MARINE RESERVE IMPLEMENTATION:
WA SOUTH COAST & EUCLA

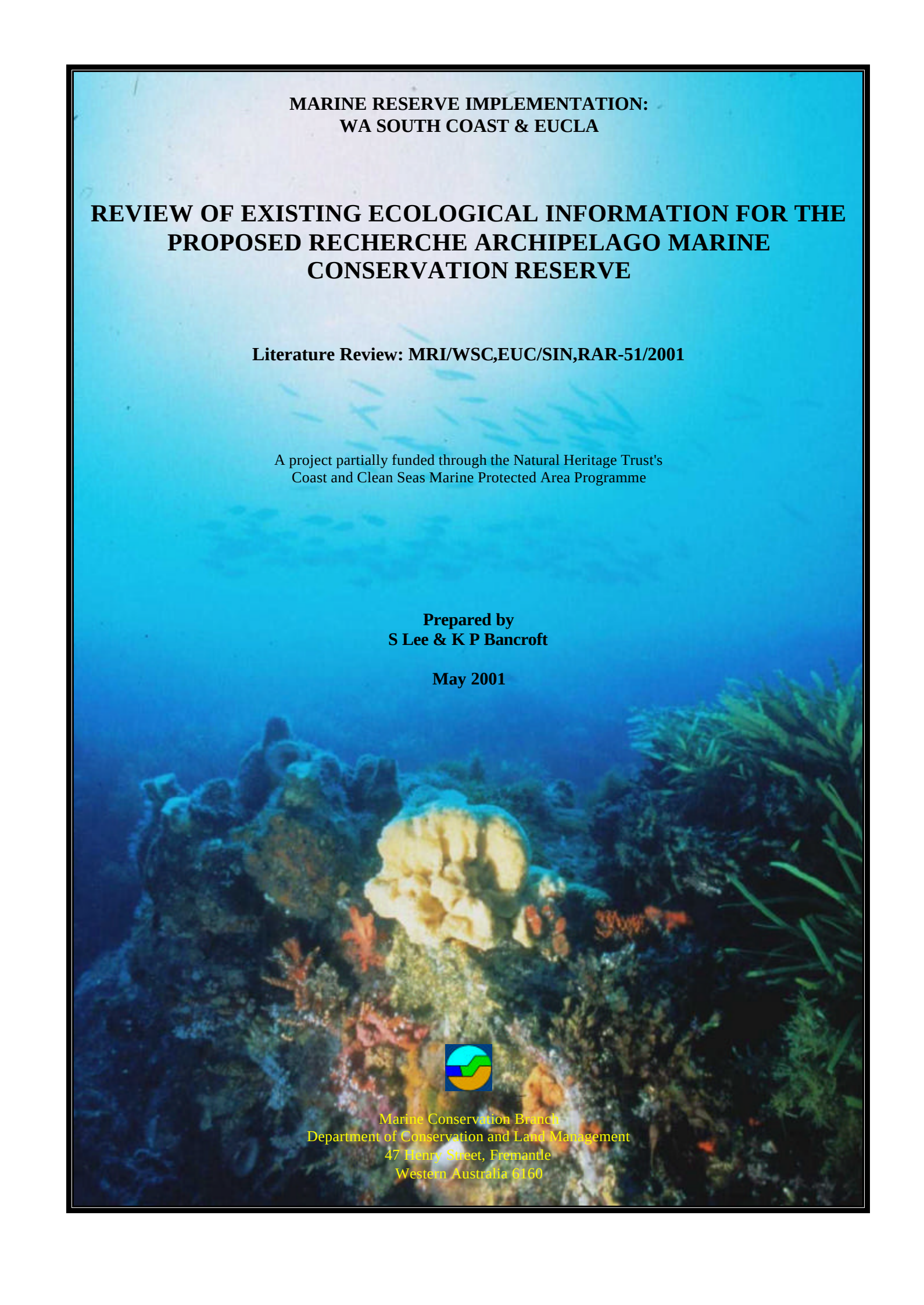
REVIEW OF EXISTING ECOLOGICAL INFORMATION FOR THE PROPOSED RECHERCHE ARCHIPELAGO MARINE CONSERVATION RESERVE

Literature Review: MRI/WSC,EUC/SIN,RAR-51/2001

A project partially funded through the Natural Heritage Trust's
Coast and Clean Seas Marine Protected Area Programme

Prepared by
S Lee & K P Bancroft

May 2001



Marine Conservation Branch
Department of Conservation and Land Management
47 Henry Street, Fremantle
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SUMMARY

In 1994, the Marine Parks and Reserves Selection Working Group (MPRSWG) recommended that the Stokes Inlet and Recherche Archipelago regions be considered for reservation as marine conservation reserves (CALM, 1994).

The MPRSWG suggested that Stokes and Torradup Inlets have high conservation values as representatives of the south coast semi-permanently closed lagoonal and riverine estuaries. Stokes Inlet supports a diverse aquatic flora and fauna, has a high scenic value, is an important element of the scenic quality of the surrounding national park and has considerable value for its recreational fishing (CALM, 1994). The MPRSWG recommended that:

> 'The State coastal waters adjacent to the Stokes National Park, encompassing Margaret Cove, Dunster Castle Bay and Fanny Cove, and including the tidal parts of Stokes Inlet and Torradup Inlet, be considered for reservation as a marine reserve for the purpose of conservation of flora and fauna and public recreation, and managed in conjunction with the national park.'

With regards to the Recherche Archipelago, the MPRSWG believed that the reservation of these waters could be justified on the grounds that the habitats are diverse and that added protection would be provided for the Australian sea lion, New Zealand fur seal and seabird colonies. However, with the limited information available, the MPRSWG was unable to identify parts of the Recherche Archipelago which were of high conservation value. Therefore it was concluded that the selection of specific areas would be unwise and that the reservation of the entire area as a multiple use marine reserve was warranted (CALM, 1994). Accordingly the MPRSWG recommended 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 conservation of flora and public recreation.'

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

> '….extensive assessment, community consultation and management planning before a new marine conservation reserve can be established'.

An essential component of this being:

> 'A comprehensive assessment of the area's biological and economic resources and social values being carried out'.

Consequently this review partially addresses this essential component by presenting a summary of the existing ecological information for the Stokes Inlet and Recherche Archipelago region.

The information for this review has been predominantly complied from literature searches, published material, CALM data and anecdotal information.

This review collates the information available for benthic habitats, marine flora and fauna, estuaries, coastal wetlands and coastal terrestrial biota. It highlights the gaps in ecological information, particularly:

1. The poor coverage of the existing benthic habitat mapping, and;
2. The lack of information on the abundance and distribution of marine flora and fauna found within the study area.

This review will be utilised as a resource document for the planning process in the implementation of the proposed Stokes Inlet and Recherche Archipelago marine conservation reserve.

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1 INTRODUCTION

1.1 OVERVIEW

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

The State's vesting body for marine conservation reserves is the Marine Parks and Reserves Authority (MPRA) which was established in 1997. The MPRA has prioritised the candidate areas for implementation as marine conservation reserves. The Stokes Inlet and Recherche Archipelago region is listed as a second tier priority area.

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

> 'Extensive assessment, community consultation and management planning before a new marine conservation reserve can be established'.

An essential component of this being:

> 'A comprehensive assessment of the area's biological and economic resources and social values being carried out'.

Funding for this project was supplied by grants from the Natural Heritage Trust, Coast and Clean Seas Program and the Marine Protected Area Program (MPAP) in order to establish a marine protected area in the Stokes Inlet and Recherche Archipelago regions.

This review contributes to the project by presenting a broad summary of existing ecological information for the Stokes Inlet and Recherche Archipelago region. It presents a general description of the physical characteristics and summarises the biological resources of the region. The review collates information available for benthic habitats, marine flora and fauna, estuaries, coastal wetlands and coastal terrestrial biota. The information for this review has been predominantly complied from literature searches, published material, CALM data and anecdotal information.

1.2 STUDY AREA

The study area for this review incorporates the marine and estuarine waters from Stokes Inlet to Israelite Bay (Figure 1). This represents 478km of coastline, which incorporates pristine beaches, headlands, sheltered bays, islands and estuaries. This study area includes the Marine Parks and Reserves Selection Working Group (MPRSWG) recommended areas of Stokes Inlet and Recherche Archipelago (CALM, 1994).

The Recherche Archipelago is a large chain of 105 islands and 1500 islets that extends for over 230km (linear distance), from Figure of Eight Island, west of Esperance, to Spindle Island off Israelite Bay (between longitude 121°30'E and 124°15'E). The southernmost islands are Termination and Salisbury Islands, which lie near the edge of the continental shelf, approximately 60km from the coastline.

Pieter Nuyts first discovered the Archipelago of the Recherche in January 1627, aboard the Dutch vessel *Gulde Zeepaard*. The next visit to the Archipelago was not until October 1791 during the passage of Captain George Vancouver in the ship *Discovery* (Bechervaise, 1954). Both of these captains however, did not name the Archipelago and it was not until a year later, that the French Rear-Admiral Bruny D'Entrecasteaux arrived in the command of two vessels, *La Recherche* and *L'Esperance*, and named the islands L'Archipel de la Recherche. Initial exploration and charting, of the Recherche Archipelago was undertaken in 1802 by Matthew Flinders as he charted the Australian coastline aboard the HMS *Investigator* (Jacob & Vellios, 1987).

All of the islands are nature reserves and are predominantly inaccessible because of the steep dome-shaped sides of the islands and the heavy seas and swells of the surrounding water. Only two islands, Sandy Hook and Middle, have beaches with relatively easy access, and one, Woody Island in Esperance Bay, has accommodation and ecotourism facilities. Many of the islands and islets have seabird rookeries as well as Australian sea lion and New Zealand fur seal haul-out and breeding sites. 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 is relatively unknown.

The coastline of the Recherche Archipelago is a rugged, high-energy coast, with spectacular white beaches between headlands dominated by dome-shaped granite hills and mountains (Fisheries WA, 1999). More than half the coastline is included within 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 wind blown dunes backing on to cleared agricultural lands of the Esperance Coastal Plain and Sandplains (Fisheries WA, 1999). Several small creeks and rivers arise in the sandplain and flow to lakes and interdunal lagoons near the coast, some of which 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 (Fisheries WA, 1999).

1.3 CLIMATE

The Stokes Inlet and Recherche Archipelago region experiences a Mediterranean climate, with hot, dry summers and cool, wet winters. The mean annual rainfall is 623mm with 50% of rainfall occurring between May and August, and the average annual evaporation is greatest during the summer months and is approximately about 1600mM. The 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 (Fisheries WA, 1999).

The dominant wind direction in summer is from the SE and the afternoon sea breezes usually occur from October to March. In January and February, over 25% of sea breezes exceed 30 km/h. During winter, SW winds frequently prevail and NW storm events occur, with calmer periods between fronts. Periods of calm are few, but may occur in autumn and winter (Fisheries WA, 1999).

1.4 COASTAL GEOLOGY AND GEOMORPHOLOGY

The coastal region associated with the Stokes Inlet and Recherche Archipelago region lies on the southern margin of the Yilgarn Craton. This region is fringed by the Albany-Frazer Orogen, a zone of intense Proterozoic tectonic activity, which is characterised by granites and high-grade gneisses with some doleritic intrusions and very uneven landforms (Myers, 1990). High points of the Proterozoic land surface form hills inlands, high headlands at the coast, and islands offshore.

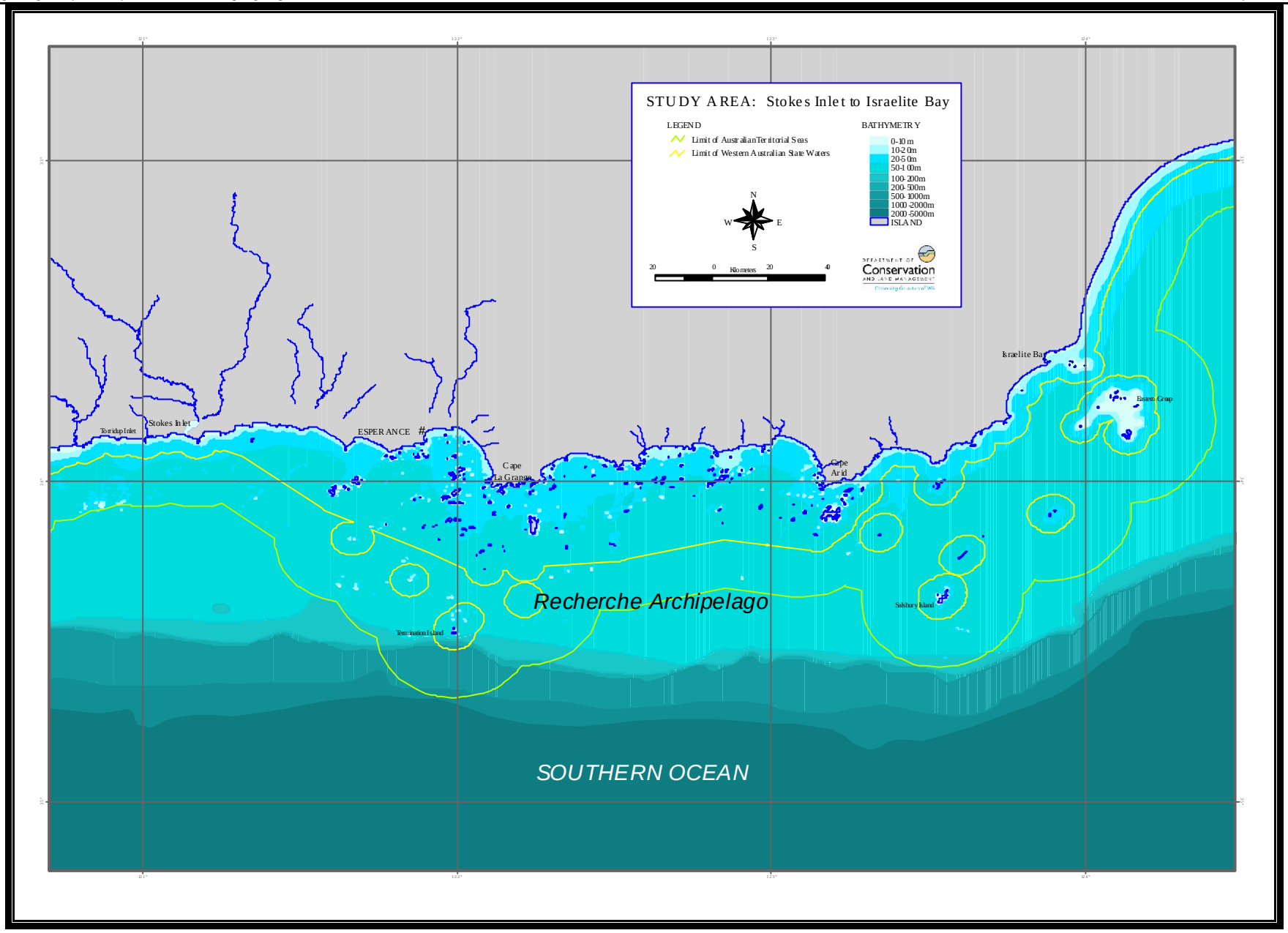

Figure 1. Study area: Recherche Archipelago (Stokes Inlet to Israelite Bay).

Inland, depressions in the ancient land surface are filled by flat-lying Eocene sediments, but at the coast there are fringes of Pleistocene aeolanites and Holocene dunes between granitic or gneissic headlands (CALM, 1994).

The result of these structures is a ruggedly scenic coastline characterised by a repeated pattern of long, arcuate sandy beach backed by dunes (some of which are mobile) located between high, cliffed granitic, doleritic or meta-sedimentary headlands (CALM, 1994). The headlands, many of which are over 300 m high, are often multiple with small lunate bays and beaches between the projecting units. The most exposed parts of the headlands, facing south and southwest, are either cliffed or fronted by steep slopes, which are swept by swell surge. The south-eastern sides of the headlands, adjacent to the next wide bay and beach, are exposed to lesser wave action and tend to have granitic or gneissic boulder fields along the shore (CALM, 1994).

Between Esperance and Israelite Bay, much of the Proterozoic land surface of the Orogen lies below present sea level so that its high points form the Recherche Archipelago of granitic and gneissic islands (CALM, 1994). Similar, but smaller islands also occur along the whole of this shore (CALM, 1994).

As well as active dune fields backing the long arcuate beaches, there are frequently perched dunes on the Proterozoic headlands. In many places, older perched dunes have consolidated and formed aeolianite limestones as a fringe or rim above the Proterozoic rocks (CALM, 1994). In a few cases, the aeolianites have considerable thickness and extend down to sea level where they are eroded to form limestone rock platforms between high and low tide levels. Limestone also forms as beach rock below the surface along many of the long beaches (CALM, 1994). Frequently, the beach rock surfaces are exposed by erosion and from intertidal rock platforms, especially at the eastern ends of the beaches. Limestone shore, presumably of this origin, are a notable feature of the coast between Hopetoun and Esperance (CALM, 1994). In that area there are a series of narrow limestone reefs paralleling the shore, apparently representing different positions of the shore at periods of different sea level during the Pleistocene and Holocene.

Therefore, the open rocky shores of this region provide a variety of habitats for marine plants and animals, including the wave-swept granitic and gneissic slopes of the headlands, the boulder fields and pools of the less exposed sides of the headlands, and the limestone rock platforms and reefs (CALM, 1994). Commonly, the headland shores are ‘steep to’, dropping off steeply into relatively deep water, and meeting the sandy sea floor at depths of 20-30 M. Vertical sublittoral rock walls are also common. Offshore, granitic and gneissic reefs are very common and these too usually have steep or even vertical walls (CALM, 1994). Along jointing cracks and doleritic intrusions, erosion often forms precipitous underwater canyons.

The beaches in this region are exposed to heavy surf and are generally of coarse-grained sand (CALM, 1994). They provide suitable habitat for only a few specialised plants and animals. Intertidal sand flats occur only in protected corners and are never very extensive (CALM, 1994). The wide bays tend to slope gently from the surf zone into the sublittoral and there is usually development of seagrass beds beyond the action of the surf.

1.5 DRAINAGE AND GROUNDWATER

The major estuaries located within the study area are: Torradup Estuary; Stokes Inlet; Barker Inlet; Bandy Creek Inlet; Mungliginup Inlet; Alexander River Inlet; Blackboy Creek Inlet; Thomas River Inlet; Jorndee Creek Inlet, and; Poison and Fern Creeks. These estuaries are discussed in greater detail in the ‘Estuaries’ section.

The area to the east of Esperance has a low average annual rainfall (range of 450-600 mm along the coastal strip) which declines rapidly northwards (Bancroft *et al.*,1997). The streams of this area are

small and ephemeral, with most of their catchment in the coastal plain, which is in some areas up to 40km wide. In most cases, the catchments have recently been substantially cleared for agriculture subsequently putting stream pools and inlets at risk from salinity, sedimentation and eutrophication (Hodgkin & Clark, 1989). The catchments of the Thomas, Jorndee, Poison and Fern creeks lie mostly in the Cape Arid National Park (Hodgkin & Clark, 1989; SCRAP & SCRIPT, 1997a; Bancroft *et al.*, 1997).

Similarly, the area to the west of Esperance is a low rainfall region (around 350-500mm per annum) (Bancroft *et al.*, 1997). All of the river catchments have recently (1950s) been significantly cleared (around 50%) for agriculture and are therefore at risk from salinity, sedimentation and eutrophication. The larger catchments of the Esperance region (the Jerdacuttup, Oldfield, Young and Lort Rivers - some of which extend inland for about 100km) drain marginal wheatbelt broadacre farms. The Barker and Torradup Rivers have smaller catchments which lie within the coastal plain (SCRAP & SCRIPT, 1997a).

Most of the ground water in the area is saline, but in specific areas is fresh to brackish and suitable for town water supplies and watering stock (Johnson & Baddock, 1998). Fresh groundwater is restricted to the coastal areas with significant potable resources within the Quaternary coastal sediments. There are large brackish to saline groundwater resources within the Tertiary sedimentary aquifers, suitable for stock watering, with the least saline groundwater present in the higher rainfall areas of the south and localised beneath catchment divides. Small ground water supplies perched above the regional watertable, and seasonal in occurrence, may be found sporadically throughout the sandplain.

1.6 OCEANOGRAPHY

Offshore, the sea floor is relatively flat with an average depth of 40 M. The islands rise steeply from the sea floor and only two, Sandy Hook and Mondrain Islands, have beaches which permit easy landing (Fisheries WA, 1999). The continental shelf is approximately 70 km from the coast. The outer islands, near the edge of the shelf, rise from about 70 m depth (Fisheries WA, 1999).

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. Although, this coverage does not have the same degree of accuracy as the standard charts published by the Australian Hydrographic Service, R.A.N. Many parts of the Recherche Archipelago are shown as 'unsurveyed' or 'inadequately surveyed' on these charts.

The Recherche Archipelago is affected by a strong, relatively consistent swell from the SW for most of the year. These swells can be reinforced by wind generated waves, producing a net eastward littoral drift along the south coast (Fisheries WA, 1999).

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 (Fisheries WA, 1999). It is characterised by strong thermal fronts as the tropical water borders cooler Southern Ocean waters. Between October and March, a nearshore current called the Capes Current (Pearse & Pattiaratchi, 1997), flows westward long 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 (Fisheries WA, 1999).

Within the Recherche Archipelago, little is known of current movements. Tides are diurnal and the maximum spring tidal range is 1.1 M. While some tidal currents may be experienced locally between islands or other constrictions, tidal currents are likely to be insignificant compared with currents generated by the wind. Current velocities near the seabed are likely to be significantly lower than at the surface (Fisheries WA, 1999).

Some modelling of waves and currents has been undertaken by the University of Western Australia's Centre for Water Research in connection with recent proposal by Fisheries Western Australia, to establish tuna farming in Esperance bay (Fisheries WA, 1998).

The waters off the Recherche Archipelago are known to have low nutrient status, in common with other oceanic waters of the South West of WA, however, no records were found. Sea temperatures range from 14°C in winter to 21°C in summer. The surface temperature in the Remark Island group was 19°C on the 25 January 1999 (Fisheries WA, 1999).

A more extensive review of the oceanography of the study area is currently being undertaken by CALM (van Hazel, in prep.).

2 WATER QUALITY

There is very little information available to describe the quality of the waters found within the study area. The only water quality data found was related to a preliminary survey of the impacts of the Sanko Harvest spill (Kinhill, 1991b). A synopsis of this disaster is provided in Section 9.

Physio-chemical parameters measured during this survey included:

- temperature,
- conductivity,
- dissolved oxygen,
- pH,
- light attenuation,
- Chlorophyll-a
- nutrients (orthophosphate, total phosphates, organic phosphorus, ammonia-ammonium nitrogen, nitrate-nitrite nitrogen, total kjeldhal nitrogen & organic nitrogen),
- fluoride, and
- metallic elements (cadmium, chromium, nickel, lead, zinc & arsenic).

Results from this study suggested that the background level for chlorophyll-a was 0.5ìg/L, <1ìg/L for orthophosphate, <1ìg/L for ammonia-ammonium nitrogen, and 3-75ìg/L for nitrate-nitrite nitrogen (Kinhill, 1991b). These levels and the high water clarity indicate that the oceanic waters of the Recherche Archipelago are oligotrophic.

Possible threats to the water quality of the region would include nutrient enrichment from estuarine discharges and accidental spills and dredging spoils associated with the Port of Esperance activities.

3 ECOLOGICAL COMMUNITIES

3.1 BIOGEOGRAPHY

The temperate waters of the southern coast of Australia are recognised as a major biogeographic region, the Flindersian Province, which extends from southwest Western Australia to southern New South Wales (Edyvane & Baker, 1996). This broad biogeographic regionalisation is largely based on sea temperature, with the coastal waters varying from warm-to-cool temperate along Western

Australia's south coast and in the Great Australian Bight, to cold temperate east of Robe in South Australia (Poore, 1995). The Flindersian Province is characterised by very high levels of marine biodiversity and endemicity, which is partly a result of the long east-west extent of the southern coastline and a long period of geological isolation (Poore, 1995; Edyvane, 1996). The diversity of marine flora is particularly high, as is the diversity of invertebrate taxa such as bryozoans, ascidians, molluscs and echinoderms (Womersley, 1990; Shepherd, 1991; Poore, 1995). Approximately 1,155 species of macroalgae, 22 species of seagrasses, 600 species of fishes, 110 species of echinoderms and 189 species of ascidians have been recorded in the Flindersian Province (Wilson & Allen, 1987; Womersley, 1990; Shepherd, 1991). Another feature of this province is the very high levels of endemicity, with approximately 85% of fishes, 95% of molluscs and 90% of echinoderms being endemic (Poore, 1995). The marine macroalgal diversity of the Flindersian Province is among the highest in the world, with over 800 species and 75% endemism in the red algae alone (Womersley, 1990).

Since 1995, the Commonwealth Government has provided funding for a project to provide a single, ecosystem-level regionalisation of Australia's coastal and marine environments. This project, known as the '*Interim Marine and Coastal Regionalisation of Australia'* (IMCRA), is coordinated by Environment Australia (Biodiversity Group). IMCRA uses a hierarchical structure to provide information and identify bioregions at two different levels, continental (provinces) and regional (meso-scale regions) (IMCRA, 1997). The study area is encompassed within the WA South Coast (WSC) IMCRA (Version 3.1) region, which extends from Black Head in the west to Israelite Bay in the east.

IMCRA (Version 3.1) also provides two provincial-scale regionalisations for continental shelf waters, based on classifications of demersal and pelagic fish species diversity and richness, the Demersal Provinces and Biotones Regionalisation and the Pelagic Provinces and Biotones (IMCRA, 1997). The study area is encompassed within the South Western Province (SWP) of the Demersal Provinces and Biotones, with Israelite Bay on the eastern boundary line of this province. According to the Pelagic Provinces and Biotones regionalisation, the study area falls into the Southern Pelagic Province (SPP).

3.2 BROADSCALE MARINE ECOLOGICAL COMMUNITIES

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, 1997). The maps were prepared using the blue band or band 1 of the Landsat TM satellite (Everall, 1999a).

Ground truthing of 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 (Everall, 1999a). Currently the ground truth of a particular area is about 80% accurate. Further ground truthing was undertaken near Mondrain Island during a voyage of the STS *Leeuwin* in February 1998, using drop down TV (Colman, 1997). Additional information from Dr Kirkman's field notes for surveys of the south coast, including GPS positions of ground-truthing sites, records of seagrass and macroalgal species, water depth and codes for predicted and actual benthic habitat category, was used during this survey.

