are limited to how far they can steam.
- **Southern Demersal Gillnet and Demersal Long line Fishery.** For management purposes this fishery is divided into two zones. The study area is contained within Zone 2, between 116°30' east longitude and the Western Australian and South Australian border and south to the limit of the Australian Fishing Zone.
- **South Coast Estuarine Fishery.** This fishery operates outside of the study area. Operators occasionally fish for garfish east of Duke of Orleans Bay.

- **Esperance Rock Lobster Managed Fishery.** Fishing for rock lobster takes place between 120° east longitude (near Hopetoun) and 125° east longitude (near Point Culver) and south to the 200 nm Australian Fishing Zone outer limit. The eleven boats operating out of Bandy Creek Boat Harbour are often out for up to five or six days at a time.
- **South Coast Inshore Trawl.** During 1986 several vessels operating out of Esperance discovered promising beds of saucer scallops in the Recherche Archipelago, creating the need for the establishment of the South Coast Inshore Trawl Fishery. In 1998 there was only one vessel targeting scallops within 121° 30' east longitude and 123° 20' east longitude and south 34° 20'.
- **Zone 1 and 3 Abalone.** The boundaries of the Zone 1 abalone fishery extend from the WA-SA border to Shoal Cape. According to a spokesman from the Esperance Professional Divers Association the islands within the Recherche are a reliable and valuable source of catch. Areas worked include:
  - Sandy Hook Island – 75%;
  - Remark Island – 50%;
  - Frederick Island 100%;
  - Long Island 50%;
  - Mart Group – nearly all have abalone;
  - Middle Island – not as much as Mart but still gets regularly worked.

**Table 1 Beach Usage**

Location Name	Fishing Effort	Comment
Butty Hbr-Nine Mile Beach	Medium	Beach fishing gutters & holes
Twilight Bay & Blue Haven	High	
Harbour & Tanker Jetty	High	KG Whiting & whiting tailor at tanker jetty
Bandy Ck to Wylie Head	High	Bandy Hbr Groynes, Rec side whiting, Comm skippy & herring
Cape Le Grand Beach	High	Wylie Bay dinghy west end holes -night fishing
Beach west Cape le Grand	Medium	No land access, salmon off beach, skippy off rocks
Hellfire Bay	Medium	Access Gas BBQ, Salmon off beach
Thistle Cove	Low	Not many fishers salmon off beach, skippy from rocks
Lucky Bay	High	Boat Ramp popular, CALM camping site
Rossiter Bay	Low	Mainly tourist fishers
Dunn's Rocks	Medium	Night fishing sharks, abalone, road access camp site
Dunn's Beach	Medium	Popular all along to east, headlands prevent further access
Victoria Harbour	High	Good fishing, very popular, salmon
Cheyne Beach	High	Very popular, 100 cars per day, swimming & fishing
Little Wharton Beach	High	Very popular
Nares Is to Little Wharton	Low	Minimum fishing
Nares Island & Beach	High	Diving off rocks, waterski along beach
Big Wharton Beach	Low	Caravan Park, formal ramp, minimal fishing east end
Daniel's Beach	Low	Minimal fishing
Daniel's Rocks	Low	Track around rocks, some fishing
Munglignup Ck	Low	Some fishing
Alexander Bay	High	All Alexander Beach fished, popular camping boat launching
Kennedy's Beach	Medium	Surfcasters Club Hut, good fishing Taylor Bay Track Alexander
Tagon Bay	High	Very popular – shacks
Thomas River	High	CALM carpark residence Shire Camping area
Yokinup Bay	Medium	Rocks popular
Long Beach	High	Popular good fishing all along to Cape Arid
Arid Bay	Medium	Good fishing Barry Anchorage and divers camp, tractor launching

## 7 RESOURCES REQUIRED FOR AQUACULTURE

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### 7.1 Land Resources

#### 7.1.1 Planning Context

Esperance is an important sub-regional centre of the Goldfields-Esperance Region, located approximately 725 km south east of Perth, with a population of 12,500. Esperance has a district hospital, high and primary schools, and is serviced by sealed road access, goods standard rail and an airport with regular air service to Perth and Albany. Annual population growth has been 1.3 – 1.4 per cent but is locally expected to reach three per cent this year. The economy of Esperance is reliant on the pastoral industry, and local advice is that the town needs an extra two to three thousand people to achieve economic viability (B Thorpe *pers com*).

Esperance had its origins in the pastoral industry in 1863, then as a port for the Goldfields in 1895. Following the successful development of the Esperance Sandplain for agriculture in the Fifties and Sixties, Esperance emerged as a significant centre. It has developed into an established rural coastal town depending on agriculture, tourism, fishing and industry for its economic viability. Industries include grain and cereal production; wool and fat lambs; beef; cattle; pigs; tourism; fishing; fish processing; superphosphate, solar salt and cement works; abattoir; bulk petroleum storage; winery; light industry; and cottage crafts. It is a significant export port handling iron ore, grain and fertilisers. The town is also assuming a role as a retirement centre for the Goldfields and other areas.

The Shire of Esperance has thirteen localities and suburbs. The township of Condingup, 67 km east of Esperance and 18 km from Duke of Orleans Bay, may have significance for future aquaculture development in the east of the Recherche Archipelago by providing for infrastructure and housing.

#### 7.1.2 Shire of Esperance Local Town Planning Scheme

The Shire of Esperance administers a zoning scheme which covers the whole of its district. The Council has Rural Planning Guidelines which set standards for development within the rural areas of the Shire. Due to its identification as a sub-regional centre and its potential for growth, a structure plan for the town is presently being prepared for Esperance by the Ministry for Planning and the Shire of Esperance. The structure plan for the town is based on a population projection of 20,000-30,000 by 2026 (GHD 1998). There are no specific provisions for aquaculture in the planning scheme and it may be appropriate to amend it to provide for aquaculture as a permitted purpose in the Rural Zone.

#### 7.1.3 Coastal Reserves and Zoning

The coastline of the Recherche Archipelago is very restricted from the point of view of ocean side access for land-based aquaculture. The only sections of the coast not included in National Parks are:

- west of Esperance to Butty Head;
- east of Esperance from Bandy Creek Harbour to Cape Le Grand National Park;
- Duke of Orleans Bay East to Cape Arid National Park.

- These three sections of coast all have local town planning scheme Parks and Recreation Reserves approximately four kilometres wide over the private and public lands involved. The only points at which the reserve is very narrow are;
- Fourth Beach, West of Esperance, Zoned Rural Residential;
- between Bandy Creek Harbour and Wylie Head in Esperance Bay;
- immediately east of Duke of Orleans Bay.

Between Bandy Creek Harbour and Wylie Head there is a narrow foreshore Crown Reserve which is reserved for Parks and Recreation. The hinterland is zoned Harbour, Rural and Public Purposes (Land Fill Site).

The effect of the Parks and Recreation Reserve is to limit development that is inconsistent with the purpose of the reserve. While aquaculture development may be possible, scheme rezoning may be required for a particular proposal.

#### 7.1.4 Status of Land Availability in Esperance

The Shire of Esperance manages the development of land at Esperance and as a significant land owner, participates in land development. Residential development has increased in the last five years and land prices have risen significantly in response to market factors and the requirement for deep sewerage in new subdivisions.

There is presently a reasonable turnover of urban real estate involving upgrading of homes, people from the Goldfields buying properties for investment, retirement or rental properties, and retirees. It was advised that many retirees who went to Mandurah or Bunbury are returning to Esperance because of the perception of crime and other issues in those communities. (B Thorpe *pers com*).

In the commercial-industrial area, it was reported that there is a shortage of industrial units, complexes and land. New commercial zoning is rare and there are few vacant commercial properties. Those that come onto the market sell straight away if offered at the right price (B Thorpe *pers com*). General land values off main thoroughfares is about \$250,000 per hectare (R Bower *pers com*). Land is also available for aquaculture purposes in the commercial precinct of the boat harbour.

Rural lands have maintained good value despite recent poor seasons, weather and prices. Near Esperance, there are very few properties with water frontages which are suitable for aquaculture as most have parks and recreation reserve buffer zones or fragile environments. The few waterfront properties available are very valuable because they would be prime residential or tourism sites. Some prime residential land is likely to be redeveloped for tourism in the future (B Thorpe *pers com*).

A Native Title claim affects much of the land and waters of Esperance and the Recherche Archipelago.

#### 7.1.5 Status of Land Availability in Duke of Orleans Bay

The Duke of Orleans Bay area has great scenic beauty and is a popular tourism and recreation destination. The town site of Wharton at Duke of Orleans Bay is mostly taken up by the existing caravan park. The fishing industry has traditional associations with the area, using the boat ramp for launching, and the anchorage at Nares Island to unload fish into refrigerated vans to Perth. Council has supported berthing and ramp facilities proposed for the anchorage at Nares Island.

The Duke of Orleans Bay area could have a future role as an access point to aquaculture projects in the eastern parts of the Recherche Archipelago. However it lacks services and infrastructure, particularly, developable land, roads and power, which would be required for industry support or in situ aquaculture development. The present power supply is a single phase supply to the caravan park. Some of the land surrounding the town site may have potential for development, though there are constraints on its availability as it has natural bushland cover and is composed of Crown Reserve for Recreation vested in Esperance Shire Council. Native title may be an issue.

### 7.1.6 Status of Land Availability in Condingup

The township of Condingup is located 18 km north of Wharton (Duke of Orleans Bay) at the junction of Fisheries Road and Duke of Orleans Bay Road. It has a population of about 140, with 40 houses, a primary school, tavern, power, water and other infrastructure. It has some vacant residential, industrial and light industrial-zoned land. Industrial land values in Condingup are approximately \$20,000 per hectare (R Bower *pers com*). Condingup appears to have significant potential for staff housing, fabrication, cold storage and other facilities which would be required by a future aquaculture industry operating out of Duke of Orleans Bay. This may be a preferable location to Wharton.

## 7.2 Water Supplies

The Esperance water supply is managed by the Water Corporation and is based on bore water, and high level storage within the town. The bore water is extracted by 34 bores to the west of the town, from a coastal aquifer 10m thick, which contains fresh water over a wedge of higher salinity. There are some problems with rising salinity which are being dealt with by seeking alternative sites. There are adequate water supply bores to the west of the town but other ground water areas are available for future town growth. A bore use survey of special rural and special residential areas is being undertaken by the Water Corporation.

While the overall quality of the towns' water supply is within Australian drinking standards, potential threats exist from industry and rural activity, and urban development. In a report produced by the Water Authority in 1992, "Esperance Water Reserve Protection of Ground Water Quality", occasional incidents of contamination of eight production wells by the pesticide Atrazine were noted.

## 7.3 Ground Water and Ocean Water for Aquaculture

The coastal plain contains significant fresh water, and the underlying saline water may have potential for aquaculture. Access to this water may be limited because of other demands on the aquifer and the potential for pollution from other industrial operations close to developed areas. Pumping oceanic water to land-based aquaculture projects is possible, but approval is required to cross foreshore reserves which occur in most areas. Some of these are affected by native title and the claimants' approval will also be required.

While there is no immediate evidence of water pollution in the area, Esperance is a large town reliant upon limited ground water resources and lacking complete sewerage reticulation, particularly in industrial areas. Waste disposal is via landfill operation. While no problems have been reported from the site, some of the most prospective land for aquaculture is nearby.

Esperance is a significant port with attendant risks of pollution events, spills, and ballast water discharge, even though controls are in place. Aquaculture, as a food producing industry, has an absolute requirement for water



which is free from pollution or contamination. It also requires reliability of supply or backup water resources because of its vulnerability to contamination.

Equally, it is self-evident that aquaculture outputs must not contribute to environment or groundwater pollution. Proponents need to carefully examine prospective water supplies and undertake risk assessment procedures for any proposed site water supply.

## 7.4 Waste Water

Esperance has a reticulated sewage scheme managed by the Water Corporation, which is currently being extended under the sewage infill program. All new development is required to connect to the scheme. Sewage treatment is by primary and secondary oxidation ponds which are situated between Esperance and Castletown. Effluent discharge is to the ground water, but rising water tables have led to plans for bore recovery for reuse on council playing fields. Local advice is that residential development is being held up by slow expansion of the sewerage scheme (B. Thorpe *pers com*).

Areas of potential interest to aquaculture (i.e. Bandy Creek Harbour and light industrial area) are not sewered.

There is a long-term plan to place a new treatment works at the Council tip, 8km east of town, when the population level requires. Plans in place will ensure the water supply and waste water schemes will adequately cater for the town's expansion to at least 2026 (GHD, 1998).

Stormwater drainage is disposed of on site, and recharges the ground water.

## 7.5 Power Supply

The Esperance Power supply is managed by Western Power and is based on diesel generators supplemented by wind generators. The supply also services rural properties and other townships in the Shire. Nine wind generators of 225kW each supply about 11-15 per cent of consumption.

The permanent capacity of the power supply is 11.5MW but demand is expected to be greater than 18 MW by the year 2002. The current nominal demand of 13 MW is growing at 9.5 per cent each year. Demand often exceeds supply and peak demand is met by hired diesel plants (GHD, 1998). Because of supply difficulties, the Esperance Port Authority has gone to its own diesel power supply which produces 5 MW. Current use is 3 – 5MW. The power supply for Esperance is considered to be inadequate and fifteen years past its replacement date.

## 7.6 Education

There are eight primary, two secondary, one private and two pre-schools in the Shire. Condingup has a primary school with grades 1 through to 7. There are proposals to establish a new high school or senior campus/college in Esperance. These include proposals to establish an open-learning community college near the high school in association with Curtin University. It was suggested to the consultants that there was potential in this proposal for the creation of a cold water research facility to assist research in connection with marine park proposals and to provide education training and research for a future aquaculture industry (R Bower *pers com*).

### 7.7 Harbour Facilities

Bandy Creek Boat Harbour, 5 km east of Esperance, is a modern harbour precinct for recreational and commercial fishing industry support, seafood handling and processing. The harbour is located within Bandy Creek and flows are controlled by a weir. The harbour entrance across the beach is protected by groynes and maintained to allow entry by larger vessels. The western side has a boat ramp, car and trailer parking, public comfort facilities and the premises of the Esperance Deep Sea Angling Club. The eastern side has commercial fuel, landing and mooring jetties, and a marina with pens, power, slipway and facilities for commercial fishing boats. An additional large slipway and hardstanding area has recently been completed.

Bandy Creek Harbour was designed for a regional purpose, which included the concentration of all the fish processing industries in one area. Because the power supply was insufficient, many industries went to industrial areas near the centre of town (B Sponberg *pers com*).

Approximately 30 hectares of land zoned 'Harbour' is available for commercial fishing industry support, seafood handling and processing. Established facilities include the office of Fisheries Western Australia, seafood freezers and exporters, and fishing company workshops and handling facilities.

The land is currently available on lease from the Department of Transport but is being converted to freehold. Over the next two to three years, this process will include the creation of more lots and upgrading of the power supply which is currently limited.

The area could readily provide for future waterside landing facilities associated with aquaculture and marine farming operations and is appropriately zoned for aquaculture. Part of the land, which is vested in the Minister for Transport, within the boat harbour precinct could be made available for aquaculture purposes including a hatchery and processing facilities.

### 7.8 Industry Prospects

The investigations and consultations have indicated that in relation to the availability of infrastructure, the overall prospects for development of the aquaculture industry at Esperance and in the Recherche Archipelago are good. There are adequate water, infrastructure and labour resources to support the development of the industry for the foreseeable future. Power supply and cost, and suitably located land are likely to be initial concerns.

Concerns about the potential impact of urban development and processes on the quality of marine water and groundwater on which the food producing industries (including both aquaculture and wild fisheries operating in inshore waters) are reliant, are capable of resolution through strict planning, administrative control; research and monitoring.

### 7.9 Summary

- Adequate harbour, marine holding areas and onshore facilities are available for reasonable development of the aquaculture industry.
- Esperance Townsite and its surrounding area has ample freehold, Crown and leasehold land which is relatively flat and close to services.

- Esperance has been identified as a major sub-regional centre and the rate of growth of the town can be expected to increase, with the result that land supply and land cost for aquaculture may become a limiting factor in the foreseeable future. At present, adequate appropriately zoned land is available at reasonable cost.
- The most prospective land for aquaculture in or near Esperance is where suitable zoned land occurs over saline ground water aquifers or adjacent to the coast. Careful site selection would be necessary to ensure water supply, waste water disposal, services and operational space can be achieved at reasonable cost.
- The availability of significant quantities of ground water in coastal aquifers (of salinities from sea water to brackish and fresh) is of potential significance to aquaculture development at Esperance provided it is carefully exploited. It is probable that many aquaculture species could be hatched or grown out in land-based facilities using saline or fresh water from these sources. Precise quantities of water available and appropriate methods of disposal of waste water from aquaculture sites away from the coast are matters requiring further examination.
- Urban processes and port activities could present a health risk or nutrient enrichment problems to the seafood industries using adjacent waters or ground water, unless management and monitoring procedures are strictly adhered to by operators and government agencies.
- National Parks, Crown foreshore reserves and the Parks and Recreation Reservation in the Esperance Town planning Scheme impose restrictions on the development of land-based facilities and access to ocean waters for pumping and disposal of waters used for aquaculture.
- There is a need for the Shire of Esperance Local Town Planning Scheme to be amended to provide for aquaculture as a permitted purpose in the Rural Zone No. 9.

## 8 CONSTRAINTS TO AQUACULTURE ACTIVITIES

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### 8.1 Overview

It is necessary for the planning for the future development of an aquaculture industry to identify any limiting factors which may constrain any of the major components of the industry.

Generic constraints to aquaculture development in Western Australia are discussed in **Appendix F**.

In a local and regional planning context, this section addresses specific constraints to development in the Recherche, including environmental and social issues, infrastructure, water and land resources needed by this industry, with the objective of identifying any limiting factors which may exist.

### 8.2 Environmental Constraints

The main environmental constraints to the development of aquaculture which were identified in Esperance and the Recherche Archipelago are:

- Any proposal will need to recognise the value of the Recherche Archipelago in terms of the importance of nature based tourism and conservation values of the area.
- The impact on benthic habitat such as seagrass meadows, coral growth, and other substrate should be understood before the siting of aquaculture structures.
- Strong prevailing winds, swells and storm events in the Recherche Archipelago will require special consideration in the design and location of marine aquaculture structures.
- Many of the islands of the Recherche Archipelago have seabird breeding areas, seal and sea lion breeding and haul out areas. Marine mammals including whales, dolphins and seals occur in the area. These will impose special management requirements on marine aquaculture operations.
- The benthic habitats of the Recherche Archipelago are not well known and detailed survey of the location and function of the benthos will be required before marine aquaculture projects can proceed to full production.
- Land-based aquaculture and support facilities are not normally permitted on island nature reserves or coastal National Park lands.
- Land-based aquaculture and marine farming has the potential to cause nutrient enrichment and pollution of inshore waters unless husbandry and monitoring procedures are strictly adhered to by operators and government agencies.

### 8.3 Existing Users

As documented in **Section 6**, there are a number of existing commercial and private users of the Recherche archipelago. The needs of these users, both now and in the future, need to be considered in the selection of operate aquaculture sites, operations and species. The degree to which aquaculture will conflict with other users will depend on unique specifications of each proposed operation.

### 8.3.1 Competition for Space

In broad terms the main constraint to proponents seeking to use public lands or waters for aquaculture is competition for space with other existing and potential users of the resource. **Section 6** contains a number of charts of the main areas of interest to other users, which have been prepared for use as preliminary constraints mapping for aquaculture planning. Conflicts arising from competition for space may be direct or indirect, and the severity of the conflict will be related to the size and extent of the aquaculture proposal, and the perceived importance of the area to other users.

Indirect conflicts may arise with tourism and recreation interests where aquaculture ventures are proposed near beauty spots or coastal access points. The main concerns relate to area amenity and the aesthetics of farms, buildings and infrastructure located in the coastal zone. Other indirect concerns include perceptions of shark danger and pollution associated with aquaculture. Most of these issues are capable of resolution through careful design and siting, planning and close consultation with the groups most likely to have such concerns.

Direct conflicts with other users may occur with marine based proposals where the shelter of islands is required. Sheltered locations are inevitably valued for diving, fishing, mooring and shelter from unfavourable sea conditions. Similarly, sites on or near the coast are highly prized by many sections of the community and careful planning and consultation will be required to obtain access to these areas.

**Table 2** lists some of the likely aquaculture development scenarios for the Recherche Archipelago and adjacent areas and identifies potential constraints posed by other users.

**Table 2 Potential User Constraints**

<b>Development Scenario</b>	<b>Type of Constraint</b>	<b>Competing Use or Interest</b>
Land-based Aquaculture on freehold land away from the coast.	<ul style="list-style-type: none"> <li>• Ground water allocation;</li> <li>• Disposal of waste water;</li> <li>• Amenity.</li> </ul>	<ul style="list-style-type: none"> <li>• Neighbouring land uses.</li> </ul>
Land-based Aquaculture on foreshore sites.	<ul style="list-style-type: none"> <li>• Ground water allocation;</li> <li>• Disposal of waste water;</li> <li>• Seawater intake and outfall pipes across coastal reserves;</li> <li>• Amenity and aesthetics;</li> <li>• Building and infrastructure design and siting.</li> </ul>	<ul style="list-style-type: none"> <li>• Neighbouring land uses;</li> <li>• Tourism;</li> <li>• Beach Recreation;</li> <li>• Beach Fishing;</li> <li>• Traditional Aboriginal hunting and land rights.</li> </ul>
Marine aquaculture in coastal waters.	<ul style="list-style-type: none"> <li>• Amenity and aesthetics;</li> <li>• Mooring and shelter;</li> <li>• Boating and fishing;</li> <li>• Diving;</li> <li>• Shore based infrastructure;</li> <li>• Boat launching areas;</li> <li>• Navigation.</li> </ul>	<ul style="list-style-type: none"> <li>• Neighbouring land uses;</li> <li>• Tourism;</li> <li>• Beach recreation;</li> <li>• Beach fishing;</li> <li>• Boating;</li> <li>• Commercial fishing</li> <li>• Traditional aboriginal hunting and land rights.</li> </ul>
Small scale marine aquaculture in offshore waters.	<ul style="list-style-type: none"> <li>• Amenity and aesthetics;</li> <li>• Mooring and shelter;</li> <li>• Boating and fishing;</li> <li>• Navigation.</li> </ul>	<ul style="list-style-type: none"> <li>• Boating;</li> <li>• Commercial fishing.</li> </ul>
Large scale marine aquaculture in offshore waters.	<ul style="list-style-type: none"> <li>• Amenity and aesthetics;</li> <li>• Mooring and shelter;</li> <li>• Boating and fishing;</li> <li>• Diving;</li> <li>• Commercial fishing and diving;</li> <li>• Navigation;</li> <li>• Interactions with predators.</li> </ul>	<ul style="list-style-type: none"> <li>• Boating;</li> <li>• Commercial fishing and diving;</li> <li>• Charter operators;</li> <li>• Shipping.</li> </ul>

## Large-scale Sea Cage Farming

Large-scale sea cage farms need only restrict access for recreational boating and fishing to the extent of the cages themselves, and the near vicinity. Farm licences, which cover a much greater area, do not give the operator the right to exclude others. It is a condition of aquaculture licences that the aquaculture would be beneficial if conditions were applied to any proposal to ensure that sea cages are marked properly so as not to cause a threat to navigational safety, and that permanent moorings were installed to provide safe anchorages in the event of rough conditions.

The issues of visual amenity, the perception of pollution and the perceived increase of shark danger, which are of concern to the tourism and other industries, have been dealt with in previous sections. As the Western Australian Tourism Corporation has pointed out, the success of a tourism destination is often based on the consumer's perception of that destination. This perception deals with many aspects of the area's characteristics including such things as the pristine environment, safe diving and swimming waters, friendly locals and 'wilderness experiences'.

For planning purposes, the perception that tuna farming will adversely affect, recreational and commercial diving, including abalone diving has implications for any tuna or sea cage proposal. In forming decisions on any proposal, decision makers will be required to give consideration to this important issue.

### 8.4 Community Support

The process of aquaculture industry development will be greatly enhanced when a community recognises the socio-economic benefits a healthy aquaculture industry can bring to its region. Conversely, a community which is not supportive of aquaculture can impede the planning progress, demand unrealistic environmental restrictions and generally fail to help integrate the industry into the social and economic fabric of the community.

At an early stage, proponents will be encouraged to maintain open and frequent communications with the Esperance community and hold workshops to explain their project. Proponents will need to ensure the community has a role in the planning process.

### 8.5 Other Social Constraints

Other social constraints include:

- National Parks, Crown foreshore reserves and the Parks and Recreation Reservation in the Esperance Town planning Scheme, impose restrictions on the development of land-based facilities; and access to ocean waters for pumping and disposal of waters used for aquaculture;
- The location of aquaculture structures should avoid creating restrictions to boat access.

Community consultation is an essential component of aquaculture planning and the development of aquaculture proposals. A community based management advisory group may assist in the development and management of the aquaculture industry.

## 8.6 Infrastructure Constraints

Although there are adequate water, infrastructure and labour resources to support the development of the aquaculture industry for the foreseeable future, securing an adequate power supply at reasonable cost, and locating suitable land, are likely to be initial concerns.

Concerns about the potential impact of urban development and processes on the quality of marine water and groundwater needed for use by food producing industries, including both aquaculture and wild fisheries operating in inshore waters, are capable of resolution through strict planning and administrative control; and research and monitoring.