A broadscale map developed by Kirkman (1997) showing the marine benthic habitats of the Recherche Archipelago study area is presented in Figure 2.

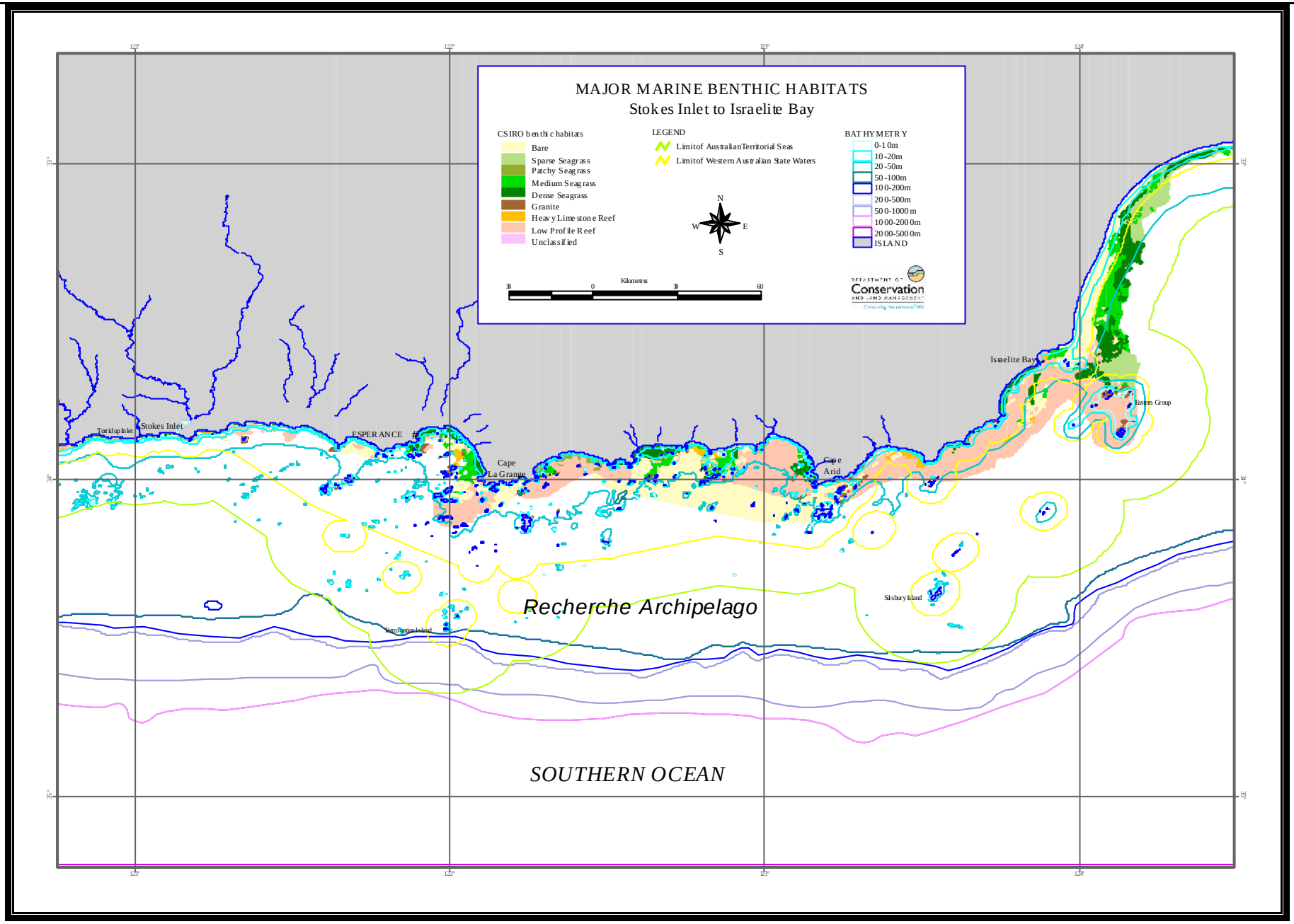

Figure 2. A broadscale map developed by Kirkman (1997) showing the marine benthic habitats of the Recherche Archipelago study area.

4 MARINE AND COASTAL FAUNA

4.1 MARINE MAMMALS

4.1.1 Cetaceans

A total of 35 cetacean species have been recorded off the Western Australian coast. This number is more than 80% of the total number of cetaceans that are found in Australian waters. Australia's government policy regarding the preservation and protection of cetaceans is embodied in the *Whale Protection Act 1980* (CALM, 1997). The Act prohibits the killing, injuring, capturing or harassment of cetaceans within the Australian Fishing Zone, from 3 nautical miles offshore to the 200 nautical mile limit. State regulation is enforced within 3 nautical miles of the shoreline (Kaufman *et al.*, 1993).

Whales

Since European settlement in Western Australia, two species of whales have been historically significant (CALM, 1997). These two species, the southern right whale (*Eubalaena australis*) and the humpback whale (*Megaptera novaeangliae*) are both baleen whales, which feed almost exclusively on small shrimps (krill) close to the sea surface (CALM, 1997). They gather their food by simply sieving seawater through a set of fringed horny plates known as baleen (Bannister, 1994a,b & c). Both southern right whales and humpback whales are listed as '*Fauna that is rare or likely to become extinct*' under the Australian Wildlife Conservation (Specially Protected Fauna) Notice 1998. Although, since the cessation of commercial whaling, both species appear to be recovering from their once perilously low numbers (Bannister, 1978; 1986; 1990; 1994a; 1995).

Humpback whale

The humpback breeding population off Western Australia (Southern Hemisphere Group IV), is one of three different populations in the Australasian region (CALM, 1997). This population is both behaviourally and genetically different from the Eastern Australian and New Zealand populations. Western Australian humpback whales exhibit different calling songs and in general are not as closely related to the other Southern Hemisphere breeding populations as their eastern counterparts are.

Once fully grown, humpback whales are approximately 16 m in length and weigh about 45 tonnes (CALM, 1997). This species has an average life span of more than 50 years, and as with all baleen whales, the females are slightly larger than the males. Humpback whales both mate and give birth in tropical breeding grounds. The gestation period lasts approximately eleven months, and once born the calves are weaned for a further eleven months (CALM, 1997). Unlike other whale species, the humpback's flippers are long and oar-like and can be up to one third of the body length. These flippers are remarkably mobile and may be used to row the animal through the water, sometimes waving about at the surface. This species' blow is distinctive, rising in a single busy cloud that can reach heights of 3M. When migrating, the whale will blow once every minute, for approximately five minutes, and will then dive for 15 minutes. The humpback whale has a distinctive behaviour-they can breach clear of the water, 'lobtail' where their tail or flipper slaps the water and 'spyhop' where they bring their head out of the water and look around (CALM, 1997).

Humpback whales would appear to spend a considerable amount of their time migrating between their summer feeding and their winter breeding grounds. The feeding grounds are located in the krill-rich waters of Antarctica, where the whales stay from approximately December to February, whereas the breeding grounds are in the warm, tropical waters off northern Western Australia, where the whales stay from about June to August. Humpback whales are commonly seen as they pass by the Recherche

Archipelago and Stokes Inlet region during their migrations between the southern feeding grounds and the northern breeding grounds.

In 1963, the Southern Hemisphere Group IV humpback whale population was estimated at approximately 600 individuals. Following numerous sightings in 1976, series of aerial surveys were initiated in the Shark Bay breeding ground (CALM, 1997). A 1994 report on these aerial surveys estimated the humpback population to comprise of about 3,000 individuals-a 20% increase over 31 years. Photoidentification of individuals has been performed since 1982 to provide information on stock identity, migrations, distribution and reproductive biology of identified animals (CALM, 1997).

Southern right whale

The southern right whale received its name during whaling as it was known to be the 'right' whale to catch, as it was easily approached in open boats, did not sink when dead, and had greater quantities of oil and whale bone (CALM, 1997). This species is bulky and slow moving, it grows up to 17.5 m long and weighs around 80 tonnes. Females are sexually mature at 9 to 10 years and have one calf approximately every 3 years. Southern right whales, like other baleen whales, are presumed to live up to 50 years or more (CALM, 1997). They feed in colder waters and migrate to warmer waters, but their movements are not as large scale or well defined as for humpback whales. In winter and spring they can be found close inshore along the coast of southern Australia (CALM, 1997). The females use sheltered bays as birthing and nursery areas, and cows with calves may often be seen very close to shore in August and October (CALM, 1994). Southern right whales can often be seen between Albany in Western Australia and Ceduna in South Australia, with many localities recently becoming popular 'whale watch' sites (CALM, 1997).

Southern right whales are easy to identify as they have no dorsal fin and they have a very distinctive V-shaped blow. Also they have a series of whitish wort-like excrescences, known as callosities, on the top of the head, near the eyes and along the lower jaws (CALM, 1997). A monitoring program of the southern right whale, which began in 1978, has shown a steady increase in the South Coast population of this animal (Bannister, *pers. comm.*). The highest number of southern rights seen in 1993 was 182 animals, including 63 cows. Between Cape Leeuwin and Twilight Cove, there were 128 animals with 39 cow-calf pairs (Bannister, 1994a). Between 1977 and 1993, the increase rate of the southern right whales in Western Australia was averaging 10% per year (Bannister, 1994a). However, despite these encouraging results, the numbers of animals in the population are still very small, perhaps no more than 800, with the total number of Southern right whales in the Southern Hemisphere may not yet be more the 3-4,000 (CALM, 1997).

Dolphins

Common dolphin

Common dolphins (*Delphinus delphis*) have an hourglass pattern of light grey and tan or yellow on their sides and a dark stripe from flipper to lower jaw, with a long, well-defined, black beak. They have a prominent triangular dorsal fin, pointed flippers and a slender, streamlined body. Average length varies according to the location, but is approximately 2M. This species are predominantly offshore inhabitants and are one of the world's most abundant dolphin species.

Bottlenose dolphin

Bottlenose dolphins (*Tursiops trancatus*) have prominent dorsal fins, which are seen slicing through the water. The fin is slightly hooked and set midway along the body. The species has a medium grey back above a pale or lighter grey flank. The flippers are broad at the base and taper to a point. They are variable in size, ranging from 2 to 4m as an adult. This species is commonly found within the study area. It is often seen close inshore in estuaries as well as offshore.

In 1994, a study was carried out on the level of heavy metals and organochlorine in marine mammals in Australia (Kemper, 1994). The research found that adult bottlenose dolphins inhabiting the inshore gulfs of South Australia had considerably higher levels of cadmium compared with other regions (CALM, 1997). Although information of organochlorine levels was sparse, with only approximately 39 specimens investigated, the results suggested low levels of organochlorine in Australia when compared to other parts of the world (Kemper, 1994).

Cetacean strandings

CALM Wildlife Officers from the Albany and Esperance Districts, from 1984 to 1996 have recorded a number of cetacean strandings and sightings across the south coast region. These are listed in Appendices 1 and 2. No data is available for recent years, as strandings are no longer recorded.

Other cetaceans

Of the 38 species of whales and dolphins recorded in Western Australia, 27 occur, or could reasonably be expected to do so, off the south coast (CALM, 1997). By far, the majority of these are oceanic animals which are widely distributed and not truly coastal (Appendix 3).

Recommendations

Protection could be afforded by the creation of a multiple-use marine reserve that incorporates significant coastal habitat for both the Southern right whale and the Humpback whale. The importance of the Stokes Inlet and Recherche Archipelago sections, as significant coastal habitat for cetacean species has not as yet been identified. However, it should be noted that southern right whales and humpback whales (among other cetacean species) frequent such areas.

4.1.2 Pinnipeds

Two species of pinniped use the islands of the south coast as resting and breeding sites (CALM, 1994). These are the Australia sea lion (*Neophoca cinerea*) and the New Zealand fur seal (*Arctocephalus forsteri*) (CALM, 1994). The Australian sea lion is considered to be *Lower Risk, near threatened* because the number of mature individuals is below the limit of 10,000. The New Zealand fur seal and the Australian fur seal are considered to be *Lower Risk, conservation dependent.* This is because the cessation of a 'habitat-specific conservation program' could lead to each of them qualifying for a threatened category if ready access by humans to breeding sites were permitted during the breeding season (Shaughnessy, 1999). Both are classified as *'specially protected fauna'* under the *Western Australian Wildlife Conservation Act* (1950). Islands within the study area that are associated with pinniped activity are shown in Figure 3.

Australian sea lion

The Australian sea lion (*Neophoca cinerea*) is one of Australia's most endangered marine mammals, and one of the rarest and most endangered pinnipeds in the world (Gales, 1990). As one of our very few native marine mammals, *N. cinerea* is a high profile species, which is the basis for a growing tourist industry. The Australian sea lion is restricted to the south and south-western coasts of Australia, from Houtman Abrolhos (28°S, 114°E) in Western Australia to just east of Kangaroo Island in South Australia (36°S, 138°E). Prior to commercial sealing in the nineteenth century, the range extended eastwards to the Bass Strait. The majority of the Western Australian population's breeding and haul-out sites are located within the Stokes Inlet and Recherche Archipelago section (Appendix 4). Although, the sea lions are fully protected in Australia and as far as known, the population is stable (but small) it is rather vulnerable to chance hazards (Bonner, 1994).

In 1953, an expedition to the Recherche Archipelago discovered Australian sea lions on several of the islands including Round, Kermadec, and Salisbury (Seventy, 1953a). A review of past and present distribution and status of sea lions and fur seals in Western Australia was carried out in 1979 (Abbott, 1979). It was found that when comparing the distribution and abundance of seals in Western Australia from accounts made by early navigators and colonists with records from survey in 1874-75, that the Australian sea lion population had only declined in abundance not distribution (CALM, 1997). In 1979, the total population size of Australian sea lions in Western Australia was estimated to be approximately 700 individuals (Abbott, 1979).

A survey, carried out in 1989-1990, established the abundance of Australian sea lions in Western Australia (Gales, 1990). A total of 13 islands along the south coast were found to support breeding populations, and a further 16 islands were listed as possible breeding sites (CALM, 1997). An estimate of the total number of pups born on south coast islands confirmed as breeding sites was 429. In 1989/1990, the estimate for total population size in Western Australia was 3,100.

Gales *et al.* (1994) produced a summary report on the distribution, abundance and breeding cycle of the Australian sea lion. Surveys were conducted throughout the sea lion's range between December 1987 and February 1992, and sea lions were found to breed on at least 50 islands, 27 in Western Australia and 23 in South Australia (Appendix 5). Of the 50 breeding sites, 31 had not been reported previously. A total of 1,941 pups were counted and pup production was estimated at 2,432 (CALM, 1997).

Although there is a clear pattern of site selection for pupping on the south coast, an important criterion is the existence of protected shallow pools in which the pups congregate and presumably learn to swim (Bennet, 1996/97). Australian sea lions breed on at least 27 islands in Western Australia (CALM, 1997). The shallow, on-shelf waters frequented by the sea lions, yield an unlimited diet of crayfish, squid, cuttlefish, octopus, small shark and fish. Sea lions may be exercising adaptations evolved over thousands of years to survive in one of the most nutrient poor environments in the world, each aimed at minimising the food requirements of the populations as a whole (CALM, 1997). For example, a wide distribution of small colonies minimises competition for a limited food supply (CALM, 1997). Other adaptations that may serve this survival strategy include: an 18 month breeding cycle; extended lactation and lower energy milk compared with other ottariids; a five to seven month breeding season; and an asynchronous breeding cycle (neither seasonally or geographically dependent) (CALM, 1997).

New Zealand fur seal

The New Zealand fur seal, *Arctocephalus forsteri*, was named after the German Naturalist, George Forster, who accompanied Captain Cook on his second voyage around the world. Today *A. forsteri* breed on many islands off the west coast of New Zealand and on all of the major islands and island groups to the south of New Zealand (Bonner, 1994). The species also occurs in Australia, where it ranges from about 117° to 136°E. Breeding colonies occur at the western end of Kangaroo Island, at South Neptune and Four Hummocks Islands in South Australia and at the Recherche Archipelago in Western Australia (Bonner, 1994).

The population in New Zealand and its outlying islands is estimated to be about 50,000 with another 5,000 New Zealand fur seals in Australia (Bonner, 1994). There does not seem to be any definite trend, either upwards or downwards, for these populations, but as there are no obvious pressures on these seals and as they are protected in both countries, it seems likely that they are increasing slowly. The New Zealand fur seal is believed to feed mainly on squid and barracouta at the surface at night, but it also takes octopus from the sea floor during the daytime.

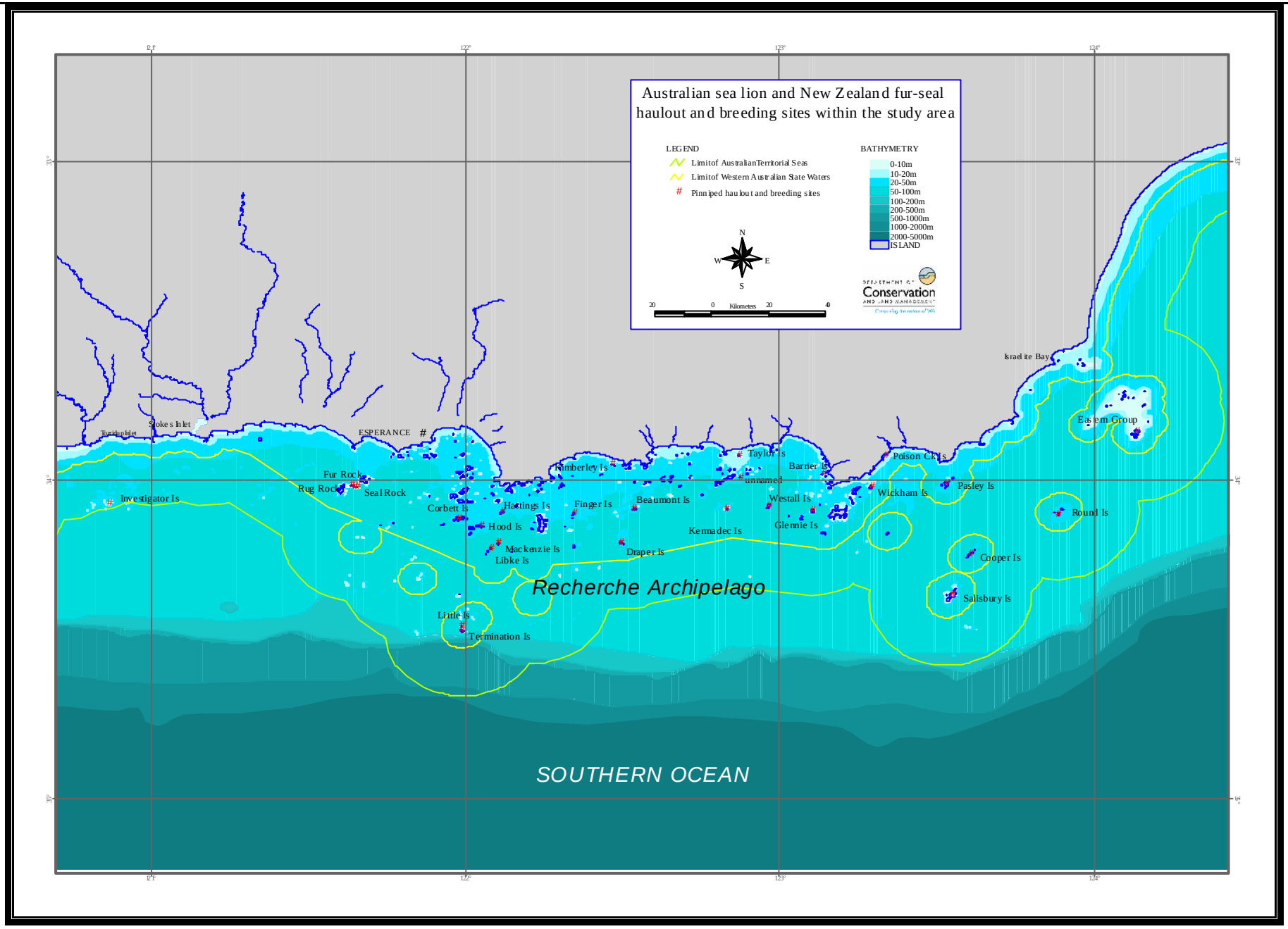

Figure 3. Pinniped activity in the Recherche Archipelago region

In 1953, an expedition to the Recherche Archipelago noted only one party of 50 adult New Zealand fur seals on Salisbury Island (Seventy, 1953a). Surveys carried out in 1974 to 1977 suggested that fur seal distribution and abundance had contracted (CALM, 1997). During this time period, the total New Zealand fur seal population of Western Australia was estimated to be 400 to 500 individuals (Abbott, 1979). In May 1979, Salisbury Island was classified as a 'Class A' reserve in the Recherche Archipelago Nature Reserve, under the Western Australian Wildlife Authority. A 1982 biological survey of the island counted 500 New Zealand fur seals, of which 70% were pups, however, the colony was estimated to consist of approximately 1, 000 animals, making it the largest known breeding colony of this species in Western Australia (CALM, 1997).

During the summer of 1989-1990, Peter Shaughnessy carried out a survey of the distribution and abundance of New Zealand fur seals from Eclipse Island near Albany across to the Eastern Group of the Recherche Archipelago (Shaughnessy, 1990). It was discovered that New Zealand fur seals haul-out on many islands and breed on a total of 13 islands (Appendix 6). Eighty-five percent of fur seals sighted during the survey were on these 13 islands and 11% were on another five important haul-out (non-breeding) islands (CALM, 1997). The population size for Western Australia was estimated to be 4,600 individuals, two thirds of which were from three major colonies (Salisbury Island, Seal Rock and Cooper Island) in the Recherche Archipelago (Shaughnessy, 1990).

Another survey was conducted in the Recherche Archipelago soon after the pupping season of summer 1990-1991 (Shaughnessy, 1991). A total of 16 islands were visited and fur seals were recorded on nine of these islands (CALM, 1997). Individual counts were made for West, Libke, Finger and Draper Islands, and the latter two islands were confirmed as breeding colonies (CALM, 1997). At Finger Island during July 1990, approximately 40 small individuals were seen which were judged to be less than one year old, a few of which were still nursing. It is more than likely that most of these individuals came from nearby colonies as the pup production on Finger Island is considerably small (CALM, 1997). Paisley Island appears to be only a haulout site (Shaughnessy, 1991).

In 1994 a survey was conducted to determine the distribution and abundance of New Zealand fur seals in South Australian and Western Australian waters (Shaughnessy *et al.*, 1994). Pups were counted and in more accessible and larger colonies, numbers of pups were estimated by a mark-recapture technique. The latter technique gave higher estimates than counting and was considered more accurate. The Western Australian survey covered islands on the south coast, from the Recherche Archipelago to islands near Cape Leeuwin (Appendices 7 & 8). There were 29 breeding localities in total, 13 in South Australia and 16 in Western Australia. Eighteen of these had not been reported previously. Estimates of the number of pups for the 1989-1990 breeding season were 5,636 in South Australia and 1,429 in Western Australia (CALM, 1997).

Diseases

Tuberculosis was diagnosed in three otariid seals found dead along the south coast of Western Australia between May 1990 and March 1991 (CALM, 1997). This indicates that tuberculosis is present in both the New Zealand fur seal and Australian sea lion populations. Since the disease has been found in these two species over a period of 10 years, it is believed that tuberculosis is endemic in these species (Cousins *et al.*, 1993).

Pinniped strandings

A number of pinniped strandings and sightings across the south coast region have been recorded by CALM Wildlife officers from the Albany and Esperance districts in the last five years (CALM, 1997). These are listed in Appendix 9.

Other pinnipeds

Of the 34 different species of pinnipeds in the world, eleven occur in the Australian and Australian Antarctic regions (King, 1988) and could be expected to be found in coastal waters along the south coast. These include :

OTARIIDAE	
Australian sea lion	*Neophoca cinerea*
New Zealand sea lion	*Phocarctos hookeri*
Australian fur seal	*Arctocephalus pusilli doriferus*
New Zealand fur seal	*Arctocephalus forsteri*
Subantarctic fur seal	*Arctocephalus tropicalis*
Antarctic fur seal	*Arctocephalus gazella*
PHOCIDAE	
Southern elephant seal	*Mirounga leonina*
Leopard seal	*Hydrurga leptonyx*
Weddell seal	*Leptonychotes weddelli*
Crab-eater seal	*Lobodon carcinophagus*
Ross seal	*Ommatophoca rossi*

Recommendations

Despite the encouraging response to the cessation of sealing, full recovery in numbers and distribution has not occurred for any previously harvested species, and new threats have displaced the commercial exploitation that caused such devastating declines in the past (Shaughnessy, 1999). In order to assess whether pinniped species would benefit from the construction of a marine conservation reserve, we must look at their habitat utilisation: terrestrial and marine component, and assess the threatening processes associated with both components

The terrestrial habitat of pinnipeds is where they come ashore to breed, moult and rest (Shaughnessy, 1999). On the Australian coast, the terrestrial habitat is largely untouched and most areas have some protection, however, human disturbance is still a threat at some island colonies, particularly during the breeding season. Most disturbances are caused as a result of visitation by:

- professional and amateur photographers;
- commercial tourism ventures (including those by the white shark viewing industry which often involved berleying to attract predators);
- private boat owners;
- inappropriately timed servicing of navigational aid equipment by the Australian Maritime Safety Authority (AMSA), and;
- scientists.

(Shaughnessy, 1999)

Harassment can also occur at haul-out sites, where seals have been shot or taken for bait. Low-flying aircraft, particularly helicopters, can also disturb seals. Such disturbances during the breeding season could result in seal numbers falling rapidly as disturbances can lead to increases in pup mortality. For this reason, pinniped breeding colonies and haul-out sites should be considered as 'critical habitat'.

The other major habitat component of seals is the sea, where they feed and spend a large proportion of their life (Shaughnessy, 1999). In Australia, the waters adjacent to fur seal and sea lion breeding colonies can be termed 'critical habitat' in the sense that they are traversed frequently (particularly by mothers at the beginning and end of each feeding bout), and are used by pinnipeds for resting, feeding and refuge when their colonies are disturbed (Shaughnessy, 1999). Furthermore, pinnipeds in Australian mainland waters are at times attracted to fishing vessels and to fishing nets as opportunistic food sources, and often suffer as a consequence (for example, there is a high frequency of observations

of entangled and drown sea lions in crayfish pots). In that sense, the vicinity of fishing vessels and fishing nets should be considered as risky habitat for pinnipeds (Shaughnessy, 1999). Additionally, fisheries have the potential for depleting the food resources available for pinnipeds. Fishery interactions will increase concurrently with increasing populations of pinnipeds. Marine protected areas around breeding colonies could lessen the interaction between humans (including fishers) and seals.