## 8.7 Resource Constraints

Resource constraints include the following:

- Urban processes and port activities could present a health risk or nutrient enrichment problems to the seafood industries using adjacent waters or ground water. Management and monitoring procedures must be strictly adhered to by operators and government agencies.
- Great care is required to monitor and protect ground water resources at Esperance from pollution, over-pumping and stormwater because of their potential value to the food production industry.
- Potential conflict between aquaculture operations and existing shipping activities of Esperance's major export port must be recognised. Planning for sea-based aquaculture, must consider shipping routes.
- The risk of oil and ballast water emissions and problems associated with dredging of shipping channels which will generate turbidity and suspend soils, must be allowed for.

## 8.8 Lack of Information

There has been much concern expressed over the lack of environmental, social and economic data on the region and the influence of this on the development of an aquaculture industry.

Some individuals considered that a full environmental study and preparation of an overall plan for the Recherche Archipelago, and the proposed Marine Park, should occur before any offshore marine aquaculture proposals were further considered.

The dearth of environmental information on the Recherche Archipelago must be acknowledged, but the situation is not unique to this or other marine areas; it is a problem facing planners and proponents in many parts of Western Australia. The need to proceed with a development in the absence of an overall plan is a common situation which was anticipated and included in the formulation of the *Environmental Protection Act 1986*. The procedures in the Act are considered adequate and put the onus of environmental research, site investigation and management of efforts on the proponent and the regulatory authority.

In June 1998, the Environmental Protection Authority (EPA) released a draft *Environmental Protection Policy for State Marine Waters (EPP)* which details the way the EPA proposes to manage development within the State's marine waters.



Furthermore, benthic mapping and environmental investigations would be required on a finer scale in conjunction with any formal aquaculture application. Such surveys of biological resources are considered to have more focused benefits for aquaculture than broader-scale surveys of larger areas. In this manner, an accumulation of knowledge of the environment will occur in coordination with the development of the aquaculture industry. This information will add considerable value to future marine planning in the area, as it has the potential to provide a considerable source of baseline data which would not have been obtained in the absence of an aquaculture industry.

## PART C CURRENT MANAGEMENT ARRANGEMENTS

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### 9 MANAGEMENT AUTHORITIES

#### 9.1 Decision Making Authorities

##### 9.1.1 Fisheries Western Australia

The Executive Director of Fisheries WA determines applications for licences and leases over areas of the Western Australian marine environment to enable the operations of the aquaculture industry. These decisions are made after planning and consultation processes undertaken pursuant to the *Fish Resources Management Act 1994*.

Fisheries Western Australia provides technical support and advisory services to aquaculture through its regional Aquaculture Development Officers and research support staff.

Fisheries Western Australia's aquaculture licence application package and Ministerial Policy Guideline No 8 (Assessment of Applications for Authorisations for Aquaculture and Pearling in Coastal Waters of Western Australia (FWA, 1997)) provides guidance for proponents.

##### 9.1.2 Shire of Esperance

Under the *Local Government Act 1960*, municipal authorities have the power to make by-laws with respect to matters including planning, health, zoning, land use and environmental controls, to the extent that such by-laws are not inconsistent with Commonwealth or State planning.

Proponents wishing to develop aquaculture projects on land will in most cases require development approval from the local authority. Council will be interested in, *inter alia*, design and siting details, health and amenity, access to water supplies, disposal of wastes and noise generation.

Marine-based projects need to be referred to Council for comment and conditions relating to land-based support facilities and activities connected to the proposal, particularly the proponent's intentions regarding the disposal of waste and offal.

The Shire of Esperance administers a zoning scheme which covers the whole of its district. Further information about the scheme is provided in **Section 7.1.2**.

##### 9.1.3 Environmental Protection Authority (EPA)

Pursuant to the *Environmental Protection Act 1986* the EPA has prescribed guidelines for environmental assessment documents and provides advice to the Minister for Environment on environmental factors relevant to the proposal and any conditions or procedures that should be applied to a proposal.

The EPA has prime responsibility for environmental protection in the State. Proposals that are likely, if implemented, to have a significant effect on the environment must be referred to the EPA for environmental

impact assessment. The EPA requires a certain minimum level of information to enable it to determine whether environmental impact assessment is required and at what level it will be set. All aquaculture applications are referred to the EPA for assessment.

#### 9.1.4 Department of Environmental Protection (DEP)

The DEP facilitates the preparation of assessment documents in accordance with EPA procedures and is responsible for issuing any approvals or licences pursuant to Part V of the *Environmental Protection Act 1986* following the issue of environmental approval by the Minister for the Environment pursuant to Part IV of this Act. The DEP also performs an advisory and pollution control function, which is of importance to aquaculture.

#### 9.1.5 Water and Rivers Commission (WRC)

The Water and Rivers Commission has the responsibility for licensing the allocation or abstraction of certain water resources, protecting and securing water resources and the preparation of water allocation plans. The Commission, as manager of WA's inland waters, aims to ensure that various land users do not create an unacceptable impact on the State's water resources. Aquaculture projects are a potential source of significant water draw.

The Commission has various powers that may relate to aquaculture projects. These include the licensing of groundwater extraction within certain proclaimed areas, and controls over disturbance to the bed, banks or foreshore of waters in declared management areas.

#### 9.1.6 Department of Transport

The Department of Transport is concerned with the navigational aspects of aquaculture and issues Mooring Licences under the provisions of the *Western Australian Marine Act*. Its Coastal Management Branch is the custodian of the WA Coastal Atlas, which is a digital geographic information system (GIS) containing much information on the coastal environment in mapped form.

#### 9.1.7 Esperance Port Authority

The waters of Esperance Bay and the inner islands within about 15 km of Esperance are vested in the Esperance Port Authority. Potential aquaculturists require a lease from the Esperance Port Authority for aquaculture before an aquaculture licence can be issued by Fisheries WA.

## 9.2 Other Agencies Involved with Aquaculture Proposals

### 9.2.1 Western Australian Museum

The Western Australian Museum is responsible for the protection of historic shipwrecks.

### 9.2.2 Department of Aboriginal Affairs (DAA)

Under the *Aboriginal Heritage Act 1972-1980* the DAA ensures that all heritage issues in relation to a development have been addressed. Where alteration or damage to a site can not be avoided, consent to use the land may be sought under Section 18 of the Act.

### 9.2.3 Aboriginal Heritage Act 1972-1980

All Aboriginal Sites in Western Australia are protected under the provisions of the *Aboriginal Heritage Act 1972-1980*. A register of known sites is maintained by the Department of Aboriginal Affairs. However, in areas being considered which have not been previously examined, an archaeological survey may be required. There are many sites of Aboriginal significance and interest associated with the ocean, coastline and islands, including mythological sites, fish traps, middens and burial areas.

Under Section 18 of the Act, Ministerial consent is required where a development may alter or damage the significance of an Aboriginal site. The proponent must report to the WA Museum and propose strategies to avoid or mitigate against disturbance of sites if any were found.

Applicants for an aquaculture lease or licence should be aware of potential Aboriginal interests and would well be advised to discuss proposals with any relevant Aboriginal communities in the vicinity of their proposed site during the planning phase.

According to the *Commonwealth Native Title Act 1993*, offshore activities are permissible and valid provided the same procedural rights are observed regarding any native title holders as are acceptable to other persons holding corresponding rights and interests in the area.

### 9.2.3 Department of Conservation and Land Management (CALM)

CALM administers the *Conservation and Land Management Act 1984* and the *Wildlife Conservation Act 1950* which aim to conserve Western Australia's flora and fauna. The *Acts Amendment (Marine Reserves) Act 1997* amends the marine reserves provisions of the *Conservation and Land Management Act 1984*, as well as the *Fish Resources Management Act 1994*, and provides a clear statutory regime governing aquaculture in marine conservation reserves.

The principal vesting authorities under its legislation are the Marine Parks and Reserves Authority (MPRA) and the National Parks and Nature Conservation Authority (NPNCA).

## 9.3 Community and Industry Organisations

Community and industry organisations will be of great significance to the development of aquaculture in the Recherche Archipelago, because they can act as contact points for proponents and government in gaining local knowledge. Relevant organisations in the study area include:

- The Recherche Archipelago Consultative Group (RACG);
- Esperance Professional Fishermens Association;
- Esperance Chamber of Commerce;
- Aquaculture Council of Western Australia (ACWA), and
- Esperance Regional Recreational Fishing Advisory Committee.

## 10 PROCEDURES FOR APPLYING FOR AN AQUACULTURE LICENCE

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### 10.1 Application Procedures

The application and consultation procedures for an aquaculture licence are set out in *Ministerial Policy Guideline No 8, Assessment of Applications for Authorisations for Aquaculture and Pearling in Coastal Waters of Western Australia* (FWA 1997). Fisheries Western Australia also has a licence application pack to assist applicants.

### 10.2 Pre-application Investigations and Procedures

While this report has outlined various opportunities and constraints facing the development of aquaculture in the Recherche Archipelago there must be further work carried out by the proponents and in some cases the Esperance community themselves before sites are allocated.

Proponents should bear in mind that all applications for an aquaculture licence will require assessment by the Environmental Protection Authority (EPA). The level of assessment will be determined by the EPA. Fisheries WA cannot approve an aquaculture licence until it has the approval of the EPA/DEP.

Broadly speaking, the quality of pre-application investigations and procedures will assist the consideration of an application for an aquaculture licence. Conscientious environmental investigations and community consultations are at least as important as the economic and technical aspects of a business plan, and project budgeting should allow for these aspects.

### 10.3 Site Identification Considerations

In order to determine the most appropriate site for an aquaculture project it is necessary to consider and in some cases map the following:

#### 1. Physical Characteristics:

- temperature;
- wind direction and velocity;
- direction and velocity of currents;
- maximum wave height/wave direction;
- velocity overwash zones;
- bathymetry;
- surface water designations;
- mean low water/mean high water;
- barrier beaches;
- shoreline changes.

### 2. Areas with biological management designation:

- endangered species and critical habitats;
- identifiable nursery areas and haul out sites;
- sea grass;
- plankton density.

### 3. Cultural features:

- community values;
- importance to Aboriginal people;
- importance to other users.

Possible negative effects on the aquaculture operation from:

- agricultural runoff;
- commercial fishing;
- recreational fishing;
- diving;
- charter operators;
- commercial shipping;
- port operations (pollution).

The proponent should provide sufficient information in their application to enable an environmental impact assessment (EIA) to be undertaken. This may include:

- video diver survey;
- appropriate benthic analysis;
- water quality sampling;
- hydrographic data collection.

Proponents are encouraged to give consideration to enabling community representative input into the EIA and proposed environmental monitoring plans.

## PART D

# A STRATEGY FOR AQUACULTURE

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## 11 Overview

The consultations and investigations have found that Esperance and the Recherche Archipelago have significant potential for the development of aquaculture, but that community concern about tuna farming has tended to adversely affect the perceptions of other forms of aquaculture which could be most beneficial to the region. The following objective should be pursued in the development of an aquaculture industry in the Recherche Archipelago:

“Encourage the development of a vibrant, environmentally sustainable aquaculture industry, that can co-exist with the existing and planned physical, cultural, social and historic values of the Recherche Archipelago.”

‘Constraints planning’ invariably produces issues which could easily discourage proponents. While there are some significant constraints to aquaculture in the study area, these can be managed without undue cost or difficulty, so the strategy proposed below suggests and examines ways in which aquaculture development can be encouraged.

## 12 AQUACULTURE SYSTEMS

### 12.1 General Features

As with conventional farming, aquaculture systems vary in intensity and may be described as ranging from extensive through to intensive systems. Extensive systems are characterised by having relatively few inputs by the operator.

*Extensive culture*, for example yabby farming, is characterised by the following features:

- limited or no feeding;
- low control over the systems;
- low energy;
- low stocking rate;
- site critical;
- large areas needed for economic production;
- low yields.

*Intensive Culture*, for example sea cage farming, requires far greater inputs by the operator and is intended for maximum yield. The features are:

- artificial diet;
- high level of management required;
- high energy input;
- high stocking rate;

- site not as relevant;
- smaller area required;
- high yields;
- capital intensive.

A variety of aquaculture systems have been developed. The diversity of systems is described in the following classifications of Avault (1996) and are taken from Anderson et al (1997).

The following **Table 3** highlights the advantages and disadvantages between offshore sea cages and land-based systems. While the information relates to the culturing of salmon in British Columbia there exists some similarities between the salmon farming industry and the potential industry in the Esperance Region. These include user conflicts, pollution effects and the need to develop cost effective production systems.

**Table 3 Comparison of Land and Sea-based Systems**

System Type	Advantages	Disadvantages
<b>Exposed Offshore Open Marine Systems</b>	<ul style="list-style-type: none"> <li>- Proven commercial viability</li> <li>- Avoids/reduces environmental issues associated with near-shore coast (e.g., benthic smothering, potential nutrient loading of inshore waters, predator interactions)</li> <li>- Less conflict with competing coastal resource users</li> <li>- Potential for many new sites to become available for the industry</li> <li>- Higher quality rearing environment, leading to a potentially healthier, higher quality product</li> </ul>	<ul style="list-style-type: none"> <li>- Changes required in farming methodologies</li> <li>- Investment in new engineering and new capital</li> <li>- Changes required in industry corporate focus</li> <li>- Potential for navigational conflict</li> <li>- Uncertain government policy and regulatory environment</li> <li>- Possible redirection of economic benefits associated with processing and services</li> </ul>
<b>Land-based Saltwater Systems</b>	<ul style="list-style-type: none"> <li>- Highly controlled, more optimal rearing environment for culture fish</li> <li>- With treatment technology, avoidance of potential deleterious impacts on the marine environment associated with waste discharges</li> <li>- Easier, safer working environment</li> <li>- Limits or eliminates escapes and interactions with predators</li> </ul>	<ul style="list-style-type: none"> <li>- Poor record of economic success – commercial viability doubtful at this time</li> <li>- High capital and energy costs</li> <li>- Treatment of solid wastes and waste water difficult, although technology is emerging</li> <li>- Environmental issues associated with water intake and effluent still evident without recirculation/treatment</li> <li>- Highly restrictive siting requirements</li> <li>- Conflict with upland property users expected</li> </ul>

Source: Environmental Assessment Office (1997)



## 12.2 Systems Applicable to the Recherche Archipelago

The systems described in **Table 4** are commonly found throughout the world in varying degrees of sophistication and intensity. Given the physical and socio/cultural features of the Recherche Archipelago as described in this report, certain systems will be most suitable for industry development in Esperance. These are described below:

### 12.2.1 Land-based Aquaculture

The Esperance area has adequate flat land near the coast or over saline groundwater reserves, which suggests the area would be most suitable for the aquaculture systems listed previously. These systems are commonly used interstate and overseas where similar topography, environmental conditions and species occur. Land-based systems, including a hatchery, would also provide support for sea-based aquaculture operations.

- Suitable systems for an Esperance industry would thus be:
- tank systems for fingerling production;
- raceway and tank systems for growout of abalone and possibly finfish;
- pond culture in areas of suitable soils adjacent to the coast or lined ponds (clay or plastic) if soils are not suitable for ponds.

Recirculating and flow through systems will be necessary for both hatchery and growout. The design of the system should take into consideration preventing or minimising any possible effects of waste discharge from the system on the immediate environment.

**Table 4** Types of Land-based and Sea-based Aquaculture Systems

Land-based Aquaculture Systems	
<b>Pond Culture</b> structures additions discharges	Aquaculture ponds are typically earthen or concrete, and can be natural or artificially lined. Cultured species can be artificially fed or allowed to feed through the natural food chain. The addition of organic and inorganic fertilizers is common in non-fed ponds. Circulation and pure oxygen injection are sometimes used to enhance water quality. Paddle wheels or other means of agitation are also used to enhance oxygenation.
<b>Raceways</b> structures additions discharges	Raceways are long, narrow rectangular tracks or trenches through which water is flushed continuously. They can be constructed of various materials, including plastic, fibreglass, concrete or metal. Water flow can be maintained by flow through pumping, or through artificial means such as recirculation systems with oxygen injection.
<b>Tanks with recirculation systems</b> structures additions discharges	Land-based recirculation systems often involve metal, plastic, or fiberglass tanks, normally built above ground. The systems are often enclosed in warehouse type structures. Recirculating systems allow greater control of temperature and tend to minimise water use and effluent discharge. Generally, use of these systems requires highly skilled site managers.
<b>Hydroponics</b> structures additions discharges	Hydroponics is the practice of raising aquatic and terrestrial plants in nutrient-rich water. Fish culture can be integrated with hydroponic systems to grow plants such as tomatoes, lettuce and basil. Fish waste is utilised as the nutrient source for the plants.

<b>Sea-based Aquaculture Systems</b>	
<b>Net-Pen Culture</b> structures, additions discharges	Net-pen culture involves the culture of species in floating nets that can be secured to the bottom. Submersible cages have been developed to avoid heavy sea conditions.
<b>Sea Ranching</b> no structures no additions no discharges	Sea ranching involves the release of hatchery raised fish into the wild. Animals are allowed to grow in the wild, and surviving stock is harvested when it returns to the release site as with salmon, or is harvested in the commercial or recreational fisheries.
<b>Bottom Culture</b> no structures no additions no discharges	Bottom culture includes the culture of oysters and other molluscs on ocean or pond bottoms. Markers are used to set boundaries, but public navigation is not generally restricted.
<b>Off-Bottom Culture</b> structures no additions no discharges	Off-bottom culture of oysters and other molluscs involves techniques employing long lines floating rafts, strings, and sticks. Applications for the Recherche Archipelago may include the culture of seaweeds adjacent to cages.
<b>Transient Gear Culture</b> Structures additions discharges	Transient gear aquaculture refers to the use of submerged cages for containment of the animal being raised. These cages are movable and marked by buoys similar to those used by the lobster industry. The cages are raised to the surface for maintenance and harvest. This method is used for oysters and scallops.

### 12.2.2 Sea-based Aquaculture

The Recherche Archipelago has an abundance of clean, highly oxygenated water which suggests that high volume offshore production of finfish may be possible. Abalone has been considered a likely aquaculture prospect for some time in this area and both land and sea-based operations could be considered. Suitable systems for the Recherche Archipelago would thus be:

- sea cages that can withstand open ocean conditions either anchored to the sea bottom or when technology is fully developed, submersible cages;
- barrel and bottom cage culture may be utilised for growout of abalone;
- long lines and racks.

It should be recognised that the design and commissioning of hard infrastructure will require considerable financial investment by the proponents and should be preceded by extensive technical research and review. In reality the level of research will be proportional to the level of total investment.

## 13 SPECIES SUITABLE FOR AQUACULTURE

### 13.1 Principles of Species Selection

There are many factors to consider when determining appropriate species to culture. This decision making process should begin with the purpose for culturing and progress to include biological and commercial features. A checklist of all the features desirable should then be constructed by the proponent.

The purposes for culturing aquatic organisms may include:

- food production;
- conservation, for example restocking of black bream;
- maintenance of wild fisheries, for example seeding of scallops;
- recreation, termed “put and take fisheries”;
- ornamental fish and plants for the aquarium industry;
- feed production for aquaculture, for example brine shrimp (*Artemia*).

In order to grow stock out to a market size there must be juveniles available at an affordable price. As the collection of juveniles from the wild is normally not allowed in Australia, broodstock must be sourced to produce juveniles which will, in turn, rely on established hatchery techniques. There are a number of distinct stages in the culture of aquatic species and for technical, biological and business reasons it is important to understand the requirements of each stage. These are illustrated in **Table 5**.

**Table 5** Culture Stages of Aquatic Species

Stage	Requirements
<b>1. Spawning</b>	<ul style="list-style-type: none"> <li>• can occur in the wild</li> <li>• can be controlled in ponds</li> <li>• may be triggered by environmental cues</li> <li>• can be induced by hormones injected into fish</li> </ul>
<b>2. Egg incubation</b>	<ul style="list-style-type: none"> <li>• need to provide conditions which maximise survival</li> </ul>
<b>3. Juvenile and larval rearing</b>	<ul style="list-style-type: none"> <li>• need to provide suitable conditions</li> <li>• need to provide suitable feed and weaning</li> <li>• minimise mortalities while maximising growth</li> </ul>
<b>4. Growout to market size</b>	<ul style="list-style-type: none"> <li>• minimise mortalities while maximising growth.</li> <li>• stocking density important</li> <li>• minimising losses to predation</li> </ul>

In addition to assessing culturing techniques, other biological selection criteria should include those shown in **Table 6**.

**Table 6 Species Selection Criteria**

<b>Criteria</b>	<b>Considerations</b>
<b>Stock</b>	Hatchery techniques established or feasible.
<b>Stocking density</b>	The cultivated species must be able to grow in relatively high stocking densities. The higher the stocking density at which the fish can be maintained the greater the potential of production.
<b>Behavior</b>	The species being cultured should adapt well to captivity and be relatively easy to capture. Schooling species and those that are not timid are suitable for growing.
<b>Growth</b>	The species being cultured should exhibit a good growth rate with as little variation as possible. This will reduce the need for grading on a regular basis and prevent the development of dominant stock within the culture system.
<b>Feeding</b>	Species should readily accept an artificial diet. Ease of feeding with artificial diets and the increase in growth rate is essential providing water quality is maintained.
<b>Efficient food</b>	Feeding costs can be as high as 50% of the total cost of production and therefore <b>conversion</b> efficient utilisation of diet will affect profit.
<b>Non-cannibalistic</b>	Cannibalism will reduce the survival rate of the species and can cause disease through stress and physical damage. Feeding rates can help alleviate this.
<b>Disease resistant</b>	Some species are more resistant to disease than others. This factor should be considered when choosing a species or strain of species for cultivation.
<b>High meat recovery</b>	Species should have a relatively high meat recovery as a percentage of the total body weight. This becomes very important if the end product is to be processed as it reduces the wastage generated.
<b>Hardiness</b>	The ability to tolerate sub-optimum conditions is desirable in a species. Water quality parameters may change to below those that are considered optimum for short periods of time and the ability to tolerate this is desirable.
<b>Market</b>	A species must have a high market acceptance. The more marketable a species is, the greater the chance of establishing a consistent supply agreement with a wholesaler.

## 13.2 Candidate Aquaculture Species for the Recherche Archipelago

**Table 7** below provides a list of candidate species for the Recherche Archipelago, based on consideration of the following criteria:

- market potential;
- known culturing techniques;
- level of technology required to culture new species;
- any existing (or planned) sources for fry or fingerlings from within the region;

- suitability with the culture systems predicted for the Recherche;
- suitability of the species to the area.

Species are divided into the categories of primary and secondary species. The primary species are those considered to have good prospects for aquaculture development. The secondary species are those considered to have aquaculture potential in the future, subject to the development of suitable culture technologies.

Profiles of each of these species and a summary of their aquaculture potential is provided below.

### 13.2.1 Primary Species

#### Abalone

Roe's, greenlip and brownlip abalone are considered good aquaculture candidates. The production efficiency and commercial viability of these species is good in other areas and likely to be reproducible in Western Australia. In addition, culture technologies for these species are generally well known and established under Australian conditions. Abalone are generally amenable to onshore and offshore production systems and have a high market value.

Abalone may be grown out in land-based flow through or recirculating systems or in barrels and bottom cages offshore. While land-based systems will need to monitor the quality of outflow water, generally the effects of abalone culture is benign. Opportunities exist for the integration of seaweed species to be used as filtration systems in land-based projects.

In addition to the economic advantages and environmental considerations, abalone represents an ideal species for Esperance as it could complement the existing fishery and provide opportunities for local investment. Both land-based and offshore growout should be piloted before large investment is made in hatcheries. Offshore growout should be trialled in barrel and seabed cage culture. It is suggested that spat could be sourced from any existing operators in accordance with the *Fisheries Management Paper No. 133, Abalone Aquaculture in Western Australia – A Policy Guideline* (FWA, 1999).

#### Marron

Marron has received significant attention from researchers, farmers and investors. Consequently, there is now a good understanding of the basic biology and aquaculture requirements of the species. The technology for farming marron has been developed and published by researchers from Fisheries WA and refined by individual farmers. Generally there is now a reliable supply of juveniles for stocking ponds. However, production within and between commercial production ponds has been too variable and research and extension activities have been directed towards identifying the major causes of this variability. Until a nutritionally complete diet has been developed for this species, the intensive battery culture of marron does not appear to be viable.

#### Yabbies

In the eastern Wheatbelt and Great Southern regions of Western Australia, yabbies are currently harvested commercially from existing inland farm dams by trapping. This level of farming has been very successful, although it is low-yielding and dependent upon very large numbers of small dams to produce the annual State production.

**Table 7 Candidate Aquaculture Species for the Recherche Archipelago**

Common Name	Species name	Technology required (a)	Status (b)	Culture method	States cultured	Native to Recherche
<b>PRIMARY SPECIES</b>						
Abalone	<i>Haliotis</i> spp.	Medium	Cultured Fishery	Land-based Sea cage	WA SA	yes
Marron	<i>Cherax tenuimanus</i>	Low	Cultured Fishery	Ponds	WA NSW SA	yes
Yabby	<i>Cherax albidus</i>	Low	Cultured Fishery	Land-based dams	WA NSW VIC SA	no
Pink snapper	<i>Pagrus auratus</i>	High	Cultured	Sea cage Land-based	WA	yes
Silver perch	<i>Bidyanus bidyanus</i>	Medium	Cultured	Pond Land-based	WA	no
Southern Bluefin Tuna	<i>Thunnus maccoyii</i>	High	Grow out	Sea cage	SA	yes
<b>SECONDARY SPECIES</b>						
Oysters	<i>Saccostrea</i> spp. <i>Ostrea</i> spp.	High High	Cultured	Racks	WA NSW VIC SA TAS	yes
Dhufish	<i>Glaucosoma hebraicum</i>	High	Developing Fishery	Tank/cage	WA	yes
Marine aquarium spp		Medium	Several species cultured	Tanks		species dependent
Yellowtail Kingfish	<i>Seriola</i> spp.	High	Culture of similar species	Sea cage Land-based		yes
Whiting	<i>Sillago</i> spp	High	Developing	Sea-cage Land-based		yes
Flounder	<i>Pseudorhombus</i> spp	High	Developing	Sea cage Land-based		species dependent
Trout	<i>Onchorynchus mykiss</i> (Rainbow) <i>Salmo trutta</i> (Brown)	Medium	Cultured	Sea cage Land-based	WA, NSW VIC SA TAS	no
Black bream	<i>Acanthopagrus butcheri</i>	High	Cultured	Sea cage Land-based	WA	yes

*Explanatory Notes:*

a) *Technology required* refers to the general level of infrastructure, equipment, food requirements and technical expertise required to culture the species. The marine finfish species are generally ranked higher as they require intensive and complex operations including the production of live foods.

b) *This* refers to the culture status of the species. In some cases a species will have developed culture technologies and be part of a commercial fishery, such as pink snapper or abalone.