With pinniped habitat utilisation in mind, it could be said that the Australian sea lion and New Zealand fur seal colonies, which occur within the study area, would benefit from the construction of a marine conservation reserve. Such a reserve would serve to protect the breeding colonies and feeding zones, hence the 'critical habitats' of these species. Additionally, the conservation reserve would attempt to minimise the impacts of mainly human orientated disturbances on pinniped haul-out sites, feeding zones and breeding colonies.

4.2 SEABIRDS AND SHOREBIRDS

In 1953 an expedition to the Recherche Archipelago carried out a survey of the seabird fauna of the islands. On the 22 islands visited, 57 different species of birds were seen. In 1976, Serventy produced a monograph on the birds of Western Australia (CALM, 1997). This publication covered all of the birds which are likely to be found along the south coast and describes their nesting habitats, distribution and islands which they are known to occur (Serventy & Whittell, 1976).

A 1976 expedition to Eclipse Island surveyed the seabird fauna of the island (CALM, 1997). Twelve species were suspected to breed on the island, but it was found that eleven breed and the remaining species is a vagrant. An additional 25 seabird species were recorded off Eclipse Island and the surrounding seas (Fullagar & Van Tets, 1976).

In 1982, a survey of the avifauna of the islands off Esperance was carried out (Lane, 1982). Ten islands were visited-Nares, Lorraine, Ram, MacKenzie, Frederick, Remark, Long, Cull, Observatory and Figure of Eight Islands (CALM, 1997). The species recorded off these islands were as follows:

- Little penguin (*Eudyptula minor*) was found on all but Nares, Frederick and Long Islands.
- Great-winged petrel (*Pterodroma macroptera*) was found on only remark Islands.
- Flesh-footed shearwater (*Puffinus carneipes*), this is the common shearwater of the area and these birds were found at sea often. However, birds were found in burrows on Ram, Frederick, Remark and Long Islands. Remains of birds were found on McKenzie, Observatory and Figure of Eight Islands.
- Short-tailed shearwater (*P. tenuirostris*), nineteen adults were found on Figure of Eight Island.
- Little shearwater (*P. assimslis*) was found on McKenzie Island.
- White-faced storm petrel (*Pelagodroma marina*) was found on Nares, Lorraine and Frederick Island. Remains were found on Remark, Long, Cull, Observatory and Figure of Eight Island where predation from the pacific gull may be a concern.
- Black-faced shag (*Leucocarbo fuscescens*) was only seen on Nares, Figure of Eight and Remark Islands.
- Little black cormorant (*Phalacrocorax sulcirostris*) was seen on Remark Island only.
- Cape Barren goose (*Cereopsis novaehollandiae*) was recorded on Lorraine, MacKenzie, Frederick, Long, Cull and Figure of Eight Islands.
- White-bellied sea eagle (*Haliaeetus leucogaster*) was seen over Ram, McKenzie, Frederick, Observatory and Figure of Eight Islands.
- Peregrine falcon (*Falco peregrinus*) was seen on Cull Island only.
- Australian kestrel (F. cenchroides) was seen on Ram and Figure of Eight Island.

- Sooty oystercatcher (*Haematopus fuliginosus*) was recorded on all islands visited and nesting on McKenzie Island.
- Common sandpiper (*Tringa hypoleucos*) was seen on Nares and Lorraine Islands.
- Silver gull (*Larus novaehollandiae*) was recorded on all islands visited but only in small numbers.
- Pacific gull (*L. pacificus*) was recorded on Nares, Lorraine, Ram, McKenzie, Frederick, Remark and Long Islands.

In 1982, Lane produced another report on a survey of 14 islands in the Recherche Archipelago (Lane, 1982). The report included a map of the islands, conservation status of the islands, landing areas, history, and seabird status (CALM, 1997). The islands surveyed were Middle, Nares, Lorraine, Ram, McKenzie, Hood, Frederick, Sandy Hook, Remark, Long, Cull, Observatory, Canning and Figure of Eight Islands (CALM, 1997). The seabird fauna recorded is shown in Appendix 10.

Lindsey's publication on the seabirds of Australia (1986), lists the species of seabird that might be expected to occur along the south coast of Western Australia (Lindsey, 1986). For the south coast region there is one species of penguin, one gannet, one darter and five cormorant species, which may be seen in this area (Appendix 11). A total of 39 out of 90 Australian seabird species occur in the south coast region, within the Stokes Inlet and Recherche Archipelago sections (Lindsey, 1986).

A 1987 book on the shorebirds of Australia gives a list of species which may be found in the south coast region (Pringle, 1987). A total of 43 out of 106 species of the birds that live on or near the coasts, beaches, reefs and tidal mudflats of Australian seashores are found along the south coast and within the study area (Appendix 12). The majority of the shorebirds that occur in Australia spend approximately half the year in the Northern Hemisphere (CALM, 1997). Australian shorebirds included waders, skuas, gulls and tern. The waders are notable for their spectacular migrations, while gulls and tern are among the most familiar birds of Australian harbours and coasts. Shorebirds tend to be extremely gregarious, wary and unapproachable, they fly strongly and seldom swim (Pringle, 1987).

In 1987, a survey was carried out on breeding colonies of the Short-tailed Shearwater in the Recherche Archipelago (CALM, 1997). The survey found two breeding colonies, one on Inshore Island and another on Ben Island. Inshore Island had approximately 200 burrows, while 3,000 burrows were found on Ben Island (Johnstone & Smith, 1987). This was followed by a 1988 survey of Eclipse Island at Albany. During this survey, it was noted that the type of birds that inhabit and breed on the island, were restricted to those that venture out to sea, such as the Little penguin, Great-winged petrel, Fleshy-footed shearwater, and Silver gull. Other varieties which are known to visit the island are the White-faced storm petrel, Red-tailed tropic bird, Sooty oystercatcher and Pacific gull (Scott, 1988).

The action plan for Australian birds (1992), listed the Cape Barren goose as endangered, with numbers being small and subject to catastrophes (Garnett, 1992). The distribution of this Cape Barren goose originally covered the south coast of Western Australia, being centred in the Recherche Archipelago, but occurring in small numbers on the mainland from Busselton to the Nullarbor Plain (CALM, 1997). However, its current distribution is confined to the Recherche Archipelago with infrequent records from nearby promontories. The Recherche Cape Barren goose (*Cereopsis novaehollandiae grisea*) breeds only in the Recherche Archipelago. Consequently, all of the islands in the Recherche Archipelago (and other nearby islands) where the Cape Barren goose has been recorded, are listed as Nature Reserves (Garnett, 1992).

During 1991, the population of Cape Barren geese in the Recherche Archipelago stuck on hard times. This period was considered to be a year of low abundance, with local droughts and hot weather causing a shortage of available food on the islands. Forty percent of the geese found were dead, apparently from starvation. In 1993, a survey was carried out on the Cape Barren goose in the Recherche Archipelago. The total population was estimated at approximately 650 birds with, on average, 8.5 birds per island (compared with 6.5 in earlier surveys). The population appeared to have

recovered. Consequently, the greatest threat to the Cape Barren goose status would appear to be natural catastrophes, such as drought (Burbidge *et al.*, 1993).

The Recherche Cape Barren goose is currently listed by ANZECC as 'vulnerable' nationally, and is listed under the Western Australian *Wildlife Conservation Act 1950* as fauna 'which is likely to become, extinct, or is rare'. Other species that are known to occur within the study area and are also listed under the Western Australian *Wildlife Conservation Notice (1998)* include Wandering albatross, Sooty albatross, Shy albatross, Grey-headed albatross and Peregrine falcon.

The islands in the study area that are associated with seabird activity are shown by Figure 4.

4.3 MARINE REPTILES

Loggerhead and Leatherback turtles and Sea snakes can often be seen along the south coast. These turtles and snakes get picked up in the strong south-flowing Leeuwin Current and are carried hundreds of miles from their home territory. These species are usually found in the warmer northern waters of Western Australian. From 1989 to 1995 there have been six loggerhead turtles and two leatherback turtles found along the Albany coast (Collins, P., *pers. comm*.), and there has been one yellow-bellied sea snake found at Stokes Inlet in 1995 (Bancroft, K., *pers. comm*.).

4.4 FISHES

In general, very little research has been conducted into establishing the relative distribution and abundances of fish species occurring specifically within the study area. A survey of the nearshore reef fish fauna of Western Australia's west and south coasts, conducted by the Western Australian Museum between 1977 and 1993, included a number of sites between Walpole and Cheyne Beach and in the Recherche Archipelago (Hutchins, 1994). In addition, Avayzian and Hyndes (1995) investigated the surf-zone fish assemblages of a number of sandy beaches of the west and south coasts and examined the influence of nearshore habitats and the Leeuwin Current on the characteristics of the fish fauna.

Dr. Barry Hutchins of the Western Australian Museum has conducted a few detailed surveys within the Archipelago in recent years, and the results of this research are expected to be published in the near future. In the meantime, using reference texts such as that of Gommon *et al.* (1994) *The fishes of Australia's South Coast*, is not unreasonable to expect that the elasmobranch and osteichthyes species listed in Appendix 13 and 14 occur within the study area (Appendices 13 and 14).

4.4.1 Australian salmon and herring nursery

There is a widely held view that the shoreline region that extends from east of Esperance through to the WA/SA border is an important WA nursery for Australian salmon (*Arripis truttacea*) and Australian herring (*Arripis georgiana*) (Fisheries WA, 1995). This has been confirmed with capture of:

a) post-larval Australian salmon and herring in plankton trawls from the western Great Australian Bight, and;
b) small >0 year old Australian salmon and herring at a number of shoreline locations throughout this region.

At present, with the exception of some fishing around Esperance as far east as the Duke of Orleans Bay, there is no commercial shoreline net fishing undertaken throughout this region. In view of the significance of this region as a nursery area for Australian salmon and herring, shoreline net fishing will not be permitted to expand into this region.

4.4.2 Leafy and weedy seadragons

Seadragons belong to the Family Sygnathidae, and in Australia, are only found in southern waters. Both the leafy seadragon (*Pycodurus eques*) and the weedy seadragon (*Phyllopteryx taeniolatus*) occur within the study area. Although these fish are totally protected under the *Fish Resources Management Act* (1994), coastal development, pollution and exploitation constantly threaten their abundances and distributions by humans. 'Dragon Search' is a monitoring program, which encourages members of the community to provide information on seadragon sightings. The information will be used to determine the distribution, habitat requirements and research and management priorities for these little known species.

According to the 1998-2000 Western Australian Summary for 'Dragon Search' the area from Albany to Esperance appears to be important for both species of seadragon, with the majority of sightings coming from the reef and seagrass beds associated with the bays, sounds and headlands within this area. Eighteen percent of sightings for both leafy and weedy seadragons from the South Coast Bioregion have come from the Esperance area (within the study area). Many of which have recorded more than one individual being found at a time (groups of 2 or more).

Consequently, it would appear that such endemic fish species as the leafy and weedy seadragons would benefit from the implementation of a marine reserve to protect their habitats and abundances.

4.5 INVERTEBRATES

There have been few intensive collections of any marine invertebrates within the study area. Several publications discuss the general distribution of some species:

1) Morgan & Jones (1991) gives records on the distribution and habitat of 115 species of decapod crustaceans from the south coast Australia (between Cape Naturaliste and the South Australian border);
2) Jones (1991) describes and provides a key for 31 species of shallow water barnacles (*Cirripedia*) which have been collected between the Houtman Abrolhos Islands and Albany;
3) Britton *et al. (*1991). Examines general relationships between topography, substratum and surface temperature in determining the spatial distribution of intertidal fauna of the rocky shores of south-western Australia;
4) Wells & Mulvay (1995) describes the population biology and reproductive ecology of the greenlip abalone (*Haliotis laevigata*) populations at Augusta (and Esperance and Hopetoun);
5) Wells (1980) has discussed the distribution of shallow water marine prosobranch gastropod molluscs along the coastline of Western Australia, and;
6) Marsh (1991) has described the shallow-water echinoderms of the Albany region, South-Western Australia.

4.5.1 Echinoderms

Little research has been conducted investigating the occurrence, abundance and relative distribution of echinoderm species within the study area. However it is presumed that the echinoderm community that occurs within the study area is abundant, diverse and exhibits a reasonable level of endemism, consistent with that displayed by the south coast marine fauna as a whole (Appendix 15).

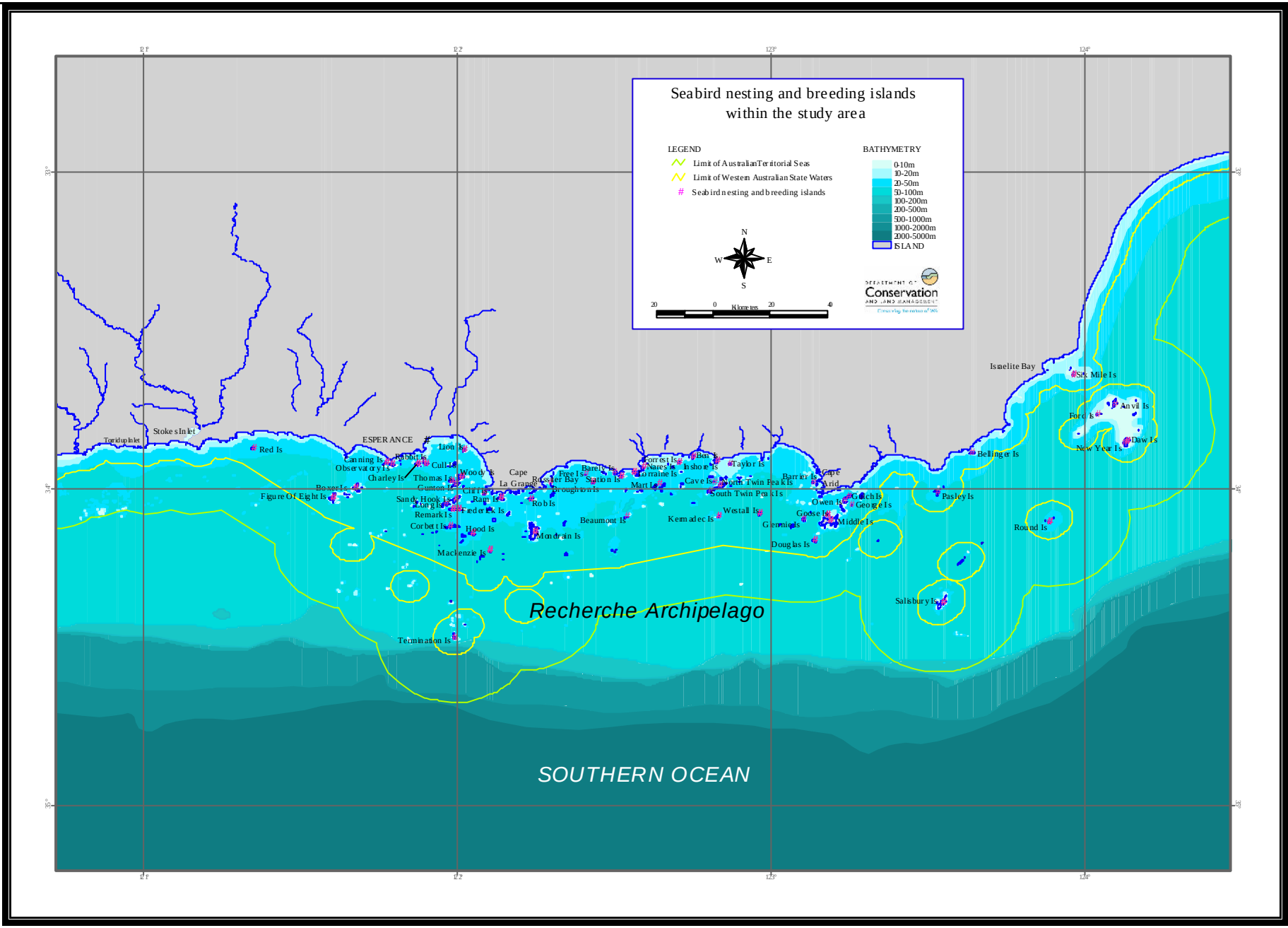

Figure 4. Seabird breeding pair islands of the Recherche Archipelago region

4.5.2 Crustaceans

In general, little research has been conducted investigating the occurrence, abundance and relative distribution of crustacean species within the study area. However it is presumed that the crustacean community that occurs within the study area is abundant, diverse and exhibits a reasonable level of endemism, consistent with that displayed by the south coast marine fauna as a whole.

As the distribution of barnacle and decapod species has recently been described in a couple of publications, these two orders of crustaceans will now be discussed in more detail.

Barnacles

The shallow-water barnacle (Cirripedia: Lepadomorpha, Balanomorpha) fauna of southwestern Australia has been shown to differ characteristically from that of northwestern areas (Jones, 1991). The material shows a large cosmopolitan component, and a relatively high Australian endemic element, with low species numbers exhibiting Australasian, Indian Ocean/Malaysian or Indo-West Pacific affinities. The shallow-water barnacle species (both goose and acorn barnacles) are expected to be found to occur, according to distribution (Appendix 16).

Decapods

The specific abundance and distribution of decapods within the study area has been poorly researched. However, using reference texts to determine relevant distribution, it is possible to suggest which species are likely to occur within the study area (Appendix 17).

4.5.3 Molluscs

The abundance and distribution of molluscs in the study area has yet to be fully established. A couple of small surveys have been conducted in the Recherche Archipelago, for example Macpherson (1954), but on the whole, more research needs to be performed to have a greater understanding of the abundances and level of endemicity shown by molluscan species within the study area.

However, using references such as Macpherson (1954); Wilson (1993); Wells & Bryce (1993), and; Edgar (1997), the likely occurrence of species within the study area, according to distribution information, can be estimated. Estimates of occurrence have been made for Chitons (Appendix 18), Prosobranchs (Appendix 19), Sea slugs (Appendix 20), Bivalves (Appendix 21) and Cephalopods (Appendix 22).

4.5.4 Cnidarians

Cnidarians include hydroids, siphonophores, anemones, corals, zoanthids and jellyfish. Little research has focussed on this phylum in the south coast, and certainly the abundance and distribution of cnidarians within the study area has not been addressed. However it is thought likely, using reference texts such as Edgar (1997), that the cnidarian community is diverse and relative abundant within the study area (Appendix 23).

4.5.5 Other invertebrates

Little research has been conducted, within the study area, on the relative distribution and abundance of invertebrate species such as bryozoans, sponges and ascidians. However, using texts such as Edgar (1997), it is possible to suggest that the species listed in Appendix 24 are likely occur within the study area.

4.6 INTRODUCED MARINE PESTS

The introduced marine fanworm *Sabella spallanzanii* has been discovered in Bandy Creek Harbour in Esperance (G. Clapin, *pers. comm.*). *S. spallanzanii* comprises of a flexible semi-transparent tube that can extend to 50cm and 1cm wide, with feather-like projections (radioles), up to 20cm long, extending from the tube. The crown of radioles varies in colour from orange to white to red-brown and the outer layer tube is often covered in greyish silt, mud and other small marine organisms. It is thought likely that this species will colonise other areas of Esperance Bay, particularly where there are man-made structures such as jetty and wharf pylons and channel markers.

To date, no other introduced marine pests, that have been discovered in temperate waters in other parts of Australia (such as the Japanese kelp *Undaria pinnatifida* and the northern Pacific seastar *Asterias amurensis*), have been found along the south coast of Western Australia (G. Clapin, *pers. comm.*). However, the region between Stokes Inlet and Israelite Bay has yet to be surveyed in detail for introduced marine pests.

5 MARINE FLORA

5.1 SEAGRASS

Seagrasses are flowering plants adapted for life submerged in a water environment. Like flowering plants on land they produce flowers and seeds. The flowers and seeds are small, seasonal and difficult to observe in many species, consequently the identification of seagrasses relies largely on leaf, root and rhizome characteristics. About 60 species are known worldwide, with one-third of these restricted to southern Australia. The exact distribution and abundance of seagrasses within the study area is unknown, however a broad picture has been formed for the south coast of Western Australia as a whole.

Seagrass beds are extensively developed along the south coast although there is very little known of their diversity (CALM, 1994). The genus *Posidonia* dominates both as meadow-forming seagrass and as fringing and clumped patches. *P. australis* and *P. sinuosa* are the main meadow-forming species but *P. robertsonae* also forms well-defined meadows. Edges and blowouts usually harbour *Amphibolis* (*A. antarctica, A. griffithii*) species. The smaller plants *Halophila australis, H. ovalis* and *Heterozostera tasmanica* also often grow in disturbed areas and blowouts (CALM, 1994).

There is a high level of endemism of seagrasses along the south coast, with nine out of 17 species being endemic (Kuo & McComb, 1989). The south coast may be the centre of distribution of the genus *Posidonia*. This is because, in addition to the dominant species noted above, *P. ostenfeldii, P. angustifolia, P. robertsonae, P. denhartogii* and *P. kirkmanii* are all found in large quantities in some bays, but their respective habitat preferences are not known (CALM, 1994). All of the *Posidonia* species produce flower and fruit in summer. It is believed that some seagrass species grow to depths of at least 45m along the south coast. The plants are well adapted to the large swells as they have deep, well-developed rhizomes. The 'ostenfeldii' group (*P. ostenfeldii, P. denhartogii, P. robertsonae* and *P. kirkmanii*) has rhizomes, which grow vertically downwards, and hence the aboveground plants appear as clumps (CALM, 1994). The 'australis' group tends to spread horizontally at a rate less than 2cm/year. *Thalassodendron pachyrhyzium* has been found as drift but not growing. It is expected that it is attached to rocky substrates.

5.2 MACROALGAE

There have been no intensive collections or taxonomic studies of macroalgae in the study area, however it is believed that the macroalgal community is both diverse and abundant and exhibits a high degree of endemicity. In adjacent regions, such as the Fitzgerald biosphere, numerous macroalgal species have been found to be present (Appendix 25).

The exact distribution and abundance of macroalgae within the study area is relatively unknown, however a broad picture has been formed for the south coast of Western Australia as a whole. The small kelp *Ecklonia radiata*, which often forms as dense beds in the shallow sublittoral zone, is the dominant alga along the south coast (CALM, 1994). Other common brown algae include *Cystoceira, Scytothallia, Cystophora* and *Hormosira banksii*. Conspicuous green algae include various species of *Caulerpa*, while the 'reds' are represented by many cool temperate species (CALM, 1994). Generally speaking, the limestone reefs afford more protection and a better surface for attachment of algae than the granitic or gneissic rocks (CALM, 1994).

5.3 CYANOBACTERIA (NON-BLOOM POPULATIONS)

Cyanobacteria are bacteria that produce oxygen from water using the process of photosynthesis. They are unicellular, but often form long filaments. Most marine cyanobacteria are attached to the seabed, however, some are planktonic. On southern Australian shores, cyanobacteria occur commonly as mats or globular structures but are rarely a dominant feature. The most noticeable species belong to the genus *Rivularia* and produce shiny green gelatinous colonies, which are easily mistaken for green algae. However, within the study area, the distribution and abundance of cyanobacteria has yet to be established.

6 RECREATIONAL FISHING

Since 1987, the participation in recreational fishing of all kinds has more than doubled from 284,000 people to between approximately 500,000 and 600,000 people a year. A 1987 Australian Bureau of Statistics survey of recreational fishing estimated that 13.5% of about 284,000 Western Australian recreational anglers operated in the South Coast region in 1986-1987.

Recreational fishing in the study area occurs both in marine and estuarine waters. The most sought after species are Australian herring, whiting and Australian salmon (CALM, 1994). Offshore species taken by boaters include queen snapper, bright redfish, samsonfish (*Seriola hippos*), breaksea cod (*Epinephelus armatus*), blue groper and sharks. Netting is undertaken mostly in estuaries, such as Stokes Inlet, Torradup River and Jerdacuttup River, for species such as sea mullet, yelloweye mullet, Australian herring and black breaM. In addition, rock lobster potting, squid jigging and diving for abalone occurs in the study area.

7 COMMERCIAL FISHING

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, 1998/1999), 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 within

the study region 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 Trawl; and
- Abalone Fishery

For further information see Fisheries WA (1999/2000).

7.1 South Coast Purse Seine Fishery

This fishery involves the purse seining of small pelagic fish, primarily for pilchards (*Sardinops neopilchardus*), 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.

7.2 Southern Demersal Gillnet and Demersal Longline Fishery

The demersal gillnet and demersal longline fishery, primarily for gummy (*Mustelus antarcticus*), whiskery (*Furgaleus macki*) and dusky or bronze whaler (*Carcharhinus obscurus*) sharks and demersal scalefish, is the largest offshore fishery of the South Coast (CALM, 1994). This fishery, which extends offshore to the 200m isobath, operates from Cape Bouvard to the South Australian border and its annual value is estimated at $0.636 million. For management purposes, this fishery is divided into two zones. The study area is contained within zone 2, between 116°30' E and the South Australian border. In this zone, 25 full-time and 29 supplementary access license holders landed 1080 tonnes of shark and 160 tonnes of scalefish during 1991-92 (CALM, 1994). Key species of scalefish include deepwater fishes such as leatherjackets (*Monocanthidae* spp.), hapuku (*Polyprion oxygeneios*), blue-eyed trevalla (*Hyperoglyphe antarctica*) and grey-banded rock cod (*Epinephelus septyemfasciatus*), together with species that can be taken closer inshore such as bright redfish (*Centroberyx gerradi*), queen snapper (*Nemadactylus valenciensi*) and blue groper (*Achoerodus gouldii*) (CALM, 1994). The catch in 1997/98 was estimated to be 136 tonnes (Fisheries WA, 1998/1999).

7.3 South Coast Estuarine Fishery

The South Coast commercial estuarine fishery is one of the oldest fisheries in Western Australia. It began in the mid 19th century and has continued until the present day in remarkably unchanged forM. The two basic techniques of seining and gillnetting from small boats with hand-pulled gear are little changed. This fishery is managed as a single, limited entry fishery. Commercial fishers can operate in all of the South Coast estuaries along the Recherche Archipelago. Catches are dominated by black bream (*Acanthopagrus butcheri*) and to a lesser extent yelloweye mullet (*Aldrichetta forsteri*) and sea mullet (*Mugil cephalus*). Small catches of blue manna crabs (*Portunus pelagicus*), cobbler (*Cnidoglanis macrocephalus*) and squid are taken in some estuaries.