### Pink Snapper

There is a significant commercial snapper fishery in Western Australia with the peak fishing season from May to July. Consequently, seasonal oversupply in the local market may depress the market price for snapper. For the culture of snapper to be successful in Western Australia, farmers may need to concentrate on live fish sales or high volume production for export markets.

Small numbers of snapper fry are presently available for trial stocking of sea cages from the Fremantle Maritime Centre. The Centre also has eggs available for most of the year for both small-scale and commercial uses.

### Silver Perch

Since silver perch is an exotic species to Western Australia, there are concerns about its escape into rivers in the South-West. For this reason Fisheries WA has produced a Fisheries Management Paper (No.107) outlining areas where species may or may not be cultured in Western Australia (Fisheries WA, 1997). However, in man-made and isolated pond situations, the species is one of more promising temperate to subtropical aquaculture species for inland Western Australia. The silver perch industry in Western Australia will only grow successfully if it can address several critical success factors, principally product quality management, training needs and the promotion of this new freshwater product to consumers.

### Southern Bluefin Tuna

Southern bluefin tuna is considered a priority species despite having a poorly-known culture technology, because it has a very high market value and its commercial production has been shown to be commercially viable within Australia. Currently, Southern bluefin tuna aquaculture is dependent upon the growout or fattening of wild-caught juvenile fish; however, hatchery production techniques for the species are being developed overseas and commercial juvenile production appears imminent.

While there has been a high degree of community concern relating to the proposal to farm Southern bluefin tuna at Esperance, the species could develop into a highly valued industry sector if the environmental and community aspects were resolved. These issues, common to all finfish farming, are discussed in **Section 15.2.2.2**.

## 13.2.2 Secondary Species

### Oysters

The production efficiency, commercial viability and culture technologies for various species of edible oysters are well known.

### Western Australian Dhufish

Western Australian dhufish is a high-value species in Western Australia but unknown in other markets. The culture technology for the species is being developed and early results encouraging in relation to its hatchery production. The production efficiency and commercial viability of the species are unknown at this stage; its commercial success may be dependent upon its acceptability in the South-East Asian market place.

### Marine Aquarium Fish

Marine aquarium species are included because the culture technology for some species is well known and, while it is very competitive internationally, this sector of the aquaculture industry is considered to have good growth potential.

### Yellowtail Kingfish

The culture technology for yellowtail kingfish has yet to be developed under Australian conditions. A closely-related species is produced by aquaculture in very large quantities in Japan (over 300,000 t/yr) although the industry there depends on the growout of wild-caught juveniles. Yellowtail kingfish aquaculture in Australia would be dependent on the development of hatchery techniques for supplying juveniles for growout. The species has favourable biological and market characteristics and could be an excellent species for commercial aquaculture.

### Flounder

Culture techniques are well developed for greenback flounder and the species is generally considered to have good aquaculture potential. The commercial aquaculture potential of the species is currently being explored in Tasmania and Victoria and it is considered to have some potential in South Australia. Warmer waters on the western coast of Western Australia may be conducive to improved growth rates and yield competitive advantages over producers of this species in southern and eastern Australia.

Large-toothed and small-toothed flounder have not been produced by aquaculture in Western Australia, but similar species have been cultured elsewhere. Flounders generally are considered comparatively uncomplicated marine fish to produce by aquaculture and these species may have high-values as live product in some export markets.

### Whiting

King George whiting, western school whiting and yellow-finned whiting have not been produced by aquaculture in Western Australia, but similar species have been cultured elsewhere. Fertile eggs are relatively simple to acquire from wild-caught adults and the culture technologies for the species appear comparatively uncomplicated. Some limited work carried out on King George whiting in South Australia indicated that it may have a more difficult culture technology and slower growth rate than other whiting species; however, the evidence is inconclusive and the species is considered as viable for aquaculture development as the other whiting species. In markets where it is known, King George whiting is a highly-regarded species with a high-value and is considered to have good export potential.

### Trout

Trout has been successfully farmed internationally for hundreds of years and for over 50 years in Western Australia, and Fisheries WA has fostered trout farming through the South West Freshwater Research and Aquaculture Centre. Consequently, the biology, nutrition, culture requirements and disease of both rainbow and brown trout are well understood.

The major factors limiting trout production in Western Australia are warm water temperatures. The present modest scale of operation can limit competitiveness against interstate suppliers. Due to environmental constraints, trout farms in Western Australia are largely restricted to the cooler south-west corner of the State.

Trout can also be farmed in the sea. Sea trout an excellent candidate for commercial aquaculture in the cold-water of the Recherche Archipelago. Since they are not influenced by the warm Leeuwin Current, it is possible that these areas may be characterised by sea water temperatures cold enough to support rainbow trout growout. The necessary culture technology is well known, fingerlings are available in commercial quantities from existing hatcheries and sea trout are likely to have domestic and export market values that approach those of the high-value Atlantic salmon.



### **Black Bream**

The black bream is a relatively hardy species that is adaptable to a range of environments. This may provide some aquaculture options, from brackish ponds, or ponds in salt damaged farming land, through to ocean cage culture. The species has an established market acceptance Australia-wide. Related species of sparids are successfully cultured in sea cages and tanks in the Mediterranean, Middle East and Asia, especially Japan. The major concern is whether growth rates are adequate for commercial aquaculture.

### **13.2.3 Other Species for with a Future in Esperance**

#### **Scallops**

Saucer scallops have a high market value. However, despite some successes at a laboratory scale, their culture technology is poorly developed and some aspects of the life history of the species are not conducive to commercial cultivation (for example, the larval stage does not settle well). The species is further characterised by poorly-known production efficiency and commercial viability factors under Western Australian conditions. The species has been eliminated as an aquaculture candidate in Japan, where its potential was evaluated.

#### **Red snapper**

Red snapper is unlikely to be a viable species in the short term but is included in this plan as a result of much support for its potential from locals in Esperance. Since this is a popular fish in the region and there is an existing recreational and wild capture industry, there may be an opportunity to complement fishing effort by culturing the species. The lifecycle of this species has not been closed, but culturing techniques may be similar to pink snapper which has been cultured in Western Australia, South Australia and New South Wales.

## 14 AREAS SUITABLE FOR FUTURE AQUACULTURE ACTIVITIES

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### 14.1 Site Selection

The selection of a suitable site is a critical factor in the success of an aquaculture operation.

This plan seeks to categorise various areas in terms of:

- areas where aquaculture would not be acceptable, due to statutory constraints;
- areas with significant known constraints, such as important community resource areas, tourism and recreation areas with high usage, national park or nature reserves, or important conservation resources; and
- areas where there are currently no known constraints to aquaculture.

Note that areas with no known constraints are regarded as potentially available for aquaculture, subject to the necessary investigations and controls discussed elsewhere in this document. The constraints mapping contained in **Section 7** indicates the potential constraints to the future development of aquaculture. Further work on potential sites is needed, and should be undertaken by proponents, in coordination with Fisheries WA, for both land and sea areas as firm proposals are contemplated.

### 14.2 Land-based Sites

#### 14.2.1 Land-based Selection Criteria

The selection of an appropriate site will be intimately related to the species intended to be cultured. In particular the climatic conditions suitable for that species need to be appropriate. All fishes and crustacean are adapted to live in selected areas and have a preferred natural range based upon the water temperature in that region.

Land-based site selection criteria are listed in **Table 8**.

Table 8 Land-based Site Selection Criteria

Criteria	Considerations
<b>Water Quality</b>	<p>As water is the medium in which the species will be grown, the success of a venture will be determined in part by the supply and quality of the water at the site. A regular abundant supply is essential for the maintenance of healthy stock and this must be available all year round.</p> <p>In a land-based system the amount of water available will determine the type of culture system used and the number and type of ponds. The source of the water can be from several places such as rivers, soaks, springs and bores. The size and location of the farm along with the topography will determine the water source for the venture.</p> <p>The quality of the water source needs to be determined to ensure the optimum growing conditions for the stock. Poor water quality will result in a reduction in the growth and health of the stock. It must be free of nutrients, pesticides and other chemical contaminants and relatively clear. It needs to be monitored on a regular basis for water quality parameters such as temperature, salinity, dissolved oxygen and pH.</p>
<b>Soil</b>	<p>Ponds are designed to be relatively impervious to water to reduce the water loss due to seepage. To ensure this the pond sides and bottom must have a relatively high concentration of clay to retain the water. Before the construction of a farm begins the soil within the region must be surveyed to assess the clay content and its suitability for pond construction. Soil testing for acidity, pH and chemical residues is desirable. If soil is not suitable for pond construction 'plastic' liners could be considered.</p>
<b>Topography</b>	<p>The topography of the site plays an important role in determining the design of the farm. Sites should ideally be gently sloping and relatively open to take advantage of the natural aeration that will occur with the wind. The topography will determine the types of ponds that are constructed and their orientation.</p>
<b>Surrounding land use</b>	<p>The surrounding land usage may have an impact on the water quality, contamination issues and access to the site.</p>
<b>Legal issues</b>	<p>Land tenure, planning approval and native title will affect the selection of a site.</p>
<b>Access</b>	<p>Good access to the site is essential. It is preferred to have a sealed road that will allow truck access so that after a harvest stock can be moved quickly and efficiently.</p>
<b>Capital cost</b>	<p>The cost of the land is an important component of the capital cost of the venture and will be a significant consideration in the business's feasibility analysis.</p>
<b>Conservation sensitive sites</b>	<p>Attention must be paid to any conservation issues relating to the site. Approvals will be required from relevant conservation agencies.</p>
<b>Utilities</b>	<p>Access to power, water and sewerage is advantageous in aquaculture. The availability of power and water will greatly reduce the costs of setting up a farm and will allow a farmer to aerate ponds without the need of a generator.</p>
<b>Proximity to market</b>	<p>Ideally a farm should be located in close proximity to a market. This reduces the transportation costs associated with the selling of stock and also reduces the risk of stock spoilage or death during transport.</p>

Criteria	Considerations
<b>Land history</b>	The land history will reveal potential chemical contamination such as pesticides and heavy metals. This is extremely important as these may have adverse effects on the stock and may render the stock unsuitable for human consumption or even cause the death of the stock.
<b>Expansion</b>	Provision for the expansion of the farm must be considered during the planning stage. Ideally there should be ample room for the farm to expand as it grows in size.
<b>Predators</b>	The prevalence of birds and other predators should be considered. Land-based systems with outdoor growout may need to incorporate bird netting over ponds or tanks. A security system may also be necessary to prevent theft.
<b>Existing Land Uses</b>	The existing land use must be taken into account to determine and assess the potential impact to these activities. Future land requirements of other industries and sectors will also influence the land available to aquaculture.

### 14.2.2 Potential Land-based Sites

Finding and acquiring coastal lands suitable for land-based aquaculture may pose difficulties for proponents because much of the coastline of the Recherche Archipelago is public land within National Parks. Within the Esperance area, waterfront lands are keenly sought for tourism and residential purposes and special Council approval is required for water pipes to cross a waterfront reserve. There are areas which appear to have some potential, and are described below:

- Bandy Creek Boat Harbour;
- some industrial zoned land in Esperance may have potential if saline groundwater of adequate quality can be accessed;
- rural lands east of Esperance and east of Duke of Orleans Bay, where the coastal reserve is narrow;
- Crown and freehold land at Wharton, Duke of Orleans Bay, perhaps in conjunction with infrastructure and backup facilities at Condingup;
- Condingup, if water supplies can be accessed.

Abalone are the most likely candidate species for land-based aquaculture growout adjacent to the Recherche Archipelago. While Council land may be available to the east of Bandy Creek, proponents should consider the potential environmental risks from industrial contamination. Should this be found to be a real problem, the potential to locate land-based growout facilities east of Esperance at Wharton should be considered.

The proposal to freehold sites at the Bandy Creek Boat Harbour could allow for the development of aquaculture ventures, particularly a multi-species hatchery which will be necessary if culturing of marine finfish species is to occur. The use of either ocean intake or salt water bore systems should take into consideration land-based water quality issues such as contamination and ocean intake issues such as water depth, turbidity and storm occurrences.

## 14.3 Sea-based Site

### 14.3.1 Sea-based Selection Criteria

**Table 9** provides a general overview of the parameters to be considered when choosing an offshore site.

**Table 9** Sea-based Site Selection Criteria

Criteria	Shellfish	Finfish
<b>Water depth</b>	For subtidal species minimum depth of 10 m with more than 12 m preferred.	Minimum depth of 12 m with more than 20 m preferred.
<b>Waves</b>	Generally maximum wave heights less than 2 m. Wave period should be more than 5 seconds.	Generally maximum wave height of 2-3 m.
<b>Salinity</b>	Salinity levels need to be considered for individual species.	
<b>Water Temperatures</b>	Increased growth rates may be achieved where temperatures are at the higher end of the natural range for the species.	Water temperatures directly influence physiological processes including growth. Higher end of natural temperature range is advantageous for growth, dependent on the species. Cold water species such as Ocean trout may require production strategies that minimise the impact of warmer water temperatures in summer.
<b>Contamination</b>	Sites should not be in downstream proximity to effluent outfalls and heavy metal contaminations and faecal coliform counts should be within set limits.	
<b>Nutrient Status of Water</b>	Prefer higher levels of algal biomass, often indicated by the presence of chlorophyll A. This generally occurs where catchment runoff has enriched the water or where up welling of ocean water has carried nutrients from bottom sediments.	Not directly significant, however nutrients from other sources should be considered to ensure aquaculture operations monitoring is not influenced by external pollutants such as terrestrial runoff.
<b>Algal blooms</b>	Areas with no known history of algal blooms preferred. Known algal bloom areas may be acceptable where there are other benefits (e.g. high nutrient water) and where blooms are either rare or predictable so that stock can be moved. In the latter case alternative sites would be required.	

Criteria	Shellfish	Finfish
<b>Currents and Flushing</b>	Within range of 5-50 cm per second advantageous. Greater speeds will require more consideration of mooring.	Within range of 5-50 cm per second. Problems in managing equipment at speeds greater than 50 cm per second.
	Flushing or water exchange) may be less significant for shellfish compared with intensive finfish farming. Well flushed sites enable adequate oxygen exchange, dispersal of organic sediment outputs and reduced competition for nutrients (eg filter-feeding shellfish). Shellfish are liable to remove nutrients from the water while finfish are liable to add matter to the water over a localised area. For these reasons aquaculture sites should operate well within defined boundaries with adequate separation from high conservation areas.	
<b>Wind</b>	Areas with some protection from prevailing winds are preferred. Boat access and serviceability is limited where winds (greater than 20-30 knots) over an extended distance generate unsuitable conditions.	
<b>Sea floor</b>	Prefer sandy sea floors. Avoid seagrass, reef and coral areas where recovery time for any affected benthos is likely to be slow.	
<b>Access</b>	Areas should be in reasonable proximity to land-based infrastructure. Access is more important for finfish where generally daily operations are required. This is of particular significance to the Recherche given the number of days where sea conditions are not ideal.	
<b>Land-based infrastructure</b>	For some species (e.g. mussels) grading and cleaning is generally done at sea. Require port or jetty with loading and unloading facilities, vehicle access and vessel mooring.	Generally more land-based infrastructure required than for shellfish. Harvest, grading and processing facilities are generally required close to port with cool store and feed storage. Bandy Creek Harbour should provide this for operations closer to Esperance while Condingup may provide sufficient land for operations out of Duke of Orleans Bay.
<b>Visual Impact</b>	Areas should preferably be where visual impact is minimised.	

Source: Environment Conservation Council, Victoria 1998.

### 14.3.2 Potential Sea-Based Sites

Five potential sea cage sites were identified at the York, Mart and Remark Groups and Tory and Mondrain Islands (**Figure 13**). This was based on consultations with local people and the limited bathymetric and benthic data available.

The survey showed that using present technology the Mondrain, York and Tory Islands are not suitable for large-scale sea cage aquaculture because of inadequate protection from southeast sea conditions. The York Group has benthic habitats which may be adversely affected by nutrients and sediment associated with aquaculture. However, small-scale aquaculture projects may be appropriate in more sheltered sites, particularly at Tory Island.

The Remark and Mart Groups appear to have significant potential for large-scale sea cage culture. The Remark Group appears to have superior protection from adverse sea conditions, but is remote from land-based facilities. Currents, and habitats identified as 'sparse seagrass', require further investigation. Conflict with other users, particularly charter diving and recreational fishing, would be expected as the Remark is used extensively by these industries. The Remark Group is also important to the pilchard and abalone industries. This was highlighted in the comments received during the Public Comment Phase II, in particular that there is the potential for opposition by pilchard fishers to aquaculture proposed at the Remark/Sandy Hook area. The presence of Leafy Sea Dragons (a totally protected species) in this location also needs to be investigated. Any aquaculture application for sites within the Remark Group will need to address these issues.

The Mart Group is closer to shore, appears to have a stronger current regime, but may be less protected. The Mart Group appears to contain a number of sites suitable for the culture of finfish in surface cages. The development of submersible sea cage technology may enable cage culture to occur in more exposed locations throughout the Archipelago. Phase II consultations raised concerns about the lack of information on this area. It is acknowledged that further work is required before this area is considered for aquaculture. Community use of the group is not well known, but the bare sand of the main lagoon appears to have little potential for recreational fishing. Reef and seagrass communities surrounding the lagoon require further study, as do oceanographic aspects. Any aquaculture applications for sites within this area will need to address these issues.

Other sites which appear to meet the necessary selection criteria are generally to the east of Esperance Bay. There was some opposition during Phase II consultations to the siting of sea cages in the waters of and between the islands of Figure of Eight, Remark and east to Mondrain Island.

Many sites throughout the Archipelago should prove suitable for the locating of barrels and bottom cages for abalone growout as this form of culturing will have less impact with other user groups in terms of access and amenity.

Opportunities exist for the trialling of integrated offshore farming systems whereby seaweeds and/or molluscs are cultured in rafts or long line systems adjacent to sea cages.

## 15 ENVIRONMENTAL ISSUES – IMPACTS AND MANAGEMENT OF AQUACULTURE

### 15.1 Principles of Environmental Management

#### 15.1.1 Ecologically Sustainable Development

An important criterion for the assessment of proposals and sites for aquaculture is that they should comply with the principles of ecologically sustainable development (ESD). These principles, embraced by the Government and the Fisheries WA at policy level, are the maintenance of biodiversity, ecological integrity, and equity, both within and between generations. For land-based and sea-based farming this means the avoidance of significant long-term environmental change resulting from the activities of the industry, and the establishment of agreed resource-sharing principles with the community.

#### Equity and Resource Sharing

Aquaculture often involves the use of publicly owned lands and waters and can affect other uses of those resources. As such, equity and resource-sharing questions need to be resolved through planning procedures. This is done at three levels, through:

- consultation with affected groups and individuals as part of this study;
- the formal planning and consultation processes under Ministerial Policy Guideline No.8;
- subsequent assessment of applications for aquaculture licences by Fisheries Western Australia.

All aquaculture licence applications are referred to the EPA/DEP for assessment. The relevant procedures are referred to in **Section 10**.

### 15.2 The Effect of Aquaculture on the Environment

There are possible effects that aquaculture may have on the environment that need to be managed to ensure that the effects are minimised and that the venture is both economically and environmentally sustainable.

The potential environmental impacts and appropriate management responses vary according to species and location, however the following sections provide a general summary of the practices which need to be carried out to minimise or avoid the potential effects of aquaculture on the environment.

#### 15.2.1 Land-based Aquaculture

The two forms of land-based aquaculture likely to occur near the coastline of the Recherche Archipelago are:

- pond culture systems on private rural land for finfish and crustacea such as yabbies; and
- hatcheries and indoor culture of species such as abalone, on private or leased lands adjacent to the coast.
- Environmental considerations and management requirements of pond culture and hatchery/indoor culture operations are documented in **Table 10** and **11** respectively.



Table 10 Environmental Management of Pond Culture Systemsa

Environmental Considerations	Management Response
<p><b>Water Supply and disposal</b></p> <ul style="list-style-type: none"> <li>• Ground water quantities required;</li> <li>• Effects of abstraction on other users;</li> <li>• Licensing requirements.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure good site selection</li> <li>• Design recirculating or flow through systems that have sound waste management principles such as filtration and sediment removal</li> </ul>
<p><b>Waste and Nutrient Loadings</b></p> <ul style="list-style-type: none"> <li>• Output of solids, nutrients, disease, chemicals, antibiotics;</li> <li>• Impacts of waste materials.</li> </ul>	<ul style="list-style-type: none"> <li>• Use high quality feeds and ensure good feeding practices;</li> <li>• Minimise use of antibiotics.</li> <li>• Use of appropriate standard water treatment processes.</li> </ul>
<p><b>Degradation of Terrestrial Environment</b></p> <ul style="list-style-type: none"> <li>• Salinisation of soils,</li> <li>• Effect on adjacent agricultural practices, clearance of protective cover.</li> <li>• Effects on the environment and natural resources in areas traditionally used for camping, hunting and gathering, and ceremonial and other cultural activities.</li> </ul>	<ul style="list-style-type: none"> <li>• Through proper site selection and facility design ensure that there is no physical degradation of surrounding environment.</li> <li>• Appropriate site selection aided by consultation with Aboriginal groups.</li> </ul>
<p><b>Escaped Stocks</b></p> <ul style="list-style-type: none"> <li>• From systems damaged by flooding;</li> <li>• Damaged or ineffective discharge screens;</li> <li>• Risks of competition and genetic contamination of local stocks, disease transmission.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that facilities are maintained at a high standard., flooding levy banks are clear of debris;</li> <li>• Use disease free stocks;</li> <li>• Abide by translocation policy;</li> <li>• Establish strict hygiene and sanitation procedures.</li> </ul>
<p><b>Predation By Conservation Sensitive Species</b></p> <ul style="list-style-type: none"> <li>• Causing damage, loss, stress related disease to farmed stocks;</li> <li>• Requires controls without compromising conservation interests.</li> </ul>	<ul style="list-style-type: none"> <li>• To avoid predation (and minimise impacts on farmed stock and to conserve fauna) – increase water depth of culture system, bird net ponds, remove dead fish promptly, use visual harassment devices.</li> </ul>

**Table 11 Environmental Management of Hatcheries and Facilities Adjacent To Public Foreshores**

<b>Environmental Considerations</b>	<b>Management Response</b>
<p><b>Water Supply and disposal</b></p> <ul style="list-style-type: none"> <li>• Ground water quantities required;</li> <li>• Effects of abstraction on other users</li> <li>• Sea water intake and outlets</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure good site selection</li> <li>• Design recirculating or flow through systems that employ sound waste management principles such as filtration and sediment removal</li> </ul>
<p><b>Waste and Nutrient Loadings</b></p> <ul style="list-style-type: none"> <li>• Output of solids, nutrients, chemicals, antibiotics; impacts of waste materials</li> <li>• Impacts of waste materials on the adjacent benthos and the water column</li> <li>• Impact on species/community diversity,</li> <li>• Discharge water quality criteria</li> </ul>	<ul style="list-style-type: none"> <li>• Use high quality feeds and ensure good feeding practices</li> <li>• Minimise use of antibiotics</li> <li>• Use excess nutrients and sediment to grow other crops; e.g. seaweeds</li> <li>• Undertake environmental monitoring and abide by water quality standards</li> <li>• Use of appropriate standard and water treatment processes</li> </ul>
<p><b>Degradation of Terrestrial Environment</b></p> <ul style="list-style-type: none"> <li>• Excessive clearing of coastal fringe and protective cover</li> </ul>	<ul style="list-style-type: none"> <li>• Through proper site selection and facility design ensure that there is no physical degradation of surrounding environment</li> </ul>
<p><b>Escaped Stocks</b></p> <ul style="list-style-type: none"> <li>• From damaged systems, or through damaged or ineffective discharge screens</li> <li>• Risks of competition and genetic contamination of local stocks, disease transmission</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that facilities are maintained at a high standard</li> <li>• Use disease free stocks</li> <li>• Abide by translocation policy ie don't raise non-native stocks</li> <li>• Establish strict hygiene and sanitation procedures</li> </ul>
<p><b>Social And Visual Amenity; Disturbance</b></p> <ul style="list-style-type: none"> <li>• Visual impact, noise, activity disruptions to public amenity</li> <li>• Alienation of areas used for traditional hunting</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure site selection considers the potential conflicts with other users of the resources</li> <li>• Design and siting of buildings and infrastructure near the coast needs to minimise visual aesthetic impact</li> </ul>

## 15.2.2 Sea-based Aquaculture

### 15.2.2.1 Non finfish Species

The environmental impacts of sea-based aquaculture of non-fish species can be distinguished on the basis of whether the species farmed are fed, or whether they utilise nutrients or plankton as feed, such as in the case of filter feeders or seaweeds. Filter feeders and seaweeds are not associated with nutrient or sediment problems and can be used in conjunction with other forms of aquaculture to reduce nutrient levels further if required.

The environmental impacts, management considerations and responses appropriate to other non-fish aquaculture will be similar to those listed for fish farming (below), but because the scale of operations may be smaller, the environmental impacts may be less significant.

### 15.2.2.2 Fish Farming

During consultations many people saw a clear distinction between tuna farming, perceived as a dirty industry, and other forms of marine aquaculture or sea cage culture, even though they often have many environmental management issues in common. Environmental issues common to farming of all fish are discussed here. A summary is provided in **Table 12** below.

The limiting factor to any aquaculture operation will be the availability of appropriate feed stocks. Many sources of feed currently have some limitations. It is unlikely that harvesting locally caught pilchards at the high rates required for these systems would be sustainable. Associated with this is community concern about pilchard stocks and the ecosystem effects of removing increased numbers of pilchards from the Recherche environment. Other concerns are related to the flow on effects of this to recreational fishing and tourism. As an alternative to wild caught local feed (pilchards), there is the opportunity to import, however there is a high level of community concern revolving around the importation of fish food. This is due to the fact that the cause of the 1995 and 1998 mass pilchard death events is still unknown and there is speculation that these events were related to imported feeds.

The use of an artificial diet would alleviate a large percentage of the negative issues associated with tuna farming by those members of the community that were consulted. Diet replacements from moist feeds to semi dry feeds has seen significant improvements in feed utilisation and reduction in pollution.

Although much controversy surrounds the Tuna Farming operation at Port Lincoln, this operation provides a valuable operation from which to learn and prevent the occurrence of similar problems in future fish farming operations. The environmental concerns and issues raised are valid and must be addressed by proponents if a tuna farming proposal is to proceed.

Concern about the likely interaction between birds and marine mammals and cages can be addressed by the application of strict management conditions developed in co-ordination with CALM officers.

**Table 12 Environmental Management of Finfish Farming**

<b>Environmental Considerations</b>	<b>Management Response</b>
<p><b>Genetic And Disease Effects</b></p> <ul style="list-style-type: none"> <li>• Escaped stocks from damaged systems</li> <li>• Risks of competition and genetic contamination of local stocks</li> <li>• Disease transmission, directly or indirectly</li> <li>• Reduced biodiversity</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that facilities are maintained at a high standard</li> <li>• Predator nets kept tight</li> <li>• Use disease free stocks</li> <li>• Abide by translocation</li> <li>• Establish strict hygiene and sanitation procedures</li> </ul>
<p><b>Nutrients and Sediment</b></p> <ul style="list-style-type: none"> <li>• Net input of nutrient into the environment and the time taken to flush and dissipate to the open ocean</li> <li>• Flushing through cages or enclosure.</li> </ul>	<ul style="list-style-type: none"> <li>• Improvement of husbandry techniques</li> <li>• Reduction of stocking density in cages</li> <li>• Seasonal reduction of stocking rates</li> <li>• Movement of high production units offshore</li> <li>• Continuing research and development of husbandry and monitoring techniques</li> </ul>
<p><b>Impact On Trophic Interactions</b></p> <ul style="list-style-type: none"> <li>• Accumulation of detritus below cages</li> <li>• Changes in sediment oxygen status and the assemblage of benthic organisms</li> <li>• Downstream effects on important benthic communities such as seagrass</li> </ul>	<ul style="list-style-type: none"> <li>• Rotation of sea cages to allow areas to lie fallow</li> <li>• Research to improve the food conversion ratio (FCR)</li> <li>• Improvement and automation of feeding to reduce wastage</li> <li>• Relocation of cages where downstream environments of importance become affected</li> <li>• Regular monitoring of key habitats</li> </ul>
<p><b>Visual Amenity</b></p> <ul style="list-style-type: none"> <li>• Aesthetic amenity of structures</li> <li>• Disturbance, noise, activity disruption</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure site selection considers the potential conflicts with other users of the resources</li> <li>• Minimise aesthetic impact of on water structures</li> <li>• Minimise noise and operational disturbance</li> </ul>
<p><b>Predation By Conservation Sensitive Species</b></p> <ul style="list-style-type: none"> <li>• Causing damage, loss, stress related disease to farmed stocks</li> <li>• Requires controls without compromising conservation interests</li> </ul>	<ul style="list-style-type: none"> <li>• Use visual harassment devices for birds;</li> <li>• Keep predator nets tight</li> <li>• Remove dead fish and spilt feed promptly</li> <li>• Maintain strict hygiene and feeding regimes</li> </ul>

### 15.2.3 Environmental Management

The possible consequences of marine farming and aquaculture mentioned above can be avoided or managed to minimise adverse effects provided a carefully planned approach to environmental management is implemented. In order to develop a commercially viable and sustainable industry it will be necessary for relevant agencies and proponents to follow a series of well-constructed steps including:

- Categorise the project, for example land or sea-based, the type of culture system to be deployed and the species to be cultured.
- Develop an understanding of the effects aquaculture can have on the immediate natural environment.
- Carry out a baseline study of current environmental features ensuring that the carrying capacity of the sites/system is not exceeded.
- Based on an assessment of the carrying capacity, determine what level of environmental impact the project may have.
- Sourcing techniques and management practices which can prevent or minimise environmental impacts and set appropriate licence conditions.
- Develop monitoring guidelines.

While it is true that poorly planned and managed aquaculture projects could have a negative impact on the Recherche Archipelago, there is sufficient consideration within the existing regulatory environment to establish world's best practice and to ensure that there are no significant deleterious impacts in the environment of the Recherche Archipelago.

This report has outlined various opportunities and constraints facing the development of aquaculture in the Recherche Archipelago and it is clear that for some developments there must be further work carried out by relevant government agencies, the proponents and in some cases the Esperance community themselves before sites are approved.

## 16 OTHER OPPORTUNITIES FOR AQUACULTURE IN ESPERANCE

### 16.1 Stock Enhancement

Aquaculture could potentially be used for the enhancement of shellfish and fish stocks, such as abalone, and this opportunity should be considered for the Recherche Archipelago. Stock enhancement programs can often gain support from the community, local school programs, volunteer groups, and commercial fishermen. Aquaculture species enhancement is often accompanied by habitat restoration. For example, a successful habitat restoration program in Connecticut in the United States has helped increase the state's oyster harvest.

Aquaculture may be used in the Recherche to restore stocks of fish and shellfish destroyed as a result of an oil spill, or other marine/coastal damage, or by overfishing. Environmental damage mitigation may be accomplished through stocking of full-grown adults or juvenile animals, and may accompany habitat restoration techniques discussed above. Such damage mitigation potential may be of significant value to the Recherche Archipelago, as high traffic in the area leaves the coastline vulnerable to damage from oil spills and other manmade disasters. The recent chemical spill at Belmont Racetrack caused massive fish kills in the Swan River and aquaculture techniques have been deployed to rear 300,000 fingerlings for release into the river.

### 16.2 Support Industries

The availability of aquaculture-related opportunities in Esperance will depend on several factors, including:

- the demand for aquaculture products;
- the ability to identify and produce products in high demand;
- the capacity of aquaculture to coordinate with existing uses of the region's land and water resources in particular the commercial fishing sector;
- the existence of programs that promote aquaculture in the state and the existing regulatory environment.

Given a supportive regulatory and economic environment and community support, opportunities related to aquaculture in Esperance may include the following:

- direct supply of aquaculture food products;
- production of equipment used by local, regional and interstate aquaculture operations;
- enhancement of wild stocks of fish and shellfish (including tuna);
- mitigation of disasters that impact upon wild stocks of fish and/or shellfish;
- supply of expertise/education to potential aquaculture producers.

Each of these opportunities offers potential benefit to the state economy, and employment for residents. The following sections discuss these opportunities as they apply to Esperance.

### 16.3 Production of Potential Aquaculture Technologies and Equipment

Many of the species noted above are best cultured using one or more specific types of technology or production methods. Many species can only be effectively cultured using one method.

These aquaculture systems require operating equipment and supplies, including various types of pumps; fibreglass tanks; sea cages; filtration equipment; electrical equipment and feed for aquaculture species. Currently, few of these products are manufactured in Esperance. The need for aquaculture related industrial supplies and infrastructure offers two potential opportunities to Esperance businesses. Firstly, development of an aquaculture industry in Esperance could create business opportunities for those providing aquaculture-related infrastructure and supplies. Secondly, these businesses could develop export markets for the products.

Either option would create a source of economic growth and employment in Esperance. Potential opportunities include aquatic equipment design, the supply and/or manufacture of aquaculture equipment, and the distribution of aquaculture products. The following list is indicative of the type of support industry companies (currently in Esperance) that could potentially accommodate the needs of a developing or existing aquaculture industry:

- plastic fabrication;
- haulage;
- agricultural supplies;
- banking;
- employment services;
- environmental services;
- air supply;
- charters;
- marine supplies;
- fuel supply; and
- waste removal.

### 16.4 Opportunities for Aquaculture Related Training, Research and Development

Given the pressures on the natural environment from current and potential uses, there is a critical need for relevant agencies, industry groups and the Esperance community to acquire greater and more scientific knowledge of the natural environment and its ability to sustainably accommodate the various user groups for future generations.

It is widely accepted by several agencies that there is dearth of information on the Recherche Archipelago. In addition to developing a sounder knowledge base for the existing industries there is also a need to provide support for the development of new technologies in commercial fishing and the emerging aquaculture industries.

In recognition of these needs, the Esperance Community College wishes to undertake a feasibility study to investigate the establishment of an annexe facility which will specialise in research, training and development across all current and future marine interests within the Recherche Archipelago.

It is hoped that should this facility be established, it would continue with the philosophy of providing collaborative arrangements between relevant interested institutions, agencies and the community.



## 17 PLAN IMPLEMENTATION

### 17.1 Prospects for Aquaculture

The strong stewardship that the Esperance community displays over the Recherche Archipelago provides an ideal platform to build an ecologically sound aquaculture industry. Esperance is in the enviable position of boasting one of the world's most pristine ocean environments and is well placed to become a source for high-quality aquaculture product.

Perceptions by some members of the Esperance community that aquaculture will adversely affect the Recherche Archipelago stem from the early history of aquaculture activity overseas and to perceptions of some of the early practices at the Port Lincoln tuna farm. While there is no denying that poorly managed aquaculture practices present a threat to the environment, as does the effect of poorly managed land-based farming, there are many instances throughout the world where advances in husbandry and nutrition have greatly reduced any environmental impacts. The current legislative framework which provides the environmental assessment for aquaculture development in Western Australia is rigorous enough to ensure that proper site selection and farming practices will be sustainable, and not cause any long-term negative effects to the Archipelago.

Paradoxically, a greater threat in the Recherche Archipelago may also affect the potential aquaculture industry from pollution through contamination of ground water sources and urban development; and the potential for pollution from shipping or accidents.

The successful integration of aquaculture into the environmental, social and economic fabric of Esperance could present a watershed in this country's short marine farming history. Esperance is a microcosm all of the real and perceived issues facing industry development in Australia. An aquaculture industry can not be developed in the Recherche Archipelago unless it has strong support from the Esperance community; and earning that support through genuine consultation is essential for the industry.

### 17.2 Initial Steps

For a strong and viable aquaculture industry to be established in Esperance there needs to be community involvement and acceptance. During consultations there was strong support for the development of an Esperance Aquaculture Group to provide a focal point for industry development and community consultation. Membership could include the Esperance Chamber of Commerce, Professional Fishermen's Association, the Esperance Regional Recreation Fishing Advisory Committee, local environmental groups, the Shire of Esperance and the Goldfields-Esperance Development Commission.

The proposed Esperance Aquaculture Group could organise local aquaculture workshops to inform the general community of the key issues facing the development of aquaculture in their region. The Group's role should include informing the public of the benefits of aquaculture and help attract investment. It may be possible for such a group to provide input into aquaculture proposals and monitoring plans through the MPG8 process. An Esperance Aquaculture Information Pack comprising this report, relevant Fisheries Western Australia guidelines, other agencies' aquaculture guidelines could be developed and distributed by the Group.

During the consultations, the Aquaculture Council of WA suggested there is a strong need for natural resource mapping to be available to aquaculture proponents. The maps produced for this study are intended to be included in the Coastal Atlas maintained by the Coastal Management Branch of the Department of Transport. This Atlas could be made accessible to the public as part of a Statewide digital mapping service and be available on a 'user pays' basis.

## 18 Recommendations

The recommendations of the plan are as follows (responsible party in parenthesis):

- 1 Encourage the Recherche Archipelago Consultative Group to progress the formation of an Esperance Aquaculture Group to provide a focal point for industry development and community consultation by Fisheries WA and potential proponents. This group would operate independent of Fisheries WA. (Fisheries WA).
- 2 Provide information and undertake ongoing consultations with the Esperance community in relation to aquaculture proposals in the Recherche Archipelago (Fisheries WA/Aquaculture operators/Aquaculture proponents).
- 3 In consultation with the Department of Conservation and Land Management, support ongoing environmental investigations of the Recherche Archipelago (Fisheries WA/CALM).
- 4 Support the concept of a cold water marine research facility associated with a tertiary institution in Esperance, should such a proposal emerge (Goldfields Development Commission, Shire of Esperance).
- 5 Refer this draft aquaculture plan to the Marine Parks and Reserves Authority for use in future planning for marine parks in the Recherche Archipelago (Fisheries WA).
- 6 Ensure that all licence determinations include the condition that all environmental baseline and monitoring data collected as part of site selection process and ongoing data collected during the operational phase be provided to the Marine Parks and Reserves Authority for use in future marine park planning (Fisheries WA).
- 7 Ensure that appropriate areas and sites for aquaculture are identified in future planning for marine conservation reserves in the Recherche Archipelago (Fisheries WA/Department of Conservation and Land Management/Marine Parks and Reserves Authority).
- 8 Provide this plan to proponents as a guide in the selection of potentially suitable land and sea-based site and species for aquaculture (Fisheries WA).
- 9 Refer all aquaculture applications to the Environmental Protection Authority (Fisheries WA).

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## APPENDIX A

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### Individuals and Groups Involved in the Consultation Process

#### CONSULTATIONS IN ESPERANCE

Keith Archer	LEAF
Graeme Baesjou	Goldfields Esperance Development Commission
Nicholas (John) Bonnitcha	Member of Esperance Yacht Club
Mr Ralph E Bower, AOM	Community College
Graham Cooper	Training Officer Esperance Sea Rescue
Ray Croker	Shire Councillor and Caravan Park owner
Department of Transport	
Robin Dicks	Goldfields Air Charter
Steve Drewe	Charter Operator
Des Evans	Member Esperance Deep Sea Angling Club
Vince Evans	President Esperance Deep Sea Angling Club
Fisheries WA	
Graeme Gath	President, Recreation Fishing Advisory Committee (South)
Ken Gittins	Fisheries WA Esperance
Michelle Gray	Pilchard processor
Marcus Gray	Pilchard fisherman
Bernie Haberlie	CALM Esperance
Peter Hudson	Esperance Diving and Fishing
Leslie Hudson	Esperance Diving and Fishing
Barry Jeitz	Member of Esperance Yacht Club
Mike Kahlor	Esperance Shire Engineer
Bill Kent	President Esperance Professional Fishermen Assoc
Monica Kraft	Charter Operator
Roy Kraft	Charter Operator
Eric Loughton	Fisheries WA Esperance
Jon Lipscombe	Member Esperance Deep Sea Angling Club
Fud MacKenzie	Owner Mackenzie Tours
Hugh MacKenzie	Mackenzie Tours
D'Arcy Madgen	Skipper, Real Action
Colin Maloney	Member of Esperance Yacht Club
Ian Mickel	Esperance Shire President

Victor Nicoleho	Esperance Deep Sea Angling Club
Marie Northcoat	Wild West Sports Kalgoorlie
Matthew Payne	Goldfields Esperance Development Commission
Buck Rodgers	Shire Councillor/ Duke of Orleans Caravan Park
Rob Rollond	Esperance Air Charter
Brad Scoble	Crew for Mackenzie's Island Tours
Chris Seimer	Conservation Movement
Elaine Seimer	Conservation Movement
David Smallwood	Farmer – 'Duchess Downs'
Barry Sponberg	Esperance Shire Planner
Mike Spragg	Baywatch
Roger Stewart	Manager of Esperance Yacht Club
Brett Thorpe	President Esperance Chamber of Commerce
Klaus Tiederman	CALM Esperance
John Totterdell	Fishing Industry Consultant
Chris Unwin	Pilchard Fisherman
Ralph Walsh	Esperance Professional Abalone Divers Assoc
Rod Warne	Member of Esperance Yacht Club
Lee Warner	Abalone Processor
David White	Member of Esperance Yacht Club
Nigel Worth	Esperance Deep Sea Angling Club

### CONSULTATIONS IN PERTH

Simon Bennison	Aquaculture Council of WA
Allen Carman-Brown	Ministry for Planning
Dr Jenny Cary	Department of Conservation and Land Management
Gary Hanstead	Esperance Regional Tourism Association
Lindsay Harbord	Chair, Recreational Fishing Advisory Committee
Ben Hollyock	Department of Environmental Protection
Dr Robert Kaye	Department of Transport
Guy Leyland	WA Fishing Industry Council
Frank Prokop	RECFISHWEST
Claire Savage	Department of Tourism
Cane Spaseski	Ministry for Planning
Dr Barry Wilson, FTSE	Chair, Marine Parks and Reserves Authority
Ian Taylor	Chair, Aquaculture Development Council

## APPENDIX B

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### Overview of the Aquaculture Industry in Western Australia

#### An Overview of the Aquaculture Industry

Worldwide, the demand for fish and fish products is increasing due to the increasing population, and the fact that wild capture fisheries are declining, with most at, or near, their maximum exploitable levels.

According to the Food and Agricultural Organisation of the United Nations (FAO), total production in 1995 was 27.76 million tonnes with a value of US\$42.32 billion.

World aquaculture production has consistently increased its contribution of the total world fish harvest since the mid 1980s, when it provided 8.3 per cent (7.9 million MT) of the total world fish harvest in 1984 (83.9 million MT). Within a decade aquaculture production had more than doubled to 16.9 per cent (18.6 million MT) of the total world fish harvest (109.6 million MT) (FAO 1998).

#### National Overview of the Aquaculture Industry

Australian aquaculture production in 1995 was valued at A\$396 million compared to \$491 in 1998 representing a 26 per cent contribution to the total national fisheries production. The majority of the increased value in 1997/98 came from an estimated 10 per cent increase (\$18 million) in the value of pearls, a 76 per cent increase (\$31m) in farmed tuna and a nine per cent increase in the value of farmed salmon (ABARE Australian Fisheries Statistics 1998).

#### State Overview of the Aquaculture Industry

Western Australia has an excellent international reputation in agriculture and commercial fishing and as we enter the next century it is from this platform that the State could become a major producer of high quality aquaculture product.

In 1994, the Minister for Fisheries announced funding of \$4.5 million over three years for the development of the aquaculture industry. Fisheries Western Australia, as the lead agency, has created an Aquaculture and Pearling Program as part of its core activity. An additional \$8 million has been allocated towards future development within the term of the current government.

There has been significant investment by the State Government for aquaculture development and considerable emphasis placed on creating an appropriate legislative and planning framework for industry development.

The effective regulatory approach by the agency provides the State with a sound base to develop an ecologically sustainable and economically viable aquaculture industry.

Western Australia has some key advantages over many other well established aquaculture industries throughout the world because it:

- has a pristine ocean and a clean terrestrial environment;
- provides a wide range of biogeographic zones and therefore species;

- has a government committed at policy level to the development of aquaculture;
- can learn from the mistakes and opportunities from others.

Already recognised as a leading producer of the highly prized South Seas Pearl with a pearling industry valued at approximately \$200 million annually, Western Australia is poised to further establish large scale aquaculture production.

Western Australia is establishing the necessary framework to expand on current aquaculture success and include a range of new species throughout the whole state through a close working relationship between industry and Fisheries Western Australia.

### Aquaculture Industry Development

There is a significant amount of aquaculture activity currently being undertaken throughout Western Australia. Industry groups, Fisheries Western Australia, training institutions, schools and universities are engaging in a variety of projects covering a diverse range of species and culture methods.

While the *Pinctada maxima* pearl oyster remains the most valuable aquaculture product in Western Australia, other species contributing to the State's economy include mussels, microalgae, yabbies, marron, trout, barramundi and oysters.

Current research and development activity includes Western Australian dhufish, barramundi, abalone, edible oysters, pink snapper, black bream, silver perch and ornamental fish species.

As Western Australia's peak industry body the Aquaculture Council of Western Australia (ACWA) plays the pivotal role in representing the needs of industry. Comprising ten regional and species associations, ACWA supports associations' activities, creates and implements strategic initiatives and provides a professional voice to all levels of government.

Fisheries Western Australia has developed a planning and approval process that allows for a highly consultative approach, ensuring that all stakeholders in the community have ownership of the development of the emerging industry. The agency has taken the proactive step of providing capital infrastructure, such as the Broome Tropical Aquaculture Park and the Albany Aquaculture Park, to assist new players in the industry, as well as providing ongoing technical and policy advice.



## APPENDIX C

### User Profile for the Recherche Archipelago - Supplementary Information

#### 1. TOURISM

##### Woody Island

Woody Island is the only island in the Recherche Archipelago with accommodation and general public access. It is a 'B' Class Nature Reserve. MacKenzie's Island Cruises (*MV Seabreeze*) conduct a full-time tourist charter operation which comprises a number of different sightseeing cruises around the islands in Esperance Bay. The Woody Island nature experience culminates with a stopover on Woody Island where the company has established a permanent base. Facilities on the island include ablutions, overnight up market tent camping for up to three nights, and a new interpretative/tearoom centre. All of the other islands in the Recherche Archipelago are 'A' Class nature reserves and are generally inaccessible, except for Sandy Hook and Middle Islands which have beaches. On quieter days access to some islands is possible.

##### Accommodation

There are eight caravan parks in Esperance and along the coast, 23 guest house/farmstay/ cottage/B&B establishments, and 11 hotel/motels providing accommodation. Average occupancy rates for caravan parks range from just over 70 per cent in January to a low of 33 per cent in July. For hotels and motels, the average occupancy rates range from 60-70 per cent in January to just over 30 per cent in June. (SERTS)

The Australian Bureau of Statistics figures for tourist accommodation for the March 1997 quarter were as follows:

Hotels Motels Number	Rooms	Beds	Caravan Parks Number	On Site Vans	Other Powered Sites	Unpowered Sites	Cabins Flats etc
10	283	747	7	68	478	63	35

Guest arrivals for hotels, motels and caravan parks for 1996 were as follows:

Month	Hotels and Motels	Caravan Parks	Total
January	5415	5623	11038
February	3109	2941	6050
March	3646	2714	6360
April	4158	4164	8322
May	3216	1999	5215
June	2140	1535	3675
July	2519	1909	4428
August	3071	2404	5475
September	3988	4773	8761
October	5757	5252	11009
November	5469	3177	8646
December	3811	4954	8765
<b>Total</b>	<b>46128</b>	<b>42977</b>	<b>89105</b>

Source: ABS in SERTS

### Events

There are a number of aquatic based events on the tourism calendar including a three-day wave sailing regatta, the Esperance Archipelago Offshore Angling Classic in February and a surfcasting classic in March. In 1999, the World and National Flying 15 Yacht Championships will be held at Esperance Bay Yacht Club.

### Tourism Season

The main tourism season occurs between November and April with the largest numbers occurring in the school holidays after Christmas and at Easter and the April School holidays. The Tourism Strategy report notes that, like most holiday venues in WA, Esperance has a problem with seasonality and that the Region has something of an image problem regarding its weather and wind.

### Tourism Participation and Demographics

The consultations indicated that during the Christmas – January peak period, the population of Esperance swells from 12,500 to twenty or thirty thousand people and popular beaches and fishing spots experience double or triple their usual usage.

*The Strategic Plan for the Tourism Industry in the South Eastern Region of Western Australia* (SERTS) released in July 1997 contains visitor data from its own survey, and from the WA Tourism Commission's Regional Travel Survey (WATS). The WATS figures estimate that the total number of visitors to Esperance was 139,000 in 94/95

with an approximate total of 445,000 visitor nights. WATS figures on visitor activity also indicate that 30 per cent of visitors to the South East Region visit the beach, 17 per cent go fishing, and 16 per cent visit the islands or go pleasure boating. However as the region includes Ravensthorpe and other centres away from the coast, the figures are not directly comparable to the SERTS survey summarised below. These figures are based on a questionnaire survey carried out in 1996/97 for SERTS, in which 4,000 questionnaires were distributed through commercial operators in the area. The survey was undertaken over the period of October 1996 – February 1997 and provides the following information on visitor activity in Esperance in that period. This information needs to be used with care because of the small sample size (226 responses).

Activity	%age (SERTS)	Estimated Total #	Comment
visit beaches	81%	112,590	no details of breakup of activities
go on island cruise	41%	56,990	
go fishing	30%	41,700	no breakup into beach, jetty, small boat, deep sea, charter etc
go snorkeling	9%	12,510	
go scuba diving	1%	1,390	
visit the Duke of Orleans Bay	41%	56,990	

### Other Visitor Data

- MacKenzie's Island Cruises advised that 17,000 people visit Woody Island annually.
- The Department of Conservation and Land Management advised that in 1993, 59,000 people visited Cape Le Grand National Park and 38,772 visited in 1997/8.
- 6,000 people visited Cape Arid National Park in 1993. No later figures are available.