At present, with the exception of cobbler, there is little or no evidence that there is any immediate problem with stock levels of the estuarine fish species targeted by both commercial and recreational fishermen. There is some concern, however, that the economic viability of many of the commercial fishermen may be jeopardised, should the current level of commercial fishing effort increase and greater demands by the recreational sector for the same resource continue. Currently there are few or no restrictions on the quantity of fishing gear that may be employed in catching estuarine species. There are, however, seasonal closures to commercial fishing in a number of estuaries and certain other estuarine systems and inlets are completely closed to commercial net fishing. In addition there is a prohibition on the setting of commercial gillnets between 1½ hours after sunrise and 1½ hours before sunset. The above seasonal and time closures are in place to manage the interaction between recreational and commercial user groups and for fish stock conservation.

7.4 Esperance Rock Lobster Managed Fishery

Southern rock lobster fishing is an important coastal activity, which is managed as two separate fisheries. The Esperance fishery is located between 120°E (near Hopetoun) and 125°E (near Point Culver) and south to the limit of the Australian Fishing Zone (AFZ). The rock lobster season operates between 15 November and 30 June and each licence is entitled to 10 pots per metre of boat length, with a maximum entitlement of 90 pots. In 1998-99, eleven vessels caught 82 tonnes of southern rock lobster (*Jasus edwardsii*), estimated at a value of $2.3 million (CALM, 1999). The eleven boats operating out of Bandy Creek Boat Harbour are often out for up to five or six days at a time.

7.5 South Coast Trawl

7.5.1 South Coast Demersal Trawl Fishery

The South Coast Demersal Trawl Fishery, extending offshore to the 200m isobath between Cape Leeuwin and the Australian Bight, is managed under Western Australian State jurisdiction. The target species are demersal finfish such as queen snapper, bright redfish, boarfish (*Pentacerotidae* spp.) and deepwater flathead (*Platycephalus conatus*). Presently, four vessels have access to this fishery. The area of the Recherche Archipelago between 121°30'E and 123°30'E, and offshore to 34°20'S, is excluded from general trawl fishing and has been allocated to the inshore trawl fishery.

7.5.2 South Coast Inshore Trawl Fishery

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 that operates between 121°30'E to 123°30'E and 34°20'S. The waters of the archipelago are seasonally open (April 1 to November 30) to endorse vessels to fish only for scallops (*Pecten* spp.). This is a small fishery and at present, there are two endorsed scallop vessels operating. These vessels also have access to the Commonwealth Bight Trawl Fishery for scallops in shelf waters between 125°E and 129°E.

7.6 Abalone Fishery

Abalone is one of the most valuable nearshore resources harvested off the South Coast. Commercial abalone operations are managed in two zones, on either side of Shoal Cape (120°E) (CALM, 1994). The boundaries of the Zone 1 abalone fishery extends 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, Remark Island, Frederick Island, Long Island, the Mart Group and Middle Island. Six divers have

access to this zone. They take three species of abalone, Roe's (*Haliotis roei*), greenlip (*H. laevigata*) and brownlip (*H. conicopora*).

In 1998/99, Zone 1 had a catch of just over 100 tonnes (669 diver days), which was valued at approximately $4 million. Zone 3 (Divers taking only Roe's abalone) effort in the corresponding year was estimated to be just over 11 tonnes with a value of $0.428 million for WA.

7.7 Offshore Tuna Fishery

There is an important offshore tuna fishery (mainly for southern bluefin tuna *Thunnus maccoyii*) operating from the major South Coast ports, including Esperance. The Australian Government manages the offshore tuna fishery.

8 AQUACULTURE

Currently, there are no ocean-based aquaculture activities operating within the study area. However in recent years, Fisheries Western Australia has investigated the potential that the Recherche Archipelago has for supporting prospective aquaculture enterprises.

Fisheries WA identified a number of areas, considered suitable for aquaculture, during the course of a planning study. The land-based site selection process addressed the following components:

- water quality;
- soil;
- topography;
- surrounding land use;
- legal issues;
- access;
- capital cost;
- conservation sensitivity;
- utilities, and;
- proximity to market.

According to this criteria, the following sites are suitable for land-based aquaculture:

- 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), and;
- Crown and freehold land at Wharton, Duke of Orleans Bay, perhaps in conjunction with infrastructure and backup facilities at Condingup, and; Codingup (if water supplies can be accessed).

The sea-based site selection process investigated the following components:

- water depth;
- waves;
- salinity;
- water temperatures;

- contamination;
- nutrient status of water;
- algal blooms;
- currents and flushing;
- wind;
- sea floor;
- access;
- land-based infrastructure, and;
- visual impact.

Five potential sea-cage sites were identified at the York, Mart and Remark Groups and Tory and Mondrain islands. However unlike the Remark and Mart Groups, Mondrain, York and Tory Islands were considered unsuitable for large-scale sea cage aquaculture. Furthermore, many sites throughout the Archipelago were considered suitable for the location of barrels and bottom cages for abalone growout.

A list of candidate species for potential aquaculture activities in the Recherche Archipelago was also determined (Appendix 26) by Fisheries WA, based on the 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, and;
- suitability of the species to the area.

For further information see Fisheries WA (1999).

9 SANKO HARVEST- A CASE STUDY OF AN ENVIRONMENTAL THREAT

9.1 SYNOPSIS

Thursday 14 February, 1991.

At 3.20am on Thursday 14th February 1991, the vessel 'Sanko Harvest' hit a reef in the Recherche Archipelago about 10km south of Cape Le Grand. The master of the ship, a 31 year old Korean, was navigating in dangerous waters outside the normal shipping channels. The 33,000 tonne vessel was carrying 30,000 tonnes of superphosphate and dimonium phosphate fertiliser worth $10.5 million. Also onboard were 570 tonnes of bunker fuel and 74 tonnes of mainly diesel fuel stored in the engine rooM. It was initially reported that only 'a small amount of oil was leaking'. An urgent request was sent for oil pollution equipment to be sent to Esperance and the State Emergency Transport Plan was activated to move the equipment.

The report from Esperance Harbour Master Captain Ian Harrod, was that the ballast double bottoms 1, 2, 3, and 4 on the port side, which run under the first four cargo holds, and the forepeak were holed. The inner double bottoms under hold 4, which contained fuel tanks, were also holed. However, at this stage only a very small amount of oil was leaking. The winds were southeasterly and the forecasts were for worsening condition. By now, the ship was moving further onto the rocks. At this stage it was believed that the ship could be salvaged, taken to Esperance and it's cargo and bunkers unloaded. A call from the only major Australian salvage company, United Salvage, said that their operators was on their way. Consideration was given to dumping 2000 tonnes of cargo in a bid to refloat the vessel. However, the cargo was still intact as none of the holds had been damaged. The State Combat

Committee met to discuss contingency plans while officers from CALM and Marine & Harbours were flown to the site. In an act to contain the spill, booms were rigged up around the ship.

Friday 15 February, 1991.
Initially, the salvage operators indicated that the ship could be salvaged. However, by 8.00am the situation had deteriorated rapidly. Overnight, ship movement on the rocks had caused holes in holds 1 and 4, and cargo was now leaking into the ocean. By now, there was no way that the vessel could be refloated, as determined by United Salvage and they recommended that the remaining oil should be taken off the ship. However, this was impossible as there was no where to put the oil and insurance companies would not allow another ship into this area as it was too dangerous to navigate. In addition, fuel oil is a heavy liquid, which solidifies in the cold conditions and would have needed to be heated before it could be removed from the ship. A seemingly impossible task!

Rocks had now pierced the fuel tanks under hold 4 and had pierced the hold itself. At this stage it was impossible to determine how much oil had been lost or might be lost. The only possible option was to request, from the Australian Government, inflatable bags to retain the oil. However this hope was dashed when the closest source for such bags was New Zealand. By now the weather conditions has caused the vessel to change from a 5° port list to a 5° starboard list with the bow under water by about 1 metre. At 5.00pm the ship was abandoned. Nothing except the crew and shipping documents were taken off. Heavy seas were breaking over the bow and extra booms were rigged around the vessel so that the spill could be treated with dispersant as it hit the water. Unfortunately due to the rough seas these had little effect. Authorities expected the ship to sink overnight.

Saturday 16 February, 1991.
A CALM plane flew over the area and determined that the ship was still aground and oil was leaking from the reef side preventing access to it. The wind was now 30 knots and only preventative measures were taken by United Salvage. By mid-afternoon, Marine & Harbours were able to pump dispersant into hold 4 from a vessel alongside. By this time 18,000 tonnes of phosphate had been lost and the remaining 12,000 tonnes were going fast. Most of the oil had already been lost, but with the prevailing winds nothing could be done except treat it with dispersant.

Sunday 17 February, 1991.
The ship had now settled further onto rocks, and the first of the oil had reached wildlife on nearby Hood Island. A CALM team travelled to Hood Island and began treating 20 oil-covered New Zealand fur seal pups. Additionally, as the vessel could no longer be approached by sea, a helicopter began spraying dispersant around the ship. However, the Civil Aviation Authority restricted access to area as small low flying aircraft were scaring the seals. Furthermore an exclusion order was put on the vessel, the reef, and Hood Island to prevent upset locals from boarding the vessel to trying to remove the polluting oil. At about 3.00pm the ship started to slide off rocks, but the weather condition prevented tugs from retrieving the vessel. Within hours the ship's bow was on the bottom of the ocean, with only one intact cargo. Oil was still spilling, and the helicopter was continually spraying more dispersant into the ocean.

Monday 18 February, 1991.
Sometime overnight the ship spilt in two and sank. By now the hatch on remaining cargo had lifted off and all 30,000 tonnes of cargo and any remaining oil or fuel was lost. However, 100 tonnes of oil sealed in the engine room remained intact.

9.2 CLEAN-UP

CALM had over 200 volunteers ready and willing to help with the clean-up process. Esperance Shire Council also had many volunteers and almost every local person, including school children, helped in some way. It took around 10 weeks to complete and the total bill came to over $1 million. Thirty kilometres to the east and west of Esperance were partly or completely covered in oil. Nearly 25km of

once pure white sand on Cape Le Grand National Park was turned black. Twilight Cove to the west of Esperance and as far as Bremer Bay had some signs of oil damage to beaches. Seventy five thousand kilograms of oil soaked sand and hundreds of litres of oil were removed from the beaches and islands. High pressure hoses were used to disperse heavier slick from the rocky shorelines and the islands affected were scrubbed with dispersant. Clean-up crews were sent to Seal Rock and Hood Island to remove oil from fur seal pups. The Sanko Line, Japanese owners of the Sanko Harvest, paid $1 million for the clean-up bill. They also donated $50,000 to CALM for seal monitoring after the clean-up, $4500 to the Local Environmental Action Forum (LEAF) to establish an environmental centre, and one of the lifeboats salvaged from the wreck was donated to the Esperance Museum.

9.3 WILDLIFE THREATENED

9.3.1 New Zealand fur seals

Gales (1991) made a report on the Sanko Harvest clean up operations. Two hundred seals were affected by the pollution, most of these were new-born New Zealand fur seals aged between two weeks and two months. Thirty-nine pups on Hood Island and up to 172 pups on Seal Rock were contaminated. Clean-up crews were sent to both of these sites and all affected pups were captured and restrained in pens while the oil was removed from the fur seal pelage. This is because any fouling of this pelage with oil leads to thermoregulation and energetic imbalance, the insulative value to the pelt being reduced by as much as 50%. The degree of oil fouling of the fur seal pups on Seal Rocks was less than those from Hood Island.

Clinical assessment of contaminated fur seals during the cleanup operation gave little indication of significant, acute toxicology. Furthermore, analysis of haematology and blood biochemistry reflected mainly a general physiological stress rather than significant, systematic, toxic challenge (Gales, 1991). The younger seals were initially terrified and stunned, but responded well to the treatment. Of the seals affected some could suffer permanent eye damage. Unfortunately six pups died from the oil on their skin before they could be returned to their home

9.3.2 Kangaroos

Surprisingly kangaroos were also affected. Some were found with oil on their tails, back legs and paws after standing in the oil while drinking from freshwater creeks in the Cape Le Grand National Park. However this was not a big problem as most had been cleaning themselves by rolling in the sand and removing what they could.

9.3.3 Sea birds

Pacific gulls and other seabirds were found either struggling in the water or washed up on the beach. Only a few were found dead and treatment of the injured birds was successful. Some even required intensive feather by feather cleaning.

9.4 REEF PROTECTED AREA

Some good has come from the wrecking of the Sanko Harvest. The wreck site is now a declared *'Reef Protected Area'*, *Fish Resource Act* (1994), with all marine life within 500m of the wreck being protected from spear fishing. With a length of 174.7m and a beam of 27.3m, the Sanko Harvest it is the largest diveable wreck off the Australian coast and the second largest in the world. The highest point is just 13m below surface and the deepest point is about 42M. People come from as far away as Japan just to dive on it, and in America, the Sanko Harvest has been described as the third best wreck in the world to dive through.

10 IMPORTANT COASTAL WETLANDS

Within the study area, there are numerous important coastal wetlands. These include the Oldfield, Stokes Barker, Esperance and Mallee Sandplain wetlands. Each of the wetlands is discussed in detail below.

10.1 OLDFIELD WETLAND

Very broad areas of shallow coastal drainage with numerous small permanent and intermittent lakes and swamps and some larger permanent lakes and swamps near the coast. Many medium size to large lakes, including the large Lake Shaster, are present within a 2-5km wide coastal band of remnant vegetation. Lake Shaster is monitored by CALM and the Royal Australasian Ornithologists Union (RAOU) for waterbird usage. It is hypersaline and open, and generally supports a few waterbirds and some breeding. It is however, an area of international and national importance for the Banded Stilt (Watkins, 1993).

10.2 STOKES BARKER WETLAND GROUP

Broad area of drainage focussed on Stokes and Barker Inlets with small permanent lakes, intermittent small lakes and swamps as well as areas subject to inundation. An area of about 16km^2 subject to inundation and with intermittent lakes nestled within it is found to the north of Barker Inlet and nearly all is within nature reserves. However, this is very much the exception as most of the wetlands are located within farmland and have been mostly cleared of their natural vegetation. Severe and extensive salinisation is evident on satellite imagery.

10.3 ESPERANCE WETLAND GROUP

Very broad area of numerous small to large permanent lakes mostly, with some intermittent tiny lakes and swamps and areas subject to inundation, especially near Esperance. The largest lakes, Pink and Warden, are located near the township of Esperance. Other named lakes include Gore, Quallitup, Mortijinup, Mullet, Bunnitup, Benje, Shark, Little Monjinup and Williamup. While a good number of the coastal wetlands are located well within coastal nature reserves, most border farmlands or are totally surrounded by it. Only a few of the more inland wetlands are associated with remnant bushland.

The Lake Mortijinup System, Pink Lake, Lake Gore and Lake Warden are on the register of wetlands of national significance. Lakes Gore and Warden are RAMSAR wetlands, representing waterbird habitats of international significance. Almost one-third of the world populations of the Hooded Plover and Banded Stilt occurs regularly at Lakes Gore and Warden, and these lakes are the most important drought refuges for waterbirds in the bioregion, especially Shelducks.

CALM and RAOU monitor Lakes Gore, Warden, Shark and Station for water depths and/or waterbird usage. Warden and Shark are brackish wetlands with fringing trees, supporting high numbers of waterbird species and individuals and heavy breeding. Gore is saline with extensive dead trees and supports moderate number of species and breeding but with high bird numbers. Lake Station is seasonal saline and relatively open with a fringe of dead trees.

10.4 MALLEE SANDPLAIN WETLAND GROUP

Huge area, about 30km wide and running from east of Esperance in a north-western direction for 100km, containing thousands of tiny intermittent salt-lakes and swamps with broad areas subject to inundation. There are also a few intermittent medium sized lakes. Some areas of high wetland density retain natural bush, but for the most part, the natural vegetation has been entirely cleared. Salinisation appears severe over broad areas from satellite imagery. CALM and RAOU monitor three lakes (Reserves 27768, 27985 and 32776) for waterbird usage. All are hypersaline, ephemeral and open and support few waterbirds.

11 ESTUARIES

Using the classification of Marine Exchange (permanently open, seasonally open, normally closed, and permanently close) and Estuary Morphology (Riverine, valley lagoon and Basin lagoon), the estuaries that occur within the study area will now be described.

11.1 ESTUARIES TO THE WEST OF ESPERANCE

11.1.1 Torradup Estuary (33°52'S 121°01'E)

Torradup Estuary (Normally Closed/Valley Lagoon) is a very narrow estuary (only 200m wide) and is 3.5km long (Bancroft *et al.*, 1991). The estuary covers an area less than 1 km^2 and its depth is no more than 2M. Its water is deeply tannin stained, and has a salinity range from 11ppt to 40ppt. The Torradup River feeds into the estuary, which is located within Stokes National Park. The bar opens regularly for short periods and waves wash over in storm surges (Hodgkin & Clark, 1989). Torradup Estuary is open to commercial fishing activities (SCEFWG, 1995). However, the management of campers, visitors, and beach access are issues of concern (Hodgkin & Clark, 1989).

11.1.2 Stokes Inlet (33°52'S 121°08'E)

Stokes Inlet (Normally Closed/Valley Lagoon) is shallow, and covers an area of 14km^2. Its major basin is approximately 10km long and 2km wide, and it is a saline to hypersaline estuary 28-96ppt (Bancroft *et al.*, 1997). The estuary is mostly surrounded in the Stokes National Park, and has extensive paperback and samphire habitats (Bancroft *et al.*, 1997). The waters of the Young and Lort Rivers, which are now saline, charge the estuary. In recent time, increases in the rates of sedimentation and nutrient loads due to agriculture in their catchments, has been observed. This decrease in runoff water quality will ultimately affect the estuary (Olsen & Skitmore, 1991). The estuary has a slight tannin discolouration. The bar breaks infrequently and is open for short periods up to 6 weeks (Hodgkin & Clarke, 1989). Currently there are 17 commercial fisheries licences at Stokes Inlet (Bancroft *et al.*, 1997). The Fisheries Department (< biblio >) introduced a half yearly closed season (30/11-1/5) at Stokes Inlet in 1982. However, catchment soil conservation, river salinity, coastal dune migration filling the oceanic channel, management of campers and visitors, and 4WD beach usage are all important issues that need to be considered for proper conservation and management (Hodgkin & Clark, 1989).

11.1.3 Barker Inlet (33°48'S 121°20'E)

Barker Inlet (Normally Closed/Basin Lagoon) is a small lagoonal estuary with an area of 1.8km^2 (Bancroft *et al.*, 1997). Its is 2km long, 1km in width, very shallow (no more than 1m in depth) and often dry. It is a saline estuary with salinities greater than 23 ppt. Waves often wash over the sand bar, which probably opens regularly (Hodgkin & Clarke, 1989). Barker Inlet is closed to all

commercial fishing (SCEFWG, 1995), and lies within Conservation of Flora Nature Reserves. Conservation and management issues include catchment soil conservation, management of campers and visitors and motor vehicle usage (Hodgkin & Clarke, 1989).

11.2 ESTUARIES TO THE EAST OF ESPERANCE

East of Esperance there are numerous creeks. They are only small and only a few are estuarine (Bancroft *et al.*, 1997). The waters of all these inlets discharge into the study area. Information on these estuaries is scarce, as there has been little or no investigation into the surface waters of this region. In most of these little estuaries the major management issues are the increase in river salinity and the increases in sediment loads (Bancroft *et al.*, 1997).

11.2.1 Bandy Creek Inlet (33°39'S 122°02'E)

Bandy Creek (Normally Closed/Riverine) is no longer considered a true estuary as it has been grossly modified (Bancroft *et al.*, 1997). In 1983, construction for the Bandy Creek Boat Harbour was commenced. The mouth of the inlet has two stonewall groins constructed and the bar was removed (DCEWA, 1983; Hodgkin & Clark 1989). The creek water is saline (Olsen & Skitmore, 1991), and recently, the introduced marine tube worm *Sabella spallanzanii* has been observed at Bandy Creek Inlet (G. Clapin, *pers. comm.* 1997) (Bancroft *et al.*, 1997).

11.2.2 Mungliginup Inlet (33°51'S 122°46'E)

Mungliginup Inlet (Normally Closed/Riverine) is a narrow riverine estuary 2km long, 10-20m wide and has a maximum depth of 2.5 m (Bancroft *et al.*, 1997). The estuary cuts through coastal spongolite rock and always holds water. The waters of the estuary are hypersaline and on 6 May 1977 recorded 46ppt (Bancroft *et al.*, 1997). *Ruppia* seagrass beds and *Polyphysa* algae have been observed (Hodgkin & Clark 1989). There is a small camping area with a small borehole toilet on the fringe of the inlet. Mungliginup Inlet enters the ocean at Membinup Beach and the bar breaks infrequently (DCEWA, 1983).

11.2.3 Alexander River Inlet (33°51'S 122°47'E)

Only about 1km of the Alexander River (Normally Closed/Riverine) is estuarine (Bancroft *et al.*, 1997). The estuary is very narrow with a width of 10m, and on 6 May 1977, the salinity was recorded as 26 ppt. The inlet is a popular camping and recreational area, and it has a small camping area with a small borehole toilet (Hodgkin & Clark, 1989). The estuary opens into Alexander Bay over a 200m wide white silica sand beach (Bancroft *et al.*, 1997). The maintenance of human impacts are management issues (DCEWA, 1983).

11.2.4 Blackboy Creek Inlet (33°53.45'S 122°53.33'E)

Blackboy Creek Inlet (Normally Closed/Riverine) is a small estuary that is about 1km long and 10m wide (Bancroft *et al.*, 1997). It cuts through spongolite rock and reaches the ocean over a 250m wide sandy beach. Most of its catchment is naturally vegetated (Hodgkin & Clark 1989).

11.2.5 Thomas River Inlet (33°49'S 123°02'E)

The Thomas River Inlet (Seasonally Open/Riverine) is a narrow estuary that is 10-20m wide and approximately 1km long (Bancroft *et al.*, 1997). The majority of the Thomas River catchment lies within the Cape Arid National Park, however, a small part is cleared farmlands (Bancroft *et al.*, 1997). Salinities recorded were 22.5ppt in October 1971 and 26ppt in May 1977. A pool has been observed to be always present on the beach (Hodgkin & Clark, 1898b).

11.2.6 Jorndee Creek Inlet (33°57'S 123°18'E)

Jorndee Creek Inlet (Permanently Open/Riverine) is the only permanently opened inlet, east of Albany besides Waychinicup Inlet (Bancroft *et al.*, 1997). This shallow estuary is 500m long, 5-7m wide and is tidally influenced, and on occasions the inlet empties at low tide. The creek cuts through the granite rocks of the eastern face of Cape Arid (Bancroft *et al.*, 1997). On two sampling occasions in 1971 and 1977, salinity recorded was seawater, 35ppt. Jorndee Creek Inlet is housed within the Cape Arid National Park. On the northern shore of the inlet, there is a camping ground and a borehole toilet (Hodgkin &Clark, 1989).

11.2.7 Poison and Fern Creeks (33°54.32'S 123°21.10'E)

The estuary of Poison and Fern Creeks (Seasonally Open/Riverine) is nestled behind coastal dunes (Bancroft *et al.*, 1997). It has a length of 700m, width of 15m and is quite shallow near the ocean cut. Salinities recorded are from 20-51ppt (Hodgkin & Clark, 1989). Poison Creek Inlet is wholly within the Cape Arid National Park. The estuary has dense natural vegetative fringe of paperbarks and coastal heath, however, the paperbarks thickets have been badly degraded by campers. Consequently the maintenance of this and other human impacts are management issues (Bancroft *et al.*, 1997).

11.3 MANAGEMENT ISSUES

11.3.1 Loss of native Bushland

The most damaging change to riverine and estuarine ecosystems that has occurred since European settlement of the south coast region, has been the wholesale clearing of native bushland in most river catchments (Bancroft *et al.*, 1997). The clearing of vegetation within catchments has indirectly caused rising water tables which has contributed to, or has been associated with, many environmental problems (WAWRC, 1992):

1) Water logging and subsequent loss of riparian vegetation;
2) Increases in the rate and volume of runoff which transports nutrients from artificial fertilisers applied to broad-acre farmlands and increases erosion;
3) Soil erosion leading to river and estuary siltation, and nutrient transportation in the form of sediment bound phosphorous, nitrogen and trace metals;
4) Leaching of salts from soil leading to increases in river salinity;
5) Increased flooding requiring engineered drainage systems, especially in low lying areas, and;
6) Loss of buffer zones allowing transport of nutrient and sediment to rivers and estuaries.

The clearing of virtually all of the fringing vegetation along the watercourses radically changed the character of the streams. The watercourse changed from an environment that supported a multitude of organisms, to that of an open drainage channel (WAWRC, 1992). The loss of riparian vegetation in some areas represented a loss of endemic plant and animal species and a loss of sediment trapping and denitrification processes. This is because the health of remnant vegetation determines the structural and ecological stability of a river, which ultimately determines the structural and ecological stability of its receiving estuary.

11.3.2 Salinity

In the south coast region, the fundamental cause of the increase in salinisation has been the widespread removal of perennial deep-rooted native vegetation and its replacement with shallow-rooted annual crops and pastures (Bancroft *et al.*, 1997). Extensive clearing throughout low rainfall regions (such as

that within the study area), has resulted in surface water streams having increased salinity. This is because the permanent removal of native bushland has given rise to the accelerated leaching of salts to the river systems (Sanders, 1991). Salt leaching has had devastating effects on the environment, which impacts both the catchment and the rivers. Rising water table levels as a result of clearing often causes the death of remnant vegetation through water logging and salinity. It can also cause waterbirds to abandon their wetlands in search of freshwater, and can alter the aquatic community structure according to salinity gradients.

11.3.3 Erosion

Removal of natural vegetation from rivers and stream courses and their natural flood plains has exposed the fragile, shallow topsoil over large areas of land. Increased runoff from these areas facilitates the transport of sediments to streams, rivers, estuaries and ultimately the sea. All estuaries with catchment clearing and a lack of riparian buffer strips have significant signs of silting.

11.3.4 Eutrophication

The process, by which nutrient pollutants cause riverine and estuarine ecosystems to change, is called eutrophication. South coast estuaries are more likely to be affected by eutrophication, than rivers, because these water bodies are poorly flushed. This lack of flushing can result in the nutrient loads in winter runoff, rapidly accumulating to excessive levels. Excessive nutrients in estuaries can cause accelerated growth of plants, macrophytes and plankton. Increase macrophyte biomass can smother existing seagrass communities, which can result in the water column becoming de-oxygenated, leading to fish kills and foul smelling decaying organics being washed up on the estuary's shoreline. If eutrophication is extreme, blue-green algal blooms may occur.

The estuaries found within the study area fortunately do not experience extensive environmental problems (Appendix 27). The two estuaries that are most affected by catchment clearing and the associated problems are Torradup and Stoked Inlet. However, with proper management and conservation, these environmental problems may not escalate to the same levels as that experienced by other estuaries in Western Australia.

11.4 ESTUARINE FLORA AND FAUNA

South coast estuaries are depauperate in terms of diversity of plants and animals due to their strongly seasonal nature and the extreme hydrological conditions that result, although biological production and population density of tolerant species may be very high when conditions are favourable (CALM, 1994). Most of the estuaries are becoming progressively degraded as biological environments as a result of nutrient enrichment and sedimentation and increased frequency of flooding following extensive clearing in their catchments.

There is only a handful of obligate estuarine species (i.e. aquatic species found in estuaries but not in marine or freshwater habitats) in the south coast biota. Most of the animals present in the seasonally open estuaries are opportunistic marine invaders that enter with tidal flows in early summer when the flow of freshwater decreases (CALM, 1994). Some of these species are subject to mass mortalities when the next winter floods scour the estuaries with freshwater. In the case of the semi-permanently closed estuaries (e.g. Thomas, Poison and Fern Estuaries), marine species invade on those occasions when the bars open and a progressive decline in species diversity follows after the bars reclose (CALM, 1994).

Obligate estuarine molluscs that occur within the study area include the gastropods *Hydrococcus brazieri, Salinator fragilis, Tatea preisii* and *Hydrobia buccinoides* and the bivalves *Fluviolanatus subtorta, Xenostrobus inconstans* and *X. securis*. Among the marine mollusc species which normally

inhabit protected bays and inlets and invade the estuaries when conditions are suitable are the bivalves *Arthritica semen, Katelysia scalarina, K. peroni, Spisula trigonella, Mytilus edulis planulatus, Wallucina assimilis, Macomona deltoidalis, Soletellina donacioides, Sanguinolaria biradiata, Iris crenata* and *Theora lubrica,* and the gastropods *Nassarius burchardi, N. pauperatus, Liloa brevis and Philine* species (CALM, 1994). Some of this second group of molluscs may maintain populations within the estuaries for several years even if the bars remain closed. Fossil beds containing shells of these and other marine species are commonly found around the shores of the estuaries, providing evidence that seasonal conditions during earlier times in the Holocene and Pleistocene were rather less extreme than at present (CALM, 1994).

The tubeworm *Ficopomatus enigmaticus* is found in most of the estuaries wherever there are hard substrates (CALM, 1994). Other common polychaetes are *Capitella capitata, Scoloplos simplex, Ceratonereis aequisetes, Neanthes vaali, Prionospio* cf. *cirrifera* and *Polydora* species. Two species of benthic amphipod, *Melita* spp. and *Paracorophium spp*., are commonly present. The estuarine crab *Halicarcinus ovatus* is also usually common, especially in beds of the mussel *Xenostrobus*. The shrimp *Palaemonetes australis* seems to be everywhere. Two marine crustaceans, the blue manna crab, *Portunus pelagicus* and the barnacle *Balanus amphitrite*, invade the larger estuaries when the bars open but neither is capable of surviving prolonged winter flooding. The crab moves out of the estuaries to avoid such flooding while the fixed barnacle suffers mass mortality. Empty barnacle shells are frequently seen on rocks and timber, evidence of the transient success of the species.

With the exception of some atherinid and gobiid species, few fish breed in the south coast estuaries (CALM, 1994). The most notable of those which do are the black bream and the cobbler which are target species of both the commercial and recreational fisheries. However, there are many species, which enter the estuaries from the sea as juveniles and use them as nursery areas (Lenanton, 1974a; 1974b; 1984; Lenanton & Hodgkin, 1985). Large numbers of juveniles of fishes, such as mullet and whiting, which enter the estuaries when they are open to the sea and establish flourishing populations become isolated from the sea after the bars close again. Such populations may flourish in the semi-permanently closed estuaries for several years following breaching of the entrance bars (CALM, 1994).

Plankton blooms occur in early summer in the south coast estuaries, developing in wedges of saline water that penetrate upstream as the summer progresses (CALM, 1994). The majority of zooplankton species are the larvae of marine species and are the source of recruitment to the estuarine fauna. However, there are a few truly estuarine planktonic animals. The most ubiquitous of these is the copepod *Galdioferens imparipes*. Also recorded are the copepods *Sulcanus conflictus, Acartia tranteri, A. clausi* and *Oithona nana*. Nearer the entrances these are usually replaced by more marine copepods such as *Gladioferens inermis*. Small medusae of the genus *Australomedusa* are also common.

Ruppia megacarpa is the only submerged aquatic plant that commonly occurs in south coast estuaries (CALM, 1994). It is a dominant plant in the basins of the lagoonal estuaries and lower reaches of most of the riverine estuaries. It grows on sand in the shallows and is an important food resource for Black Swans. Other seagrasses occur mainly in the lower parts of those estuaries, which are permanently open. Seagrasses are vulnerable to reduced light intensity. This detrimental condition may be caused by turbidity or eutrophication, which produced increased density of phytoplankton and epiphytes. Seagrass communities of many of the south coast estuaries show evidence of decline caused by these forms of pollution (Hodgkin & Clark, 1990).

There is a variety of macroalgae and filamentous algae in the south coast estuaries. Brown algae are not common. Green algae dominate most of the vegetation, including species of *Polyphysa, Cladophora, Chaetomorpha, Enteromorpha* and *Vaucheria*. The stonewart *Lamprothamnium papulosum* is common in most estuaries. Some of these algae are subject to spring blooms and eutrophication and sedimentation may smother the seagrasses.

12 COASTAL TERRESTRIAL BIOTA

12.1 VEGETATION

The study area lies in the Eyre Botanical Region of the South West Botanical Province. A number of plant formations are present in the area between Stokes Inlet and Israelite Bay. The following descriptions have been modified from Beard (1973). Additionally, a comprehensive list of vascular plants that have been found to occur within the Recherche Archipelago is included in Appendix 28.

1. Coastal dune scrub covers the young land surface of predominantly Quaternary sands, which represent several cycles of dune building. On the seaward side of the primary dune there is a low mixed scrub in which *Ricinocarpus glaucus* is abundant. Whereas in areas of deep sand, particularly dune ridges, thickets of showy banksia (*Banksia speciosa*) are present. Species of *Melalueca* often comprise an understorey and from areas of dense scrub in interdunal swales. The plant cover is very variable and where the sand is shallow or where the gravel outcrops the vegetation may be less than a metre high.
2. Coastal foredunes are highly susceptible to erosion when the protected vegetation is removed. Fires, indiscriminate clearing or cutting of trees for firewood, 4WD tracks and paths can cause loss of vegetation. Wind erosion of these devegetated areas can cause large blowouts to develop.
3. Scrub-heath is found inland from the coast both where the remnant aeolian dunes overlying the tertiary plateau (where the sands are rather old) and the Pallinup siltstone scarp which may have a thin veneer of aeolian sand. It is a floristically rich community, consisting mainly of *Banksia media*, *B. speciosa*, *B. repens*, *B. blechnifolia*; Hakeas such as *Hakea corymbosa* and *H. cinera*; and Peppermint trees (*Agonis flexuosa*) growing on the ridges. The hollows are covered with a heath abundant with sedges and *Restionaceae* with scattered Christmas trees (*Nuytsia floribunda*). On the Tertiary plateau, Blackboy (*Xanthorrhoea preisii*) is a common component of the shrub layer.
4. Mallee-heath occurs on the Tertiary plateau and scarp, and is similar to scrub-heath except mallee eucalypts, such as *Eucalyptus tetragona*, *E. redunca*, *E. unicata*, *E. tetraptera*, *E. preissiana* and *E. stoatei* form the tall shrub layer. There is also a complex coastal heath occurring on the foreslopes of the coastal dunes, which includes species such as *Scaevola crassifolia* and *Spinifex hirsutus*.
5. Mallee. The young soils of the valley slopes of the Dailey, Mungliginup, Alexander, Blackboy and Thomas Rivers usually support a mallee woodland. Black Marlock (*Eucalyptus redunca*) is usually dominant in this tall shrub community, but *E. tetragona, E. unicata, E. tetraptera*, *E. preissiana, E. eremorpha* and *E. stoatei* usually also contribute to the tall shrub layer.
6. Paperbark Woodland. The winter-wet swampy depressions and lakes are colonised by salt-water paperbark (*Melaleuca cuticularis*) near the coast and *M. preissiana* further inland. On the drier margins, the growth is scrubbier with water bush (*Banksia occidentalis*) being common.
7. Rock Associations. Granite forms massive domal outcrops but plants can be found growing in patches of soil and rubble clinging to the slopes. The flora is commonly specialised and strongly endemic to this habitat including *Barya nitida, Macrozamia reidlei* and species of *Acacia, Agonis* and *Hakea* (DCEWA, 1983; Craig & Oma, 1984; SCAP & SCRIPT, 1997a).

The study area has not been surveyed for rare plants. There are occurrences of gazetted rare plants in Cape Le Grand National Park, including *Eucalyptus aquilina, E. insularis* and *Lambertia echinata*. In Cape Arid National Park, *Grevillea baxteri* and *Kennedia beckxiana* have been recorded.

12.2 WILDLIFE

12.2.1 Mammals

Several species of mammal are commonly found in both Cape Le Grand and Cape Arid National Parks. The southern bush rat (*Rattus fuscipes*) inhabits thickets of *Banksia speciosa.* Flowering banksias provided a food source for the honey possum (*Tarsipes rostratus*) which also frequent low heath environments. The common dunnart (*Sminthopsis murina*) has a very wide range, preferring wet and dry open woodland and swamps. The Western grey kangaroo (*Macropus fuliginosus*) and the Southern brown bandicoot (*Isodon obesulus*) are also common throughout the area.

The Western pygmy possum (*Certartetus concinnus*) and Brush-tailed rock wallaby (*Petrogale penicillata*) are seldom seen in the parks but it is possibly not uncommon. A species that has been found infrequently is the ash-grey mouse (*Pseudomys albocinereus*). The tammar wallaby (*Macropus eugenii*) is still known to exist on a couple of the islands within the Recherche Archipelago (e.g. Middle Island), however, it has not been recorded on the mainland since 1977.

The bone remains of mammals from surface cave deposits have been studied near Marbellup Hill and Mount Arid to determine the past fauna of the area (Appendix 29). The now rare dibbler (*Antechinus apicalis*) has been discovered in these deposits.

Exotic animals are also found in the area. These species include the fox (*Vulpes vulpes*), cat (*Felis catus*), house mouse (*Mus musculus*), horse (*Equus caballus*) and European rabbit (*Oryctolagus cuniculus*).

12.2.2 Birds

A large number of birds have been recorded within the study area (Appendix 30). The Wandering albatross, Recherche Cape Barren goose and ground parrot are all protected under the *Wildlife Conservation Notice* (1998), and the ground parrot is critically endangered.

12.2.3 Reptiles and Amphibians

Numerous species of reptiles and amphibian are found to occur within the terrestrial component of the study area. Species found during surveys are illustrated by Appendix 31.

12.2.4 Invertebrates

Numerous invertebrate species (spiders and insects etc.) are found to occur within the terrestrial component of the study area. A list of species found during a 1977 survey in Cape Le Grand National Park by the National Parks Authority, illustrates the terrestrial invertebrate diversity found within the study area (Appendix 32).

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APPENDICES

APPENDIX I: WHALE STRANDINGS AND MORTALITIES RECORDED FOR THE SOUTH COAST FROM JULY 1984 TO OCTOBER 1996 (*after* CALM, 1997).

Date	Species	Health	Location	Sex & Length
19/7/84	Pygmy right whale	death unknown	Mutton Bird Beach	1.59m
20/11/84	Short-finned pilot whale	mild decay	Between Gull Rock and Ledge Beach	2.78m
2/8/85	Pygmy sperm whale	alive and sent back, but found dead the next day	Windy Harbour Beach	1.46m
10/12/85	Sperm whale	advanced decomposition	Prescotvale Road Beach	10.4 possibly female
21/9/86	Minke whale	death unknown	Hassel Beach	3.06m
23/8/87	Minke whale	found alive, died 24th, death due to stress	Princess Royal Harbour	3m new born male
13/1/88	Long-finned pilot whale	death unknown	Dingo Beach	4.45m female
13/11/88	Sperm whale	death unknown	Cheynes Beach	10m female
1/1/89	Arnoux's beaked whale	death unknown	Kordenup Beach	8.4m male
9/9/89	Minke whale calf	sent out to sea OK	Two Peoples Bay	3.8m
5/8/90	Whale	decomposed	Sinker Reef, Two Peoples Bay	approximately 20m
15/10/90	2 x True's beaked whale	death unknown	Fosters Beach	
29/1/91	Sperm whale skeleton		Dunster Castle Bay, Stokes National Park	4.5m skull
25/6/91	Pilot whale	death unknown	Hamersley Beach	1.7m male
18/11/91	Humpback whale	death unknown	Two Peoples Bay	5.5m juvenile
23/4/93	Pygmy sperm whale	death unknown	Mutton Bird Beach	1.8m
8/11/93	Sperm whale	death unknown	Madfish Bay	15m
25/12/93	Strap-toothed beaked whale	4 originally, now 2 (1 dead, 1 alive)	West of Wilson Inlet	
19/9/94	Minke whale	alive	Cheynes Beach	5.1m female
3/6/95	Sperm whale	death unknown	East of Banksia Camp	newborn female 4m
12/6/95	Shepherd's beaked whale	death unknown	East of Parry's Inlet	female
8/12/95	True's beaked whale	death unknown	Cable Beach, Torndirrup	immature female
9/1/96	Whale	badly decomposed	Aldridge Cove, Walpole	6m +
8/1/96	Whale skeleton/head		Seal Island, Goodie Beach	
23/8/96	Humpback whale	decomposing, cause of death unknown	West of Miles Beach	3.5m male
10/10/96	Southern right whale	dead ~ 4-5 weeks	East of Fitzgerald River	7.8m
18/10/96	Sperm whale	cause of death unknown	West Beach, Hopetoun	17m

APPENDIX II: DOLPHIN STRANDINGS AND MORTALITIES RECORDED FOR THE SOUTH COAST FROM NOVEMBER 1990 TO JULY 1996 (*after* CALM, 1997).

Date	Species	Health	Location	Sex & Length
19/11/90	Bottlenose dolphin	Death unknown, advanced decomposition	Princess Royal Harbour	
29/1/91	2 x Common dolphin	Advanced decomposition	Peppermint Beach, Bremer Bay	1.85m
6/2/91	2 x Common dolphin	Death unknown	Bremer Bay	
24/5/91	Common dolphin	Death unknown	Banksia Bay	1.25m male
1/1/92	Common dolphin	Drowned in mulie net	Bremer Bay	2m female
19/1/92	Common dolphin	Drowned in net	Bremer Bay	2.21m
28/1/92	Dolphin	Drowned in net, carcass lost overboard	Bremer Bay	
30/1/92	Common dolphin	Badly decomposed	Middleton Beach	1m juvenile
21/2/92	Bottlenose dolphin	Deep decomposition	Rossiter Beach, Esperance	2.5m
3/4/92	Common dolphin	Drowned in net	Dillon Bay	1.68m male
20/3/92	Common dolphin	Drowned in net	Dillon Bay	1.75m female
1/1/93	Bottlenose dolphin	Death unknown	Fitzgerald Inlet Beach	8 feet 6 inches
28/1/93	Common dolphin	Drowned in net	Bremer Bay	mature male
21/4/93	Common dolphin	Death unknown	Ledge Beach & Gull Rock	1.45m juvenile
27/4/93	Bottlenose dolphin	Death unknown	Middleton Beach	1.8m male
28/4/93	Common dolphin	Death unknown	Middleton Beach	1.7m female
13/5/93	Dolphin	Drowned in mulie net, carcass lost overboard		
5/10/93	Common dolphin	Drowned in net	Bremer Bay	2.25m male
10/12/93	Common dolphin	Drowned in net	Bremer Bay	1.93m female
12/2/94	Common dolphin	Drowned in mulie net	Bremer Bay	1.64m male
21/2/94	Common dolphin	Caught in mulie net	Bremer Bay	2.24m male
16/4/94	Common dolphin	Caught in mulie net	Bremer Bay	1.2m juvenile female
16/6/94	Common dolphin	Drowned in net	Bremer Bay	1.9m male
15/7/96	Common dolphin	Advanced decomposition	Ledge Beach	

APPENDIX III: CETACEAN SPECIES, WHICH MAY OCCUR OFF THE SOUTH COAST OF WESTERN AUSTRALIA (*after* CALM, 1997).

Common name	Scientific name	Coastal species
Dusky dolphin	*Lagenorhynchus obscurus*	
Bottlenose dolphin	*Tursiops truncatus*	Yes
Striped dolphin	*Stenella coeruleoalba*	
Common dolphin	*Delphinus delphis*	Yes
Southern right whale dolphin	*Lissodelphis peronii*	
False killer whale	*Pseudorca crassidens*	
Killer whale	*Orcinus orca*	
Long-finned pilot whale	*Globicephala melas*	
Short-finned pilot whale	*Globicephala macrorhynchus*	
Shepherd's beaked whale	*Tasmacetus sheperdi*	
Arnoux's beaked whale	*Berardius arnuxii*	
Strap-toothed whale	*Mesoplodon layardii*	
Gray's beaked whale	*Mesoplodon grayi*	
True's beaked whale	*Mesoplodon mirus*	
Cuvier's beaked whale	*Ziphius cavirostris*	
Southern bottlenose whale	*Hyperoodon planifrons*	
Sperm whale	*Physeter macrocephalus*	
Pygmy sperm whale	*Kogia breviceps*	
Dwarf sperm whale	*Kogia simus*	Possibly
Southern right whale	*Eubalaena australis*	Yes
Pygmy right whale	*Caperea marginata*	Yes
Minke whale	*Balaenoptera acutorostrata*	Yes
Sei whale	*Balaenoptera borealis*	
Bryde's whale	*Balaenoptera edeni*	Yes
Blue whale	*Balaenoptera musculus*	Possibly
Fin whale	*Balaenoptera physalus*	
Humpback whale	*Megaptera novaeangliae*	Yes

APPENDIX IV: LOCATION OF AUSTRALIAN SEA LION BREEDING COLONIES IN WESTERN AUSTRALIA (*after* Shaughnessy, 1999).

Australian sea lion colonies in Western Australia	
Great Australian Bight, B10	MacKenzie Island
Spindle Island	Little Island
Ford Island	Investigator Island
Six Mile Island	West Island
Round Island	Red Islet
Cooper Island	Middle Doubtful Island
Salisbury Island	Hauloff Rock
Poison Creek Island	Buller Island
Wickham Island	North Fisherman Island
Glennie Island	Beagle Island
Taylor Island	Houtman Abrolhos, Suomi Island
Twin Peaks Island, SW Rock E of	Houtman Abrolhos, Alexander Island
Kermadec Island	Houtman Abrolhos, Gilbert Island
Kimberley Island	Houtman Abrolhos, Serventy Island

APPENDIX V: AUSTRALIAN SEA LION PUP COUNTS AND ESTIMATED PUP PRODUCTION AT KNOWN BREEDING SITES IN WESTERN AUSTRALIA (*after* CALM, 1997).

Location	Date	Maximum number of pups counted	Estimated pup production
Spindle island	9/1/90	53	60
Ford Island	28/6/90	24	30
Six Mile Island	7/5/91	43	50
Round Island	28/6/90	20	25
Cooper island	22/6/90	3	4
Salisbury Island	22/6/90	14	25
Poison Creek Island	24/9/88	2	5
Wickham Island	19/5/89	18	20
Glennie Island	10/2/92	24	30
SW Rock E of Twin Peaks	21/6/90	1	1
Taylor Island	9/2/92	7	7
Kermadec Island	10/2/92	4	6
Kimberley Island	9/2/92	42	50
McKenzie Island	6/2/92	5	38
Little Island	15/1/90	1	5
Rocky Island	13/9/89	17	25
West Island	12/2/91	20	25
Red Islet	11/9/89	27	40
Middle Doubtful Island	11/9/89	10	20
Hauloff Rock	2/9/89	29	35
Buller Island	6/11/89	39	39
North Fisherman Island	7/11/89	63	63
Beagle island	23/3/91	79	79
Houtman Abrolhos	6/1/89	11	20
Total		**556**	**702**

APPENDIX VI: LOCATION OF NEW ZEALAND FUR SEAL BREEDING COLONIES IN WESTERN AUSTRALIA (*after* Shaughnessy, 1999).

New Zealand fur seal colonies in Western Australia	
Daw (Christmas) Island	Hood Island
New Year Island	Seal Rock
Cranny Island	Investigator Island
Cooper Island	West Island
Salisbury Island	Doubtful Island
Beaumont Island	Hauloff Island
Draper Island	Eclipse Island
Finger Island	Flinders Island
Libke Island	

APPENDIX VII: NEW ZEALAND FUR SEAL PUPS IN BREEDING COLONIES DURING FOUR SUCCESSIVE SEASONS, 1987-88 TO 1990-91 (*after* CALM, 1997).

Location	1987-88	1988-89	1989-90	1990-91
Daw Island	-	-	73	70
New Year Island	-	-	32	21
Cranny Island	-	-	60	50
Cooper Island	-	-	123	-
Salisbury island	-	-	451	-
Beaumont island	-	-	39	75
Draper Island	-	-	-	22
Finger Island	-	-	0	4
Libke Island	-	-	0	166
Hood Island	32	-	33	40
Seal Rock	5a	-	187	172
Rocky Island	-	-	27	-
West Island	-	-	2a	43
Doubtful Islands	49	31	49	-
Hauloff Rock	-	-	51	-
Eclipse Island	-	24	33	-
Total	86	55	1160	663

APPENDIX VIII: NEW ZEALAND FUR SEALS IN BREEDING COLONIES AND HAUL-OUT SITES DURING FOUR SUCCESSIVE SEASONS, 1987-88 TO 1990-91 (*after* CALM, 1997).

Location	1987-88	1988-89	1989-90	1990-91
Daw Island	-	-	-	133
Daw Colony	-	-	124	-
Daw Coast	-	-	96	-
New Year Island	-	-	81	42
New Year Coast	-	-	4	-
Cranny Island	-	-	126	113
Paisley Island	-	-	-	12
Paisley Rocks	-	-	20	-
Beaumont Island	-	-	99	128
Draper Island	-	-	-	127
Finger Island	-	-	17	18
Libke Island	-	-	13	261
Hood Island	82	-	65	73
Seal Rock	50	-	307	172
West Island	-	-	21	98
Pointer Island	-	-	33	-
Round Rock	-	-	13	-
Round Island	-	-	135	-
Cooper Island	-	-	286	-
Salisbury Coast	-	-	105	-
Salisbury Island	-	-	792	-
Westall Island	-	-	1	-
Kermadec Island	-	-	9	-
Hastings Island	-	-	1	-
MacKenzie Island	-	-	2	-
Termination Island	-	-	58	-
Little Island	-	-	90	-
Corbett Island	-	-	5	-
Fur Rock	1	-	7	-
Rug Rock	25	-	10	-
Square Rock	-	-	22	-
Figure of Eight Island	20	-	13	-
Rocky Island	-	-	94	-
East Doubtful Island	17	-	47	-
Middle Doubtful Island	145	212	148	-
West Doubtful Island	12	-	1	-
Hauloff Rock	-	-	212	-
Bird Rock	-	-	9	-
Bald Island	15	-	26	-
Coffin Island	-	-	9	-
Eclipse Island	-	85	98	-
Chatham Island	-	-	12	-
Flinders Island	-	-	12	-
Gunton Island	1	-	-	-
Capps Island	2	-	-	-
Total	370	297	3223	1177

APPENDIX IX: PINNIPED STRANDINGS AND SIGHTINGS RECORDED FOR THE SOUTH COAST FROM OCTOBER 1992 TO JANUARY 1997 (*after* CALM, 1997).

Species	Date	State of health	Location	Sex & length
Elephant seal	1992	alive and disappeared	King George Sound	
Subantarctic fur seal	10/07/1992	death unknown	Point Possession	Juvenile F
Subantarctic fur seal	09/08/1992	euthanased 11/09/1992	Peaceful Bay	Juvenile
New Zealand fur seal	22/09/1992	advanced decomposition		
Subantarctic fur seal	22/12/1992	starvation	Princess Royal Harbour	Juvenile
New Zealand fur seal	14/01/1993	advanced decomposition	Dillon Bay Beach	
Australian sea lion	13/02/1993	emaciated, ensnared in shark net, euthanased	Norman's Beach	
New Zealand fur seal	19/02/1993	emaciated & died	Cheynes Beach	F mature
Australian sea lion	22/02/1993	death unknown	Oyster Harbour	M
Crabeater seal	02/03/1993	hauling out, then disappeared	Princess Royal Harbour	2.6m
New Zealand fur seal	24/03/1993	died before release	Hauloff Rock	Juvenile
Subantarctic fur seal	14/04/1993	ensnared in shark net, rescued & swam away	William Bay National Park	
Subantarctic fur seal	17/11/1994	starvation	Cheynes Beach	Juvenile
Leopard seal	09/01/1995	euthanased	Princess Royal Harbour	F 3.2m
New Zealand fur seal	14/03/1995	tuberculosis positive	Two Peoples Bay	M 2.2m
Leopard seal	09/04/1995	euthanased	Mutton Bird Beach, Torbay	M 2.2m
Australian sea lion	10/08/1996	wounded & died 13/10/1996	Fanny Cove	
Australian sea lion	28/08/1995	death unknown	Parry's Inlet Walpole	Juvenile F
Elephant seal	23/01/1997	hauling out	Oyster Harbour	

APPENDIX X: SEABIRD SPECIES OCCURRING ON ISLANDS IN THE RECHERCHE ARCHIPELAGO IN 1982 (*after* CALM, 1997; and *Corella 'Seabird Island' series* published between 1982-1990).