## 2. RECREATIONAL BOATING AND FISHING

### Sea Rescue

Esperance Sea Rescue has a membership of 15 and provides extensive coverage of the Recherche Archipelago. In the last three years it has been called out for rescues as far away as 80 miles to the southwest, and 120 miles east. The Training Officer is the only radio examiner currently in Esperance. Several tragedies have occurred in recent years, exemplifying the dangerous nature of these waters.

### Boating and Fishing Season

Weather conditions are the main limiting factor on boating and access to the Recherche Archipelago. The area is noted for a large prevailing south-westerly swell. From November through January, morning calms and light easterlies are often followed by an afternoon south easterly sea breeze of up to 35 knots with wave heights up to 2.5m. During February and March conditions are less severe and there are longer periods of calm weather

and seas. The prevailing winds are from the southwest to south, but easterlies and north-easterlies are significant in summer. North-westerlies can also occur. Esperance Sea Rescue reported that the anchorage at Middle Island is subject to north westerlies.

The main recreational boating season occurs between November and April with the largest numbers occurring in the school holidays after Christmas and at Easter and the April school holidays. Weather conditions are sometimes suitable for another peak in numbers during the October holidays. Significant boating activity occurs on long weekends, while work practices in the Goldfields often allow people to take three or four days off. June is considered unsuitable for boating but there are occasional calm days through winter which enable boating and fishing activity.

### Boating and Fishing Effort

The overall impression gained from the consultations and research is that recreational boating numbers are low in comparison to other popular boating centres. The following table based on data provided by the Department of Transport, shows the number and size of registered recreational boats in the region as at January 1999.

#### Number and Size of Registered Recreational Boats

Centre	0-4.9m	5m-9.99m	10m-14.9m	Over 15m	Total
Esperance	302	156	12	nil	470
Norseman	15	3	nil	nil	18
Kalgoorlie	133	78	2	1	214
<b>Total</b>	<b>450</b>	<b>237</b>	<b>14</b>	<b>1</b>	<b>702</b>

It can be seen from the table that the overwhelming majority of recreational boating craft is less than 10 metres long.

Esperance Bay Yacht Club has 35 yachts on its register, including visiting yachts, which are capable of voyages to the outer islands.

No records were found of boat ramp usage, however Mr Graham Cooper of Esperance Sea Rescue reported that up to 50 boats of 4.2 m and above leave Esperance on peak days between -easterly sea breeze. He logs about 11 calls per day on 27 Meg and VHF radio. During winter only two or three boats go out when conditions permit. Fisheries Western Australia officers reported that in summer, up to 60 boats regularly launch from the recreational boating ramp at Bandy Creek Harbour. Commonly the parking area has room for 20 to 30 boat trailers for boats of 8m.

Mr Michael Kahlor of the Shire of Esperance indicated that he is in the process of carrying out a profile on boat ramp usage.

### 3. SURFCASTERS AND BEACHSIDE RECREATION

#### Participation and Fishing Effort

During the Christmas – January peak, the population of Esperance swells from 12,500 to between twenty and thirty thousand people and popular fishing spots experience double or triple their usual usage. Officers of Fisheries Western Australia reported that on a busy day in the peak period, Bandy Creek Harbour carpark was full with cars; cars were scattered along the full length of Cape Le Grand Beach, and Lucky Bay was full. Cheynes Point experiences over 100 people per day in summer. They estimated that between Butty Head and Thomas Fishery at Cape Arid in summer, the average number of fishers for whole day is likely to be 500, and on busy days there can be a thousand or more.

Nearly 59,000 people visited Cape Le Grand National Park in 1993 with Lucky Bay considered to be the most popular site.

### 4. CHARTERS AND CRUISES

#### Charter Effort

##### *Fishing Charters*

The majority of fishing charters are day trips operating within 20-30 nautical miles steaming distance from Esperance. There are four boats which concentrate on fishing charters:

- *The Southern Image* – Esperance Diving and Fishing;
- *Tammy II* – Mr A Cummings;
- *Real Action* – R and M Kraft;
- *Men at Work* – Mr S Drew.

The majority of fishing occurs over bommies and lumps in open sea with occasional fishing closer to island shores. If the fishing is on the boil then lunch is consumed in between bites. If the fishing is quiet or the clients prefer a more sheltered spot then the charter operator will seek a protected site near an island.

*The Southern Image* (16m), owned and operated by Esperance Diving and Fishing, conducts fishing charters carrying 9-12 people on board. It operates four times per week during the tourist season and 2-3 times per week in the off season. It also runs popular overnight fishing charters for usually 3-4 days duration. (Estimate: 1200 people, 120 voyages per year)

*Tammy II* (12.5m) operates 3-4 times a week during the months of September through to March carrying an average of eight passengers. It conducts the occasional overnight trip. During the non-tourist season the vessel is engaged in commercial fishing out of the region. (Estimate: 672 people, 84 voyages per year)

*Men at Work* (10m.) conduct eight charters per month (yearly average) generally carrying six passengers. The majority of their clientele is from the Goldfields. As is the case with *Tammy II* they prefer to fish over bommies away from islands and may seek shelter for lunch at an island group. (Estimate: 576 people, 96 voyages per year)

*Real Action* conducts fishing charters carrying 7-12 people on board. It operates at least four times per week in the tourist season and weekends in the off season, weather permitting. (Estimate: 660 people, 66 voyages per year)

On the above information, the total estimated number of people taking fishing charters is 3108 per year. The estimated number of voyages per year is 366.

### *Diving Charters*

*The Southern Image* (16m) is owned by Esperance Diving and Fishing and is the town's only dedicated dive charter vessel. It also conducts fishing charters on demand and carries an average of 12-15 passengers. Total diving and fishing numbers have varied over a four-year period between 188 and 230 days per year.

### *Air Charter*

Air Charter is a popular means of tourist access to the Recherche Archipelago. Mr Rob Rollond of Esperance Air three flights a week over the Islands. During the whale watching season (July/August) he may go out once a week if the whales are close in around Rossiter Bay or Cape Le Grand.

He mentioned that when he visits friends in Kangaroo Island he often takes paying passengers with him and they are very interested in flying over the tuna cages at Port Lincoln. He considers that any cage operation may provide him with an opportunity to take people flying over them. He said that if he thought people didn't like seeing the cages he would fly elsewhere. (Estimate: 78 people, 26 flights per year)

Robin Dicks from Goldfields Air Services indicated that she rarely takes clients over the islands within the Archipelago. Their scenic flights follow the coastline.

### *Sightseeing and Ecotourism*

MacKenzie's Island Tours offers a number of sightseeing tours within the Recherche Archipelago. Their principal vessel, the *Seabreeze*, carries an average 17,000 people to Woody Island per year.

## 5. COMMERCIAL FISHING

### Participation and Commercial Fishing Effort

- **South Coast Purse Seine Fishery.** This fishery involves the purse seining of small pelagic fish (pilchards) within four prescribed zones along the southern coast and has taken place in the Esperance region since 1989. With advances in fishing technique, greater understanding of the resource and new onshore infrastructure, the fishery in Esperance has grown from developmental status to become part of the overall south coast purse seine managed fishery. The Recherche Archipelago is located within Zone 4 where six licenses hold 133 units. The total allowable catch at the commencement of the 1999/2000 season was set at 1330 tonnes.
- **Southern Demersal Gillnet and Demersal Long line Fishery.** This operates from Cape Bouvard to the South Australian border and its annual value is estimated at \$0.636 million. In 1997/98 there were seven boats operating in the fishery. The catch predominately comprises several species of shark and queen snapper. The catch in 1997/98 was estimated to be 136 tonnes. (FWA 1999)
- **Esperance Rock Lobster Managed Fishery.** The catch for this fishery in 1997/98 was estimated to be 33 tonnes at an approximate value of \$1.02 million. There were 9 vessels operating in this fishery at the time. (FWA 1999)
- **South Coast Inshore Trawl.** This fishery operates east of Cape Leeuwin and in 1997/98 comprised two vessels. Figures for catch and value are not available.

- **Abalone.** In 1997/98 Zone 1 comprised six divers licensed to take greenlip, brownlip and Roe's abalone from the WA-SA border to Shoal Cape with an estimated catch of just under 100 tonnes, valued at approximately \$3 million. Zone 3 (Roe's Abalone only) effort in the corresponding year was estimated to be just over 11t with a value of \$0.428m for WA. The abalone fishing effort in 1997/98 comprised 14 boats (FWA 1999).
- **Fishing Boat Licence Catch.** In 1997/98 a total of 24 vessels caught approximately 34 tonnes of various species with an approximate value of \$0.117 million.(FWA 1999)

## 6. SOURCES

The sources of the information contained in the profile are as follows. A legend of the terms used in this table is below.

SECTOR	SOURCE
<b>Tourism</b>	SERTS, WATC, BH, FM, BR, EL, BS, MK
<b>Recreational Diving</b>	PH, LH, MN, BT, RC, BH, BR,
<b>Recreational Boating and Fishing</b>	VE, BT, GC, EL, FM, BH, BS, KG, DOT Members of EBYC RS, NJB, CM, BS, RWii, DW, DS Members of EDSAC VE, JL, DE, VN, NW.
<b>Surfcasters and Beachside Recreation</b>	EL, KG, GG,
<b>Charters and Cruisers</b>	FM, DH R&MK, SD, RR, RD, DOT.
<b>Commercial Fishing</b>	BK.LW.CU.MG.MG.RWi.WAFIC.FWA.GC

## 7. LIST OF ACRONYMS

CALM	Department of Conservation and Land Management
DEP	Department of Environmental Protection
DOT	Department of Transport
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
FCR	Food Conversion Ratio
FWA	Fisheries Western Australia
LEAF	Local Environmental Action Forum
MPRA	Marine Parks and Reserves Authority
RACG	Recherche Archipelago Consultative Group
RFAC	Recreational Fishing Advisory Committee
SBT	Southern Bluefin Tuna
SERTS	South East Regional Tourism Strategy
WATC	Western Australian Tourism Commission

### 8. GLOSSARY OF TERMS

**Aquaculture:** Aquaculture is defined as the farming of aquatic organisms including finfish, molluscs and crustaceans and aquatic plants. Farming implies some form of human intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated. (Food and Agricultural Organisation of the United Nations 1988)

**Benthic** Associated with the bottom of water body such as pond, lake or ocean.

**Broodstock** Captured fish (or other aquatic organisms) which are conditioned in a hatchery and kept for breeding purposes.

**Cage Culture** The rearing of aquatic organisms in cages placed either on or just below the surface of the water.

**Food Conversion Ratio (FCR)** The utilisation of feed (generally dry) by cultured species and expressed as a ratio of feed input versus weight gain

**Husbandry** The application of skills, knowledge and technique to the systematic rearing of aquatic organisms.

**Non-endemic** A species that is not native to the region in which it is located.

**Puerulus** Leaf like early larval stage of a rock lobster.

**Purse-seining** Method of fishing (from a boat) for quickly surrounding fast moving fish in a purse like action.

**Ranching** The release of fingerlings (or other juvenile aquatic organisms) into the wild.

**Reseeding** The “planting” of aquatic organisms (usually molluscs such as abalone) into the wild.

**Translocation** Movement of native or introduced species from their natural or previous habitat

**Wet feeds** Diet given to cultured fish or other aquatic organisms where it is predominately made up of unprocessed protein such as fish and molluscs.

**Wild Capture Fisheries** The capture of fish and other aquatic organisms from the wild using various techniques.



## 9. LEGEND SOURCE

<b>Name</b>	<b>Source Reference</b>	<b>Organisation</b>
Keith Archer	KA	LEAF
Graeme Baesjou	GB	Goldfields Esperance Development Commission
Nicholas (John) Bonnitcha	NJB	Member of Esperance Yacht Club
Ralph E Bower OAM	RB	Community College
Graham Cooper	GC	Training Officer Esperance Sea Rescue
Ray Croker	RK	Shire Councillor and Caravan Park owner
Department of Transport	DOT	
Robin Dicks	RD	Goldfields Air Charter
Steve Drewe	SD	Charter Operator
Des Evans	DE	Member Esperance Deep Sea Angling Club
Vince Evans	VE	President Esperance Deep Sea Angling Club
Fisheries WA	FWA	
Graeme Gath	GG	President Recreation Fishing Adv Comm (South)
Ken Gittins	KG	Fisheries WA Esperance
Michelle Gray	MG	Pilchard processor
Marcus Gray	MG	Pilchard fisherman
Bernie Haberlie	BH	CALM Esperance
Peter Hudson	PH	Esperance Diving and Fishing
Leslie Hudson	LH	Esperance Diving and Fishing
Barry Jeitz	BJ	Member of Esperance Yacht Club
Mike Kahlor	MK	Esperance Shire Engineer
Bill Kent	BK	President Esperance Professional Fishermen Assoc
Monica Kraft	MK	Charter Operator
Roy Kraft	RK	Charter Operator
Eric Loughton	EL	Fisheries WA Esperance
Jon Lipscombe	JL	Member Esperance Deep Sea Angling Club
Fud MacKenzie	FM	Owner Mackenzie Tours

## Appendix B

Hugh MacKenzie	HM	Hugh MacKenzie
D'Arcy Madgen	DM	Skipper, Real Action
Colin Maloney	CM	Member of Esperance Yacht Club
Ian Mickel	IM	Esperance Shire President
Victor Nicoleho	VN	Esperance Deep Sea Angling Club
Marie Northcoat	MN	Wild West Sports Kalgoorlie
Matthew Payne	MP	Goldfields Esperance Development Commission
Buck Rodgers	BR	Shire Councillor/ Duke of Orleans Caravan Park
Rob Rollond	RR	Esperance Air Charter
Brad Scoble	BS	Crews for Mackenzie's Island Tours
Chris Siemer	CS	Conservation Movement
Elaine Siemer	ES	Conservation Movement
David Smallwood	DS	Farmer – Duchess Downs
Barry Sponberg	BS	Esperance Shire Planner
Mike Spragg	MS	Baywatch
Roger Stewart	RS	Manager of Esperance Yacht Club
Brett Thorpe	BT	President Esperance Chamber of Commerce
Klaus Tiederman	KT	CALM Esperance
John Totterdell	JT	Fishing Industry Consultant
Chris Unwin	CU	Pilchard Fisherman
Ralph Walsh	RWi	Esperance Professional Abalone Divers Assoc
Rod Warne	RWii	Member of Esperance Yacht Club
Lee Warner	LW	Abalone Processor
David White	DW	Member of Esperance Yacht Club
Nigel Worth	NW	Esperance Deep Sea Angling Club

## 10. RECHERCHE ARCHIPELAGO CONSULTATIVE GROUP – MEMBERS

Ross Ainsworth MLA, Chair

Chris Siemer

Dick Thorpe

Bernie Haberlie

Michelle Gray

Eric Loughton

Vince Evans

Doug Dixon

Chris Buckley

Ralph Walsh

John Bonnitcha

Chris Unwin

Cr Lawrie Shaw

Keith Archer, Secretary

Trevor Burleigh

Cr Ray Croker

Leslie Hudson

Bill Kent

Danni Layman

Fud Mckenzie

Cr Wayne Rodgers

Mike Spragg

## APPENDIX D

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### Summary of Phase II Consultations

#### Public Consultation Report

#### Draft Aquaculture Plan for the Recherche Archipelago

The *Draft Aquaculture Plan for the Recherche Archipelago* and the *Draft User Profile of the Recherche Archipelago* were released for a public comment for a period of two months in April 1999. This public consultation report forms a summary of submissions with a justification for the response to each submission.

The report is separated into sections based on recommendation, issue or chapter on which comments were received. The report commences with comments on the recommendations of the draft plan, followed by specific issues or chapter and ending with other general comments.

Each section is structured as follows:

- **Title of Section** – Statement of the Recommendation, Issue or Chapter (including reference page number where appropriate).
- **Summary of Submissions** – Summation of the nature of submissions received.
- **Response to Comment** – Fisheries WA's response to the comments, justification of the response and indication of any alteration made to the document in response to the comment.

#### **Recommendation 1** Provide regular information and undertake ongoing consultations with the Esperance community in relation to aquaculture.

Two submissions supported continued consultation. One of these submissions (1) recommended that more consultation is required before the adoption of the plan however, no explanation of why more consultation is required and with whom.

There were no submissions opposing Recommendation 1.

(Note that this recommendation is now 'Recommendation 2' in the final report).

**RESPONSE TO COMMENTS – Recommendation 1 of the report is adopted.**

#### **Recommendation 2** In consultation with the Esperance Professional Fishermens Association and the Esperance Chamber of Commerce, sponsor the formation of an Esperance aquaculture group to provide a focal point for industry development and community consultation.

Four submissions supported the formation of an Aquaculture Consultative Group. One of these submissions suggested that the aquaculture group should be industry based.

There were no submissions opposing Recommendation 2.

**RESPONSE TO COMMENTS – Amend the Recommendation 2 as follows: Encourage the Recherche Archipelago Consultative Group to progress the formation of an Esperance Aquaculture Group to provide a focal point for industry development and community consultation. This group would operate independent of Fisheries WA. Fisheries WA will consult with the group on aquaculture generally and on applications via the MPG 8 process.**

(Note that this recommendation is now ‘Recommendation 1’ in the final report).

**Recommendation 3** In consultation with the Department of Conservation and Land Management, sponsor ongoing environmental investigations of the Recherche Archipelago.

Seven submission supported the recommendation that further research was required. Of these, four specified the type of research which was believed to be required. These were:

- investigations into the birds in the archipelago and an assessment of the impacts of the current fishing activities.
- biophysical monitoring and information of culture of species.
- thorough analysis using comprehensive, biological and commercial selection criteria, before culture techniques are developed for any species.
- investigations into benthic habitats.
- full scientific assessment of the marine environment necessary to ensure that aquaculture proposals are acceptable.

An additional four submissions suggested that more research was required before any aquaculture development proceeded. Of these, three indicated the nature of the research which was believed to be required which are:

- flora and fauna studies.
- marine park planning.
- complete study of the Recherche Archipelago.

There were no submissions opposing the need for further research.

**RESPONSE TO COMMENTS – The lack of information on the Recherche Archipelago and the limitations this poses are highlighted in the report, in particular in Section 8.8 and Recommendation 3. The plan recommends that further research should be undertaken, the scope of which should be determined strategically. The plan also acknowledges the role that aquaculture development can play in the establishment of baseline data for the area. The plan recommends that aquaculture development should proceed with data collection.**

**An additional recommendation was added to the plan to reflect this issue: ‘Recommendation 6: Fisheries WA to make it a condition of all licence determinations that all environmental baseline and monitoring data collected as part of site selection process and ongoing data collected during the operational phase be provided to the MPRA for use in future marine park planning.’**

**Recommendation 4** Support the concept of a cold water marine research facility associated with a tertiary institution in Esperance, should such a proposal emerge.

Three submissions supported the recommendation of a Marine Research Centre in the Esperance Region. There were no submissions opposing the establishment of a marine research facility.

**RESPONSE TO COMMENTS – The Recommendation 4 of the report remains unaltered.**

**Recommendation 5** Provide this draft aquaculture plan, and any subsequent research and information, to the marine parks and reserves authority for use in future planning for marine parks in the Recherche Archipelago.

Two submissions were received supporting Recommendation 5.

There were no submissions opposing this recommendation.

**RESPONSE TO COMMENTS – The Recommendation 5 of the report remains unaltered.**

**Recommendation 6** Ensure appropriate areas and sites for aquaculture are identified in future planning for marine parks in the Recherche Archipelago.

Two submissions were received supporting Recommendation 6. One of these submissions also suggested that the planning for aquaculture should not be allowed to pre-empt future sites for marine conservation.

There were no submissions opposing Recommendation 6.

**RESPONSE TO COMMENTS – Since provisions for aquaculture planning is clearly legislated for in the marine park planning process, and Fisheries WA is responsible for undertaking this aquaculture planning, the current planning exercise is not outside the marine park planning process. Furthermore, aquaculture development could provide a wealth of baseline information which will be useful for marine park planning. Many other marine parks, for example, the proposed Jurien Bay Marine Conservation Reserve, contained aquaculture operations prior to the marine planning process. These views are detailed in Section 6.2 of the Aquaculture Plan. Recommendation remains unaltered.**

(Note that this Recommendation is now Recommendation 7 in the final plan).

## SECTION 5 – Consultation

One submission questioned the integrity of the consultation, in particular the background behind the statement ‘Most of the Esperance Community who were consulted, supported the development of an aquaculture industry in their region.’ – the submission questioned the evidence for this and whether this was the conclusion after all the issues have been discussed.

**RESPONSE TO COMMENTS – The consultation process is clearly outlined in Section 3 of the report, and the report also acknowledges that the interpretation of the consultations was the responsibility of the consultant undertaking this task. As there were no submissions from those who took part in the consultation refuting the conclusions made by the consultant, Fisheries WA is confident in the conclusions reported are credible.**

## Marine Park Planning (Section 3.3, 6.4)

Five submissions supported the establishment of a marine park over the Recherche Archipelago. Of these, two suggested that no aquaculture should proceed until after the marine park planning process. One additional submission suggested that the MPRA be involved in all future planning exercises.

**RESPONSE TO COMMENTS – Refer to response to Recommendation 6 above. Fisheries WA is required by legislation to consider competent aquaculture applications under Ministerial Policy Guideline No. 8 and under the Fish Resources Management Act 1994. The consultation process is required under this including consultation with the Department of Conservation and Land Management.**

## Aquaculture Vs Groundwater Contamination

Two submissions suggest that the statement other activities such as ground water contamination, urban development etc can be greater threat than aquaculture needs to be justified.

**RESPONSE TO COMMENTS – These conclusions were based on government published information. The plan remains unaltered.**

## SECTION 10 – Species Suitable for Aquaculture

Two submissions suggested that ocean trout and red snapper would cause similar conflicts and problems as the Southern bluefin tuna proposal.

Nine submissions opposed the selection of Southern bluefin tuna as a potential candidate species. Reasons, given by respondents, for opposing this species include:

- Believes that there is no long term future.
- Does not believe it is sustainable and that there are too many ramifications on the environment and other long term industries.
- Assumption that the plan does not allow for the breeding and re-stocking of tuna making it a diminishing resource.

- Believes that tuna will be wiped out as a result of tuna farming and this will in turn impact on other industries, in particular recreational fishing and tourism.
- No conclusion on the reason for pilchard deaths around the south coast.
- Need to have a suitable alternative feed stock to pilchards.
- The enormous amount of pilchard required to feed captured tuna is beyond the capabilities of WA fishery – quantities required would lead to the loss of a fishery.
- Tuna farming will cause pilchards to be removed as feed for natural predators and may require importation.
- Concerned about the practices in Port Lincoln Tuna Farms.

One submission opposed tuna farming only around the area of Hook/Remark Group and stated that these locations would be vehemently opposed by pilchard fishers.

One submission supported tuna farming stating that point raised against tuna farming relates to public perception only and are not sustained by relevant research or literature review.

**RESPONSE TO COMMENTS – The environmental risks associated with all forms of aquaculture have been acknowledged in the plan. The Environmental Protection Authority will assess and set conditions for all major aquaculture projects.**

(note: Section 10 of the draft plan is now Section 13 of the final report)

## SECTION 11 – Areas Suitable for Marine Aquaculture – General

- One submission was opposed to aquaculture, in particular tuna farming, in the areas from Figure of Eight, Remark to East of Mondrain Is. due to conflict with recreational fishing, diving and tourism.

**RESPONSE TO COMMENTS – Acknowledged in the plan.**

- One submission suggested that aquaculture should be based further east towards Duke of Orleans Bay and Cape Arid Areas.

**RESPONSE TO COMMENTS – Acknowledged in the plan.**

- One submission suggested that large scale aquaculture only to be considered east of Mondrain Is.

**RESPONSE TO COMMENTS – Acknowledged in the plan.**

- One submission suggested that it was too early to specific sites as too little is known about the culture of species.

**RESPONSE TO COMMENTS – Acknowledged, no response required.**

- Submissions stated that areas under consideration should be left to attract tourism which is seen as more profitable, is not destructive and will employ more Western Australians.

**RESPONSE TO COMMENTS – Plan amended to acknowledge the tourism pursuits in the proposed areas.**

- One submission supported the suggestion that aquaculture not be acceptable in the Port Authority area due to proximity to the townsite.

**RESPONSE TO COMMENTS – the risks of aquaculture within the port area is acknowledges in the plan.**

(note: Section 11 of the draft plan is now Section 14 of the final report)



## SECTION 11 – Areas Suitable for Marine Aquaculture – Remark Group

Five submissions were opposed to aquaculture in the Remark group for the following reasons:

- conflict with recreational fishing, diving and tourism;
- diversity of uses, including habitat for the Leafy Sea Dragon;
- all current user groups use the Remark Group of Islands without conflict, the introduction of large scale cage farming will conflict with all user groups;
- tuna farming in Sandy Hook/Remark would not be accepted by the pilchard fisherman and would be vehemently opposed.

**RESPONSE TO COMMENT – The diversity of current users of the Remark Group and the potential constraint that this may cause for aquaculture is acknowledged in the plan. The plan states that any aquaculture application for sites within the Remark Group will need to address these issues.**

Four submissions (of which are represented above) were specifically opposed to ‘earmarking’ the Remark for aquaculture, for the following reasons:

- Earmarking would be ‘politically insensitive’.
- It is not appropriate to earmark until more research is done.
- It is not appropriate to earmark the Remark group due to diversity of uses, including presence of Sea Dragons.
- Goes against the concepts of good consultation and management.

One submission supported the earmarking of the Remark group for aquaculture as this would allow proponents of aquaculture to run pilot scale activities in the area and for the public to assess the impacts before embarking on larger scale activities.

**RESPONSE TO COMMENTS – The concept of ‘earmarking’ a particular area or site has been removed from the document.**

(note: Section 11 of the draft plan is now Section 14 of the final report)

## SECTION 11 – Areas Suitable for Marine Aquaculture – Mart Group

- Two submissions were opposed to aquaculture in the Mart group as the decision to highlight this site was based on lack of information.

**RESPONSE TO COMMENT – Acknowledged in plan.**

(note: Section 11 of the draft plan is now Section 14 of the final report)

## SECTION 11 – Areas Suitable for Land-based Aquaculture

- *‘Potentially suitable areas for future marine and land-based aquaculture’* – One submission stated that it was unclear whether the (in the 2nd para) area east of Bandy Creek has potential environmental risk from ground water contamination are due to aquaculture impacts or other sources. Appropriately managed land-based operations should produce no contamination – if the impact is due to some other source than this needs to be listed.

**RESPONSE TO COMMENTS – This point has been clarified in the plan – the potential environmental risk is from other industrial developments.**

- One submission was received opposing siting land-based aquaculture in the national park, when there are available and workable sites closer to Esperance and outside of the National Parks.

**RESPONSE TO COMMENTS – The plan acknowledges the limitations on National Parks with regards to the siting of land-based aquaculture operations.**

(note: Section 11 of the draft plan is now Section 14 of the final report)

## Environmental Effects of Aquaculture (Section 12.2) and Port Lincoln Issues

Two submissions raised concerns about the use of introduced feeds with one of these stating that the plan does not properly address the dangers of introduced feeds.

Four submissions raised concerns about the effect of harvesting pilchards for fish cage feed. In particular the concerns were:

- This would have a ‘graveyard effect’ similar to that experienced as a result of ‘rolling.’
- Pilchards are a major food source of many other fish which in turn sustain many other fishing industries.
- The destruction of pilchard fishery will affect recreational fishing which is reliant on pilchards as bait.
- Pilchards would have a better long term benefit if not used as feed stock. Recreational fisheries rely on pilchards as bait – which in turn supports many other industries – eg. tackle, accommodation.

One submission raised the following concerns about environmental effects of aquaculture:

- land degradation, including effects on the environment and natural resources in areas traditionally used for camping, hunting and gathering and ceremonial and other cultural activities;
- protection of the environment from pollution caused by wastes such as waste water, sludge, carcasses, chemicals and drugs;
- adequacy of environmental monitoring programs and reporting- the visual impact of cages in the ocean; and risk of adverse genetic and disease effects of escaped fish on wild stock.

Five submissions stated that there were concerns about the current practices at Port Lincoln including:

- unsolved pilchard kills of 1995 and 1998;
- tuna farmers possibly trying to move away from polluted waters in what is believed to be an attempt to ‘spread their risk’;
- moving of cages by Port Lincoln tuna farmers to Lough Bay;

- apparent tangled mesh between the Tuna Boat Owners Association and the South Australian Government;
- The Eyre Peninsula Tourism Association has stated that tuna farming is not a ‘draw card’ for tourism.
- Abalone divers in the Port Lincoln area are fighting the tuna farmers to stop them moving cages into the Thorny passage area.
- Abalone divers do not like to dive near tuna cages because of the risk of shark attack.
- Tuna farmers have a poor reputation because of the wildlife caught in their nets.
- Feed-lotting of this nature is seriously depleting world stocks.

**RESPONSE TO COMMENTS – Concerns have been acknowledged in the plan, particularly in Section 14. Potential environmental risk and environmental management measures are detailed in Section 14.**

## SECTION 5 – Constraints

One submission suggested a number of further constraints:

- potential conflicts that will arise between aquaculture operations and existing shipping activity of Esperance’s major export port, must be recognised.
- Planning for sea-based aquaculture must consider shipping routes for export.
- The risk of unplanned oil and ballast water emissions must be allowed for, and problems associated with the dredging of shipping channels, which will generate turbidity and suspend soils needs to be considered.
- Land for future resource and industrial development must also be allowed for when considering land for aquaculture.

**RESPONSE TO COMMENTS – Constraints have been acknowledged in Section 8.**

## Long Term Future

Several submissions raised the issue of the long term future of Esperance and the Recherche Archipelago and the part of aquaculture in that future. Comments received on this issue are bullet-pointed below, followed by Fisheries WA’s response to each comment.

- If the industry is monopolised or controlled by overseas interests we can see no long- term future.

**RESPONSE TO COMMENTS – This concern is documented in the Report on Community Consultation (Phase I). No amendment to plan required.**

- Placing pristine areas of coastal water in danger for short-term gain is not consistent with ‘*Fish for the Future*’.

**RESPONSE TO COMMENTS – The plan is explicit in regards to the need for aquaculture operations to be environmentally sustainable as opposed to for short term gain. No amendment to plan required.**

- Holds that the introduction of aquaculture to the area would not be a sustainable industry and that it would have too many ramifications on other long term industries and environment.

**RESPONSE TO COMMENTS – The plan is explicit in regards to the need for aquaculture operations to be environmentally sustainable as opposed to for short term gain. No amendment to plan required.**

### Community Benefits

- One submission disagreed with the statement – ‘any benefits to the Esperance community will be lost if a company from outside Esperance were granted a permit’ – Believes that this will not be the case as the requirements for labor and infrastructure cannot be imported to the region in its entirety.

**RESPONSE TO COMMENTS – Acknowledged. No amendment to plan required.**

- One submission supported the idea of a cost benefit analysis to allow the community to have more information on the potential benefits of tuna farming in a more quantitative form specific to Esperance.

**RESPONSE TO COMMENTS – Acknowledged. No amendment to plan required.**

- One submission stated that given the traditional practice of subsisting on natural resources, aboriginal people have an interest in opportunities for gainful employment in aquaculture and request to be kept informed of State support for rural and state farmers.

**RESPONSE TO COMMENTS – Acknowledged. No response required.**

### General Comments

- Two submissions stated that the message for aquaculture is that the people are prepared to have an aquaculture industry, but on their terms and only in an environmentally sustainable way.

**RESPONSE TO COMMENTS – Acknowledged. No amendment to plan required.**

- One submission stated that the process should focus on the totality of the area rather than selected sites.

**RESPONSE TO COMMENTS- Acknowledged. The plan focuses on the totality of the Recherche Archipelago and makes suggestions as to some potentially suitable sites only. No amendment to plan required.**

- One submission stated that the draft plan is a balanced document.

**RESPONSE TO COMMENTS – Acknowledged. No amendment to plan required.**

- Para 16, 3.7.2 Commercial Fishing and Fish Processing – “the notion of using pilchards caught for tuna farming was not considered as it is generally an inferior product and therefore attracts a lower price” – 1 submission suggested that this is not true and that the majority of the locally caught pilchards would not be used for tuna farming due to price.

**RESPONSE TO COMMENTS – Acknowledged. No response required.**

- One submission suggested that Chapter 14 (Aquaculture Application Procedure) should be included in the Executive Summary.

**RESPONSE TO COMMENTS – Acknowledged. Executive Summary has been amended to include Chapter 14.**

## APPENDIX E

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### Esperance Wind Roses

#### Wind Frequency Analyses and Wind Roses

The included set of wind frequency analysis tables and/or wind roses show the frequency with which winds of various strengths are observed coming from various directions. These notes should help you to use the information.

#### Data

Wind speed and direction are measured by a number of means. In some cases, they are only estimated. To find out exactly which method has been used, a search of the appropriate station history file would be required.

The data are collected by the National Climate Centre in the Bureau of Meteorology's Melbourne head office. They are stored in ADAM (the Australian Data Archive for Meteorology), an extensive computer database of meteorological observations.

As the observations are stored, basic checks are performed. Any observations that fail these tests (specifically, any whose quality flag is poorer than "4 – estimated, medium certainty") are excluded from the frequency analyses that follow.

#### Analysis

The data are collated in a number of ways, depending on the nature of your request.

To group by hour, the observations are assigned to the closest standard three-hour reporting time. For example, all observations between 7:30 am and 10:30 am local standard time are labelled "9 am".

If a seasonal grouping has been requested, then "autumn" is March, April and May, "winter" is June, July and August, "spring" is September, October and November, and "summer" is December, January and February.

The observations are then grouped by speed. The exact number of speed ranges and their size depends on your request. When the speed ranges are labelled, "1-10" is used for all speeds greater than 0 but less than or equal to 10. "11-20" means greater than 10 but less than or equal to 20.

The data are then grouped by direction; into 8 or 16 bins as requested. When doing this, observations that fall on a bin boundary are split equally between the two bins. For example, when grouping into 8 bins, a direction of "NE" covers all observations with directions strictly between NNE and ENE; "E" covers from ENE to ESE. If the direction is exactly ENE (67.5°), then it will be placed half in the "NE" bin and half in "E" one.

#### Tables

If you have requested wind frequency tables, then you will get a separate table for each time group. Each table shows the time to which it applies, and the total number of observations used at that time. The percentage frequency with which calm conditions (that is, no wind) are observed are displayed at the top left of the table.

The rest of the table is laid out with directions across and speeds down. To find the frequency with which winds of a given speed and direction occur, follow down the appropriate direction column and across the speed row until they intersect. The value printed there is the frequency you require. For example, a value of “14” indicates that this speed/direction group occur about 14 per cent of the time. \*\*\* Indicates the range has occurred but less than 0.5 per cent of the time.

The last column, labelled “All”, gives the frequency of each speed range regardless of direction. Similarly, the last row gives the frequency of each direction, regardless of speed.

### Roses

Wind Roses seek to make the data in a wind frequency table easier to digest. Although not ideal for quantitative work, they are good for providing a quick visual impression of the wind regime.

Like the tables, there is one wind rose for each time group that you requested. Each rose consist of a central circle, surrounded by branches, each made up of a number of petals.

The circle represents the frequency of calm conditions. The size of the circle is proportional to the number of calms; a scale is given in the legend at the top of the page.

Each branch represents the wind coming from that direction. North is to the top, and the other directions are shown in the legend. In each case, the wind is blowing from that direction toward the calms circle. Each petal corresponds to a speed range from that direction. The length of the petal is proportional to the frequency of that wind; the scale is shown in the legend. The thickness of the petal is used to indicate which speed range it represents.

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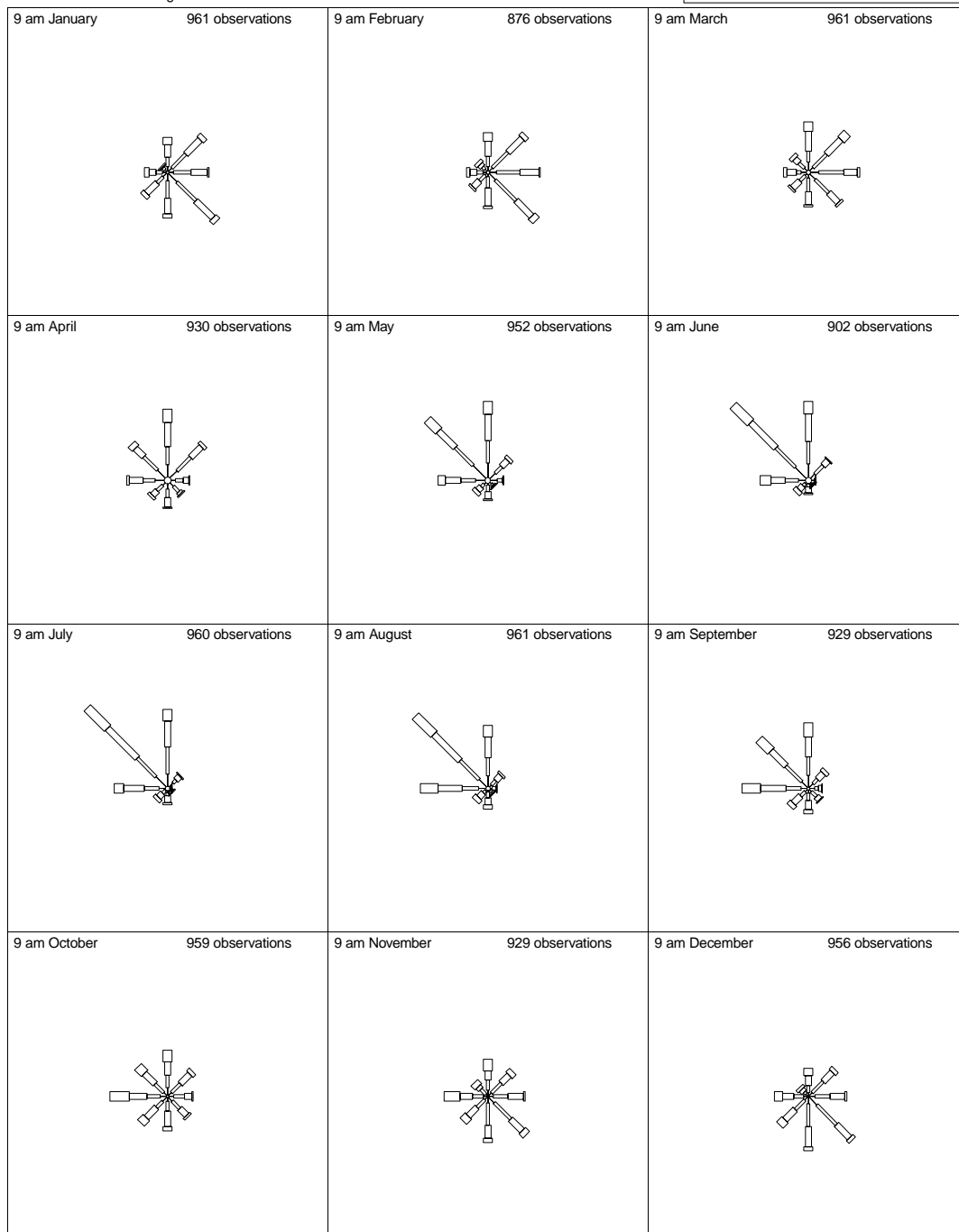
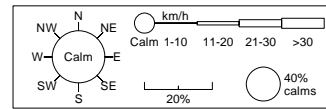
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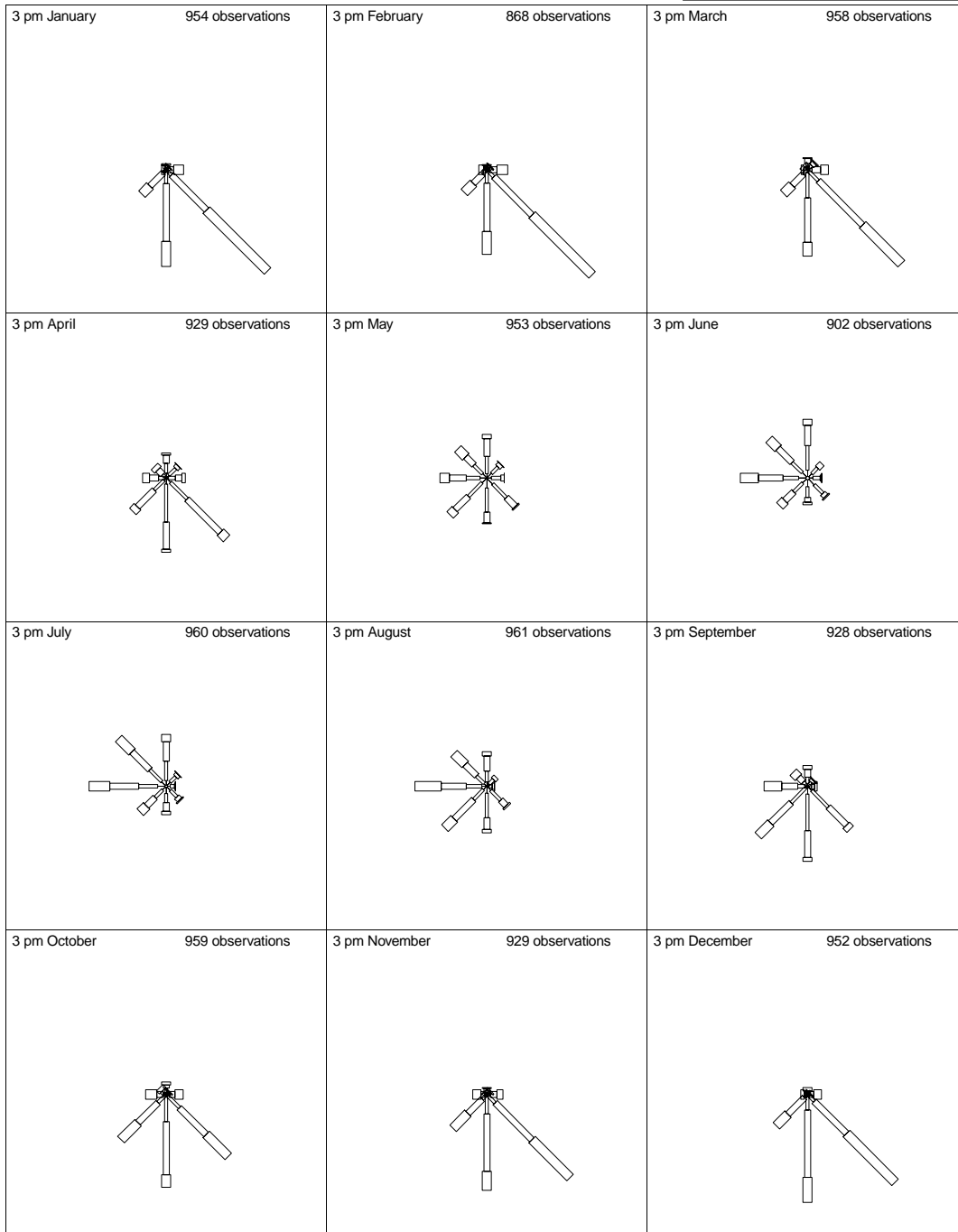
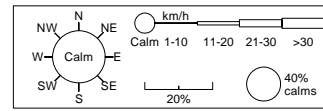
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## APPENDIX F

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### Generic Constraints to Aquaculture in Western Australia

#### Generic Constraints to Aquaculture in Western Australia

There are a number of constraints facing the development of the aquaculture industry in Western Australia which also apply to the Recherche Archipelago. While these constraints are presently affecting the pace of development it is encouraging to note that many of the issues are being addressed by Fisheries Western Australia, the Fremantle Maritime Centre and a range of institutions and private companies. The constraints include:

#### Technology

The current level of technical knowledge in Western Australia will constrain the development of the industry in the Recherche Archipelago in a number of different ways including:

- limited choice of suitable species available;
- diets;
- knowledge of disease and treatment;
- lack of personnel with commercial aquaculture experience;
- lack of practical knowledge in cage culture techniques in Western Australian conditions.

#### Species Choice

There is a danger that a decision to grow a particular species is often based more on the basis of availability rather than a more comprehensive selection criteria. For example, while pink snapper have been cultured and are available (in part) this may not be the best finfish species to grow in a particular region. Therefore a commercial operator (or government) will have to develop culturing techniques for the selected species.

#### Diets

When developing culturing techniques for marine species a vital part of the work includes creating the best nutritional requirements for the various stages of production and getting this right requires additional human and financial resources.

Despite the fact that there is considerable research and development investigating alternative protein sources for fish feed (including a lupin trial at the Fremantle Maritime Centre) the aquaculture industry is still a net protein consumer (through the use of Atrash<sup>®</sup> fish for meal) and comes under criticism from the environmental movement worldwide when it champions its role as easing world fishing pressures. There is encouraging results being achieved at Port Lincoln with the artificial diet developed for Southern bluefin tuna.

#### Knowledge of Disease and Treatments

While there is considerable knowledge throughout the world on the various diseases fish and other aquatic organisms are subject to, from a fish farming perspective there is a critical need to know why, how and what to look for when they manifest. It is also imperative to know how to treat the fish and mitigate the reasons for the disease. Generally speaking, the majority of disease problems in fish farming are attributable to husbandry and management.

### Lack of Personnel

Although there are excellent education and training opportunities being made available to the state, including practical hands on learning, there is a dearth of large food aquaculture projects employing significant numbers of people. This can result in a small relatively inexperienced workforce. As the industry develops, providing operators are prepared to give commercially inexperienced technician-level staff a chance, this problem should reduce. Alternatively, experienced staff are imported.

### Lack of Practical Knowledge in Cage Culture Techniques in Western Australian Conditions

Despite the advances being made in the hatchery aspects of creating skill and knowledge, there is very limited practical, commercial experience in handling cage culture in Western Australia. This is simply due to the lack of projects.

The lack of commercial technical experience in a developing industry can seriously impede its progress. There are a range of complex issues to deal with when developing cage culture techniques for new species, as well as the ongoing challenges that arise such as improving survivability and maximising growth rates.

Proponents should not underestimate the level of technical knowledge required to achieve long-term success. Furthermore, this demand for knowledge is not static and the operator should always be seeking ways to achieve better results in an industry that must not only be economically viable but also increasingly ecologically sustainable.

### Market Knowledge

To date there has been relatively little work carried out on the market potential for most candidate species in Western Australia and while several private companies have undertaken studies related to their particular operations the findings are commercially sensitive and are not in the public domain.

A lack of knowledge of the dynamics of the seafood market and how to differentiate or position aquaculture product in the market place may lead to incorrect assumptions about price needed, volume required and how best to promote the product. Proponents of developing projects in the Recherche should carry out a thorough market analysis of candidate species as part of their business planning.

### Marketing

Aquaculturists often require a premium price for their products to offset high production costs, and must actively develop high-value niche markets. This process is both time consuming and costly. While aquaculture operations have the distinct advantage of controlling the size of the product and the time of harvest, the highest-value size and time of harvest may conflict with existing fisheries therefore effort is needed to ensure that well planned marketing can maximise the advantages of aquaculture product over wild caught product.

Aquaculture proponents should include a thorough marketing plan as an integral component of their overall development strategy and if necessary seek professional expertise to carry out the work.

### Transport

Although the infrastructure surrounding the regional hub of Kalgoorlie-Boulder has resulted in a sophisticated transport system that serves Esperance well (This includes sealed roads, rail freight capacity, regular air services and a major port), the majority of the aquaculture industry's transport requirements will be serviced by a seven-hour road trip.

While there is no shortage of transport capacity it should still be recognised that the seven hour road distance may affect have a constraining effect on the industry in terms of additional cost of transporting materials to

Esperance. This should be offset by the fact that chillers and freezers are sent to Perth empty six days a week and cheaper backloading rates should apply to the transport of product.

Proponents should be aware of potential increased project costs associated with transport and where possible and competitive, utilise local suppliers.

### **Finance and Investment**

Financial institutions lend money when they believe there is a reasonable return subject to the risk of the venture. In aquaculture, there is a relatively high degree of regulatory, environmental (weather, temperature, water quality), disease, predation, and market risk.

Because of the risky nature of aquaculture enterprises, traditional banks may be unlikely to lend to potential or existing operations and given the lack of private financing, there are limited financing options available to potential aquaculturists.

The industry needs to approach leading financial institutions and make presentations on the status of the industry, level of government commitment and support and the opportunities it presents

### **Community Support**

The process of any industry development is greatly enhanced when a community recognises the socio-economic benefits a healthy aquaculture industry can bring to its region. Conversely, a community which is not supportive of aquaculture can impede the planning progress, command unrealistic environmental restrictions and generally fail to help integrate the industry into the social and economic fabric of the community.

At an early stage, proponents should maintain open and frequent communications with the Esperance community and hold workshops to explain their project. With Fisheries Western Australia proponents should ensure the community has a role in the planning process including endorsing the level of assessment and on-going monitoring programs.

### **Water Quality and Quantity**

Land-based systems will require an initial fill, water reserves to offset losses from harvests, seepage, evaporation and flushing. While the quality and quantity of large volumes of fresh water may be a limiting factor for some industries in Esperance the availability of oceanic water for the development of marine species in land-based systems should not present major problems. However the cost and approval processes of ocean intake supply and drainage can be significant.

While it is likely that the majority number of land-based projects adjacent to the Recherche Archipelago will comprise marine species requiring large quantities of good quality oceanic water these projects will also need some freshwater for operations including cleaning of tanks, treatments for fish and production of rotifers (Kennerly D.1999 *pers comm*).

### **Ocean Aquaculture**

#### *Carrying Capacity*

In order to develop a sustainable industry the carrying capacity of the site should be determined. Given the lack of scientific research on the Recherche Archipelago to date, establishing carrying capacity will require additional resources to provide a detailed account of:

- current nutrient loadings;

- water quality;
- hydrographical features such as currents, wave actions;
- benthic status and habitat.

Without this baseline data it is difficult to judge whether carrying capacity will constrain the scale of industry being proposed in the Recherche Archipelago. Proponent need to undertake an environmental impact assessment of the site after determining carrying capacity.

A proponent needs to develop and implement (with FWA/CALM/DEP assistance) a monitoring program that can provide an indication of change in selected water quality and benthic characteristics, and whether this change is within the acceptable pre-determined parameters set for that specific farm.

### *Predation and Entanglements*

There is no doubt that sea cages will attract the curiosity of birds and seals and can inflict considerable economic harm on operators. Stock losses can occur through direct prey, wounded fish attract lower market prices and stress may cause fish to reduce feeding and become more susceptible to disease (EOA 1997).

The entanglement of seals, birds and other marine mammals, while of significant concern to government agencies (Fisheries Western Australia, CALM) and the community, can also cause damage to predator nets and cages. It is in the best interest of the operator to install good quality predator nets and adopt a feeding management regime that minimises the opportunities for scavenging. Acoustic deterrent devices have been found to become ineffective over time as the seals become accustomed to, or deafened by, them. There is also evidence that the devices may interfere with animal communications.