Common Name	Scientific Name	Middle Island	Nares Island	Lorraine Island	Ram Island	MacKenzie Island	Hood Island	Frederick Island	Sandy Hook Island	Remark Island	Long Island	Cull Island	Observatory Island	Canning Island	Figure of Eight Island	Charley Island	Woody Island	Mondrain Island	Forrest Island	Skink Island	Harlequin Island	Gulch Island	Wickham Island	Bellinger Island	Six Mile Island
Brown goshawk	*Accipiter fasciatus*																								
Cape Barren goose	*Cereopsis novaehollandiae*																								
Marsh harrier	*Circus aeruginosus*																								
Australian raven	*Corvus coronoides*																								
Cape petrel	*Daption capense*																								
Yellow-nosed albatross	*Diomedea chlororhynchus*																								
Eastern reef egret	*Egretta sacra*																								
Little penguin	*Eudyptula minor*																								
Peregrine falcon	*Falco peregrinus*																								
Sooty oystercatcher	*Haematopus fuliginosus*																								
White-bellied sea eagle	*Haliaeetus leucogaster*																								
Caspian tern	*Hydroprogne caspia*																								
Silver gull	*Larus novaehollandiae*																								
Pacific gull	*Larus pacificus*																								
Black-faced shag	*Leucocarbo fuscescens*																								
White-faced storm petrel	*Pelagodroma marina*																								
Great cormorant	*Phalacrocorax carbo*																								
Little black cormorant	*Phalacrocorax sulcirostris*																								
Great winged petrel	*Pterodroma macroptera*																								
Little shearwater	*Puffinus assimslis*																								
Flesh-footed shearwater	*Puffinus carneipes*																								
Short-tailed shearwater	*Puffinus tenuirostris*																								
Crested tern	*Sterna bergii*																								
Fairy tern	*Sterna nereis*																								

APPENDIX XI: SEABIRD SPECIES WHICH MAY OCCUR OFF THE SOUTH COAST OF WESTERN AUSTRALIA (*after* CALM, 1997).

Common Name	Scientific Name
PENGUINS	
Little penguin	*Eudyptula minor*
ALBATROSSES	
Wandering albatross	*Diomedea exulans*
Black-browed albatross	*Diomedea melanophrys*
Grey-headed albatross	*Diomedea chrysostoma*
Yellow-nosed albatross	*Diomedea chlororhynchos*
Shy albatross	*Diomedea cauta*
Sooty albatross	*Phoebetria fusca*
Light-mantled albatross	*Phoebetria palpebrata*
PETRELS & SHEARWATERS	
Southern giant petrel	*Macronectes giganteus*
Northern giant petrel	*Macronectes halli*
Cape petrel	*Daption capense*
Great-winged petrel	*Pterodroma macroptera*
White-headed petrel	*Pterodroma lessonii*
Kerguelen petrel	*Pterodroma brevirostris*
Soft-plumed petrel	*Pterodroma mollis*
Blue petrel	*Halobaena caerulea*
Salvin's prion	*Pachyptila salvini*
Antarctic prion	*Pachyptila desolata*
Slender-billed prion	*Pachyptila belcheri*
Fairy prion	*Pachyptila turtur*
White-chinned petrel	*Procellaria aequinoctialis*
Flesh-footed shearwater	*Puffinus carneipes*
Sooty shearwater	*Puffinus griseus*
Short-tailed shearwater	*Puffinus tenuirostis*
Fluttering shearwater	*Puffinus gavia*
Huttons shearwater	*Puffinus huttoni*
Little sheawater	*Puffinus assimilis*
STORM PETRELS	
Wilsons storm petrel	*Oceanites oceanicus*
DIVING PETRELS	
White-faced storm petrel	*Pelagodroma marina*
Black-bellied storm petrel	*Fregetta tropica*
PELICANS	
Australian pelican	*Pelecanus conspicillatus*
GANNETS & BOOBIES	
Australian gannet	*Morus serrator*

Common Name	Scientific Name
DARTERS	
Darter	*Anhinga melanogaster*
CORMORANT	
Black-faced cormorant	*Leucocarbo fuscescens*
Great cormorant	*Phalacrocorax carbo*
Pied cormorant	*Phalacrocorax varius*
Little-black cormorant	*Phalacrocorax sulcirostris*
Little-pied cormorant	*Phalacrocorax melanoleucos*

APPENDIX XII: SHOREBIRD SPECIES WHICH MAY OCCUR ALONG THE SOUTH COAST OF WESTERN AUSTRALIA (*after* CALM, 1997).

Common Name	Scientific Name
OYSTERCATCHERS	
Pied oystercatcher	*Haematopus longvostris*
Sooty oystercatcher	*Haematopus fuliginosus*
DOTTERS, PLOVERS & LAPWINGS	
Banded lapwing	*Vanellus tricolor*
Grey plover	*Pluvialis squatarola*
Pacific golden plover	*Pluvialis dominica*
Red-kneed dotterel	*Erythrogonys cinctus*
Hooded plover	*Charadrius rubricollis*
Mongolian plover	*Charadrius mongolus*
Double-banded plover	*Charadrius bicinctus*
Large sand plover	*Charadrius leschenaultii*
Red-capped plover	*Charadrius ruficapillus*
Black-fronted plover	*Charadrius melanops*
Inland dotterel	*Peltohyas australis*
STILTS & AVOCETS	
Black-winged stilt	*Himantopus leucocephalus*
Banded stilt	*Cladorhynchus leucocephalus*
Red-necked stilt	*Recurvirostra novaehollandiae*
SANDPIPERS, SNIPE, CURLEWS & GODWITS	
Ruddy turnstone	*Arenaria interpres*
Eastern curlew	*Numenius madagascariensis*
Whimbrel	*Numenius phaeopus*
Wood sandpiper	*Tringa glareola*
Grey-tailed tattler	*Tringa brevipes*
Common sandpiper	*Tringa hypoleucos*
Greenshank	*Tringa nebularia*
Black-tailed godwit	*Limosa limosa*
Bar-tailed godwit	*Limosa lapponica*
Red knot	*Calidris canutus*
Sharp-tailed sandpiper	*Calidris acuminata*
Red-necked stint	*Calidris ruficollis*
Long-toed stint	*Calidris subminuta*
Curlew sandpiper	*Calidris ferruginea*
Sanderling	*Calidris alba*
SHEATHBILLS	
Lesser sheathbill	*Chionis minor*
SKUAS & JAEGERS	
Southern skua	*Catharacta antarctica*
Arctic jaeger	*Stercorarius parasiticus*

Common Name	Scientific Name
GULLS & TERNS	
Silver gull	*Larus novaehollandiae*
Pacific gull	*Larus pacificus*
Kelp gull	*Larus dominicanus*
Whiskered tern	*Chlidonias hybridus*
Gull-billed tern	*Gelochelidon nilotica*
Caspian tern	*Hydroprogne caspia*
Arctic tern	*Sterna paradisaea*
Fairy tern	*Sterna nereis*
Crested tern	*Sterna bergii*

APPENDIX XIII: ELASMOBRANCH SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*after* Gommon *et al.*, 1994; Dr. Barry Hutchins, *pers. comm.*).

Common name	**Scientific name**
Port jackson shark	*Heterodontus portusjacksoni*
Bronze whaler	*Carcharhinus brachyurus*
Pencil shark	*Hypogaleus hygaensis*
School shark	*Galeorhinus galeus*
Gummy shark	*Mustelus antarcticus*
Whiskery shark	*Furgaleus macki*
Smooth-headed hammerhead	*Sphyrna zygaena*
White pointer shark	*Carcharodon carcharias*
Grey nurse shark	*Carcharias taurus*
Black-spotted catshark	*Aulohalaelurus labiosus*
Draughtboard shark	*Cephaloscyllium laticeps*
Gulf wobbegong	*Orectolobus ornatus*
Cobbler carpet shark	*Orectolobus tentaculatus*
Varied catshark	*Parascyllium variolatum*
Striped stingaree	*Trygonoptera ovalis*
Spotted stingaree	*Urolophus gigas*
Smooth stingray	*Dasyatis brevicaudata*
Eagle ray	*Myliobatis australis*

APPENDIX XIV: BONY FISH SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*after* Gommon *et al.*, 1994; Dr. Barry Hutchins, *pers. comm.*).

Common Name (*Scientific Name*)	**Common Name (*Scientific Name*)**
Shortfinned worm eel (*Muraenichthys australis*)	Longsnout boarfish (*Pentaceropsis recurvirostris*)
Longfinned worm eel (*Muraenichthys breviceps*)	Knifejaw (*Oplegnathus woodwardi*)
Green moray (*Gymnothorax prasinus*)	Western kelpfish (*Chironemus georgianus*)
Umbrella conger (*Gnathophis umbrellabia*)	Silver spot (*Threpterius maculosus*)
Blue sprat (*Spratelloides robustus*)	Western Australian seacarp (*Aplodactylus westralis*)
Beaked salmon (*Gonorynchus greyi*)	Western crested morwong (*Cheilodactylus gibbosus*)
Cobbler (*Cnidoglanis macrocephalus*)	Redlip morwong (*Cheilodactylus rubrolabiatus*)
Pink-headed frogfish (*Batrachomoeus rubricephalus*)	Dusky morwong (*Dactylophora nigricans*)
Sponge anglerfish (*Echinophryne reynoldsi*)	Jackass fish (*Nemadactylus macropterus*)
Smooth anglerfish (*Phyllophryne scortea*)	Queen snapper (*Nemadactylus valenciennesi*)
Dwarf shore-eel (*Alabes hoesei*)	Yelloweye mullet (*Aldrichetta forsteri*)
Smoothsnout clingfish (*Aspasmogaster liorhyncha*)	Flattail mullet (*Liza argentea*)
Western clingfish (*Aspasmogaster occidentalis*)	Sea mullet (*Mugil cephalus*)
Tasmanian clingfish (*Aspasmogaster tasmaniensis*)	Snook (*Sphyraena novaehollandiae*)
Western cleaner clingfish (*Cochleoceps bicolor*)	Blackhead puller (*Chromis klunzingeri*)
Spadenose clingfish (*Cochleoceps spatula*)	Golden scalyfin (*Parma bicolor*)
Green clingfish (*Cochleoceps viridis*)	McCullochs scalyfin (*Parma mccullochi*)
Longsnout clingfish (*Parvicrepis spp.*)	Blue groper (*Achoerodus gouldii*)
Smallfin clingfish (*Parvicrepis parvipinnis*)	Blackspotted wrasse (*Austrolabrus maculatus*)
Finetooth beardie (*Eeyorius hutchinsi*)	Foxfish (*Bodianus frenchii*)
Largetooth beardie (*Lotella rhacina*)	Western King wrasse (*Coris auricularis*)
Bastard red cod (*Pseudophycis breviuscula*)	Little rainbow wrasse (*Dotalabrus alleni*)
Slender blindfish (*Dermatopsis multiradiatus*)	Castlenau's wrasse (*Dotalabrus aurantiacus*)
Southern pygmy blindfish (*Ogilbia spp.*)	Snakeskin wrasse (*Eupetrichthys angustipes*)
Silver fish (*Lepthatherina presbyteroides*)	Brownfields wrasse (*Halichoeres brownfieldi*)
Surf sardine (*Iso rhothophilus*)	Orangespotted wrasse (*Notolabrus parilus*)
Red snapper (*Centroberyx gerrardi*)	Maori wrasse (*Ophthalmolepis lineolata*)
Swallowtail (*Centroberyx lineatus*)	Senator wrasse (*Pictilabrus laticlavius*)
Little pineapplefish (*Sorosichthys ananassa*)	False senator wrasse (*Pictilabrus viridis*)
Roughy (*Trachichthys australis*)	Redband wrasse (*Pseudolabrus biserialis*)
Knight fish (*Cleidopus gloriamaris*)	Blue rock whiting (*Haletta semifasciata*)
Macleays crested pipefish (*Histiogamphelus cristatus*)	Little rock whiting (*Neoodax balteatus*)
Brushtail pipefish (*Leptoichthys fistularius*)	Rainbow cale (*Odax acroptilus*)
Smooth pipefish (*Lissocampus caudalis*)	Herring cale (*Odax cyanomelas*)
Javelin pipefish (*Lissocampus runa*)	Tubemouth (*Siphonognathus argyrophanes*)
Sawtooth pipefish (*Maroubra perserrata*)	Pencil weed whiting (*Siphonognathus beddomei*)
Leafy seadragon (*Phycodurus eques*)	Sharpnose weed whiting (*Siphonognathus caninus*)
Weedy seadragon (*Phyllopteryx taeniolatus*)	Longray rock whiting (*Siphonognathus radiatus*)
Spotted pipefish (*Stigmatophora argus*)	Longtail weed whiting (*Siphonognathus tanyourus*)
Port Phillip pipefish (*Vanacampus margaritifer*)	Wavy grubfish (*Parapercis haackei*)
Goblinfish (*Glyptauchen panduratus*)	Tommyfish (*Limnichthys fasciatus*)
Little scorpionfish (*Maxillicosta scabriceps*)	Flathead sandfish (*Lesueurina platycephala*)
Gurnard perch (*Neosebastes pandus*)	Common stargazer (*Kathetostoma laeve*)
Western red scorpion cod (*Scorpaena sumptuosa*)	Jumping blenny (*Lepidoblennius marmoratus*)
Minor gunard (*Lepidotrigla spinosa*)	Notched threefin (*Norfolkia incisa*)
Spiny gunard (*Lepidotrigla papilio*)	Southern crested weedfish (*Cristiceps australis*)
Latchet (*Pterygotrigla polyommata*)	Kuiters weedfish (*Heteroclinus spp.*)

Common Name (*Scientific Name*)	Common Name (*Scientific Name*)
Whitenose pigfish (*Perryena leucometopon*)	Whitleys weedfish (*Heteroclinus spp.*)
Warty prowfish (*Aetapcus maculatus*)	Fewray weedfish (*Heteroclinus spp.*)
Longhead flathead (*Leviprora inops*)	Hutchins weedfish (*Heteroclinus spp.*)
Yank flathead (*Platycephalus speculator*)	Recherche weedfish (*Heteroclinus spp.*)
Tassel-snouted flathead (*Thysanophrys cirronasus*)	Adelaide weedfish (*Heteroclinus adelaide*)
Western wirrah (*Acanthistius serratus*)	Kelp weedfish (*Heteroclinus eckloniae*)
Barber perch (*Caesioperca rasor*)	Large-eye weedfish (*Heteroclinus macrophthalmus*)
Breaksea cod (*Epinephelides armatus*)	Earspot snakeblenny (*Ophiclinops hutchinsi*)
Harlequin fish (*Othos dentex*)	Variegated snakeblenny (*Ophiclinops varius*)
Red seaperch (*Hypoplectrodes cardinalis*)	Adelaide snakeblenny (*Ophiclinus antarcticus*)
Black-banded seaperch (*Hypoplectrodes nigroruber*)	Blackback snakeblenny (*Ophiclinus gracilis*)
Bluedevil (*Paraplesiops meleagris*)	Variable snakeblenny (*Ophiclinus ningulus*)
Western bluedevil (*Paraplesiops sinclairi*)	Whiteblotch snakeblenny (*Ophiclinus pectoralis*)
Blue-lined hulafish (*Trachinops brauni*)	Painted stinkfish (*Eocallionymus papilio*)
Yellow-headed prettyfin (*Trachinops noarlungae*)	Flathead goby (*Callogobius depressus*)
West Australian jewfish (*Glaucosoma hebraicum*)	Twospot goby (*Eviota bimaculata*)
Sea trumpeter (*Pelsartia humeralis*)	Longfin goby (*Favonigobius lateralis*)
Woods siphon fish (*Siphamia cephalotes*)	Bluespot goby (*Pseudogobius olorum*)
Scarlet cardinalfish (*Vincentia badia*)	Barracouta (*Leionura atun*)
Smooth cardinalfish (*Vincentia macrocauda*)	Dusky marine gudgeon (*Thalasseleotris adela*)
Orange cardinalfish (*Vincentia punctata*)	Frigate mackeral (*Auxis thazard*)
Longfin pike (*Dinolestes lewini*)	Skipjack tuna (*Katsuwonus pelamis*)
King George whiting (*Sillaginodes punctata*)	Blue mackerel (*Scomber australasicus*)
Silver whiting (*Sillago bassensis*)	Elongate flounder (*Ammotretis elongatus*)
Tailor (*Pomatomus saltatrix*)	Southern sole (*Aseraggodes haackeanus*)
Skipjack trevally (*Pseudocaranx dentex*)	Harrowed sole (*Zebrias cancellatus*)
Sand trevally (*Pseudocaranx wrighti*)	Spinytail leatherjacket (*Acanthaluteres brownii*)
Samson fish (*Seriola hippos*)	Bridled leatherjacket (*Acanthaluteres spilomelanurus*)
Pomfret (*Brama brama*)	Toothbrush leatherjacket (*Acanthaluteres vittiger*)
Australian herring (*Arripis georgiana*)	Southern pygmy leatherjacket (*Brachaluteres jacksonianus*)
Western Australian salmon (*Arripis truttacea*)	Black reef leatherjacket (*Eubalichthys bucephalus*)
Silverbelly (*Parequula melbournensis*)	Bluetail leatherjacket (*Eubalichthys cyanoura*)
Red snapper (*Chrysophrys auratus*)	Mosaic leatherjacket (*Eubalichthys mosaicus*)
Mulloway (*Argyrosomus hololepidotus*)	Yellowstriped leatherjacket (*Meuschenia flavolineata*)
Red mullet (*Upeneichthys vlamingii*)	Sixspine leatherjacket (*Meuschenia freycineti*)
Woodwards pomfret (*Schuettea woodwardi*)	Bluelined leatherjacket (*Meuschenia galii*)
Slender bullseye (*Parapriacanthus elongatus*)	Horseshoe leatherjacket (*Meuschenia hippocrepis*)
Orangelined bullseye (*Pempheris spp.*)	Stars-and-stripes leatherjacket (*Meuschenia venusta*)
Rough bullseye (*Pempheris klunzingeri*)	Chinaman leatherjacket (*Nelusetta ayraudi*)
Common bullseye (*Pempheris multiradiata*)	Rough leatherjacket (*Scobinichthys granulatus*)
Buffalo bream (*Kyphosus sydneyanus*)	White-barred boxfish (*Anoplocapros lenticularis*)
Rock blackfish (*Girella tephraeops*)	Shaws cowfish (*Aracana aurita*)
Zebrafish (*Girella zebra*)	Ornate cowfish (*Aracana ornata*)
Footballer sweep (*Neatypus obliquus*)	Rigid boxfish (*Caprichthys gymnura*)
Sea sweep (*Scorpis aequipinnis*)	Spiny boxfish (*Capropygia unistriata*)
Banded sweep (*Scorpis georgiana*)	Prickly pufferfish (*Contusus brevicaudus*)
Moonlighter (*Tilodon sexfasciatum*)	Ringed pufferfish (*Omegophora armilla*)
Western butterflyfish (*Chaetodon assarius*)	Small-spined porcupinefish (*Allomycterus pilatus*)
Squareback butterflyfish (*Chelmonops curiosus*)	Globefish (*Diodon nicthemerus*)
Old wife (*Enoplosus armatus*)	Short sunfish (*Mola ramsayi*)
Short boarfish (*Parazanclistius hutchinsi*)	Oblong sunfish (*Triurus laevis*)

APPENDIX XV: SHALLOW-WATER ECHINODERM SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*from* Marsh, 1991).

Crinoidea (Feather Stars)	**Asteroidea (Starfish)**	**Ophiuroidea (Brittle Stars)**	**Echinoidea (Sea Urchins)**
COMASTERIDAE	LUIDIIDAE	OPHIOMYXIDAE	CIDARIDAE
Cenolia trichoptera	*Luidia australiae*	*Ophiomyxa australis*	*Phyllacanthus irregularis*
Cenolia tasmaniae	ASTROPECTINIDAE	GORGONOCEPHALIDAE	*Goniocidaris tubaria*
Oxycomanthus muelleri	*Astropecten preissi*	*Conocladus australis*	DIADEMATIDAE
Comatulella brachiolata	*Bollonaster pectinatus*	*Astroboa ernae*	*Centrostephanus tenuispinus*
APOROMETRIDAE	GONIASTERIDAE	EURYALIDAE	TEMNOPLEURIDAE
Aporometra occidentalis	*Tosia australis*	*Euryale aspera*	*Temnopleurus michaelseni*
PTILOMETRIDAE	*Pentagonaster duebeni*	OPHIACANTHIDAE	*Amblypneustes pallidus*
Ptilometra macronema	OREASTERIDAE	*Ophiacantha alternata*	*Holopneustes porosissimus*
ANTEDONIDAE	*Anthaster valvulatus*	*Ophiactis tricolor*	ECHINOMETRIDAE
Antedon incommoda	*Nectria multispina*	*Ophiactis resiliens*	*Heliocidaris erythrogramma*
	Nectria saoria	AMPHIURIDAE	FIBULARIIDAE
	Nectria wilsoni	*Amphipholis squamata*	*Fibularia oblonga*
	Nectria macrobrachia	*Amphiura constricta*	LAGANIDAE
	ASTEROPSEIDAE	*Amphiura multiremula*	*Peronella lesueuri*
	Petricia vernicina	OPHIOTRICHIDAE	SCHIZASTERIDAE
Holothurioidea (Sea Cucumbers)	OPHIDIASTERIDAE	*Ophiothrix caespitosa*	*Echinocardium cordatum*
CUCUMARIIDAE	*Austrofromia polypora*	*Ophiothrix spongicola*	
Pentacta anceps	ASTERINIDAE	*Macrophiothrix michaelseni*	
Ocnus calcareus	*Patiriella calcar*	OPHIOCOMIDAE	
Neoamphicyclus lividus	*Patririella gunnii*	*Clarkcoma canaliculata*	
Lipotrapeza vestiens	*Patririella brevispina*	*Clarkcoma pulchra*	
HOLOTHURIIDAE	*Paranepanthia grandis*	OPHIONEREIDAE	
Holothuria hartmeyeri	*Nepanthia troughtoni*	*Ophionereis schayeri*	
STICHOPODIDAE	ECHINASTERIDAE	*Ophionereis semoni*	
Stichopus ludwigi	*Echinaster arcystatus*	OPHIODERMATIDAE	
Stichopus mollis	*Echinaster glomeratus*	*Ophiarachnella ramsayi*	
APODIDA	*Echinaster varicolor*	*Ophiopeza cylindrica*	
Leptosynapta dolabrifera	*Plectaster decanus*	*Ophiopsammus assimilis*	
	ASTERIIDAE	*Ophioconis opacum*	
	Allostichaster polyplax		
	Coscinasterias calamaria		
	Coscinasterias muricata		
	Uniophora dyscrita		

APPENDIX XVI: SHALLOW-WATER BARNACLE SPECIES THAT ARE LIKELY TO OCCUR WITHIN THE STUDY AREA (*after* Edgar, 1997; and Jones, 1991).

SCALPELLIDAE
- *Smilium peronii*

IBLIDAE
- *Ibla quadrivalvis*

LEPADIDAE
- *Lepas anserifera*
- *Lepas pectinata*
- *Lepas australis*

POECILASMATIDAE
- *Trilasmis kaempferi*

TETRACLITIDAE
- *Epopella simplex*
- *Tetraclitella purpurascens*

ARCHAEOBALANIDAE
- *Eliminus modestus*
- *Eliminus covertus*

BALANIDAE
- *Balanus variegatus*
- *Austromegabalanus nigrescens*

APPENDIX XVII: MARINE DECAPOD CRUSTACEAN SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*after* Edgar, 1997; and Morgan & Jones 1991).

PENAEIDAE (Prawns, shrimps)
Metapenaeopsis lindae

ALPHEIDAE (Pistol shrimps)
Alpheus edwardsii
Alpheus euphrosyne richardsoni
Alpheus novaezealandiae
Alpheus parasocialis
Alpheus strenuus cremnus
Alpheus villosus
Athanas granti
Synalpheus neomeris
Synalpheus streptodactylus
Synalpheus tumidomanus

PANDALIDAE (Pandalid shrimps)
Chlorotocella leptorhynchus

RHYNCHOCINETIDAE (Hinge-back shrimps)
Rhynchocinetes australis

HIPPOLYTIDAE (Hippolytid shrimps)
Hippolyte australiensis

PALAEMONIDAE (Palaemonid shrimps)
Macrobrachium intermedium
Palaemontes australis

NEPHROPIDAE
Metanephrops andamanicus
Metanephrops boschmai

AXIIDAE
Axius waroona

PALINURIDAE
(Rock lobster)
Jasus edwardsii (Southern rock lobster)

SCYLLARIDAE (Shovel-nosed lobsters)
Ibacus alticrenatus (Wollongong bug)
Ibacus peronii (Balmain bug)

DIOGENIDAE (Diogenid hermit crabs)
Dardanus arrosor
Paguristes frontalis
Paguristes sulcatus
Paguristes tuberculatus
Cancellus typus
Trizopagurus strigimanus

UPOGEBIIDAE
Upogebia bowerbankii
Upogebia tractabilis

CALLIANASSIDAE (Ghost shrimps)
Callianassa aequimana
Callianassa ceramica

PAGURIDAE (Pagurid hermit crabs)
Pagurixus handrecki
Pagurus sinuatus

LOMISIDAE (Hairy stone crabs)
Lomis hirta

PORCELLANIDAE (Porcelain crabs)
Petrocheles australiensis
Pisidia dispar
Polyonyx transversus
Porcellana gravelei

GALATHEIDAE (Squat lobsters)
Galathea australiensis
Galathea magnifica
Phylladiorhynchus pusillus

HIPPIDAE
Hippa australis

DROMIIDAE (Sponge crabs)
Cryptodromia octodentata
Dromidia australis
Dromidiopsis excavata
Petalomera lamellata
Petalomera lateralis

LEUCOSIIDAE (Pebble crabs)
Ebalia tuberculosa
Ebalia intermedia
Ebalia dentifrons
Philyra laevis
Merocryptus lambriformis
Myra mammillaris

HYMENOSOMATIDAE
Amarinus laevis
Elamena abrolhensis
Halicarcinus ovatus
Halicarcinus rostratus
Trigonoplax longirostris

PINNOTHERIDAE (Pea crabs)
Pinnotheres hickmani

OCYPODIDAE (Stalk-eyed crabs)
Macrophtalmus punctulatus

GRAPSIDAE (Shore crabs)
Cyclograpsus audouinii
Leptograpsodes octodentatus
Leptograpsus variegatus (Swift-footed crab)
Plagusia chabrus (Red bait crab)

CORYSTIDAE
Gomeza bicornis

PORTUNIDAE (Swimming crabs)
Nectocarcinus integrifrons (Red swimmer crab)
Nectocarcinus tuberculosus (Red swimmer crab)
Ovalipes australiensis (Surf crab)
Portunus pelagicus (Blue manna crab)
Portunus sanguinolentus
Macropipus corrugatus
Megametope carinatus
Pseudocarcinus gigas (Giant crab)

XANTHIDAE (Stone crabs)
Actaea peronii occidentalis

MENIPPIDAE
Hypothalassia armata
Ozius truncatus

PILUMNIDAE (Hairy shore crabs)
Actumnus setifer
Pilumnus acer
Pilumnus etheridgei
Pilumnus tomentosus
Pilumnopeus serratifrons

GONEPLACIDAE (Goneplacid crabs)
Georgeoplax glabra
Litocheira bispinosa

MAJIDAE (Spider crabs)
Antilibinia lappacea
Achaeopsis ramusculus
Cyrtomaia maccullochi
Ephippias endeavouri
Huenia australis
Huenia halei
Leptomithrax gaimardii
Leptomithrax sternocostulatus
Naxia aurita
Naxia spinosa
Paramithrax barbicornis
Paratymolus latipes
Pippacirama tuberculosa
Platymaia wyvillethomsoni
Rochinia mosaica
Schizophrys rufescens
Platymaia wyvillethomsoni
Schizophrys rufescens
Rochinia mosaica

APPENDIX XVIII: POLYPLACOPHORA (CHITON) SPECIES THAT ARE THOUGHT LIKELY TO OCCUR WITHIN THE STUDY AREA ACCORDING TO DISTRIBUTIONS (*after* Wilson, 1993; and WA Museum, *pers. comm.*).