Given the level of concern raised by members of the Esperance community and CALM regarding interactions between birds, seals and other coastal mammals it would be prudent that the operator takes all reasonable precautions to minimise entanglement and possible subsequent deaths. At the same time farmers must adopt anti-predator strategies to minimise stock loss. Fisheries Western Australia and CALM would provide assistance to industry to identify (and if necessary develop) the best available net predator systems.

### *Fish Health*

Aside from the economic losses a farmer may face from disease outbreaks in farmed stocks there are additional issues to consider in respect of fish health that should be considered. These include the risk of importation of non-indigenous pathogens and parasites, transfer of disease between farmed and wild stock and the potential for biological pollution from drugs and pesticides.

The impact of introduced pathogens, threat of disease in wild fish and the pollutive effects from over and improper use of drugs and pesticides has dogged aquaculture in the past. Aside from the risk of financial damage caused by an adverse fish health issue such as disease, the proponent is part of an ecologically sensitive environment with a community who in part are distrustful of aquaculture. Any early problems may result in the development of the industry being seriously impeded.

There should be serious consideration given to the range of practices aquaculture operators should adopt in order to prevent these occurrences. These practices should become part of the operator's licence conditions.

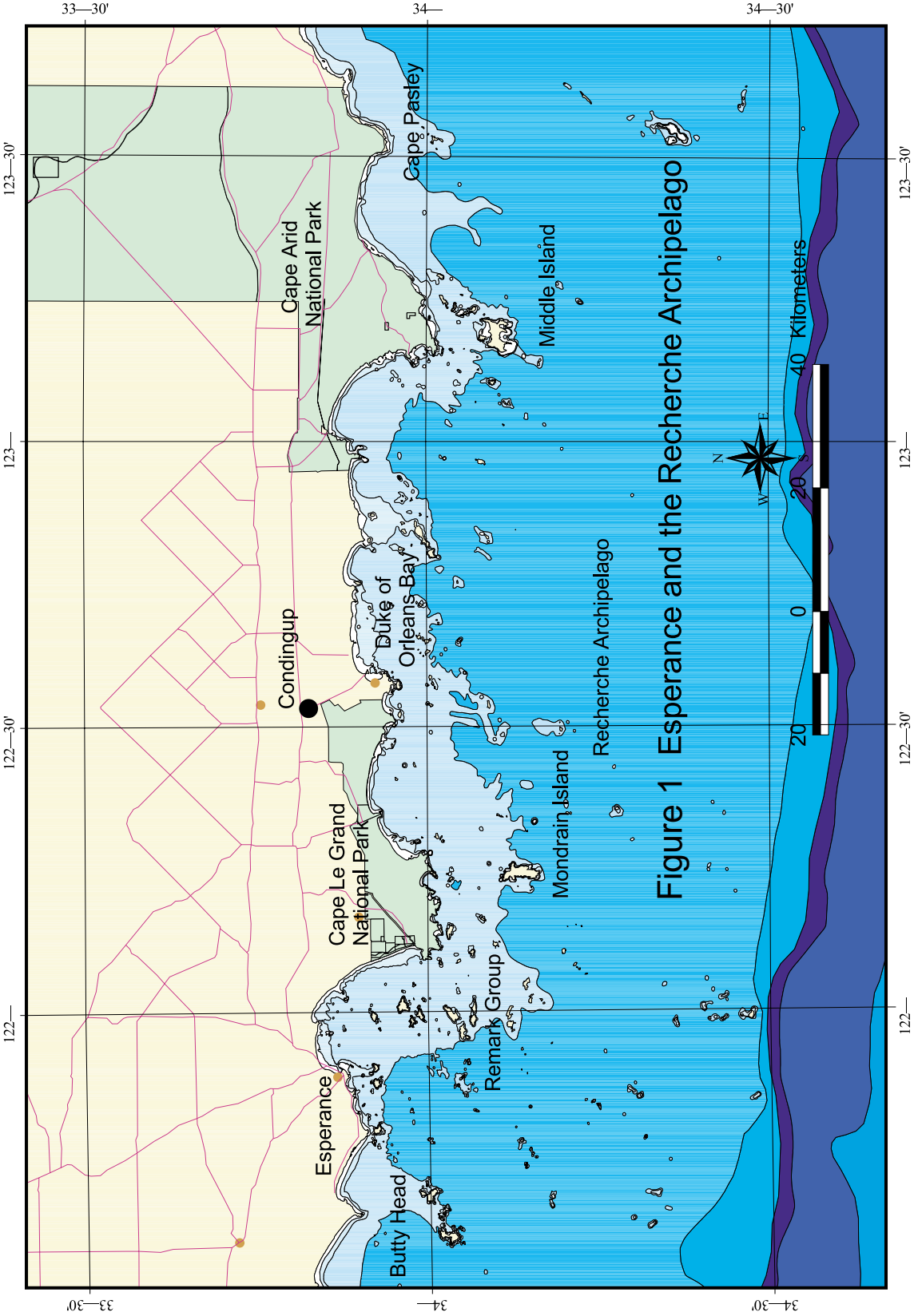
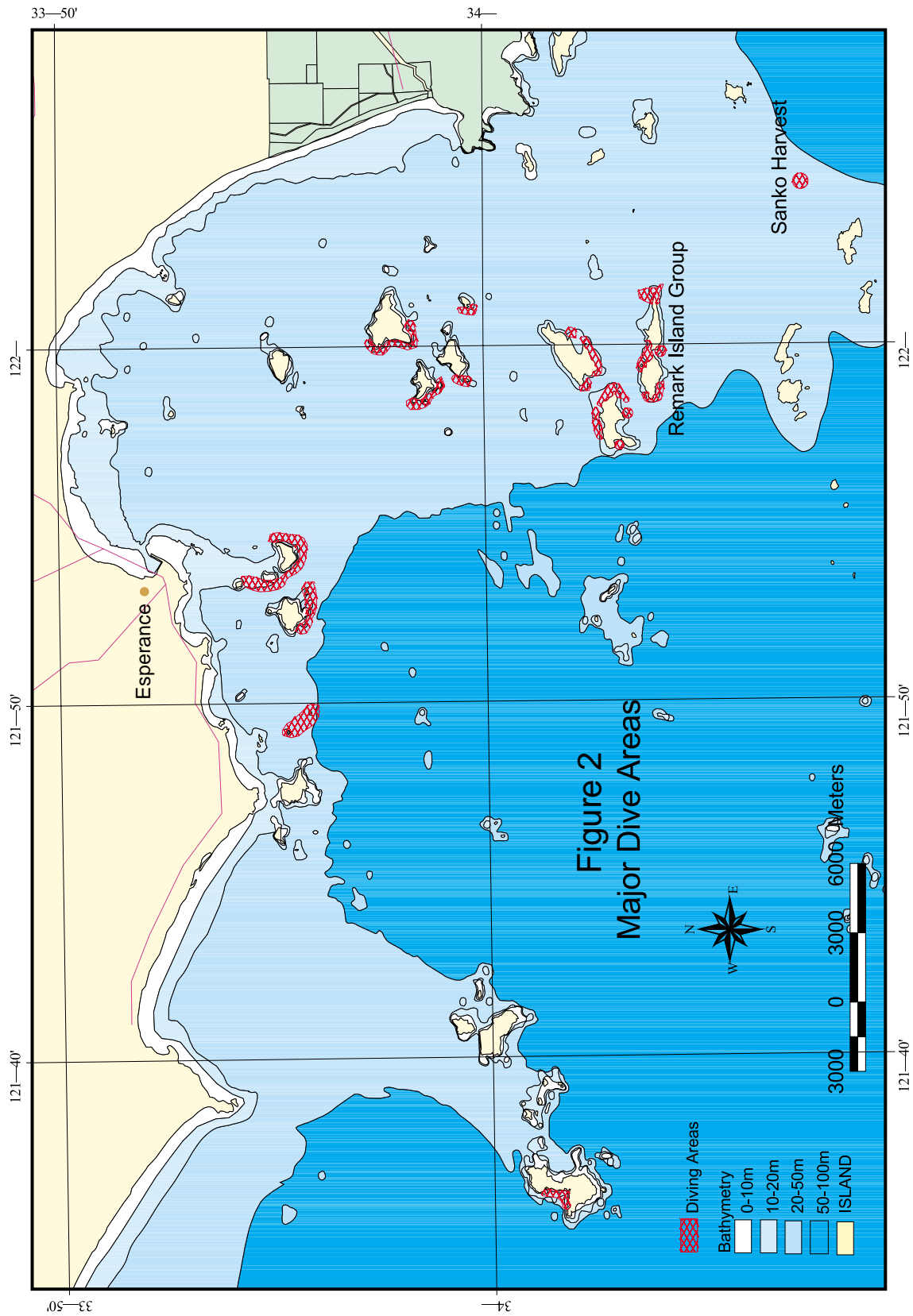
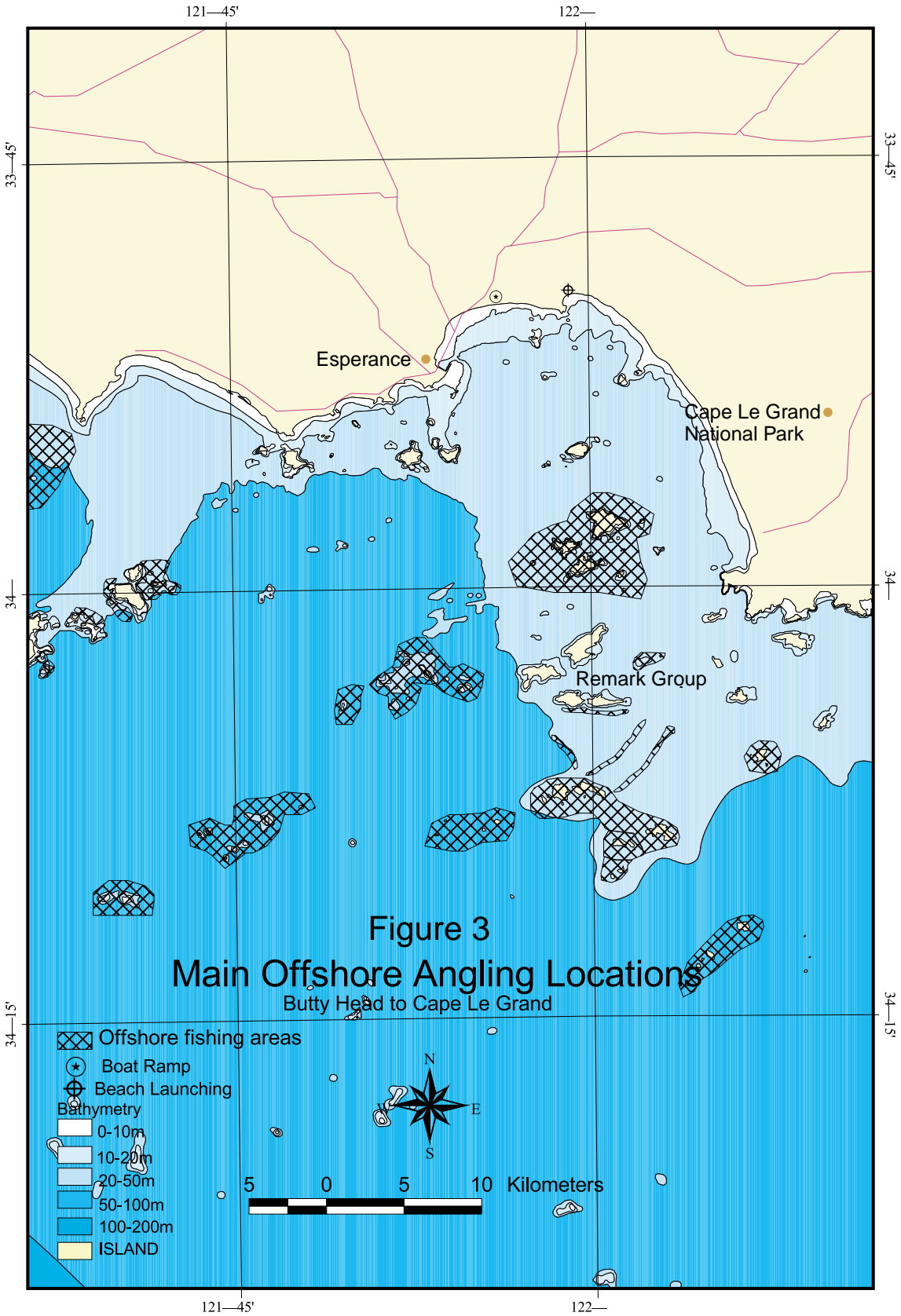
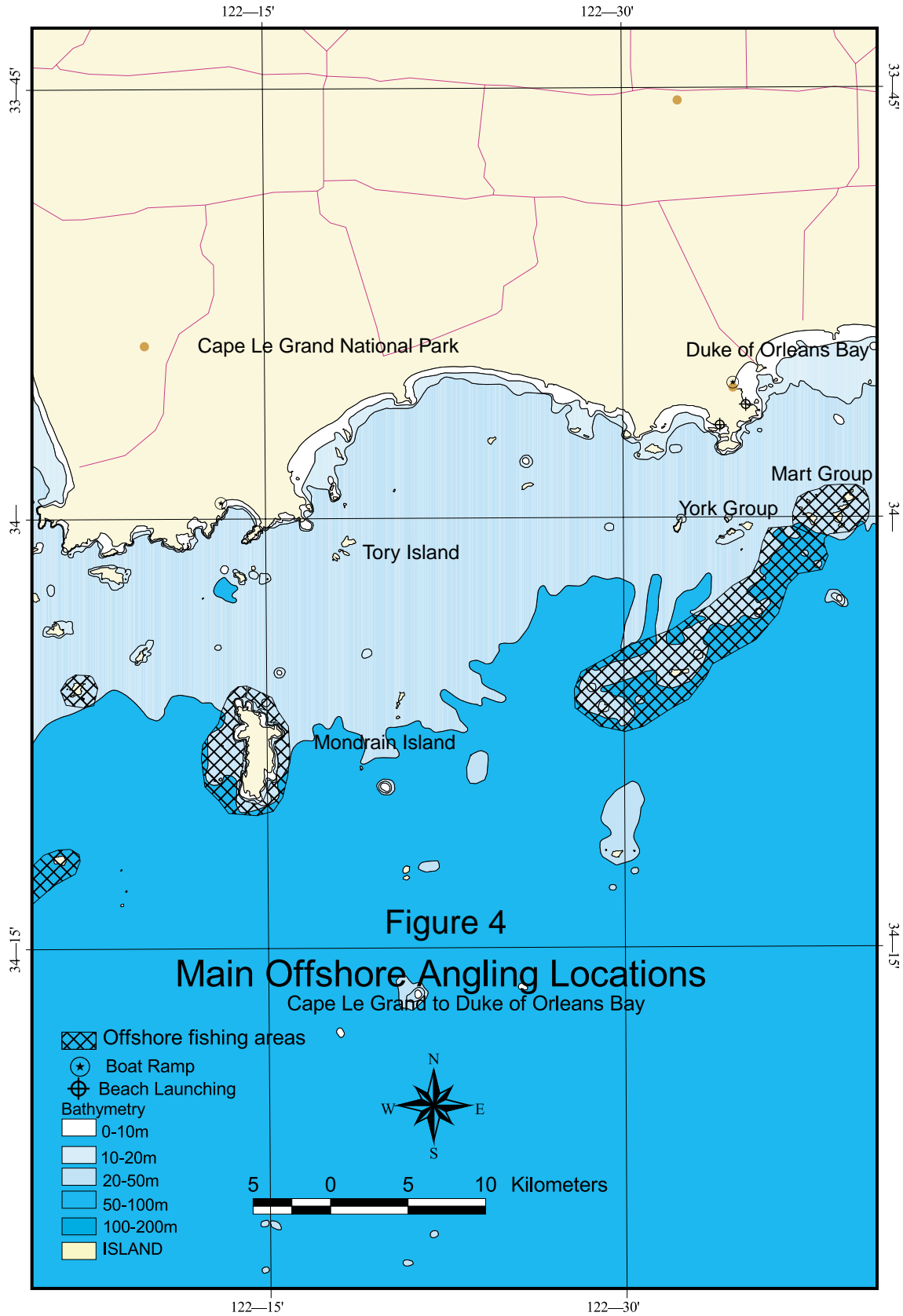


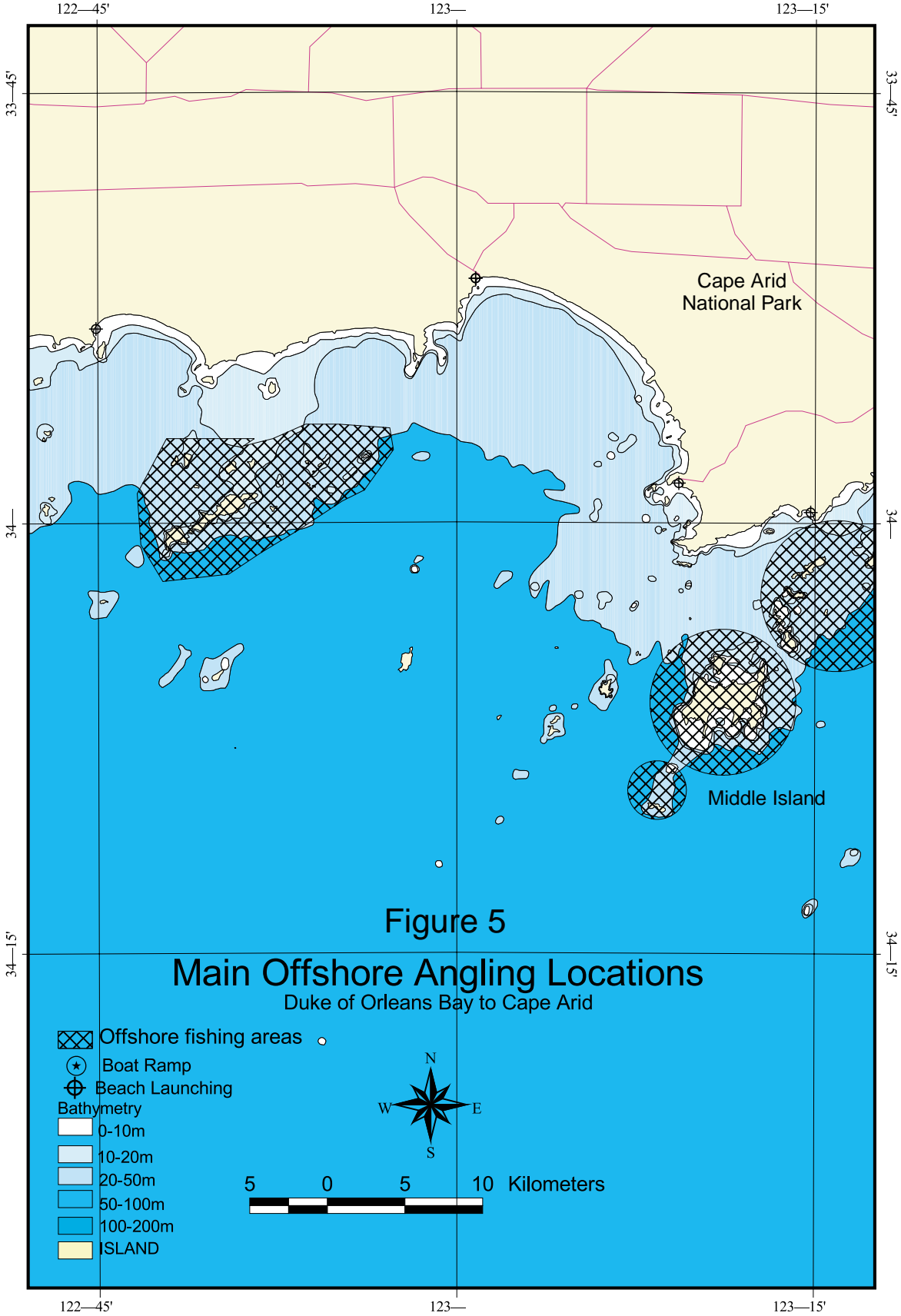
Figure 1 Esperance and the Recherche Archipelago

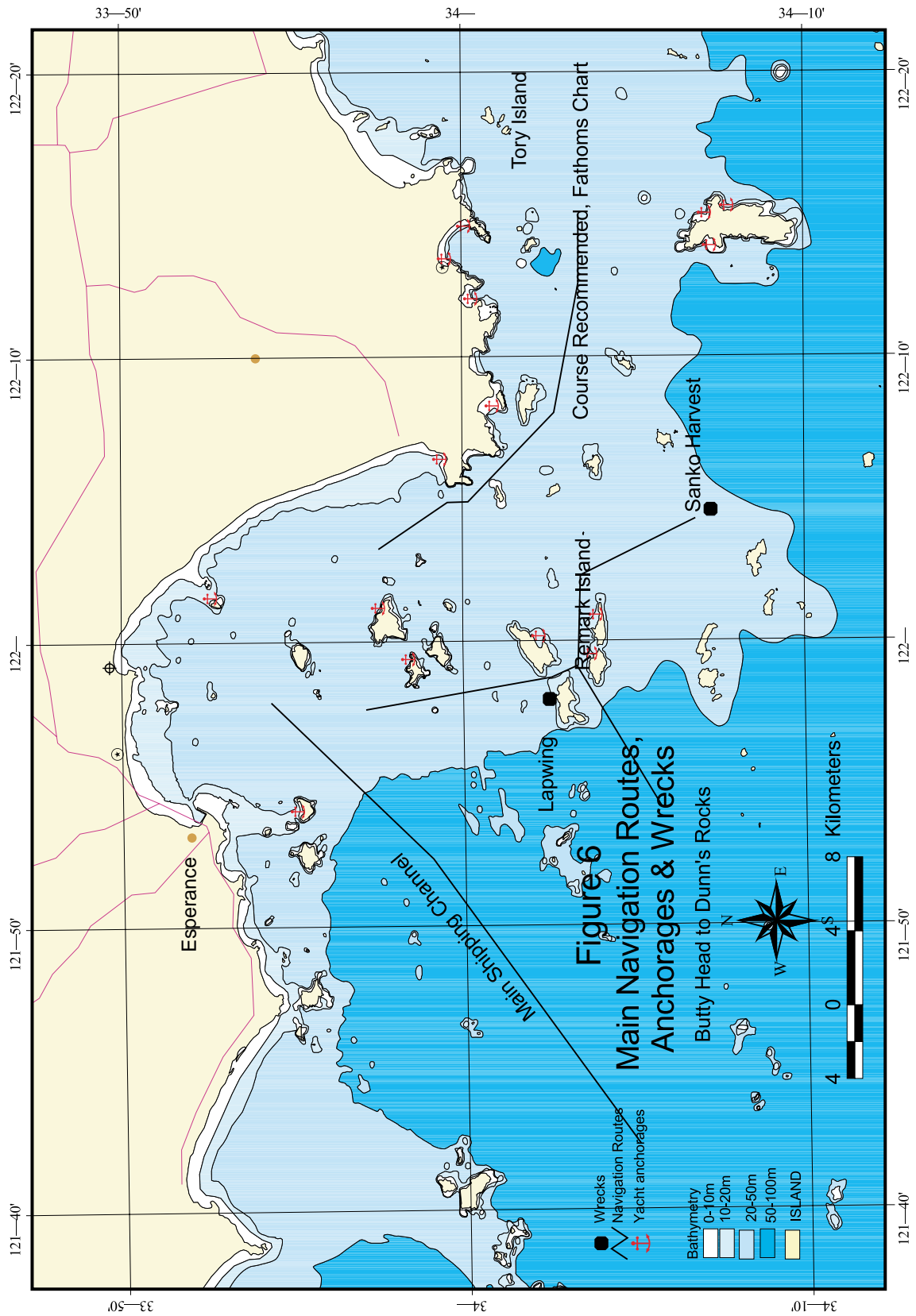


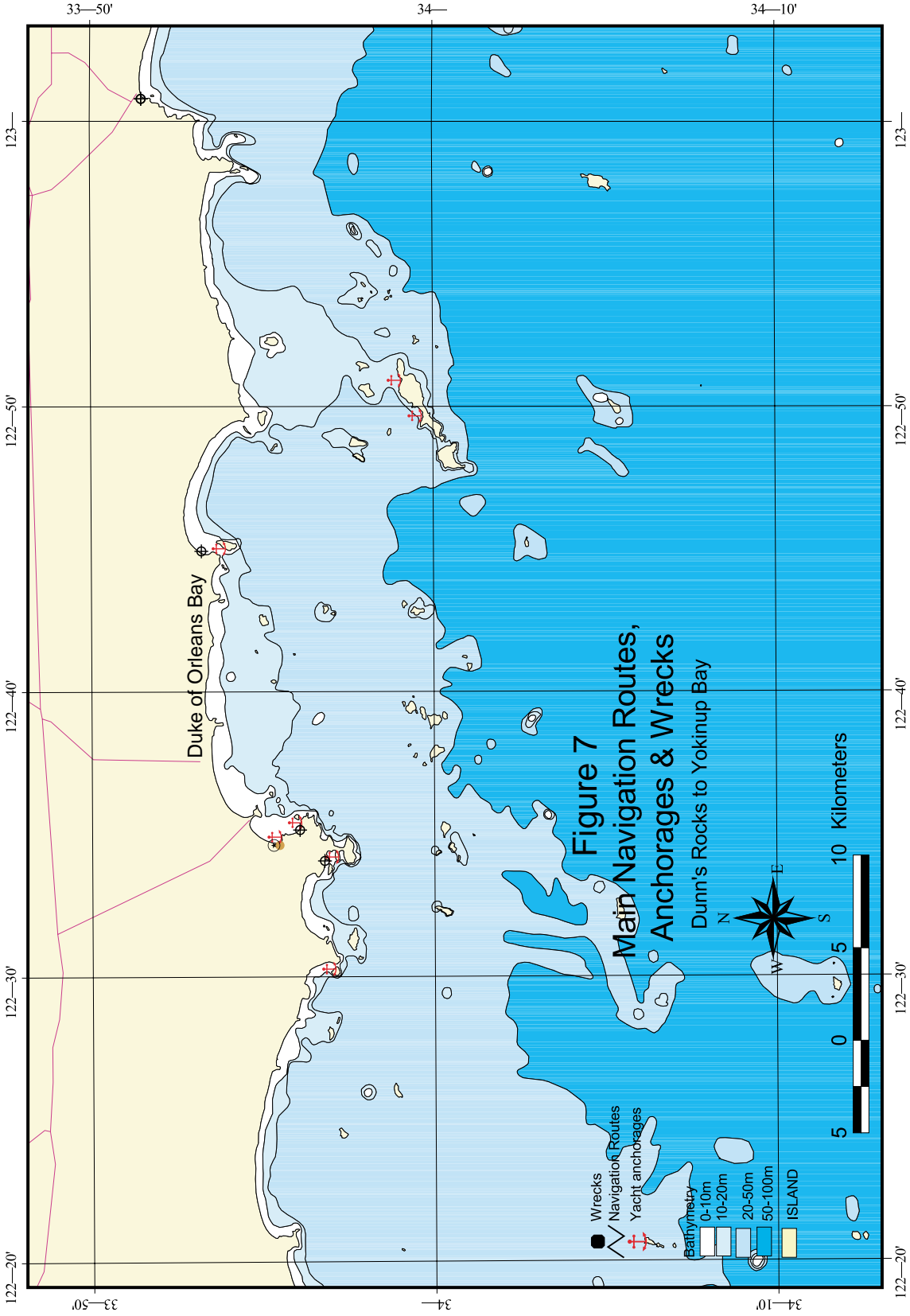


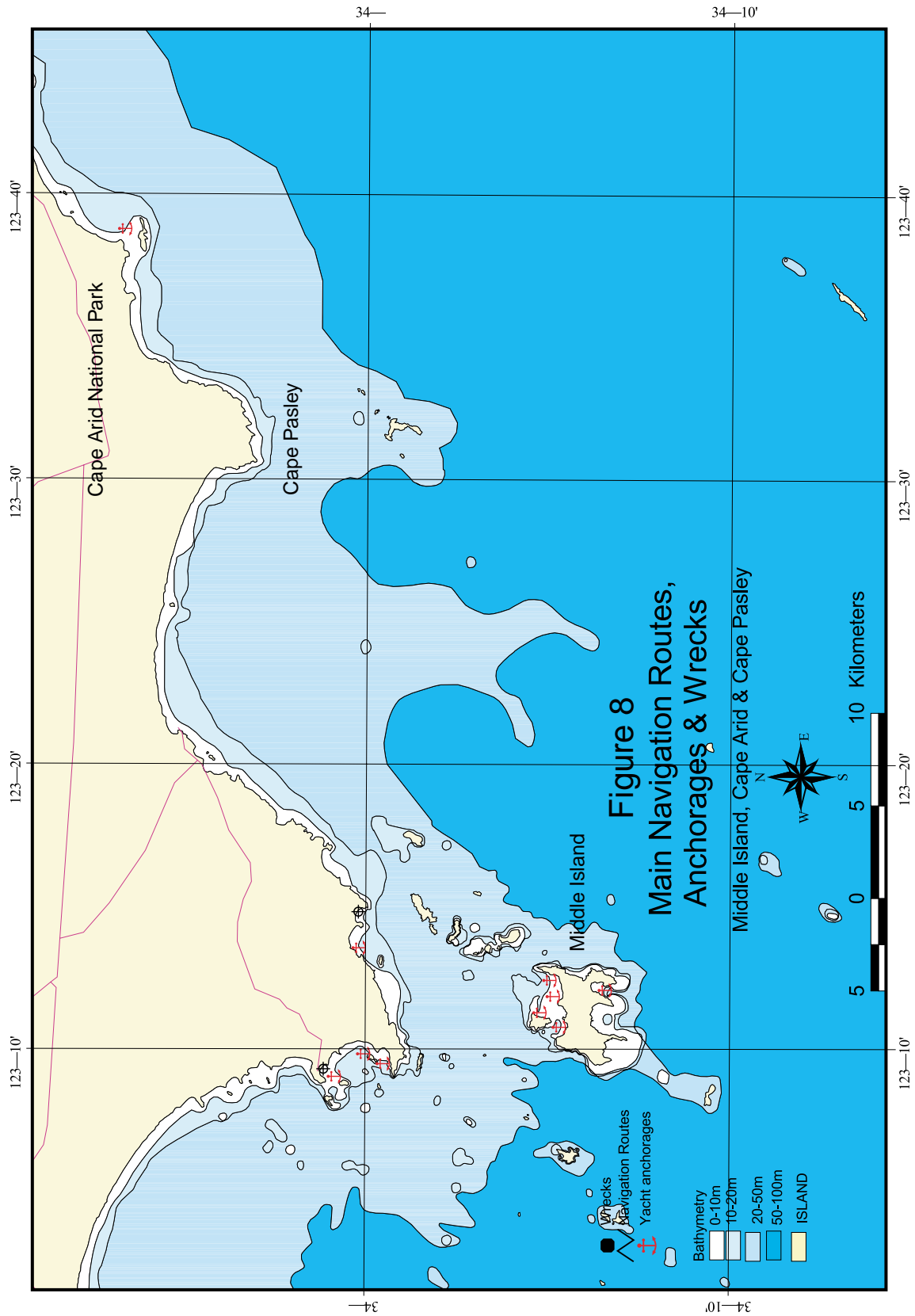


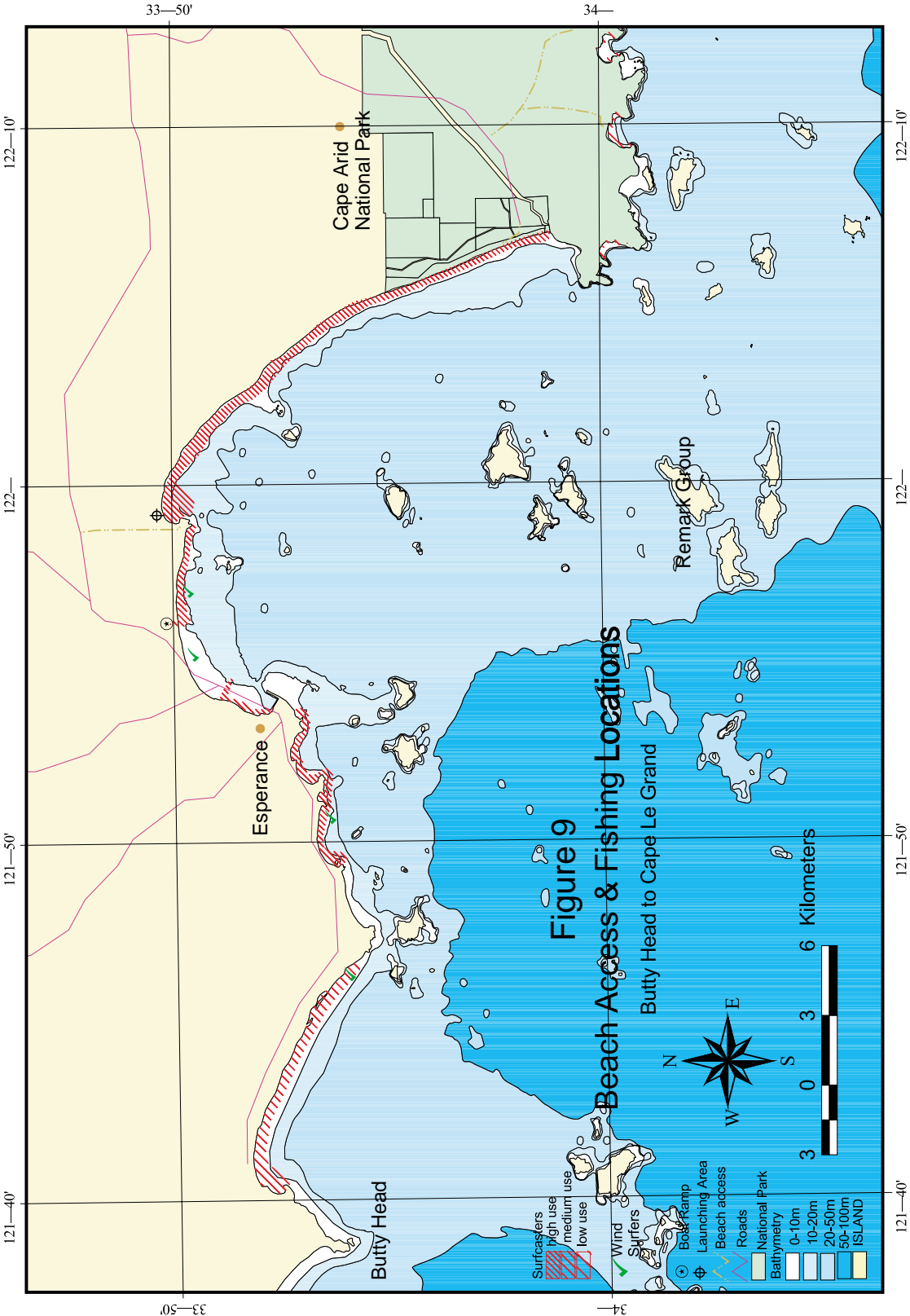


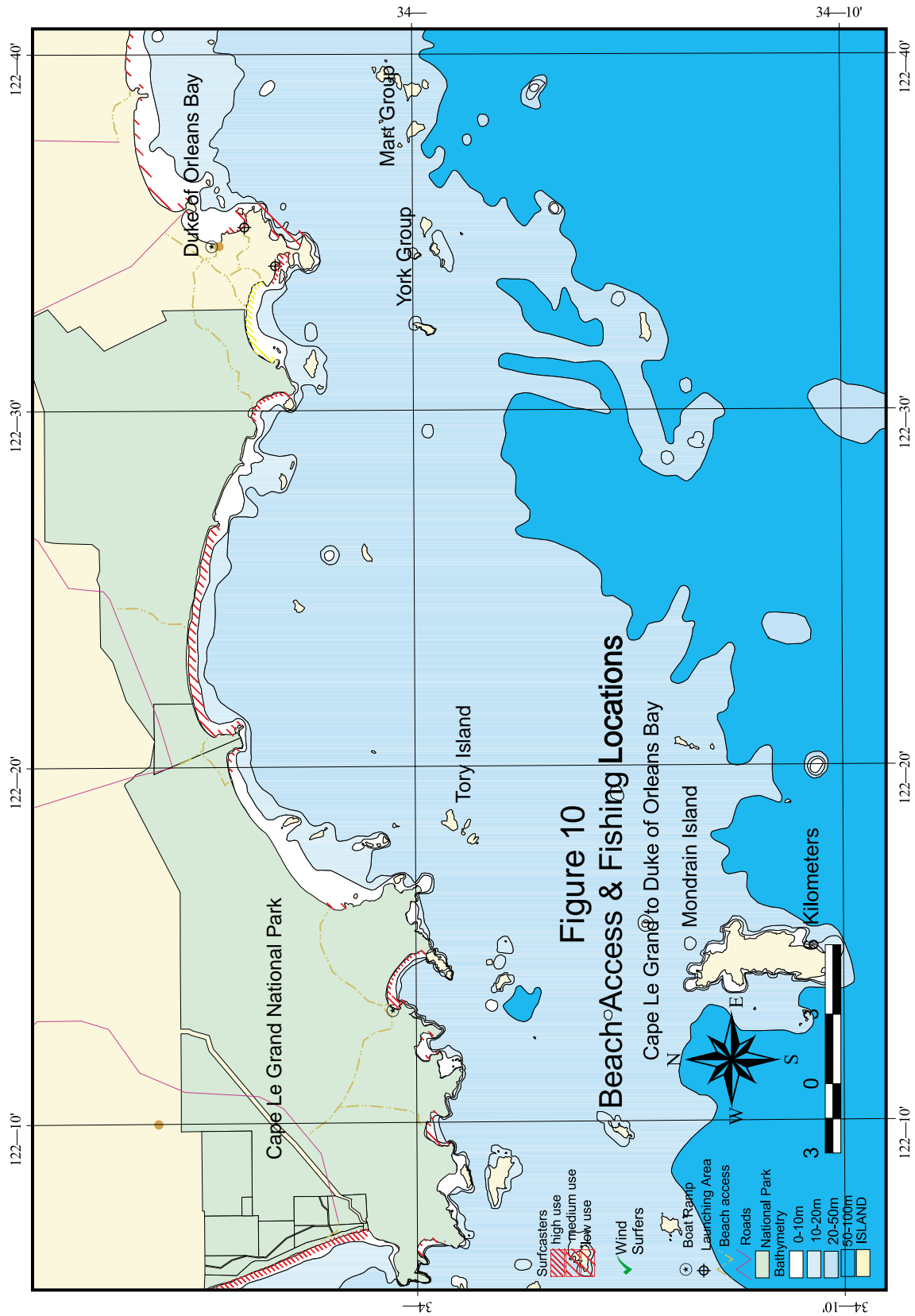


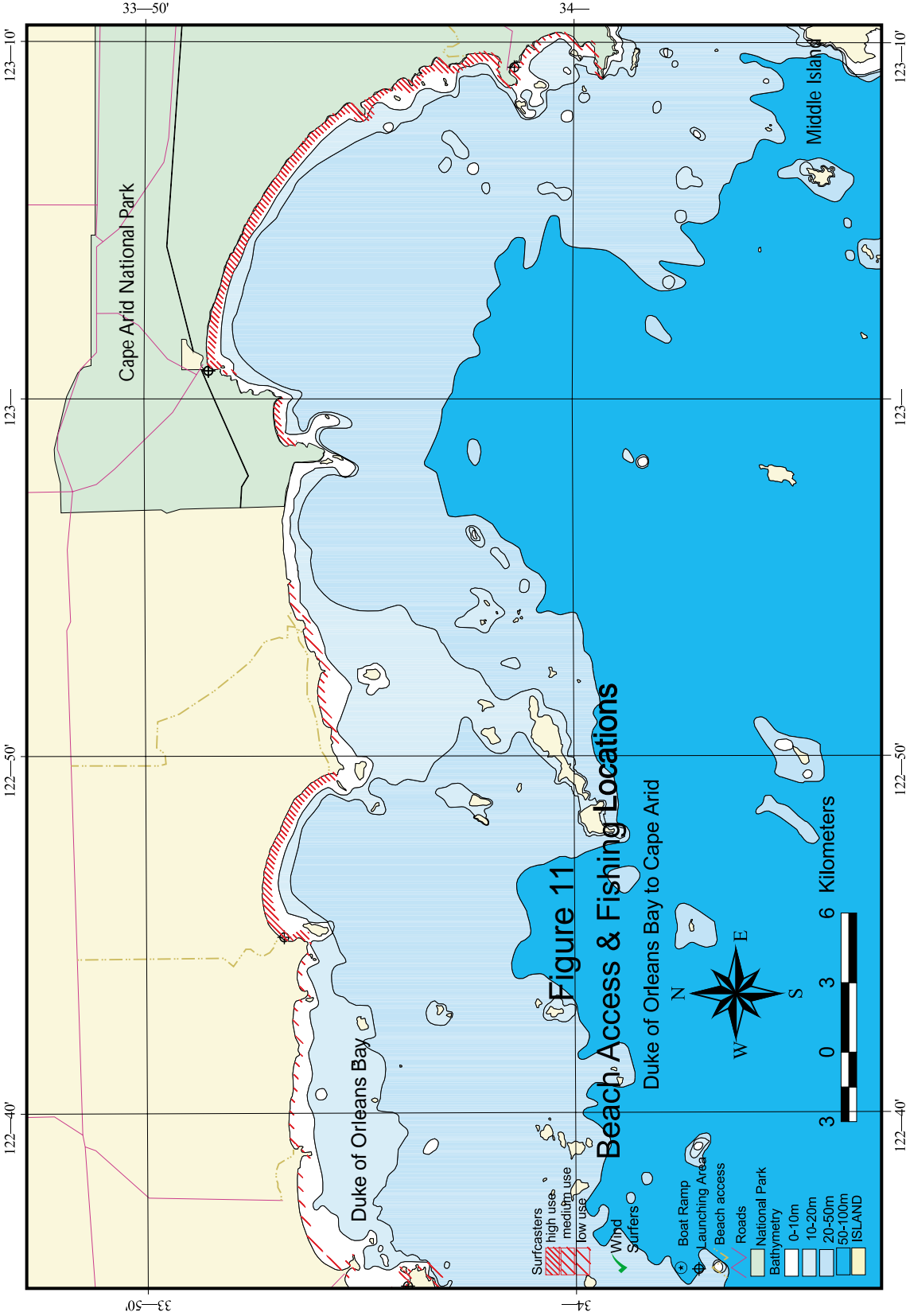


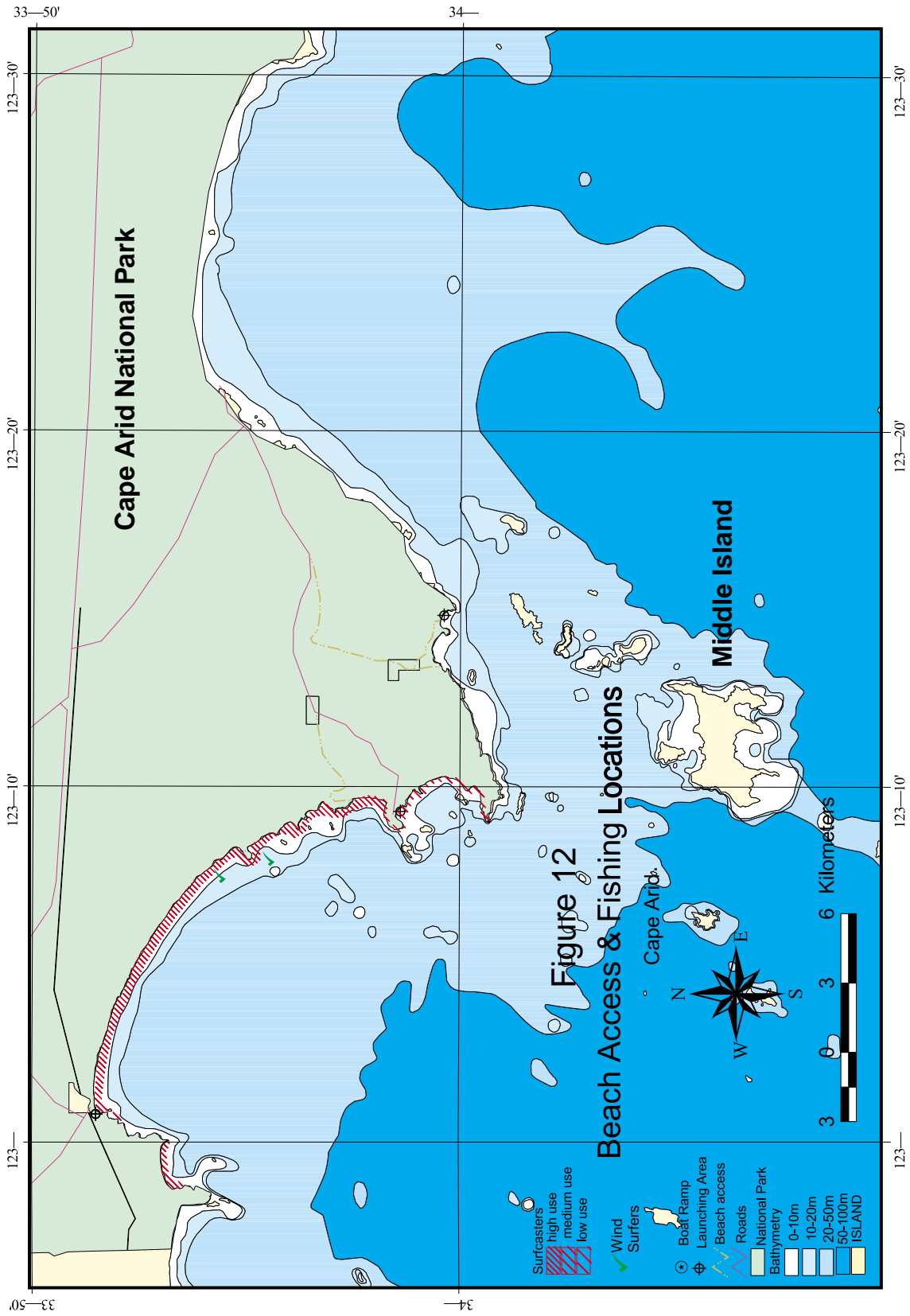




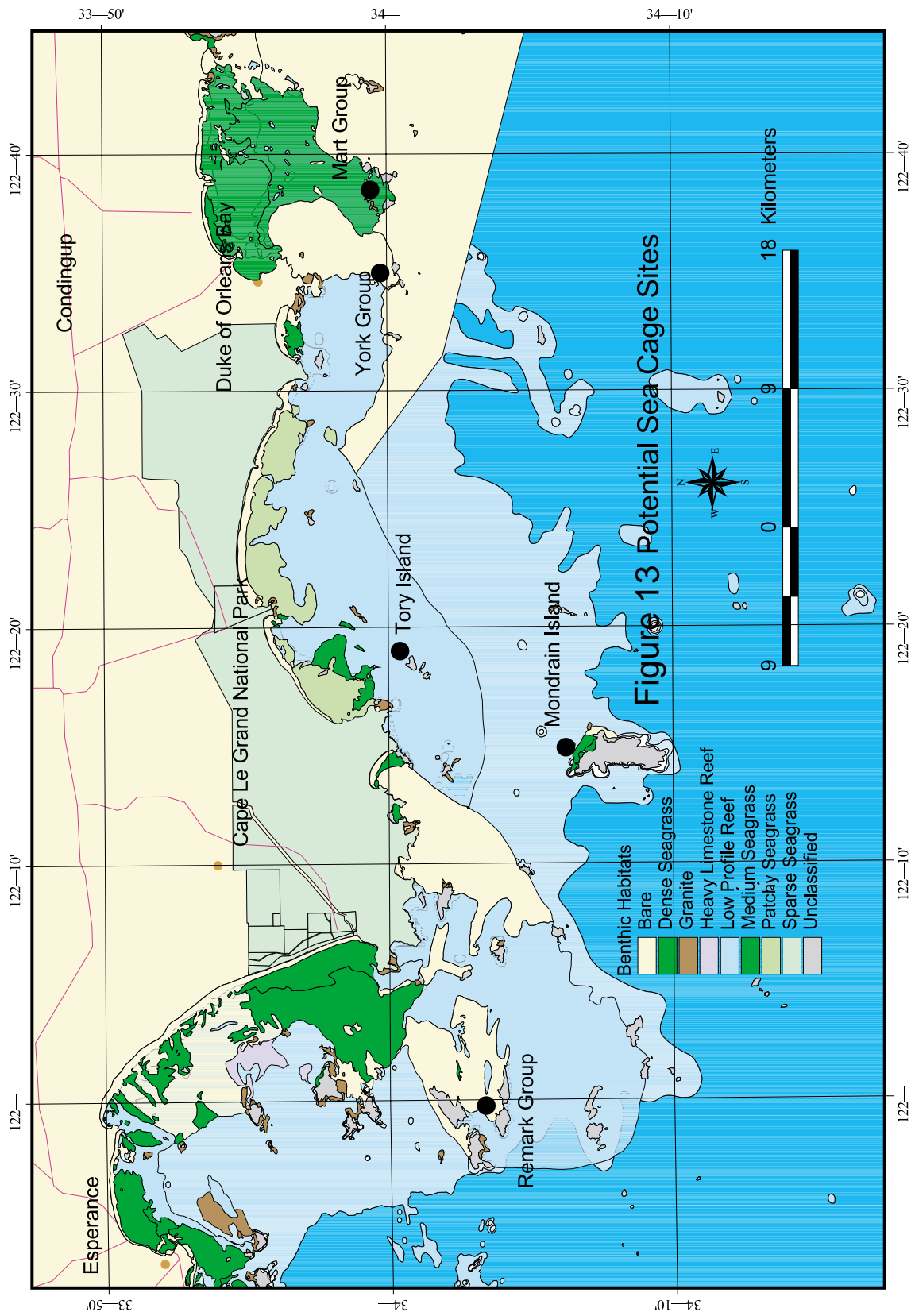














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- No. 118** Plan for the Management of the Houtman Abrolhos Islands Fish Habitat Protection Area (Schedule 1)
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- No. 120** Draft Management Plan for Sustainable Tourism at the Houtman Abrolhos Islands. Prepared by LeProvost, Dames and Moore for the Abrolhos Islands Management Advisory Committee in conjunction with Fisheries WA. (December 1998)
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- No. 123** Future directions for the Rock Lobster Industry Advisory Committee and the Western Rock Lobster Managed Fishery. A discussion paper prepared by Kevin Donohue on behalf of the Rock Lobster Industry Advisory Committee. (December 1998)
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- No. 125** Changes to Offshore Constitutional Settlement Arrangements; North West Slope Trawl Fishery and Western Deepwater Trawl Fishery. A discussion paper by Fiona Crowe and Jane Borg (May 1999)[not published]
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