ISCHNOCHITONIDAE
Ischnochiton torri
Ischnochiton contractus
Ischnochiton lineolatus
Ischnochiton verconis
Stenochiton longicymba
Ischnochiton cariosus

LORICIDAE
Lorica paucipustulosa

ACANTHOCHITONIDAE
Acanthochitona bednalli
Acanthochitona sueurii

CHITONIDAE (Chitons)
Clavariona hirtosa
Chiton torrianus
Onithochiton occidentalis

CRYPTOPLACIDAE
Cyptoplax striata

APPENDIX XIX: PROSOBRANCH SPECIES THAT ARE THOUGHT LIKELY TO OCCUR WITHIN THE STUDY AREA ACCORDING TO DISTRIBUTIONS (*after* Wilson, 1993; and WA Museum, *pers. comm.*).

PATELLIDAE
(Patellid Limpets)
Patella chapmani
Patella laticostata
Patella peronii

ACMAEIDAE
(Acmaeid Limpets)
Asteracmea axiaerata
Asteracmea crebristriata
Asteracmea roseoradiata
Asteracmea stowae
Asteracmea illibrata
Collisella onychitis
Collisella septiformis
Naccula compressa
Naccula punctata
Notoacmea conoidea
Notoacmea flammea
Patelloida alticostata
Patelloida insignis
Patelloida mufria
Patelloida nigrosulcata
Patelloida profunda

NERITIDAE (Nerites)
Nerita altramentosa

PHENACOLEPADIDAE
(Sugar Limpets)
Phenacolepas calva

SCISSURELLIDAE
(Little Slit Shells)
Incisura vincentiana
Sinezona atkinsoni
Sinezona beddomei

HALIOTIDAE
(Abalone)
Haliotis conicopora
Haliotis cyclobates
Haliotis elegans
Haliotis laevigata
Haliotis roei
Haliotis scalaris
Haliotis semiplicata

FISSURELLIDAE
(Keyhole & Slit Limpets)
Diodora lincolnensis
Amblychilepas javanicensis
Amblychilepas nigrita
Amblychilepas oblonga
Cosmetalepas concatenatus
Macroschisma bakiei
Macroschisma producta
Emarginula candida
Emarginula dilecta
Emarginula patula
Emarginula subtilitexta
Emarginula devota
Hemitoma subemarginata
Montfortula rugosa
Scutus antipodes
Tugali cicatricosa

TURBINIDAE
(Turban Shells)
Argalista corallina
Austroliotia australis
Austroliotia densilineata
Austroliotia pulcherrima
Munditia mayana
Munditia subquadrata
Phasianella australis
Phasianella solida
Phasianella variegata
Phasianella ventricosa
Tricolia gabiniana
Tricolia rosea
Tricolia tomlini
Turbo jourdani
Turbo torquatus
Turbo undulatus
Turbo gruneri
Turbo pulcher
Australium aureum
Australium squamiferum
Australium tentorium

CAMPANILIDAE
(Lighthouse Shells)
Campanile symbolicum

BATILLARIIDAE
(Southern Mud Creepers)
Batillariella estuarina
Velacumantus australis
Zeacumantus diemenesis

CERITHIIDAE
(Creepers)
Bittium granarium
Bittium icarus

DIALIDAE
(Dialids)
Diala monile

DIASTOMATIDAE
(Diastomas)
Diastoma melanioides

LITIOPIDAE
(Litiopids)
Alba translucida

PLESIOTROCHIDAE
Plesiotrochus crinitus
Plesiotrochus monachus

TROCHIDAE
(Top Shells)
Calliostoma comptum
Calliostoma hedleyi
Calliostoma legrandi
Calliostoma zietzi
Calliostoma armillatum
Calliostoma rubiginosum
Calliostoma spinulosum
Calliostoma incertum
Astele ciliare
Astele subcarinatum
Astele multigranum
Euchelus ampullus
Euchelus profundior
Granata imbricata
Herpetopoma annectans
Herpetopoma aspersa
Herpetopoma fenestrata
Herpetopoma pumilio
Herpetopoma scabriusculus
Botelloides bassianus
Spectamen marsus
Austrocochlea concamerata
Austrocochlea constricta
Austrocochlea crinita
Austrocochlea rudis
Cantharidella beachportensis
Cantharidus pulcherrimus
Fossarina legrandi
Nanuka flindersi
Notogibbula lehmanni
Notogibbula pulcherrimus
Jujubinus lepidus
Phasianotrochus apicinus
Phasianotrochus bellulus
Phasianotrochus eximius
Phasianotrochus irisodontes
Thalotia conica
Thalotia chlorostoma
Clanculus consobrinus
Clanculus denticulatus
Clanculus dunkeri
Clanculus euchelioides
Clanculus flagellatus
Clanculus leucomphalus
Clanculus limbatus
Clanculus maxillatus
Clanculus ochroleucus
Clanculus personatus
Clanculus philippi
Clanculus plebejus
Clanculus ringens
Clanculus undatus
Clanculus weedingi
Leiopyrga octona

Ethminolia vitiliginea

TURRITELLIDAE
(Screw Shells)
Archimediella occidua
Colospira accisa
Colospira smithiana
Colospira bundilla
Colospira mediolevis
Colospira wollumbi
Gazameda iredalei
Gazameda tasmanica

LITTORINIDAE
(Periwinkles)
Bembicium auratum
Bembicium vittatum
Laevilittorina johnstoni

HIPPONICIDAE
(Horse hoof Limpets)
Antisabia foliacea
Hipponix australis

CALYPTRAEIDAE
(Slipper Shells)
Cheilea occidua
Zeacrypta immersa

CAPULIDAE
(Cap Limpets & Trichotropes)
Capulus violaceus

XENOPHORIDAE
(Carrier Shells)
Xenophora flindersi

CYPRAEIDAE
(Cowries)
Cypraea reevei
Cypraea fallax
Cypraea comptoni
Cypraea piperita
Cypraea pulicaria
Cypraea armeniaca
Cypraea friendii vercoi
Cypraea marginata
Cypraea rosselli

NATICIDAE
(Sand & Moon Snails)
Natica sertata
Natica sagittata
Natica subcostata
Natica zonalis
Natica zonulata
Friginatica beddomei
Polinices conicus
Sinum zonale
Eunaticina albosutura
Eunaticina umbilicata

BURSIDAE
(Frog Shells)
Bursa humilis

CASSIDAE
(Helmet Shells)
Cassis fimbriata
Semicassis labiata
Semicassis paucirugis
Semicassis pyrum
Semicassis royanum
Semicassis adcocki
Semicassis semigranosum
Semicassis sinuosum

FICIDAE
(Fig Shells)
Ficus eospila
Thalassocyon bonus

RANELLIDAE
(Tritons & Trumpets)
Ranella australasia
Cabestana tabulata
Charonia lampas
Cymatium parthenopeum
Sassia subdistorta

TONNIDAE
(Tun Shells)
Tonna variegata

CERITHIOPSIDAE
(Cerithiopsids)
Ataxocerithium beasleyi
Ataxocerithium serotinum
Zaclys styliferus
Specula regina
Seila crocea
Euseila pileata

TRIPHORIDAE
(Triphoras)
Isotriphora nivea
Eutriphora cana
Teretriphora spica
Latitriphora latilirata
Nototriphora vestita
Hedleytriphora elata
Hedleytriphora fasciata
Aclophoropsis festiva
Obesula mamillata
Monophorus angasi
Inella intercalaris

EPITONIIDAE
(Wentletraps)
Epitonium helicornum
Epitonium jukesianum
Epitonium tacitum
Opalia granosa
Opalia australis

JANTHINIDAE
(Violet Sea Snails)
Janthina exigua
Janthina janthina
Janthina pallida

MURICIDAE
(Murex Shells & Relatives)
Maculotriton bicolor
Fusus bednalli
Pterynotus angasi
Coralliophila mira
Coralliophila wilsoni
Bedeva hanleyi
Bedeva paivae
Dermomurex angustus
Pterynotus triformis
Pterynotus undosus
Murexiella brazieri
Muricopsis diamanthina
Muricopsis planilirata
Lepsiella flindersi
Lepsiella reticulata
Lepsiella vinosa
Thais orbita
Prototyphis angasi
Tripterotyphis robustus
Typhis philippensis

TURBINELLIDAE
(Vase & Pagoda Shells & Relatives)
Vasum flindersi

COLUMBELLIDAE
(Dove Shells)
Anachis beachportensis
Anachis cominelliformis
Mitrella acuminata
Mitrella austrina
Mitrella semiconvexa
Pseudamycla dermestoidea
Pyrene bidentata

BUCCINIDAE
(Buccinid Whelks)
Buccinulum bednalli
Cominella eburnea
Cominella lineolata
Cominella torri
Cominella tasmanica
Cominella lineolata
Kapala kengrahami
Fusinus australis
Fusinus tessellatus
Fusinus undulatus
Latirus pulleinei
Pleuroploca australasia
Cyllene sulcata
Nassarius ephamillus
Nassarius pauperatus
Nassarius burchardi
Nassarius pyrrhus
Fusus bednalli
Fusus reticulatus

VOLUTIDAE
(Volutes)
Amoria exoptanda
Amoria grayi
Lyria mitraeformis
Cymbiola irvinae
Ericusa fulgetra

Ericusa papillosa
Livonia nodiplicata
Livonia roadnightae
Notopeplum translucidum

OLIVIDAE
(Olives, Olivellas & Ancillids)
Alcospira edithae
Alcospira marginata
Alcospira oblonga
Amalda coccinata
Exiquaspira ornata
Gracilispira albanyensis
Gracilispira lineata
Gracilispira monolifera
Belloliva triticea
Oliva australis

HARPIDAE
(Harp Shells)
Austroharpa loisae

MARGINELLIDAE
Alaginella borda
Dentimargo allporti
Dentimargo jaffa
Dentimargo kemblensis
Dentimargo lodderae
Dentimargo mayii
Gibberula diplostreptus
Gibberula subbulbosa
Mesoginella turbinata
Ovaginella tenisoni
Persicula albomaculata
Persicula deburghi
Volvarina occidua

MITRIDAE
(Mitres)
Mitra carbonaria
Mitra glabra
Cancilla citharoidea
Cancilla strangei

VOLUTOMITRIDAE
(Volutomitrids)
Peculator bacatus
Peculator porphyria

COSTELLARIIDAE
(Costellate Mitres)
Austromitra analogica
Vexillum acromiale
Vexillum apicitinctum
Vexillum lincolnense
Vexillum corallinum
Vexillum marrowi

CANCELLARIIDAE
(Nutmegs)
Cancellaria spirata
Cancellaria undulata
Inglisella fischeri

TURRIDAE
(Turrids)
Crassispira harpularia
Daphnella botanica

CONIDAE
(Cone Shells)
Conus anemone
Conus clarus
Conus gabelishi
Conus klemae
Conus rutilus

TERREBRIDAE
(Pencil Shells)
Terebra albida

OVULIDAE
(Egg & Spindle Cowries)
Phenacovolva philippinarum

TRIVIINAE
(Bean Cowries)
Trivia merces

APPENDIX XX: OPISTHOBRANCH (SEA SLUG) SPECIES THAT ARE THOUGHT LIKELY TO OCCUR WITHIN THE STUDY AREA ACCORDING TO DISTRIBUTIONS (*after* Wells & Bryce, 1993).

Cephalaspidea (Bubble Shells)

BULLIDAE
Bulla quoyii

AGLAJIDAE (Tailed Slugs)
Philinopsis troubridgensis

Anaspidea

AKERIDAE
Akera soluta

APLYSIIDAE (Sea hares)
Aplysia gigantea

Notaspidea (Side-gilled sea slugs)

TYLODINIDAE
Tylodina corticalis

UMBRACULIDAE
Umbraculum sinicum

PLUEROBRANCHIDAE
Pluerobranchus peroni
Berthellina citrina

Sarcoglossa (Sarcoglossans)

JULIIDAE (Bivalved gastropods)
Ascobulla fischeri
Volvatella ventricosa

OXYNOIDAE
Oxynoe viridis

ELYSIIDAE (Elysiids)
Elysia australis
Elysiella pusilla
Elysia filicauda
Pattyclaya brycei

Nudibranchia (Nudibranchs)

POLYCERIDAE (Polycerids)
Polycera hedgpethi
Thecacera pacifica

DORIDIDAE
Aphelodoris cf. *lawsae*
Sclerodoris spp.
Discodoris cf. *crawfordi*
Neodoris chrysoderma
Hoplodoris nodulosa
Doris cf. *cameroni*
Halgerda graphica
Rostanga calumus

CHROMODORIDIDAE
Hypselodoris infucata
Chromodoris epicuria
Chromodoris westraliensis
Chromodoris alternata
Mexichromis macropus
Ceratosoma amoena
Ceratosoma brevicaudatum
Cadlina nigrobranchiata
Glossodoris undaurum
Orodoris miamirana
Verconia verconis

DENDRODORIDIDAE
Dendrodoris aurea
Dendrodoris albopurpurea
Dendrodoris carneola
Dendrodoris nigra
Dendrodoris albobrunnea
Dendrodoris denisoni

AEOLIDIIDAE
Spurilla australis
Spurilla major

GLAUCIDAE
Austraeolis ornata
Phyllodesmium spp.

MADRELLIDAE
Madrella sanguinea

TRITONIIDAE (Tritoniids)
Marionia spp.

HANCOCKIIDAE
Hancockia burni

SCYLLAEIDAE
Scyllaea pelagica

TETHYIDAE
Melibe australis

APPENDIX XXI: BIVALVE SPECIES THAT ARE THOUGHT LIKELY TO OCCUR WITHIN THE STUDY AREA ACCORDING TO DISTRIBUTIONS (*after* WA Museum, *pers. comm.*; and Macpherson, 1954).

ARCIDAE (Arks)
Arca squamosa

NUCULANIDAE
(Beaked Nut shells)
Nuculana crassa

GLYCYMERIDAE
(Dog Cockles)
Glycymeris striatularis
Glycymeris radians

MALLEIDAE
(Hammer Oysters)
Vulsella spongiarium
Malleus meridianus

PECTINIDAE (Scallops & Fan Shells)
Chlamys aktinos
Pecten fumatus
Chlamys asperrimus

SPONDYLIDAE
(Thorny Oysters)
Spondylus tenellus

LIMIDAE (File Shells)
Lima lima
Limatula strangei
Austrolima nimbifera

MYTILIDAE (Mussels)
Brachidontes ustulatus
Brachidontes erosus
Brachidontes rostratus
Xenostrobus pulex
Xenostrobus inconstans
Mytilus edulis
Modiolus cottoni
Modiolus albicostus
Amygdalum beddomei
Musculus cummingianus

PTERIIDAE (Pearl Oysters)
Electroma georgiana

ANOMIIDAE (Jingle Shells, Windowpane Shells)
Anomia trigonopsis

OSTREIDAE (Oysters)
Saccostrea cucullata
Ostrea angasi

PINNIDAE (Pen Shells)
Pinna bicolor

CARDITIDAE
(Cardita Clams)
Cardita crassicosta
Venericardia rosulenta
Venericardia sowerbyi

CRASSATELLIDAE
(Crassatellas)
Eucrassatella donacina

CHAMIDAE
Chama ruderalis

LUCINIDAE
Anodontia perplexa
Divalucina cumingi
Codokia lacteola

ERYCINIDAE
Scintilla spp.
Lasaea australis
Ephippodonta lunata
Mylitta deshayesii

CARDIIDAE (Cockles)
Acrosterigma reeveanum
Fulvia tenuicostata
Cardium cygnorum
Cardium flavum
Cardium racketti

MESODESMATIDAE
(Wedge Shells)
Paphies elongata
Paphies cuneata
Anapella cycladea

SOLENIDAE (Razor Shells)
Solen vaginoides

VENERIDAE (Venus shells)
Tawera lagopus
Eumarcia fumigata
Venerupis exotica
Venerupis galactites
Katelysia rhytiphora
Katelysia scalarina
Katelysia peronii
Bassina disjecta

CLEIDOTHAERIDAE
Cleidothaerus albidus

TELLINIDAE (Tellins)
Tellina deltoidalis
Tellina marginaritina
Tellina albinella
Pseudarcopagia piratica

DONACIDAE (Pipis)
Donax deltoides

PSAMMOBIIDAE (Sunset Shells)
Gari livida
Sanguinolaria biradiata

MACTRIDAE (Trough Shells)
Spisula trigonella
Mactra pura
Mactra rufescens

Lutraria rhynchaena
AMPHIDESMATIDAE
Amphidesma angustata

ALOIDIDAE
Aloidis iredalei

HIATELLIDAE
Hiatella australis

PHOLADIDAE (Angel wings)
Barnea australasiae

APPENDIX XXII: CEPHALOPOD SPECIES THAT ARE THOUGHT LIKELY TO OCCUR WITHIN THE STUDY AREA ACCORDING TO DISTRIBUTIONS (*after* Edgar, 1997; and WA Museum, *pers. comm.*).

LOLIGINIDAE (Squid)
Sepioteuthis australis

IDIOSEPIIDAE (Pygmy Squid)
Idiosepius notoides

SEPIOLIDAE (Dumpling Squids)
Sepioloidea lineolata
Euprymna tasmanica

SEPIIDAE (Cuttlefish)
Sepia apama

OCTOPODIDAE (Octopus)
Hapalochlaena maculosa
Octopus spp.

ARGONAUTIDAE (Argonauts)
Argonauta nodosa

APPENDIX XXIII: CNIDARIAN SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*after* Edgar, 1997; and Veron & Marsh (1988).

Hydroida (Hydroids)
Gymnangium superbum
Stereotheca elongata
Halocordyle disticha
Solanderia fusca
Turritopsis nutricula
Velella velella

Siphonophora (Siphonophores)
Physalia physalis (Bluebottle)

Actiniaria (Anemones)
Actinia tenebrosa
Oulactis macmurrichi
Aulactinia veratra
Phylyctenactis
Actinothoe glandulosa

Zoanthidea (Zoanthids)
Zoanthus praelongus
Epizoanthus sabulosus

Scleractinia (Stony corals)
Plesiastrea versipora
Coscinaraea marshae
Coscinaraea mcneilli
Culicia tenella
Scolymia australis
Turbinaria mesenterina
Turbinaria reniforms
Turbinaria frondens
Symphyllia wilsoni
Favites spp.

Ceriantharia (Tube anemones)
Pachycerianthus spp. (Purple-tipped)

Antipatharia (Black corals)
Antipathes spp.

Alcyonacea (Soft corals)
Carijoa spp.
Mopsella zimmeri
Mopsella klunzingeri

Semaeostomeae (Jellyfish)
Cyanea capillata (Lion's mane jellfish)
Pelagia noctiluca
Aurelia aurita

Cubomedusae (Box jellyfish)
Carybdea rastoni

APPENDIX XXIV: OTHER INVERTEBRATE SPECIES THAT ARE LIKELY, ACCORDING TO DISTRIBUTION INFORMATION, TO OCCUR WITHIN THE STUDY AREA (*after* Edgar, 1997).

PORIFERA
Leucosolenia spp.
Tethya ingallis
Chondrilla australiensis
Echinoclathria laminaefavosa

CTENOPHORA
Beroe cucumis

CHORDATA
Ascidiacea (Ascidians)

ASCIDIIDAE
Ascidia sydneiensis
Phallusia obesa

STYELIDAE
Cnemidocarpa radicosa
Polycarpa viridis
Botrylloides magnicoecum
Botrylloides leachi
Botrylloides perspicuum

PYURIDAE
Herdmania momus
Pyura australis
Pyura gibbosa
Pyura spinifera
Pyura stolonifera

CLAVELINIDAE
Clavelina ostrearum
Clavelina cylindrica
Clavelina pseudobaudinensis
Clavelina molluccensis

PYCNOCLAVELLIDAE
Pycnoclavella aurantia
Pycnoclavella diminuta

HOLOZOIDAE
Sigillina australis
Sycozoa cerebriformis
Sycozoa pulchra
Sycozoa pedunculata

POLYCITORIDAE
Polycitor giganteus
Cystodytes dellachiajei

POLYCLINIDAE
Aplidium clivosum

DIDEMNIDAE
Didemnum mosleyi
Didemnum spongioides

Thaliacea (Salps)
Pyrosoma atlanticum
Pegea confoederata

BRACHIOPODA
Magellania flavescens

PHORONIDA
Phoronis australis

BRYOZOA
Lichenopora echinata
Membranipora membranacea
Bugula dentata
Adeona grisea
Triphyllozoon moniliferum

APPENDIX XXV: PHAEOPHYTA (BROWN), CHLOROPHYTA (GREEN) AND RHODOPHYTA (RED) MACROALGAL SPECIES THAT HAVE BEEN FOUND TO OCCUR IN THE ADJACENT FITZGERALD BIOSPHERE RESERVE, AND THEREFORE ARE EXPECTED TO OCCUR WITHIN THE STUDY AREA (*after* Colman, 1997; Edgar, 1997).

PHAEOPHYTA

CHORDARIACEAE
Cladiosiphon filum

DICTYOTACEAE
Dictyota dichotoma
Dictyota spp.
Dilophus spp.
Dilophus intermedius
Dilophus marginatus
Dictyopteris muelleri
Dictyopteris spp.
Padina fraseri
Padina iridescent
Padina spp.
Zonaria angustata
Zonaria diesingana
Zonaria spiralis
Zonaria turneriana
Lobophora variegata
Lobospira bicuspidata
Homeostrichus spp.
Distromium spp.

SPOROCHNACEAE
Carpomitra costata
Sporochnus comosus
Perithalia cordata
Encyothalia cliftoni
Bellotia eriophorum

SCYTOSIPHONACEAE
Scytosiphon lomentaria
Colpomenia perigrina
Colpomenia sinuosa
Petalonia spp.

PUNCTARIACEAE
Asperococcus bullosus

LESSONIACEAE
Lessonia corrugata
Macrocystis angustifolia
Macrocystis pyrifera

ALARIACEAE
Ecklonia radiata
Undaria pinnatifida

NOTHEIACEAE
Notheia anomala

DURVILLAEACEAE
Durvillaea potatorum

HORMOSIRACEAE
Hormosira banksii

FUCACEAE
Xiphophora chondrophylla
Xiphophora gladiata

SEIROCOCCACEAE
Phyllospora comosa
Seirococcus axillaris
Scytothalia dorycarpa

CYSTOSEIRACEAE
Caulocystis cephalomithos
Caulocystis uvifera
Platythalia quercifolia
Scaberia agardhii
Carpoglossum confluens
Cystophora botryocystis
Cystophora cephalornithos
Cystophora brownii
Cystophora congesta
Cystophora expansa
Cystophora gracilis
Cystophora grevillei
Cystophora harveyi
Cystophora monilifera
Cystophora moniliformis
Cystophora pectinata
Cystophora platylobium
Cystophora polycistidea
Cystophora racemosa
Cystophora retorta
Cystophora retroflexa
Cystophora siliquosa
Cystophora spp.
Cystophora subfarcinata
Cystophora torulosa
Cystophora uvifera
Cystophora xiphocarpa
Acrocarpia paniculata
Acrocarpia robusta

SARGASSACEAE
Sargaasum lacerifolium
Sargassum decipiens
Sargassum fallax
Sargassum heteromorphum
Sargassum lacerifolium
Sargassum sonderi
Sargassum spp.
Sargassum varians
Sargassum verruculosum
Sargassum vestitum

SPHACELARIACEAE
Cladostephus spongiosus

DESMARESTIACEAE
Desmarestia ligulata

ECTOCARPACEAE
Ectocarpus spp.

STYPOCAULACEAE
Halopteris spp.

LEATHESIACEAE
Leathesia difformis

CHLOROPHYTA

CAULEPACEAE
Caulerpa annulata
Caulerpa brownii
Caulerpa cactoides
Caulerpa brownii
Caulerpa distichophylla
Caulerpa ellistoniae
Caulerpa flexilis
Caulerpa flexilis var. muelleri
Caulerpa geminata
Caulerpa hedleyi
Caulerpa longifolia
Caulerpa longifolia forma crispata
Caulerpa obscura
Caulerpa papillosa
Caulerpa racemosa
Caulerpa remotifolia
Caulerpa scalpelliformis
Caulerpa simplisciuscula
Caulerpa trifaria
Caulerpa vesiculifera

ULVACEAE
Ulva australis
Enteromorpha spp.

CLADOPHORACEAE
Chaetomorpha linum
Chaetomorpha spp.
Cladophora spp.
Cladophora feredayi
Apjohnia laetevirens

ANADYOMENECEAE
Struvea plumosa

VALONIACEAE
Dictyosphaeria serica

CODIACEAE
Codium pomoides
Codium spongiosum
Codium duthieae
Codium harveyi

Codium spinescens
Codium australicum
Codium fragile
Codium dimorphum
Codium spp.

UDOTEACEAE
Halimeda cuneata

BRYOPSIDACEAE
Bryopsis spp.

RHODOPHYTA
BANGIACEAE
Porphyra lucasii
Bangia spp.

GELIDIACEAE
Pterocladia capillacea
Gelidium glandulaefolium
Gelidium spp.

PEYSSONNELIACEAE
Sonderopelta coriacea
Peyssonnelia novaehollandiae

HALYMENIACEAE
Grateloupia filicina
Gelinaria ulvoidea
Thamnoclonium dichotomum

KALLYMENIACEAE
Kallymenia cribrosa
Kallymenia tasmanica
Callophyllis lambertii
Callophyllis rangiferina
Thamnophyllis lacerata

PHYLLOPHORACEAE
Stenogramme interrupta

GIGARTINACEAE
Rhodoglossum gigartinoides
Gigartina crassicaulis
Gigartina spp.
Gigartina recurva

ARESCHOUGIACEAE
Callophycus oppositifolius
Erythroclonium sonderi

PLOCAMIACEAE
Plocamium angustum
Plocamium cartilagineum
Plocamium costatum
Plocamium dilatatum
Plocamium leptophyllum
Plocamium mertensii
Plocamium patagiatum
Plocamium pressianum

PHACELOCARPACEAE
Phacelocarpus alatus
Phacelocarpus peperocarpus

HYPNEACEAE
Hypnea ramentacea

BONNEMAISONIACEAE
Asparagopsis armata
Delisea pulchra
Ptilonia australasica

GRACILARIACEAE
Gracilaria secundata
Melanthalia obtusata

CORALLINACEAE
Amphiroa anceps
Haliptilon roseum
Metagoniolithon stelliferum
Metamastophora spp.
Jania spp.

RHODYMENIACEAE
Botryocladia obovata
Gloiosaccion brownii
Rhodymenia australis

CHAMPIACEAE
Champia viridis

CERAMIACEAE
Ceramium excellens
Griffithsia monilis
Carpothamnion gunnianum
Carpothamnion spp.
Ballia callitricha
Ballia scoparia
Euptilota articulata
Euptilota spp.

DELLESSERIACEAE
Hemineura frondosa
Claudea elegans
Martensia australis
Sarcomenia delesseriodes
Halicnide similans
Halicnide spp.
Acrosorium uncinatum
Myriogramme gunniana
Nitophyllum spp.

DASYACEAE
Dasya extensa

RHODOMELACEAE
Cliftonaea pectinata
Dictymenia harveyana
Jeannerettia lobata
Lenormandia marginata
Lenormandia muelleri
Laurencia elata
Laurencia majuscula
Laurencia clavata
Osmundaria prolifera
Chondria viridis
Echinothamnion hystrix
Echinothamnion spp.
Polysiphonia spp.
Rhodopeltis spp.

SOLIERIACEAE
Areschougia spp.
Sarconema spp.

CYSTOCLONIACEAE
Craspedocarpus ramentosus
Peltasta spp.
Rhodophyllis membranacea

NEMASTOMATACEAE
Nemastoma feredayae

SCHIZYMENIACEAE
Schizymenia spp.

APPENDIX XXVI: CANDIDATE SPECIES SUITABLE FOR AQUACULTURE IN THE RECHERCHE ARCHIPELAGO (*after* Fisheries WA, 2000).

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

* 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.

APPENDIX XXVII: NUTRIENT STATUS AND OBSERVED SYMPTOMS OF NUTRIENT POLLUTION OR OTHER ENVIRONMENTAL PROBLEMS IN THE ESTUARIES OF THE ESPERANCE ENVIRONS REGION (*after* Bancroft *et al.*, 1997).

Estuary	Nutrient status	Symptoms of nutrient/environmental problems	Sources
Torradup Inlet	moderate	River salinity, nutrients and siltation	(Hodgkin & Clark, 1990)
Stokes Inlet	moderate	River salinity, nutrients and siltation	(Hodgkin & Clark, 1989)
Barker Inlet			(Hodgkin & Clark, 1989)
Bandy Creek			(Hodgkin & Clark, 1989)
Dailey River	low		(Hodgkin & Clark, 1989)
Mungliginup Inlet	low		(Hodgkin & Clark, 1989)
Alexander River Inlet	low		(Hodgkin & Clark, 1989)
Blackboy Creek Inlet	low		(Hodgkin & Clark, 1989)
Thomas River Inlet	low		(Hodgkin & Clark, 1989)
Jorndee Creek Inlet	low	Pristine	(Hodgkin & Clark, 1989)
Poison & Fern Creeks	low	Pristine	(Hodgkin & Clark, 1989)

Appendix XXVIII: LIST OF VASCULAR PLANTS THAT OCCUR ON THE ISLANDS WITHIN THE RECHERCHE ARCHIPELAGO (*after* Weston, 1988).

PTERIDOPHYTA
(Ferns & Fern Allies)

ISOETACEAE
Isoetes australis

DENNSTAEDTIACEAE
Pteridium esculentum

ADIANTACEAE
Cheilanthes austrotenuifolia

GYMNOSPERMAE
(Conifers)

CUPRESSACEAE
Callitris preissii

ANGIOSPERMAE
(Flowering Plants)

JUNCAGINACEAE
Triglochin minutissima
Triglochin procera
Triglochin striata
Triglochin trichophora
Triglochin aff. *procera*

POACEAE
Agropyron scabrum
Agrostis avenacea
Aira caryophyllea
Aira praecox
Avena barbata
Avena fatua
Briza minor
Bromus arenarius
Bromus diandrus
Bromus hordeaceus
Catapodium rigidum
Cynodon dactylon
Danthonia caespitosa
Danthonia setacea
Dichelachne crinita
Erharta longiflora
Hordeum murinum
Koeleria phleoides
Lagurus ovatus
Lolium loliaceum
Neurachne alopecuroidea
Parapholis incurva
Poa annua
Poa poiformis
Poa porphyroclados
Poa spp.
Polypogon monspeliensis
Spartochloa scirpioidea
Spinifex hirsutus
Sporobolus virginicus
Stipa flavescens
Vulpia bromoides
Vulpia membranacea
Vulpia myuros

CYPERACEAE
Baumea juncea
Gahnia trifida
Isolepis cernua
Isolepis cyperoides
Isolepis marginata
Isolepis nodosa
Lepidosperma angustatum
Lepidosperma gladiatum
Lepidosperma leptostachyum
Lepidosperma tuberculatum
Lepidosperma viscidum
Schoenoplectus supinus
Schoenus sculptus
Schoenus subflavus
Schoenus submicrostachyus

RESTIONACEAE
Loxycarya flexuosa

CENTROLEPIDACEAE
Centrolepis drummondii
Centrolepis glabra
Centrolepis murrayi
Centrolepis polygyna
Centrolepis strigosa

JUNCACEAE
Juncus bufonius
Juncus caespiticius
Juncus kraussii

LILIACEAE
Agrostocrimum scabrum
Borya nitida
Bulbine semibarbata
Dianella revoluta
Lomandra rigida
Stypandra glauca
Stypandra imbrica
Thysanotus patersonii
Thysanotus dichotomus
Wurmbea dioica
Xanthorrhoea preissii

IRIDACEAE
Patersonia inaequalis

ORCHIDACEAE
Acianthus reniformis
Caladenia latifolia
Caladenia menziesii
Diuris longifolia
Diuris setacea
Eriochilus dilatatus
Microtis alba
Microtis unifolia
Prasophyllum spp.
Pterostylis nana
Pterostylis vittata
Thelymitra aristata
Thelymitra fuscolutea
Thelymitra nuda

CASUARINACEAE
Allocasuarina heugeliana
Allocasuarina trichodon

URTICACEAE
Parietaria debilis

PROTEACEAE
Banksia speciosa
Dryandra nivea
Dryandra longifolia
Hakea clavata
Hakea suaveolens
Hakea trifurcata
Isopogon formosus
Isopogon trilobus
Petrophile teretifolia

SANTALACEAE
Exocarpus sparteus
Leptomeria empetriformis

LORANTHACEAE
Amyema melaleucae

POLYGONACEAE
Muehlenbeckia adpressa
Rumex crispus

CHENOPODIACEAE
Atriplex cinerea
Atriplex paludosa
Chenopodium murale
Chenopodium pumilio
Enchylaena tomentosa
Halosarcia halocnemoides
Rhagodia baccata
Rhagodia candolleana
Rhagodia crassifolia
Rhagodia preissii
Rhagodia radiata
Sarcocornia blackiana
Sarcocornia quinqueflora
Sueda australis
Threlkeldia diffusa

GYROSTEMONACEAE
Gyrostemon sheathii

AIZOACEAE
Carpobrotus aequilaterus
Carpobrotus virescens
Disphyma crassifolium
Disphyma clavellatum

Tetragonia implexicoma

PORTULACEAE
Calandrinia calyptrata
Calandrinia brevipedata
Calandrinia granulifera
Calandrinia spp.
CARYOPHYLLACEAE
Cerastium glomeratum
Polycarpon tetraphyllum
Sagina apetala
Silene gallica
Spergularia rubra
Stellaria media
Stellaria multiflora

RANUNCULACEAE
Clematis microphylla
Clematis pubescens

LAURACEAE
Cassytha pomiformis
Cassytha racemosa

BRASSICACEAE
Cakile maritima
Hymenolobus procumbens
Lepidium foliosum

DROSERACEAE
Drosera glanduligera
Drosera macrantha
Drosera peltata
Drosera spp.

CRASSULACEAE
Crassula colorata
Crassula exserta
Crassula natans
Crassula pedicellosa
Crassula peduncularis
Crassula sieberiana
Crassula spp.

PITTOSPORACEAE
Sollya heterophylla

LEGUMINOSAE
Acacia acuminata
Acacia anceps
Acacia cochlearis
Acacia crassiuscula
Acacia cyclops
Acacia heteroclita
Acacia ligulata
Acacia myrtifolia
Acacia nigricans
Acacia nitidula
Acacia rostellifera
Acacia subcaerulea
Periserianthes lophantha

LEGUMINOSAE subfamily CAESALPINOIDEAE
Labichea lanceolata

LEGUMINOSAE subfamily PAPILIONOIDEAE
Bossiaea dentata
Chorizema aciculare
Chorizema ilicifolium
Dillwynia pungens
Eutaxia obovata
Gastrolobium bilobum
Gompholobium knightianum
Kennedia nigricans
Medicago polymorpha
Melilotus indica
Pultenaea obcordata
Templetonia retusa
Trifolium campestre
Trifolium glomeratum
Trifolium tomentosum

GERANIACEAE
Erodium cicutarium
Geranium solanderi
Pelargonium australe
Pelargonium littorale

OXALIDACEAE
Oxalis corniculata

ZYGOPHYLLACEAE
Nitraria billardieri
Zygophyllum aff. *ammophilim*
Zygophyllum billardieri
Zygophyllum cf. *glaucum*
Zygophyllum spp.

RUTACEAE
Boronia alata
Boronia albiflora
Boronia scabra
Boronia tetrandra
Nematolepis phebalioides
Phebalium rude
Rhadinothamnus euphemiae

POLYGALACEAE
Comesperma confertum
Comesperma volubile

EUPHORBIACEAE
Adriana quadripartita
Beyeria viscosa
Euphorbia paralias
Phyllanthus calycinus
Phyllanthus scaber
Poranthera microphylla

STACKHOUSIACEAE
Stackhousia monogyna

SAPINDACEAE
Dodonaea oblongifolia

RHAMNACEAE
Pomaderris myrtilloides
Pomaderris oraria
Spyridium globulosum
Spyridium spadiceum
Trymalium floribundum

MALVACEAE
Alyogyne hakeifolia
Alyogyne huegelil
Lavatera plebeia
Malva parviflora
Sida hookeriana

STERCULIACEAE
Lasiopetalum discolor
Lasiopetalum quinquenervium
Rulingia corylifolia
Rulingia cygnorum
Rulingia grandiflora

DILLENIACEAE
Hibbertia cuneiformis
Hibbertia racemosa
Hibbertia acerosa

FRANKENIACEAE
Frankenia tetrapetala

THYMELEACEAE
Pimelea argentea
Pimelea clavata
Pimelea ferruginea

MYRTACEAE
Agonis marginata
Astartea fascicularis
Calothamnus quadrifidus
Calothamnus villosus
Calytrix tetragona
Eucalyptus angulosa
Eucalyptus conferruminata
Eucalyptus conglobata
Eucalyptus cornuta
Eucalyptus insularis
Eucalyptus heterophylla
Eucalyptus spp.
Eucalyptus spp.
Eucalyptus spp.
Kunzea baxteri
Leptospermum sericeum
Melaleuca brevifolia
Mealeuca elliptica
Melaleuca globifera
Melaleuca lanceolata
Melaleuca pentagona
Melaleuca radula
Thryptomene saxicola
Verticordia minutiflora

ONAGRACEAE
Epilobium billardierlanum

HALORAGACEAE
Gonocarpus scordioides
Haloragis acutangula
Haloragodendron racemosum

APIACEAE
Apium annuum
Apium prostratum

Daucus glochidlatus
Hydrocotyle alata
Hydrocotyle hispidula
Hydrocotyle medicaginoides
Platysace compressa
Trachymene pilosa

EPACRIDACEAE
Acrotriche cordata
Acrotriche aff. *ramiflora*
Andersonia sprengeliodes
Leucopogon apiculatus
Leucopogon interruptus
Leucopogon gnaphaliodes
Leucopogon parviflorus
Leucopogon revolutus
Leucopogon rotundifolius

PRIMULACEAE
Anagallis arvensis

Samolus repens
LOGANIACEAE
Logania vaginalis
Mitrasacme paradoxa

GENTIANACEAE
Centaurium erythraea
Centaurium spicatum
Sebaea ovata

MENYANTHACEAE
Villarsia parnassifolia

APOCYNACEAE
Alyxia buxifolia

CONVOLVULACEAE
Dichondra repens

BORAGINACEAE
Myosptis australis

LAMIACEAE
Westringia dampieri

SOLANACEAE
Anthocercis littorea
Anthocercis genistoides
Anthocercis viscosa
Lycium ferocissimum
Lycopersicon lycopersicum
Solanum nigrum
Solanum simile

SCROPHULARIACEAE
Dischisma arenarium
Glossostigma diandrum
Glossostigma drummondii
Limosella australis

MYOPORACEAE
Myoporum insulare
Myoporum parvifolium
Myoporum tetrandrum

PLANTAGINACEAE
Plantago drummondii

RUBIACEAE
Galium aparine
Galium migrans
Galium tenerum
Opercularia hispidula

CAMPANULACEAE
Wahlenbergia gracilenta

LOBELIACEAE
Isotoma scapigera
Lobelia alata
Lobelia heterophylla
Lobelia rhombifolia
GOODENIACEAE

Dampiera coronata
Dampiera fasciculata
Dampiera lavandulacea
Dampiera prostrata
Goodenia scapigera
Lechenaultia formosa
Scaevola aemula
Scaevola calendulacea
Scaevola crassifolia
Scaevola linearis

STYLIDIACEAE
Levenhookia pusilla
Stylidium adnatum
Stylidium brachyphyllum
Stylidium calcaratum
Stylidium corymbosum
Stylidium glandulosum
Stylidium inundatum
Stylidium pilosum
Stylidium perpusillum
Stylidium spp.

ASTERACEAE
Angianthus humifusus
Angianthus preissianus
Angianthus tenellus
Arctotheca calendula
Arctotheca populifolia
Athrixia nivea
Brachycome eyrensis
Calocephalus brownii
Carduus tenuiflorus
Cirsium vulgare
Conyza bonariensis
Cotula australis
Cotula bipinnata
Cotula coronopifolia
Cotula cotuloides
Dittrichia graveolens
Gnaphalium candidissimum
Gnaphalium indutum
Gnaphallum luteo-album
Gnaphalium sphaericum
Hypochoeris glabra
Ixiolaena viscosa
Olearia axillaris
Picris hieracioides
Podotheca angustifolia
Quinetia urvillei
Rutidosis multiflora
Senecio glossanthus
Senecio lautus
Senecio minimus
Sonchus asper
Sonchus megalocarpus
Sonchus oleraceus
Stuartina muelleri
Vittadinia australasic
Waitzia citrina

APPENDIX XXIX: LIST OF MAMMALS FROM CAVE DEPOSITS NEAR MARBELLUP HILL AND MOUNT ARID (*after* Department of Conservation and Environment WA, 1984).

Common Name	Scientific Name
Western Quoll	*Dasyurus geoffroii*
Dibbler	*Antechinus apicalis*
White-tailed dunnart	*Sminthopsis granulipes*
Common dunnart	*Sminthopsis murina*
Southern brown bandicoot	*Isodon obesulus*
Common ringtail possum	*Pseudocheirus peregrinus*
Western pygmy possum	*Cercartetus concinnus*
Broad-faced potoroo	*Potorous platyops*
Brush-tailed bettong	*Bettongia penicillata*
Black-footed rock wallaby	*Petrogale lateralis*
Tammar wallaby	*Macropus eugenii*
Western grey kangaroo	*Macropus fuliginosus*
Dingo	*Canis familiaris*
Ash-grey mouse	*Pseudomys albocinereus*
Western mouse	*Pseudomys occidentalis*
Heath mouse	*Pseudomys shortridgei*
Hopping mouse	*Notomys spp.*
Bush rat	*Rattus fuscipes*
European rabbit	*Oryctolagus cuniculus*

APPENDIX XXX: LIST OF BIRD SPECIES FOUND TO OCCUR WITHIN THE STUDY AREA (*after* Department of Conservation and Environment WA, 1984; and Weston, 1988).

Emu
Little penguin
Hoary headed grebe
Little grebe
Wandering albatross
Black-browed albatross
Yellow-nosed albatross
White-capped albatross
Black-faced albatross
Black cormorant
Little black cormorant
Black-faced cormorant
Pied cormorant
Little pied cormorant
Northern giant petrel
Great-winged petrel
Slender-billed prion
Darter
White-faced storm petrel
Wilsons storm petrel
White-faced heron
Cattle egret
Large egret
Reef heron
Nankeen night heron
Brown bittern
White ibis
Yellow-billed spoonbill
Black swan
Chestnut shillduck
Black duck
Mountain duck
Pink-eared duck
White-eyed duck
Wood duck
Blue-billed duck
Musk duck
Grey teal
Chestnut teal
Cape Barren goose
Blue-winged shoveller
Fleshy-footed shearwater
Short-tailed shearwater
Little shearwater
Fluttering shearwater
Osprey
Black-shouldered kite
Black kite
Square tailed kite
Whistling kite
Brown goshawk
Collared sparrowhawk
Wedge-tailed eagle
Little eagle
White-brested sea eagle
Pelican
Australian gannet
Spotted harrier
Swamp harrier
Brown falcon
Little falcon
Peregrine falcon
Nankeen kestrel
Stubbe quail
Brown quail
Painted quail
Chestnut rail
Marsh cake rail
Spotted rail
Spotless rail
Black-tailed native hen
Dusky morehen
Swamphen
Coote
Spotted crake
Australian bustard
Pied oystercatcher
Sooty oystercatcher
Banded lapwing
Grey plover
Eastern golden plover
Red kneed plover
Hooded plover
Mongolian plover
Large billed plover
Red capped plover
Black fronted plover
Australian plover
Black backed stilt
Banded stilt
Avocet
Turnstone
Ped-capped dotterel
Hooded dotterel
Red-kneed dotterel
Great skua
Silver gull
Pacific gull
Red-knecked stint
Whiskered tern
Gull billed tern
Caspian tern
Common tern
Fairy tern
Crested tern
Black tailed godwit
Bar tailed godwit sandpiper
Red knot godwit sandpiper
Great knot godwit sandpiper
Sharp tailed godwit
Red knecked stint
Sanderling godwit sandpiper
Broad billed godwit
Curlew sandpiper
Whimbrell sandpiper
Wood sandpiper
Grey tattler sandpiper
Common sandpiper
Greenshark sandpiper
Marsh sandpiper
Terek sandpiper
Grey-tailed tattler

Common bronzewing pigeon
Brush bronzewing pigeon
Crested pigeon
Tawny frogmouth
Sacred kingfisher
Bee eater
Spotted nightjar
White-tailed cockatoo
Black cockatoo
Purple-crowned lorikeet
Ground parrot
Rock parrot
Port Lincoln parrot
Elegant parrot
Red capped rosella
Fork-tailed swift
Tree martin
Fairy martin
Welcome swallow
Australian pipit
Black-faced cuckoo shrike
White winged triller
Reed warbler
Broad-tailed thornbill
Spotted scrub-wren
Field wren
Willie wagtail
Hooded robin
Golden whistler
Grey strike thrush
Crested bellbird
Jack winter
Restless flycatcher
Grey fantail
Cinnamon quail thrush
White browed babbler
Clamorous reed warbler
Little grassbird
Rufous songlark
Brown songlark
Blue brested wren
White browed scrubwren
Hylacola
Weebill
Western warbler

Broad tailed thornbill
Yellow rumped thornbill
Varied sittela
Red wattlebird
Little wattlebird
Spotted pardalote
Yellow rumped pardalote
Striated pardalote
White-fronted chat
Western silvereye
Brown honeyeater
Singing honeyeater
White eared honeyeater
Purple gaped honeyeater
Yellow plumed honeyeater
Brown headed honeyeater
White-naped honeyeater
Brown honeyeater
New Holland honeyeater
White cheeked honeyeater
White-fronted honeyeater
Tawny crowned honeyeater
Western spinebill
Crimson chat honeyeater
Mistletoe bird
Silver eye
Magpie lark
Masked woodswallow
Dusky woodswallow
Grey butcher bird
Grey currawong
Fan-tailed cuckoo
Pallid cuckoo
Rufoud tailed cuckoo
Shining bronze cuckoo
Barn owl
Barking owl
Yellow-throated miner
Red-eared firetail
Little wattlebird
Western magpie
Australian raven
Little crow
Southern emu-wren

APPENDIX XXXI: LIST OF REPTILES AND AMPHIBIAN SPECIES FOUND TO OCCUR WITHIN THE STUDY AREA (*after* Department of Conservation and Environment WA, 1984; and Weston, A.S. (1988).

Gekkonidae (Geckoes)
Marbled gecko (*Phyllodactylus marmoratus*)
Thick-tailed gecko (*Underwoodisaurus millii*)
Diplodactylus spinigerus

Pygopodiae (Legless Lizards)
Scale-footed lizard (*Pygopus lepidodus*)
Delma spp.
Aprasia striolata glauerti

Agamidae (Dragon Lizards)
Ornate dragon (*Ctenophorus ornatus*)
Amphibolurus minor
Amphibolurus adelaidensis
Netted dragon *(Amphibolurus reticulatus*)

Scincidae (Skink Lizards)
Four-toed skink (*Hemiergis peronii*)
Lerista microtis
Lerista distinguenda
Elegant skink (*Lerista frosti*)
Leiolopisma trilineatum
Five-toed skink (*Morethia obscura*)
Ergenia nitida
Ergenia multiscutata bos
King's skink (*Ergenia kingii)*
Salmon-bellied skink (*Ergenia napoleonis*)
Ctenotus gemmula
Ctenotus catenifer
Grey's skink (*Ctenotus labillardierii*)
Bob-tail lizard (*Tiliqua rugosa*)
Tiliqua occipitalis
Menetia greyii

Varanidae (Goannas)
Varanus gouldii
Southern bungarra (*Varanus rosenbergi*)

Typhlopidae (Blind Snakes)
Typhlina australis

Boidae (Pythons)
Python spilotus

Elapidae
Denisonia coronata
Brachyaspis curta
Notechis scutatus
Crowned snake (*Notechis coronatus*)
Death adder (*Acanthophis antarcticus*)
Dugite (*Demansia affinis*)

Hylinae (Tree Frogs)
Litoria cyclorhyncha
Litoria adelaidensis

Leptodactylidae (Ground Frogs)
Limnodynastes dorsalis
Heleioporus eyrei
Crinia georgiana
Crinia pseudinsignifera

APPENDIX XXXII: LIST OF TERRESTRIAL INVERTEBRATE SPECIES FOUND TO OCCUR WITHIN THE STUDY AREA (*after* Department of Conservation and Environment WA, 1984).

Phyla/Order	Family	Genus/Species
Arthropoda		
Crustacea		
Isopoda		
Phreatoicoidea	Phreatoicopsidae	
Amphipoda	Gammaridae	
Ceinidae		
Myriapoda		
Chilopoda	Scutigeridae	
	Lithobiidae	
	Scolopendridae	
	Geophilidae	
Diplopoda	Chilognatha	
Arachnida		
Scorpionida (Scorpions)		*Urodacus novaehollandiae*
Chelonethida (Pseudoscorpions)	Garypidae	*Synsphyrouus* spp.
Araneae (Spiders)		
Acarina (Mites, Ticks, Watermites)		
Collembola		
Sminthuridae		*Katianna* spp.
		Sminthurinus spp.
Entomobryidae		*Willowsia* spp.
Isotomidae		*Isotoma tridentifera*
Neanuridae		*Pseudachorutella*
Insecta		
Apterygota		
Archaeognatha	Meinertellidae	
Thysanura	Ateluridae	
	Lepismatidae	
Pterygota		
Odonata	Gomphidae	
	Aeshnidae	
	Coenagrionidae	
Blattodea	Blattidae	
	Polyzosteria spp.	
Isoptera		
Mantodea	Mantidae	
Dermaptera	Forficulidae	
Orthoptera	Acrididae	
	Mymecophilidae	
	Gryllidae	
Hemiptera S.O. Homoptera		
	Fulgoridae	
	Eurymelidae	
Hemiptera S.O. Heteroptera		
	Reduviidae	
	Pentatomidae	
	Scutelleridae	

Phyla/Order	Family	Genus/Species
Thysanoptera		
Neuroptera		
Coleoptera	Carabidae	
	Gyrinidae	
	Dytiscidae	
	Hydrophilidae	
	Scydmaenidae	
	Staphylinidae	
	Pselaphidae	
	Geotrupidae	
	Scarabaeidae	
	Rhipiceridae	
	Elateridae	
	Elateridae	
	Dermestidae	
	Nitidulidae	
	Coccinellidae	
	Tenebrionidae	
	Chyrsomelidae	
	Curculionidae	
	Cerambycidae	
Diptera	Tachinidae	
	Tabanidae	
	Asilidae	
	Tipulidae	
Trichoptera		
Lepidoptera		
Hymenoptera		
Mollusca		
		Bothryembryon spp.
		Westralaoma spp.
		Tatea spp.
		Testacella spp.